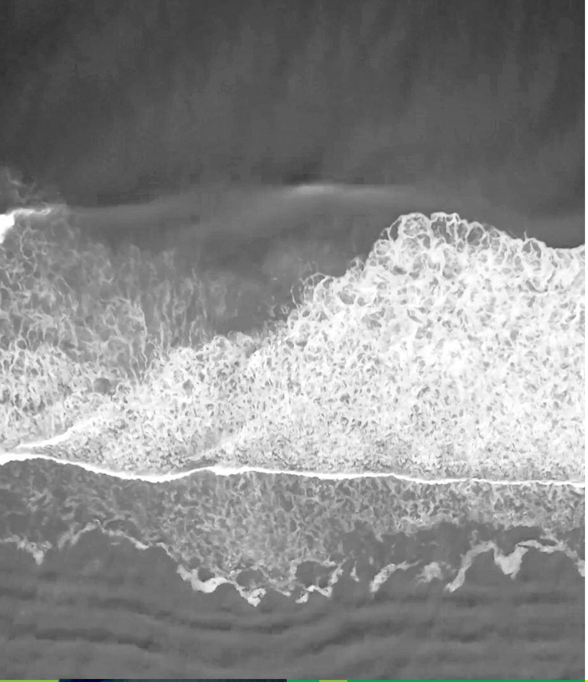

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Greater Tortue / Ahmeyim Phase 1 Gas Production Project

Environmental and Social Impact Assessment

Consolidated Final Report Including Regulatory Reviews from Mauritania and Senegal

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The report on the environmental and social impact assessment for the Greater Tortue/Ahmeyim Phase 1 Gas Production Project is divided into 7 volumes as follows:

The present document is **Volume 2** which contains:

- Chapter 7 - Identification and Analysis of Impacts

CHAPTER 7: IDENTIFICATION AND ANALYSIS OF IMPACTS

7.0 IDENTIFICATION AND ANALYSIS OF IMPACTS

The assessment of project impacts presented in this chapter includes the following subsections:

- A description of the impact assessment methodology (Section 7.1);
- An identification and analysis of impacts associated with routine activities of the proposed project presented by phases:
  - Construction Phase[78] (Section 7.2);
  - Operations Phase (Section 7.3);
  - Decommissioning Phase (Section 7.4);
- An identification and analysis of impacts associated with accidental events (Section 7.5);
- A summary of all identified impacts (Section 7.6);
- An assessment of cumulative impacts (Section 7.7); and
- An assessment of transboundary impacts (Section 7.8).

7.1 Impact Assessment Methodology

The impact assessment methodology considers potential interactions between the proposed project activities and the host environment and then classifies the significance of each potential impact. Routine (or "normal") activities of the project as well as accidental events are both considered in the impact assessment.

For routine activities, the impact assessment is based on the project activities described in Chapter 2 of this report as well as on the description of the host environment (existing conditions) presented in Chapter 4. For routine activities of the project, the existing conditions and trends of the core study area have been considered.

For the accidental event analysis, the existing conditions of the extended study area have been considered, with potential accident event scenarios including a well blowout, a failure of the FPSO due to a ship collision, and a pipelaying vessel collision (more details on these accident event scenarios are provided in Section 7.1.2 below).

7.1.1 Impact-Producing Factors for Routine Activities

As previously described, the proposed project comprises three phases:

- **Construction**: This phase will include the drilling and/or completion of twelve wells; the installation of infrastructure within the Offshore Area (wellheads, jumpers, manifolds and flowlines); laying of one subsea pipeline, umbilicals, flying leads, MEG pipeline, and pipe conductors; seafloor preparation for, and construction of, the breakwater at the Nearshore Hub/Terminal Area location; and installation of one FLNG at the Nearshore Hub/Terminal Area location and installation of the FPSO within the Pipeline Area. These construction activities will include the use of both specialized vessels and support vessels, as detailed in Chapter 2.

[78] To simplify the text of this chapter, the first phase, corresponding to the Preparation, Construction and Installation Phase described in Chapter 2, is hereby called the "Construction Phase".

- **Operations**: This phase corresponds to the production operations over 30 years. It will comprise well maintenance; pipeline pigging; maintenance operations for the vessels and facilities; operation of the FPSO and FLNG vessels; use of supply and support vessels as well as tugboats to support operations; and the export of LNG and condensate via LNGC and condensate carriers, respectively.

- **Decommissioning**: This phase will likely include various decommissioning activities including capping and sealing of wells; flushing and abandonment of flowlines and burial of flowline ends; pigging and flushing of pipelines; scrubbing of topsides to remove hydrocarbons; removal of the topsides and other materials; and removal of the FLNG and FPSO vessels. These decommissioning activities will include the use of both specialized vessels and support vessels, as detailed in Chapter 2.

All three project phases are covered in the impact assessment. For each phase, impact-producing factors (IPFs) associated with the routine activities of the project have been identified. This identification is the result of a detailed review of the three phases of the project, the activities carried out in each of them and their potential for interaction with the environment. This has allowed the establishment of a phase-specific IPF list. Each of the activities identified is considered an IPF. Table 7-1 lists the IPFs for routine activities and presents their definition.

Table 7-1. Definition of the Impact-Producing Factors (IPFs) for Routine Activities.

IPF	Phase			IPF Definitions
	Construction	Operations	Decommissioning	
Physical presence	●	●	●	Includes the physical presence (i.e., lights, physical structure) and sounds[79] produced by the drillship and drilling operations, FPSO, FLNG; physical presence of the pipeline, as well as at the Nearshore Hub/Terminal structure and the onshore Support Operations Areas. It also includes intake of seawater by the FLNG for the cooling system.
Exclusion safety zones	●	●	●	Includes: 1) a 500 m X 600 m exclusion zone around the Nearshore Hub/Terminal; 2) 500 m zones established around FPSO and drillship; 3) 500 m zones around the main construction vessels; and 4) a moving safety zone around each LNGC in transit.
Vessel movements	●	●	●	Includes movement of all project-related vessels (e.g., drillship, barges, support vessels, LNG and condensate carriers, etc.). Also includes sounds from propellers and thrusters during vessel movement, and machinery sounds on these vessels such as power generation units, compressors and pumps.
Emissions	●	●	●	Includes air emissions from vessels, helicopters, and facilities.
Discharges	●	●	●	Includes routine discharges (produced water, cooling water, sewage, etc.); discharges of muds and cuttings during drilling; and hydrotest effluent during startup.
Solid waste	●	●	●	Includes the management of solid waste (composed of both non-hazardous and hazardous waste) and accidental loss of garbage.
Chemicals and hazardous materials	●	●	●	Includes the management and use of chemicals and hazardous materials.
Helicopter traffic	●	●	●	Includes traffic and sounds from helicopter visits.
Onshore logistic activities	●	●	●	Includes activities conducted at the onshore Support Operations Areas, including the supply bases and airport facilities.
Presence of foreign workers	●	●	●	Part of the base management personnel and the contractor personnel will be foreigners, most of them male, working back-to-back on monthly assignments as is usually the case in oil and gas operations.

● : means that an IPF will be applicable to a project phase.

[79] The terms “sound” and “noise” are used throughout the baseline and impacts chapters, but are not interchangeable. For this ESIA the general approach outlined by Popper and Hawkins (2016) is followed. The term “sound” is used to characterize the inclusive acoustic characteristics of the environment (e.g., ambient sound levels; soundscape), the characteristics of equipment, vessels, and marine fauna (e.g., sound sources, sound levels, sound source levels; species- or group-specific vocalizations, communication), and how the acoustic emissions from various sources travel through the marine environment (e.g., sound propagation, attenuation). The term “noise” is used within the context of impact analysis of potential effects on marine life from project-specific sound sources that are anthropogenic (e.g., seismic airguns, vessels, drilling, sonar, etc.) that are assessed and mitigated. These definitions also apply to the social environment.

In addition to the project phases, the impact analysis is also conducted by project areas, when possible and relevant. As described in Chapter 2, the project areas are:

- The **Offshore Area**: located about 125 km from the coast and containing the hydrocarbon reservoirs to be developed;
- The **Pipeline Area**: a 3-km wide corridor for the pipeline connecting the offshore and the nearshore areas. In addition to the pipeline, this area will also include an FPSO;
- The **Nearshore Hub/Terminal Area**: an area that will be located about 10 to 11 km from the coast and that will include a breakwater, an FLNG and berthing spaces; and
- The **Support Operations Areas**: a supply base in the Port of Dakar, a supply base in the Port of Nouakchott, and facilities in the airports of Dakar and Nouakchott.

7.1.2 Impact-Producing Factors for Accidental Events

For the purpose of the impact assessment and the preparation of the oil spill contingency plan, a range of potential accidental event scenarios were identified and reviewed for the Construction and Operations Phases. Out of these, three scenarios were chosen for development into “planning scenarios” for potential spills of sizes up to and including worst credible discharge[80] on each of the IPFs (see Table 7-2). All three scenarios had a potential for high environmental impact or posed a challenge from an oil spill response perspective and were subsequently modelled. These were considered representative of other spills that could occur given the various locations of operation, type of oil and timing of the event. Planning for these should enable an overall response strategy to be developed that allows any spill to be planned for. These scenarios were analyzed by location, oil type, volume, and duration of release (BP, 2017).

It should be recognized that most spills are small, with the majority measuring less than 1 tonne (OSPAR 2010). These spills are generally operational in nature, occurring during loading, discharging and bunkering of a range of oils; they tend to be higher frequency events with less severe consequences; they generally occur on board drilling rigs or vessels, and are easily contained with little probability of reaching the marine environment. A range of design and operational controls are in place to prevent and mitigate these events. The potential impacts of these unplanned events have not been further discussed in this ESIA.

[80] For the purpose of this ESIA, Worst Case Discharge is defined as the ‘estimated amount of oil spilled (likely but not necessarily the worst credible case discharge volume and release rates considered) under credible and representative conditions (e.g., wind, currents, hydrological and geological conditions) that would be expected to result in the most severe of all identified outcomes (e.g., on environmental and socioeconomic sensitivities) that is considered plausible or reasonably believable.

Table 7-2. Definition of the Impact-Producing Factors for Accidental Events.

IPF	Location	IPF Definition
Well blowout	Wellhead (Offshore Area)	Represents the worst case deep-sea release volume and duration. Condensate would be released due to a wellhead failure at a rate of 3,783.3 m^3 per day for 60 days. Total condensate loss at the wellhead would be 227,000 m^3.
Failure of FPSO due to a ship collision	FPSO location (Pipeline Area)	Represents the worst-case surface release volume. Loss of condensate and marine diesel oil (MDO) as a result of a ship collision causing catastrophic failure of FPSO storage and fuel tanks; encompasses the loss of 160,000 m^3 of condensate and 3,200 m^3 of MDO at the surface of the ocean. The total duration of the release is 160 hours.
Pipelaying vessel collision	Nearshore Hub/ Terminal Area	Chosen in relation to the location of release (proximity to the shoreline). Fuel spill of 6,442 m^3 (2,960 m^3 of MDO; 3,370 m^3 of heavy fuel oil [HFO]; and 92 m^3 of lubricating oil), at the surface of the ocean resulting from the loss of the pipelay vessel due to collision. The total duration of the release is 3.4 hours.

Modeling activities were conducted by Oil Spill Response Ltd. (OSRL) for each IPF during Summer[81] (April to September) and during Winter[82] (October to March). The objectives of these modeling activities were to present the risk to the sea surface and shoreline by creating spatial maps of:

- Probability – to estimate how likely an area may be affected assuming an unintended release does happen;
- Arrival time – to estimate how quickly an area could be affected assuming an unintended release does happen; and
- Emulsion thickness – to estimate how severely an area could be affected assuming an unintended release does happen.

A summary of the modeling results is presented in Section 7.5.1 and the OSRL reports are included in Appendix N-1.

7.1.3 Potential Relations between Impact-Producing Factors and the Host Environment

7.1.3.1 Screening of Biophysical and Social Resources

The biophysical and social resources that characterize the host environment are all described in Chapter 4. However, the impact analysis is done only on the resources, or group of resources, that could potentially be impacted by the project. A screening of the biophysical and social resources to be carried in the impact analysis has been conducted during the preparation of the Terms of References of the ESIA (Appendix A). It has then been updated based on data gathered during the preparation of the baseline description, on data and concerns collected during public consultations activities and on the final project description.

Retained biophysical and social resources include Valued Environmental Components (VECs), which represent characteristics of special importance in the physical[83], biological and social environments. VECs have been selected based on the sensitivity of the resource and the value attributed to the resource by stakeholders. The value attributed by stakeholders derives from the results of the public

[81] There are no Summer and Winter in Mauritania and Senegal; their climate is characterized by two alternating seasons – a dry season (November to June) and a rainy season (July to October). For the modeling exercises, the years were arbitrarily split into two periods called Summer and Winter.

[82] See previous footnote.

[83] To simplify the text, the chemical environment is included with the physical environment.

consultation conducted for the current ESIA (see Chapter 6). Consultants' expert opinion based on decades of experience in impact assessment, mitigation, and monitoring is also considered. In addition, some non-VEC resources can be impacted by the project, and therefore have been considered in this assessment.

Table 7-3 below lists the resources retained for the impact analysis and presents their definition. It also identifies which resources are VECs.

Table 7-3. Identification and Definition of the Biophysical and Social Resources Retained for Impact Analysis.

Resource	VEC	Non VEC but retained	Definition
Air Quality and GHG		●	Comprises emissions of contaminants (gases, dust, etc.) in the ambient air as well as greenhouse gases (GHG). Current conditions are described in Section 4.4.7.
Water Quality		●	Refers to physico-chemical properties of the sea water. Current conditions are described in Section 4.4.6.4. Groundwater within the Senegal River delta basin were not retained in the impact analysis because three factors eliminate the potential for groundwater contamination: 1) limited activities near onshore aquifers, 2) distance, and 3) isolation of project-related fluids. First, any potential penetration of local aquifers could only occur during one activity associated with the GTA Phase 1 project - the drilling of 12 wells within the Offshore Area. No other construction, operation, or decommissioning phase activities will penetrate local aquifers. Second, all development wells are located approximately 125 km from shore in 2,700-2,800 m water depths, well removed from the onshore aquifers associated with the Senegal River delta. This distance alone will preclude any drilling-related effects to local onshore aquifers. Third, during the drilling process each wellbore will be lined with steel casing and cemented in place; the presence of the casing and surrounding cement effectively isolates well fluids from the surrounding rock layers. Consequently, seepage or flow of well fluids into local onshore aquifers cannot occur.
Coastal Erosion	●		Refers to the weathering and removal of coastal sediments (e.g., sandy beaches; rock shorelines) by natural wave and current action. Current conditions are described in Section 4.4.3 and Appendix I-1. VEC identified during the stakeholder engagement and public consultation process (see Chapter 6).
Sediment Quality		●	Refers to the grain size and chemical composition of the sediments on the ocean floor. Current conditions are described in Section 4.4.1.4.
Benthic Communities		●	Organisms that live on, in, or near the seabed. Includes soft bottom or hard bottom communities depending on the predominant substrate type foundational to the associated biological assemblages. Considers species richness as well as overall abundance. Current conditions are described in Section 4.5.3.

Resource	VEC	Non VEC but retained	Definition
Plankton & Fish and Other Fishery Resources	●		Plankton refers to those flora and fauna that are found in the water column, drifting with ocean currents. Plankton types include phytoplankton, zooplankton, and bacteria. This resource also includes fishes and fishery-related invertebrates. Considers species richness as well as overall abundance. Current conditions are described in Sections 4.5.1 and 4.5.4. VEC identified during the stakeholder engagement and public consultation process (see Chapter 6).
Marine Flora		●	Marine flora includes seagrasses and macroalgae. Considers species richness as well as overall abundance. Current conditions are described in Section 4.5.2.
Birds	●		Includes seabirds, shorebirds and coastal birds. Considers species richness as well as overall abundance. Current conditions are described in Section 4.5.5. Classified as a VEC because of the importance of birds in the protected areas in the project study area and because of the potential presence of threatened bird species.
Marine Mammals	●		These include constituents of three major taxonomic groups: Order Cetacea (whales, dolphins, and porpoises), Suborder Pinnipedia (sea lions and seals), and Order Sirenia (manatees and dugong). Current conditions are described in Section 4.5.6. Classified as a VEC because of the potential presence of threatened marine mammal species in the project study area.
Sea Turtles	●		Marine reptiles represented by either of two widely distributed families (Cheloniidae and Dermochelyidae) of the Order Testudines, represented by seven extant species. Sea turtles are large, air-breathing reptiles that inhabit tropical and subtropical seas throughout the world. Current conditions are described in Section 4.5.7. Classified as a VEC because of the potential presence of threatened sea turtle species in the project study area.
Threatened Species and Protected Areas	●		This group combines under one title: ▪ Threatened species based on the current IUCN Red List listings for Critically Endangered and Endangered species depending upon their population size, current and projected population trends, geographic range, and other symptoms of extinction risk. ▪ Protected areas comprise: protected areas of Mauritania and of Senegal, the UNESCO Senegal River Delta Transboundary Biosphere Reserve and other areas of conservation interest such as IBAs and ecologically or biologically significant areas. They will be addressed separately within their sections. Current conditions are described in Sections 4.5.8 and 4.5.9. Classified as a VEC because of the protection status given by national and/or international agencies/organizations.

Resource	VEC	Non VEC but retained	Definition
Biodiversity		•	Biodiversity, per the Convention on Biological Diversity (1992), is the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems. Current conditions are described in Section 4.5.11.
Land & Seabed Occupation and Use		•	Occupation and use of land in the footprint of on-shore project infrastructures as well as occupation and use of the seabed in the footprint of offshore project infrastructures. This includes the presence of submarine telecommunication cables and shipwrecks on the ocean floor. Potential interference between project infrastructures installed on the seabed and artisanal fishing nets are discussed under a separate resource (Artisanal Fisheries and Related Activities). Current conditions are described in Sections 4.6.5.2., 4.6.7.3, 4.6.10.3, 4.7.7.3, and 4.7.10.3.
Maritime Navigation	•		Includes the maritime traffic transiting in the shipping channels off the Mauritanian and Senegalese coasts as well as ship traffic towards/from the Ports of Dakar and Nouakchott. It also includes maritime navigation of artisanal fishing boats in the project areas. Current conditions are described in Sections 4.6.7.1, 4.7.7.1, 4.6.6.4, and 4.7.6.3. Maritime navigation safety has been identified as a VEC during the stakeholder engagement and public consultation process (see Chapter 6).
Industrial Fisheries		•	Commercial fishing activities practiced by the national (Mauritanian and Senegalese) and foreign fleets. Current conditions are described in Sections 4.6.6.2 and 4.7.6.2.
Artisanal Fisheries and Related Activities	•		Artisanal fishing activities practiced in Mauritania and Senegal. Also includes fishing-related economic activities for instance the processing of fish catches by women. Does not include the maritime navigation of artisanal fishing boats which is already covered under “Maritime Navigation”. Current conditions are described in Sections 4.6.6.3, 4.6.6.4, 4.6.6.5, 4.7.6.3, and 4.7.6.4. VEC identified during the stakeholder engagement and public consultation process (see Chapter 6).
Other Coastal & Sea-Based Activities		•	Coastal or sea based anthropogenic activities in Mauritania and Senegal other than maritime navigation, industrial fisheries and artisanal fisheries which are addressed under dedicated resources as indicated above. Current conditions are described in Sections 4.6.7 and 4.7.7.

Resource	VEC	Non VEC but retained	Definition
Employment & Business Opportunities	•		National and local economic activities, labor force and employment in Mauritania and Senegal. Does not include project induced international employment and business opportunities for workers or companies in other countries. Current conditions are described in Sections 4.6.5 and 4.7.5. VEC identified during the stakeholder engagement and public consultation process (see Chapter 6).
Population and Demography		•	National and local demography of Mauritania and Senegal. Current conditions are described in Sections 4.6.3 and 4.7.3.
Community Livelihoods	•		Means of subsistence of local coastal communities of Mauritania and Senegal. Current conditions are described in Sections 4.6.5, 4.6.6.4, 4.6.6.5, 4.7.5, 4.7.6.3, and 4.7.6.4. VEC identified during the stakeholder engagement and public consultation process (see Chapter 6).
Community Health, Safety and Security	•		National and local community health, safety and security in Mauritania and Senegal. Excludes maritime navigation safety of artisanal fishermen which is addressed under “Maritime Navigation”. Excludes accident hazards associated with the project operations that are addressed under the Risk Study in Chapter 8. Current conditions are described in Sections 4.6.9, 4.6.10.4, 4.7.9, and 4.7.10.4. VEC identified during the stakeholder engagement and public consultation process (see Chapter 6).
Public Infrastructure and Services		•	National and local public infrastructure and services in Mauritania and Senegal, for instance medical facilities, health services and security services. Current conditions are described in Sections 4.6.10 and 4.7.10.
Women and Vulnerable Groups		•	Women and vulnerable groups of local communities in Mauritania and Senegal. Current conditions are described in Sections 4.6.11 and 4.7.11.
Cultural and Archaeological Heritage		•	Non-material cultural heritage of local coastal communities in Mauritania and Senegal and marine archaeological artifacts. Current conditions are described in Sections 4.6.13 and 4.7.13.
Landscape and Seascape		•	Visual features in the areas where project infrastructures are planned. Current conditions are described in Sections 4.6.14 and 4.7.14.

Resource	VEC	Non VEC but retained	Definition
Social Climate	●		Civil peace, social tensions and social discontent in local coastal communities in Mauritania and Senegal. Current conditions are described in Sections 4.6.15 and 4.7.15. VEC identified during the stakeholder engagement and public consultation process (see Chapter 6).

It should be noted that Occupational Health, Safety and Security is not included in the impact analysis as it is thoroughly addressed in Chapter 8.

7.1.3.2 Matrices of Interrelations

The matrices of interrelations (Tables 7-4 to 7-7) identify potential interactions between the proposed project's IPFs (Sections 7.1.1 and 7.1.2) and the biophysical and social resources of the host environment (Section 7.1.3.1). Potential impacts to the physical, biological and social resources may result from multiple IPFs, as outlined below. Within the tables, a '●' identifies that an IPF listed within the left-hand column could impact the physical, biological and social resources along the top row. The potential interactions are for direct[84] impacts, but indirect[85] impacts are also considered when there are supporting data and that these indirect impacts are certain. The identification of potential interactions is based on the experience of the experts and on the following information:

- Technical characteristics of the project and planned work methods;
- Knowledge of the host environment; and
- Impacts of similar projects on the biophysical and social environments.

Potential impacts identified in these tables are discussed in detail in Sections 7.2 to 7.5.

[84] A direct impact occurs through a direct interaction of an IPF with a biophysical or social resource.
[85] An indirect impact is an impact which is not a direct result of the project and it is often later in time or farther removed in distance than a direct impact.

Table 7-4. Matrix of Potential Impacts for Biophysical and Social Resources – Construction Phase.

Project Activity/ Impact-Producing Factor (IPF)	Resources																									
	Physical				Biological								Social													
	Air Quality and GHG	Water Quality	Coastal Erosion	Sediment Quality	Benthic Communities	Plankton & Fish and Other Fishery Resources	Marine Flora	Birds	Marine Mammals	Sea Turtles	Threatened Species and Protected Areas	Biodiversity	Land & Seabed Occupation and Use	Maritime Navigation	Industrial Fisheries	Artisanal Fisheries and Related Activities	Other Coastal & Sea-Based Activities	Employment & Business Opportunities	Population and Demography	Community Livelihoods	Community Health, Safety and Security	Public Infrastructure and Services	Women and Vulnerable Groups	Cultural and Archaeological Heritage	Landscape and Seascape	Social Climate
ROUTINE ACTIVITIES																										
CONSTRUCTION PHASE																										
Physical presence			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			•	•			•	•	•
Exclusion safety zones														•	•	•	•			•	•	•				•
Vessel movements									•	•	•	•		•	•	•	•				•	•			•	
Emissions	•										•	•						•								
Discharges		•		•	•	•	•	•	•	•	•	•														
Solid waste		•		•	•	•	•	•	•	•	•	•														
Chemicals and hazardous materials		•																								
Helicopter traffic								•	•	•	•	•									•					
Onshore logistic activities																		•	•	•	•	•				•
Presence of foreign workers																					•	•	•			•

● : means a potential interaction between an IPF and a resource.

Table 7-5. Matrix of Potential Impacts for Biophysical and Social Resources – Operations Phase.

Project Activity/ Impact-Producing Factor (IPF)	Resources																									
	Physical				Biological								Social													
	Air Quality and GHG	Water Quality	Coastal Erosion	Sediment Quality	Benthic Communities	Plankton & Fish and Other Fishery Resources	Marine Flora	Birds	Marine Mammals	Sea Turtles	Threatened Species and Protected Areas	Biodiversity	Land & Seabed Occupation and Use	Maritime Navigation	Industrial Fisheries	Artisanal Fisheries and Related Activities	Other Coastal & Sea-Based Activities	Employment & Business Opportunities	Population and Demography	Community Livelihoods	Community Health, Safety and Security	Public Infrastructure and Services	Women and Vulnerable Groups	Cultural and Archaeological Heritage	Landscape and Seascape	Social Climate
ROUTINE ACTIVITIES																										
OPERATIONS PHASE																										
Physical presence			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●			●	●	●
Exclusion safety zones														●	●	●	●			●	●	●				●
Vessel movements								●	●	●	●	●		●	●	●	●	●			●	●			●	
Emissions	●										●	●														
Discharges		●		●	●	●	●	●	●	●	●	●														
Solid waste		●		●	●	●	●	●	●	●	●	●														
Chemicals and hazardous materials		●																								
Helicopter traffic								●	●	●	●	●														
Onshore logistic activities																		●	●	●	●	●				●
Presence of foreign workers																					●	●	●			●

● : means a potential interaction between an IPF and a resource.

Table 7-6. Matrix of Potential Impacts for Biophysical and Social Resources – Decommissioning Phase.

Project Activity/ Impact-Producing Factor (IPF)	Resources																									
	Physical				Biological								Social													
	Air Quality and GHG	Water Quality	Coastal Erosion	Sediment Quality	Benthic Communities	Plankton & Fish and Other Fishery Resources	Marine Flora	Birds	Marine Mammals	Sea Turtles	Threatened Species and Protected Areas	Biodiversity	Land & Seabed Occupation and Use	Maritime Navigation	Industrial Fisheries	Artisanal Fisheries and Related Activities	Other Coastal & Sea-Based Activities	Employment & Business Opportunities	Population and Demography	Community Livelihoods	Community Health, Safety and Security	Public Infrastructure and Services	Women and Vulnerable Groups	Cultural and Archaeological Heritage	Landscape and Seascape	Social Climate
ROUTINE ACTIVITIES																										
DECOMMISSIONING PHASE																										
Physical presence			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●			●	●	●
Exclusion safety zones														●	●	●	●			●	●	●				●
Vessel movements									●	●	●	●		●	●	●	●	●			●	●			●	
Emissions	●										●	●														
Discharges		●		●	●	●	●	●	●	●	●	●														
Solid waste		●		●	●	●	●	●	●	●	●	●														
Chemicals and hazardous materials		●																								
Helicopter traffic								●	●	●		●														
Onshore logistic activities																		●	●	●	●	●				●
Presence of foreign workers																					●	●	●			●

● : means a potential interaction between an IPF and a resource.

Table 7-7. Matrix of Potential Impacts for Biophysical and Social Resources – Accidental Events.

Project Activity/ Impact-Producing Factor (IPF)	**Resources**																									
	Physical				**Biological**								**Social**													
	Air Quality and Greenhouse Gases	**Water Quality**	**Coastal Erosion**	**Sediment Quality**	**Benthic Communities**	**Plankton & Fish and Other Fishery Resources**	**Marine Flora**	**Birds**	**Marine Mammals**	**Sea Turtles**	**Threatened Species and Protected Areas**	**Biodiversity**	**Land & Seabed Occupation and Use**	**Maritime Navigation**	**Industrial Fisheries**	**Artisanal Fisheries and Related Activities**	**Other Coastal & Sea-Based Activities**	**Employment & Business Opportunities**	**Population and Demography**	**Community Livelihoods**	**Community Health, Safety and Security**	**Public Infrastructure and Services**	**Women and Vulnerable Groups**	**Cultural and Archaeological Heritage**	**Landscape and Seascape**	**Social Climate**
ACCIDENTAL EVENTS – The following potential impacts are “conditional”: they would occur only in the unlikely event of an accident and subsequent spill.																										
Well blowout	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●
Failure of FPSO due to a ship collision	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●
Pipelaying vessel collision	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●

● : means a potential interaction between an IPF and a resource.

7.1.4 Method for Impact Determination and Classification

Impact consequence and impact likelihood are two factors used to determine potential impact significance (Figure 7-1).

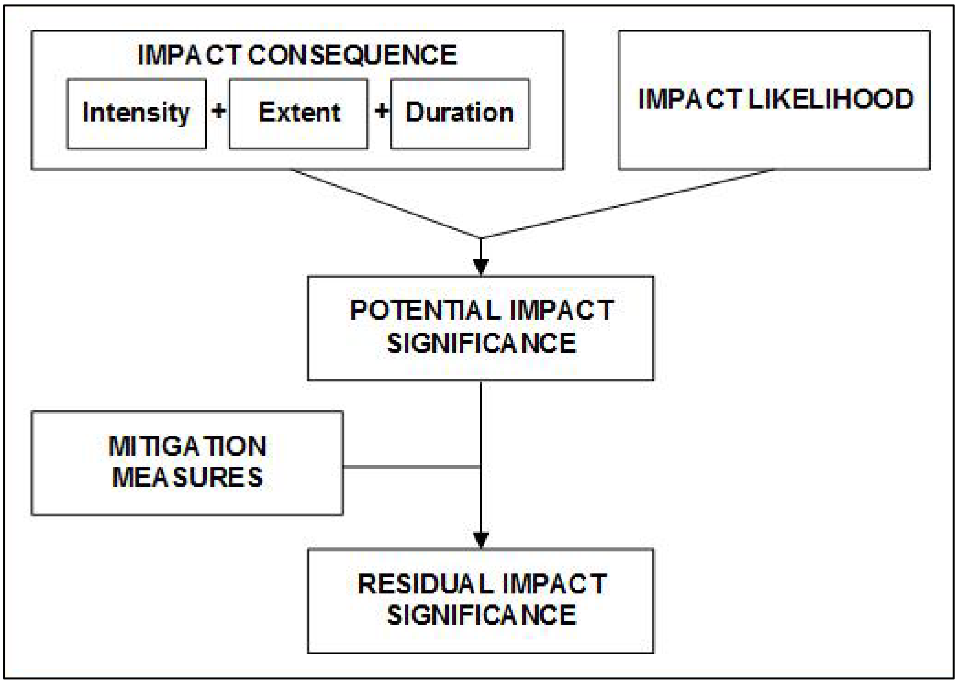


Figure 7-1. Impact Assessment Flowchart.

7.1.4.1 Determination of Impact Consequence

Impact consequence reflects an assessment of an impact's characteristics on a specific resource (e.g., air quality and GHG, benthic communities, or industrial fisheries) arising from one or more IPFs. Impact consequence is determined regardless of impact likelihood. Impact consequence classifications include Positive (Beneficial), Negligible, Minor, Moderate, and Severe.

For negative impacts[86], the determination of impact consequence is based on the integration of three criteria: intensity, extent and duration of the impact. These criteria are defined below, and Table 7-8 presents the four levels of consequence that can be attributed to a negative impact based on a rigorous analysis explained for each resource. When it is appropriate and possible, calculations or models have been carried out to characterize quantitatively the intensity and/or the extent of the impacts. These calculations or modeling are explained for each of the resources concerned. Positive impacts[87] are noted, but their consequence is not qualified.

86 A negative impact is an impact where the change to the current situation of the resource is generally considered adverse or undesirable.

87 A positive impact is an impact where the change to the current situation of the resource is generally considered better or desirable.

Intensity of an Impact

The intensity relates to the degree of disturbance associated with the impact and the alteration of the current state of the host environment. In a few specific cases (for example, coastal erosion), assumptions of future situations are used to assess impact. These will be explained in detail where appropriate along with a discussion on the associated uncertainties. Three levels of intensity can be attributed[88]:

- Low: Small adverse changes unlikely to be noticed or measurable against background activities. For the social environment, changes may be noticed only by a few individuals;
- Moderate: The project causes adverse changes that can be monitored and/or noticed, but are within the scope of existing variability without affecting the resource's integrity or use in the environment. For the social environment, adverse change that affects several people, but not the entire community; or
- High: For the physical environment, extensive or frequent violation of applicable air or water quality standards/guidelines, or widespread contamination of sediments with hydrocarbons, toxic metals, or other toxic substances. For the biological environment, extensive damage to habitats to the extent that ecosystem functions and ecological relationships would be altered, or numerous deaths or injuries of a protected species and/or continual disruption of their critical activities. For the social environment, extensive adverse change that is far-reaching and widely recognized, it significantly limits the use of a resource by a community or a regional population, or its functional and safe use is seriously compromised. An impact potentially resulting in the death of one or more community members is also considered of high intensity.

Extent of an Impact

The geographic extent of an impact expresses how widespread the impact is expected to be. It represents the area that will be affected, directly or indirectly. An impact extent is classified by the following levels:

- Immediate vicinity: Limited to a confined space within the project zone, i.e., infrastructure footprint and exclusion zone or where the project activities are conducted (for example, a supply base), generally <5 km from the source of impact;
- Local: The impact has an influence that goes beyond the project zone, but stays within a relatively small geographic area, for example N'Diago or Saint-Louis and their surroundings, generally about 5 to 20 km from the source of impact; or
- Regional: The impact affects a large geographical area, generally more than 20 km from the source of impact. For example, effects felt farther than N'Diago or Saint-Louis and their surroundings.

[88] The definitions presented here are general descriptions of the levels for each criterion. Not all resources have been included as examples, but specific explanations are provided in the assessment sections when needed.

Duration of an Impact

The duration of an impact describes the length of time over which the effects of an impact occur. It is not necessarily the same as the length of time of an activity or an IPF as an impact can sometimes continue after the source of impact has stopped or the impact can be shorter if there is an adaptation. Therefore, this period can include the recovery period or the adaptation period of the affected resource. The duration of the impact can be:

- Short term: the impacts are felt continuously or discontinuously over a limited period, generally at the beginning or during the Construction Phase of the project (around 3 years), or when the recovery or adaptation period is less than a year; or
- Long term: the impacts are felt continuously or discontinuously during the whole life of the project, equipment or activities and even longer in the case of irreversible impacts.

Consequence Criteria

Table 7-8 lists the combinations of criteria that have been used to describe impact consequence.

Table 7-8. Matrix of Consequence Determination for Negative Impacts.

Intensity	Extent	Duration	Consequence Criteria			
			Negligible	Minor	Moderate	Severe
Low	Immediate vicinity	Short term	●			
	Local	Short term	●			
	Regional	Short term	●			
	Immediate vicinity	Long term	●			
	Local	Long term		●		
	Regional	Long term		●		
Moderate	Immediate vicinity	Short term		●		
	Local	Short term		●		
	Regional	Short term		●		
	Immediate vicinity	Long term		●		
	Local	Long term			●	
	Regional	Long term			●	
High	Immediate vicinity	Short term			●	
	Local	Short term			●	
	Regional	Short term			●	
	Immediate vicinity	Long term			●	
	Local	Long term				●
	Regional	Long term				●

7.1.4.2 Determination of Impact Likelihood

Impact likelihood is the probability of an occurrence of an impact. The various categories of likelihood are similar to those used in Chapter 8 for the Risk Study and have been characterized as follows:

- Likely (>50% to 100% or may happen a few times per year);
- Occasional (>10% to 50% or may happen a few times during the lifetime of the project);
- Rare (1% to 10% or may possibly happen once during the lifetime of the project); or
- Remote (<1% or unlikely to happen at all during the lifetime of the project).

7.1.4.3 Determination of Impact Significance

The impact analysis considers impact consequence and impact likelihood to determine overall impact significance; impact significance has been determined based on the following relationship:

Impact Consequence × Impact Likelihood → Overall Impact Significance

Overall impact significance is resource specific. Negative impacts are assigned a numerical rating ranging from 1 through 4, on an increasing scale of significance. Beneficial impacts are noted as Positive but do not have a numerical rating. The matrix that integrates impact consequence with impact likelihood, shown as Table 7-9, provided the basis for determining overall impact significance for both biophysical and social impacts.

Table 7-9. Overall Impact Significance Matrix.

Likelihood vs. Consequence		← Decreasing Impact Consequence				
		Positive	Negative			
		Beneficial	Negligible	Minor	Moderate	Severe
Decreasing Impact Likelihood ↓	Likely	Positive (No numeric rating applied)	1 – Negligible	2 – Low	3 – Medium	4 – High
	Occasional		1 – Negligible	2 – Low	3 – Medium	4 – High
	Rare		1 – Negligible	1 – Negligible	2 – Low	4 – High
	Remote		1 – Negligible	1 – Negligible	2 – Low	3 – Medium

According to this matrix, the overall impact significance for negative impacts is rated as follows:

1 – Negligible;

2 – Low;

3 – Medium; and

4 – High.

It should be noted that the use of likelihood in the assessment methodology gives rise to two things when used in the context of impacts in highly unlikely accident scenarios (as opposed to routine activities impacts): (i) the reduction of most impact significances to low or negligible; and (ii) no apparent reduction in the impact with mitigation measures because although the likelihood may be reduced (in reality in the event of an incident) by the mitigation measures, it is already in the lowest possible likelihood bracket before the application of mitigation measures. The significance of the impact should therefore not be interpreted as an attempt to downplay the consequence of the impact if a highly unlikely accident were to happen.

Therefore, in order to highlight the impact consequence should an accidental event scenario did happen, the impact consequences are also highlighted using a similar color code in Section 7.5.

7.1.5 Identification of Mitigation Measures and Residual Impacts

7.1.5.1 Mitigations Hierarchy

Management/mitigation measures are proposed in parallel with project design and execution planning activities to eliminate/reduce significant negative impacts and related risks. This is achieved by the application of the mitigation hierarchy, which involves four key actions: Avoid, Minimize, Restore and Offset, applied in this order, with offsetting only undertaken when residual impacts cannot be avoided, minimized or restored:

- **Avoid:** to eliminate or modify all or part of a project to completely avoid negative impacts from the project, for instance by changing the design of the project so that a feature causing a potential impact is designed out or altered. Engineering controls to prevent unplanned events.
- **Minimize:** to decrease the intensity of those negative impacts that cannot be avoided by changing project timing, location, or physical layout, engineering controls to minimize emissions, operational or procedural controls, modifying project infrastructure utilization, building local infrastructure, capacity, etc. as far as reasonably practicable. Emergency response capability for unplanned events.
- **Restore:** to apply rehabilitation type measures to a natural, social or cultural resource damaged by unavoidable project impacts. Recovery plans for unplanned events.
- **Offset:** where none of the above approaches are practical, to compensate for project impacts, for example replacement of loss/damage at another location, provision of support, services, or other forms of compensation.

In many cases, the project design and operational procedures already incorporate measures to avoid or minimize an impact. These measures are inherent to the design and operational controls of the project facilities and align with good international industry practice. In each of the assessment sections that follow in this chapter, reference is made to design and operational controls (referred to as measures “D”) that are part of the project design and operation where this justifies the initial impact significance rating.

Mitigation measures may also be proposed to address the remaining impacts. These are spelled out separately and considered over and above the mitigation inherent to design and operational controls. Such mitigation measures are identified for negative impacts with a rating higher than 1 – Negligible. Mitigation is also considered for improvement measures of the positive impacts.

7.1.5.2 Residual Impacts

Following application of available mitigation measures on negative impacts, overall impact significance is re-evaluated. Post mitigation impacts, termed residual impacts, may reflect either a reduction in impact likelihood or consequence and a subsequent potential reduction in the significance rating. However, it may happen that reducing the consequence or likelihood of an impact will improve the environmental situation, but may not been reflected in the significance rating from 1 to 4.

7.1.6 Uncertainties

The ESIA process followed aims to identify and anticipate possible impacts based on past and present baseline information. As the ESIA involves a projection of the future there is, inevitably, always some uncertainty about what will actually happen. Impact predictions have been made based on extensive project-related surveys and with the best data, methods, professional judgment and scientific knowledge available at this time. Throughout the assessment a conservative approach has been adopted to the allocation of significance. Where significant uncertainty remains, this is acknowledged within the report and the implications thereof explained.

7.2 Impacts during the Construction Phase for Routine Activities

High Level Summary

In this section on Air Quality and GHG, the impact of one impact producing factor, this being Emissions, was evaluated. The residual impacts on Air Quality and GHG during the Construction Phase for routine activities were assessed as of negligible or low significance when mitigation measures are applied.

7.2.1 Air Quality and Greenhouse Gases

Main project vessels, platforms and drilling rigs are selected to be compliant with the Regulations for the Prevention of Air Pollution from Ships set forth in MARPOL Annex VI, where applicable.

7.2.1.1 Impact Producing Factors and Project Areas

The IPF identified for this resource in Table 7-4 is distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Emissions	•	•	•	•

7.2.1.2 Impact Description

The following subsections explain how this IPF will produce impacts in the project areas.

7.2.1.2.1 Offshore Area

Emissions

During the Construction Phase in the Offshore Area, air emissions from vessel engines will increase ambient levels of contaminants near the area of operations. Specifically, well drilling operations will introduce contaminants into the atmosphere around each well. Installation of the Subsea Production System is assessed under construction activities within the Pipeline Area. Maximum construction-related emissions calculations are outlined in Appendix B.

For the Offshore Area, drilling operations will produce the following emissions (Table 7-10). Drilling operations are expected to vary, depending upon year. In some years (e.g., 2022), a maximum of four wells will be drilled; in other years, only one or two wells may be drilled. Because the level of drilling activity will vary from year to year, two emission totals have been developed: drilling, best case and drilling, worst case. Under the best case, only one well is drilled per year (Albian well). Under the worst case, four wells will be drilled per year (i.e., 4 wells total; 2 wells each, Albian and Lower Cenomanian).

Table 7-10 provides drilling-related emissions for important air contaminants, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), oxides of nitrogen (NO_x), carbon monoxide (CO), volatile organic compounds (VOC), sulphur dioxide (SO_2), and greenhouse gases (GHG). Greenhouse gases generally include water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), tropospheric ozone (O_3) and chlorofluorocarbons (CFCs), For this assessment, the primary sources of GHG from project infrastructure and vessel engines includes CO_2, CH_4, and N_2O.

Table 7-10. Summary of Drilling-Related Emissions, Offshore Area.

Activity	CO_2 t/y	CH_4 t/y	N_2O t/y	NO_x t/y	CO t/y	VOC t/y	SO_2 t/y	GHG tCO_2eq/y
Drilling – best case	287,938	21	100	998	1,673	254	163*	288,377
Drilling – worst case	1,138,838	83	378	**3,783**	6,615	1,008	607*	1,140,575
BOEM Threshold	-	-	-	**2,584**	61,857	2,584	2,584*	-

From: MS002-EV-REP-010-01002, Rev B02

Abbreviations: CH_4 – Methane; CO – Carbon Monoxide; CO_2 – Carbon Dioxide; GHG – Greenhouse Gas; N_2O – Nitrous Oxide; NO_x – Oxides of Nitrogen; SO_2 – Sulphur Dioxide; t/y – Tonnes/year; tCO_2eq – tonnes CO_2 equivalent; VOC – Volatile Organic Compound.
Footnotes: * - calculation of SOx provided; data on the composition of SOx from combustion and other man-made sources indicate that about 98% of emitted SOx is sulfur dioxide (SO_2). BOEM threshold exceedances are shown in **bold**.

Table 7-10 also provides an annual threshold value, based on air quality screening methods employed by the U.S. Department of the Interior, Bureau of Ocean Energy Management (BOEM). BOEM oversees oil and gas operations on the U.S. outer continental shelf (OCS) using guidance provided by the U.S. Environmental Protection Agency. Inclusive of this BOEM oversight is monitoring of air emissions in select OCS regions. BOEM applies an exemption formula, based on distance from shore, to calculate annual threshold emission values, these threshold levels, presented in Table 7-10 above, have been determined based on the distance of the Offshore Area from shore. Using the BOEM approach, if a source on the U.S. OCS exceeds the annual threshold, air dispersion modeling is required to assess whether its emissions would have a significant effect on onshore air quality.

The drilling of one or two wells per year will not exceed the BOEM threshold for any of the contaminants identified in Table 7-10. Emissions from these operations will not have a significant effect on onshore air quality. With the exception of NOx emissions under the drilling worst case, drilling-related emissions in the Offshore Area are sufficiently low and/or the distance from shore sufficiently high that onshore air quality impacts are not expected. For the NOx emissions under the worst case, diminished onshore air quality may result.

No air quality standards are currently in place in Mauritania. In Senegal, the Senegal Air Pollution Discharge Standards (Document NS 05-062) applies to existing and new stationary installations and vehicles capable of generating gaseous emissions. The standards were designed to assess transportation infrastructure, buildings and other fixed structures, land development, and vehicles, among other sources. While the applicability of these standards to the GTA project infrastructure (i.e., FPSO, FLNG) remains to be determined, the thresholds contained within NS 05-062 are in units of mg/m^3 which are much more lenient that the $\mu g/m^3$ thresholds from the World Health Organization (WHO) and the U.S. EPA, the latter of which provide the basis for the BOEM thresholds noted above. Further discussion of the WHO thresholds is presented in Section 7.3.1 and Appendix J.

7.2.1.2.2 Nearshore Hub/Terminal Area

Emissions

During the Construction Phase in the Nearshore Hub/Terminal Area, air emissions from vessel engines will increase ambient levels of contaminants near the area of operations. Maximum construction-related emissions calculations are outlined in Appendix B.

For the Nearshore Hub/Terminal Area, installation of the breakwater and hub terminal infrastructure will produce the following emissions (Table 7-11). The construction activities at the Nearshore Hub/Terminal Area will require approximately 22 months.

Table 7-11. Summary of Construction-Related Emissions, Nearshore Hub/Terminal Area.

Activity	CO_2 t	CH_4 t	N_2O t	NO_x t	CO t	VOC t	SO_2 t	GHG tCO_2eq
Hub Installation – total emissions	182,667	11.4	5.4	3,596	959	92.5	1,142	184,552
Hub Installation – annual emissions	99,637	6.2	2.9	**1,961**	523	50.5	**623**	100,665
BOEM Threshold	-	-	-	**226**	12,204	226	**226***	-

From: MS002-EV-REP-010-01002, Rev B02

Abbreviations: CH_4 – Methane; CO – Carbon Monoxide; CO_2 – Carbon Dioxide; GHG – Greenhouse Gas; N_2O – Nitrous Oxide; NO_x – Oxides of Nitrogen; SO_2 – Sulphur Dioxide; t – Tonnes; tCO_2eq – tonnes CO_2 equivalent; VOC – Volatile Organic Compound.
Footnotes: * - calculation of SO_x provided; data on the composition of SO_x from combustion and other man-made sources indicate that about 98% of emitted SO_x is sulfur dioxide (SO_2). BOEM threshold exceedances are shown in **bold**.

With the exception of NO_x and SO_2 emissions, construction-related emissions in the Nearshore Hub/Terminal Area are sufficiently low that onshore air quality impacts are not expected. For the NO_x and SO_2 emissions, diminished onshore air quality may result.

7.2.1.2.3 Pipeline Area

Emissions

During the Construction Phase within the Pipeline Area, air emissions from vessel engines will increase ambient levels of contaminants near the area of operations. Maximum construction-related emissions calculations are outlined in Appendix B.

For the Pipeline Area, the laying of pipelines and other associated lines (e.g., umbilicals; flowlines; MEG line, etc.) and installation of the FPSO will produce the following emissions (Table 7-12). The installation of the subsea pipeline is scheduled to take 135 days.

Table 7-12. Summary of Construction-Related Emissions, Pipeline Area.

Activity	CO_2 t	CH_4 t	N_2O t	NO_x t	CO t	VOC t	SO_2 t	GHG tCO_2eq
Subsea Installation	62,163	3.89	1.83	**1,224**	326	31.47	**389**	62,805
BOEM Threshold @ 125 km	-	-	-	2,584	61,857	2,584	2,584*	-
BOEM Threshold @ 40 km	-	-	-	**826**	28,914	826	826*	-
BOEM Threshold @ 11 km	-	-	-	**226**	12,204	226	**226***	-

From: MS002-EV-REP-010-01002, Rev B02

Abbreviations: CH_4 – Methane; CO – Carbon Monoxide; CO_2 – Carbon Dioxide; GHG – Greenhouse Gas; N_2O – Nitrous Oxide; NO_x – Oxides of Nitrogen; SO_2 – Sulphur Dioxide; t – Tonnes; tCO_2eq – tonnes CO_2 equivalent; VOC – Volatile Organic Compound.
Footnotes: * - calculation of SO_x provided; data on the composition of SO_x from combustion and other man-made sources indicate that about 98% of emitted SO_x is sulfur dioxide (SO_2). BOEM threshold exceedances are shown in **bold**.

With the exception of NO_x and SO_2 emissions, construction-related emissions in the Pipeline Area are sufficiently low that onshore air quality impacts are not expected. Exceedances of the BOEM thresholds are noted for the following:

- SO_2 emissions at 11 km (Nearshore Hub/Terminal Area); and
- NO_x emissions at 11 and 40 km (Nearshore Hub/Terminal; within the Pipeline Area, at the FPSO).

NO_x and SO_2 exposure can aggravate the respiratory system; NO_x is also a key component in the formation of ozone and photochemical oxidants (see Appendix J). SO_2 may also interact with particles in the atmosphere to form sulfate particles, which can persist and be transported considerable distances as fine particulates and can be an important component of haze (Chen et al., 2007; Stockholm Environment Institute, 2012). For the NO_x and SO_2 emissions, shown in Table 7-12, total emissions are based on the full period of construction operation – 135 days. Activities will occur at varying distances from shore within the Pipeline Area; consequently, the BOEM threshold at 40 km or 11 km may not be exceeded. Exceedances will ultimately be based on how long construction vessels operate and how close to shore these operations are conducted. From a conservative perspective, diminished onshore air quality may result from construction activities closest to shore, likely attributed to NO_x emissions.

7.2.1.2.4 Support Operations Areas

Emissions

Operations of support vessels through the ports of Nouakchott and Dakar will occur intermittently throughout the Construction Phase. Emissions from support vessels have been accounted for in each of the prior discussions, covering operations in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area. NO_x and SO_2 exceedances noted in these discussions are unlikely to be realized at the Support Operations Areas due to the amount of time that support vessels will remain in or near port.

7.2.1.2.5 Summary

Emissions associated with construction activities in the Offshore Area, Nearshore Hub/Terminal Area, Pipeline Area, and Support Operations Areas are expected to produce localized impacts through the introduction of atmospheric contaminants. With the exception of NO_x and SO_2 emissions for certain operations, these emissions will be below threshold levels.

Impacts of elevated levels of NOx and SO2 reaching shore from construction activities at the Nearshore Hub/Terminal and FPSO could include periods of short-term onshore exposure. Onshore receptors may include coastal and estuarine habitats, upland terrestrial habitats, and the local population. Potential impacts may include periodic, short term impairment of visibility (haze), aggravation of existing respiratory conditions (e.g., asthma) among the local population, and limited effects to local onshore habitats (e.g., reduced growth of vegetation; acidification and fertilization of soils; U.S. Forest Service [USFS], National Park Service [NPS], and U.S. Fish and Wildlife Service [USFWS], 2008). NOx emissions, when combined with VOC emissions, are also of concern because they are precursors of ozone.

Greenhouse gas emissions (GHG) for all installation and construction activities are projected to range between 535,734 and 1,387,932 tonnes, during periods when drilling activity will occur (i.e., best case and worst case, respectively). During periods of non-drilling activity, GHG emissions will amount to 247,357 tonnes. By comparison, Mauritania and Senegal GHG emissions in 2014 amounted to 52 960 000 and 136 750 000 tonnes, respectively (CAIT Climate Data Explorer. 2017).

7.2.1.3 Impact Rating

Emissions

Impact intensity for criteria contaminants where no exceedances were noted is expected to be low, occurring on a local level, and of short-term duration, resulting in a negligible impact consequence. Given the likely nature of this impact, overall impact significance is 1 – Negligible (Table 7-13).

For those instances where NO_x or SO_2 thresholds may be exceeded, impact intensity is expected to be high, occurring on a local level, but may extend to regional, and of short duration, resulting in a moderate impact consequence. A high impact intensity is based on the projected exceedances occur during construction operations in the Pipeline Area and Nearshore Hub/Terminal Area, closest to shore. Given the occasional nature of this impact, overall impact significance is 3 – Medium (Table 7-13).

Summary

A summary of impact to air quality associated with emissions from routine activities during the Construction Phase is presented in Table 7-13.

Table 7-13. Impacts to Ambient Air Quality during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Emissions						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Reduction in ambient air quality (all parameters except for NO_x and SO_x).	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Likely	1 – Negligible
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Reduction in ambient air quality (NO_x and SO_x only).	Nature: Negative Intensity: High Spatial Extent: Local to Regional Duration: Short term	Moderate	Occasional	3 – Medium

7.2.1.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-14) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the measures and controls already planned in the project design but summarized here for reference:

- D01: Contractors will be expected to comply with the contract terms that have been established, including HSSE standards and performance requirements.
- D02: Compliance with applicable national and international regulations (MARPOL 73/78 Annex VI) and guidelines regarding emissions of nitrogen oxides (NOx) and sulphur oxides (SOx) from main project vessels.
- D03: An efficient flare burner head equipped with an appropriate combustion enhancement system will be selected with the intent of minimizing incomplete combustion, black smoke, and hydrocarbon fallout to the sea.
- D04: Volumes of hydrocarbons flared will be recorded.

Table 7-14. Mitigation Measures to Avoid or Reduce Impacts to Air Quality from Routine Activities during the Construction Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Reduction in ambient air quality (NO_x and SO_x only).	3 – Medium	M01, M02	2 – Low

Notes:

M01: Maintaining routine maintenance procedures to help ensure that engines are operating at defined operational performance and specified emissions levels.

M02: Monitoring fuel consumption as a proxy for measuring performance and emissions. When practical, or as required by applicable regulations, vessel operators will be expected to utilize low-sulfur fuels to limit SOx production.

7.2.2 Water Quality

High Level Summary

In this section on Water Quality, the impact of three impact producing factors, these being Discharges, Solid waste and Chemicals and hazardous materials, was evaluated. All impacts on Water Quality during the Construction Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

7.2.2.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Discharges	•	•	•	•
Solid waste	•	•	•	•
Chemicals and hazardous materials	•	•		

7.2.2.2 Impact Description

The following subsections explain how these IPF will produce impacts in the project areas. No water quality discharge standards are currently in place in Mauritania. In Senegal, the Senegal Wastewater Discharge Standards (Document NS 05-061) establish limits on select parameters for wastewater discharges into national waters. The relevant effluent discharge limitations specified in NS 05-061 include: 1) effluent to have a pH value between 5.5 and 9.5; 2) chemical and biological oxygen demand (COD, BOD) shall not exceed 50 mg/l; 3) 5-day BOD shall not exceed 40 or 80 mg/l, depending upon daily effluent (30 kg/day); 4) COD shall not exceed 100 or 200 mg/l, depending upon daily effluent (100 kg/day); 5) total nitrogen, monthly average not to exceed 30 mg/l; 6) total phosphorus, monthly average not to exceed 10 mg/l; and 7) other substances (i.e., phenols: 0.5 mg/l; hexavalent chromium: 0.2 mg/l; cyanide: 0.2 mg/l; arsenic and arsenic-containing compounds: 0.3 mg/l; trivalent chromium: 1 mg/l; total hydrocarbons: 15 mg/l; fluorine and fluorine-containing compounds: 25 mg/l). Coliforms and streptococci levels must not exceed 2000 and 1000 per 100 ml, respectively.

7.2.2.2.1 Offshore Area

Discharges

During the Construction Phase in the Offshore Area, discharges from vessels will affect local water quality near the area of operations. Specifically, discharges of sanitary and domestic wastes, food waste, small quantities of brine, and miscellaneous discharges will occur. Construction-related discharges are outlined in Appendix K-1.

For the Offshore Area, drilling operations will produce drilling muds and cuttings which will be discharged into the sea. For each Cenomanian well, the release of water-based muds and cuttings at the seafloor is expected to amount to 297 and 422 m^3, respectively. The discharge of cuttings drilled with synthetic based drilling fluids will amount to approximately 353 m^3 per Cenomanian well, with minor amounts of adhering drilling fluids. Volumes of drilling muds and cuttings for Albian wells are approximately 6.6% less. Drilling operations are expected to vary, depending upon year. In some years (e.g., 2022), a maximum of four wells will be drilled; in other years, only one or two wells may be drilled.

Vessels operating in the Offshore Area during construction activities will generate various discharges, as outlined in Table 7-15 and detailed in Appendix K-1.

Table 7-15. Summary of Construction-Related Discharges, Offshore Area.

Activity/Source	Volume Discharged (m^3)
Drilling discharges – all 12 wells	
Drilling muds	4,080
Cuttings	8,988
Vessels (black water)	29,298
Vessels (grey water)	42,160
Miscellaneous discharges (all vessels)	76,080
Total	160,606

From: Chapter 2 and Appendix K-1

When WBM and cuttings are discharged to the ocean, the larger particles and flocculated solids, representing about 90% of the mass of the mud solids, form a plume that settles quickly to the seafloor. The remaining 10% of the mass of the mud solids consisting of fine-grained unflocculated clay-sized particles and a portion of the soluble components of the mud form another plume that drifts with prevailing currents away from the discharge location and is diluted with distance in receiving waters (Neff, 2005). Because WBM and cuttings will be discharged at the wellbore, a similar plume-forming scenario may be expected, with heavier muds and cuttings components settling immediately around the wellbore and smaller, lighter fractions forming a turbidity plume which will move with ambient currents away from the wellbore and above the seafloor. Water quality in the immediate vicinity of each wellbore will be temporarily diminished, with water quality increasing as drilling materials settle to the seafloor.

Lower portions of each well will be drilled using SBDF (see Chapter 2). SBDF muds and cuttings will be processed through solids control equipment aboard the drillship. Cuttings will be separated, processed to remove SBDF, and discharged overboard, whereas muds will be recirculated into the hole until their properties become degraded, after which they will be removed from the mud processing equipment, containerized, and eventually shipped to shore. No large discharges of SBDF will occur.

Cuttings and small amounts of SBDF (i.e., residual amounts of SBDF adhering to the cuttings after processing) will be released almost continuously from the drillship during drilling. Cuttings typically are coarse particles that settle rapidly to the seafloor near the discharge point, primarily within a few hundred meters. A layer of fine cuttings particles will be dispersed and deposited over a much broader area (Boothe and Presley, 1989). Drilling fluids associated with NADF cuttings typically adhere tightly to cuttings particles and probably will produce little turbidity as the cuttings sink through the water column (Neff et al., 2000).

Discharges of drilling fluids and cuttings are likely to have little or no impact on water quality due to the low toxicity and rapid dispersion and settling of these discharges (NRC, 1983; Neff, 1987; Hinwood et al., 1994). Residual NADF levels on discharged cuttings will be low. Discharges of cuttings containing residual NADF will not create a significant water column plume. The impact consequence of muds and cuttings discharge on water quality is expected to be minor.

There will be some discharge of well completion fluids and occasional discharge of workover fluids (during the Operations Phase). These fluids will be discharged overboard from the drillship, where rapid mixing should minimize the impact on water quality.

Routine discharges from the drillship and support vessels in the Offshore Area will produce localized areas of reduced water quality, including increases in total suspended solids, nutrients, and chlorine. Sanitary waste will be treated by means of a marine sanitation device that produces an effluent with a maximum residual chlorine concentration of 1.0 mg L^{-1} and no visible floating solids or oil and grease. Wastewater treatment sludge will be transported to shore for disposal at an approved facility. Aside from screening to remove solids, domestic waste does not require treatment before discharge. Food waste, amounting to an estimated 175,000 kg for all vessels, will be ground prior to discharge in accordance with MARPOL requirements.

Sanitary and domestic wastes and food waste from the drillship may affect concentrations of suspended solids, nutrients, and chlorine in the water column as well as generate biological oxygen demand (BOD). However, these discharges are expected to be diluted rapidly in the open ocean (U.S. Environmental Protection Agency [USEPA], 2017; Minerals Management Service [MMS], 2007). Impacts would likely be undetectable beyond tens of meters from the source.

Solid Waste

The intentional release of solid waste into the marine environment is prohibited under MARPOL. Solid waste will not intentionally be discarded in the Offshore Area. However, accidental loss of debris from the drillship or support vessels during the Construction Phase may occasionally occur. Should accidental loss occur, local water quality may be affected by the presence of cardboard, plastics, or other drilling-related items (e.g., tools, gear, hardhats, containers, etc.). Buoyant materials will float and be transported by local currents; heavier items will sink to the seafloor. The occasional and unintentional loss of debris may produce localized effects to water quality, depending upon the source (e.g., floating trash, buckets containing paints or other chemicals). Floating or sinking debris may leach residual chemicals, with minor effects to local water quality.

Chemicals and Hazardous Materials

Chemicals are required for the well drilling process, including: 1) chemicals used during drilling; and 2) cement and associated chemicals used during cementing operations (e.g., while setting pipe). Table 2-7 in Chapter 2 summarized the chemicals expected to be used during drilling operations. Most of these chemicals will be discharged to the sea, often in conjunction with the discharge of drilling muds and cuttings. These discharges must meet MARPOL requirements and are expected to be diluted rapidly in the open ocean. Impacts on water quality would likely be undetectable beyond tens of meters from the source.

7.2.2.2.2 Nearshore Hub/Terminal Area

Discharges

During the Construction Phase in the Nearshore Hub/Terminal Area, vessels will discharge several different wastes, including sanitary and domestic wastes.

For the Nearshore Hub/Terminal Area, installation of the breakwater and hub terminal infrastructure will produce the following discharges (Table 7-16). The construction activities at the Nearshore Hub/Terminal Area will require 22 months.

Table 7-16. Summary of Construction-Related Discharges, Nearshore Hub/Terminal Area.

Source	Volume Discharged (m^3)
Vessels (black water)	29,549
Vessels (grey water)	42,521
Total	77,070

From: Chapter 2 and Appendix K-1

Construction-related discharges in the Nearshore Hub/Terminal Area will be diluted rapidly in the open ocean. Sanitary and domestic waste from the construction vessels may affect concentrations of suspended solids, nutrients, and chlorine in the water column as well as generate BOD. However, these discharges are expected to be diluted rapidly in the open ocean (USEPA, 2017; MMS, 2007). Impacts would likely be undetectable beyond tens of meters from the source.

Several specialized vessels will also be conducting dredging or rock transport operations, both of which are likely to produce water quality impacts. Dredging of the breakwater area will disturb sediments, where approximately 250,000 m^3 of sediment will be removed. When dredged material is sidecast, a sediment plume is created which will move and disperse in the direction of ambient currents. Oxygen concentrations within the dredging-related sediment plume may also be reduced, depending upon the organic load within the dredged sediments and ambient dissolved oxygen concentrations. Local water quality will be affected, via increased turbidity and resuspension and remobilization of sediment-associated chemical species; potential short-term reductions in dissolved oxygen concentration may also occur. Given the non-industrial nature of the project area, sediment quality is considered to be excellent and only limited chemically-related impacts to water quality are expected (i.e., increases in nutrients, changes in oxygen concentration).

Placement of rock will also mobilize sediments, creating a turbidity plume and resuspending local sediments. Rock emplacement for the breakwater will be conducted over a period of several months through the transit of two rock dumper vessels transiting to and from a source location in Mauritania or Senegal, or from outside the countries. Rock placement and resulting turbidity is expected to be intermittent during breakwater construction. As was noted for dredging operations, changes in oxygen concentrations within the sediment plume may also occur, depending upon the organic load within the local sediments. Increased turbidity and changes in oxygen concentrations will diminish water quality within the area of the plume, with only limited chemically-related impacts to water quality expected.

Sand will also be required (e.g., as founding stratum) during construction, to be sourced either onshore or offshore. The sand may be sourced from offshore borrow areas, in which case some dredging will be required. Dredging of borrow sand and subsequent placement of sand will also be a source of local turbidity. Potential changes in oxygen concentration associated with sand placement and associated turbidity will be dependent upon the organic load within the sand. Conservatively, changes in oxygen concentration may be realized.

Solid Waste

Accidental loss of debris from support vessels during the Construction Phase may occasionally occur. Should accidental loss occur, local water quality may be affected by the presence of cardboard, plastics, or other items (e.g., tools, gear, hardhats, containers, etc.). Buoyant materials will float and be transported by local currents; heavier items will sink to the seafloor. The occasional and unintentional loss of debris may produce localized effects to water quality, depending upon the source (e.g., floating trash, buckets containing paints or other chemicals). Floating or sinking debris may leach residual chemicals, with minor effects to local water quality.

7.2.2.2.3 Pipeline Area

Discharges

During the Construction Phase within the Pipeline Area, routine discharges (including sanitary and domestic wastes) from vessels may affect local water quality. The installation of the FPSO anchors and associated pipelines and umbilicals will disturb local sediments during emplacement. This disturbance will occur both at the FPSO location (i.e., from anchors and linear infrastructure) and along the full extent of the pipeline corridor (i.e., from linear infrastructure), creating a turbidity plume.

For the Pipeline Area, the laying of pipelines and other associated lines (e.g., umbilicals; flowlines; MEG line, etc.) and installation of the FPSO will produce the following discharges (Table 7-17). Discharges for the gas export pipeline, production flowline, gas export risers, and MEG pipeline are also accounted for in Table 7-17. The flowlines/pipelines will be flooded with seawater containing chemicals (e.g., biocides, oxygen scavengers and corrosion inhibitors) and hydrotested; the small volumes of added chemicals are detailed in Chapter 2. Before startup, the production flowlines and export pipeline will be dewatered.

Table 7-17. Summary of Construction-Related Discharges, Pipeline Area.

Source	Volume Discharged (m^3)
Pipeline Installation (Subsea Installation)	
Vessels (black water)	19,523
Vessels (grey water)	28,093
FPSO Hook Up and Commissioning	
Vessels (black water)	1,375
Vessels (grey water)	1,979
Pipeline Discharges	35,610

From: Chapter 2 and Appendix K-1

Construction-related discharges from vessels operating in the Pipeline Area will be diluted rapidly in the open ocean. Sanitary and domestic waste from the construction vessels may affect concentrations of suspended solids, nutrients, and chlorine in the water column as well as generate BOD. However, these discharges are expected to be diluted rapidly in the open ocean (USEPA, 2017; MMS, 2007). Impacts would likely be undetectable beyond tens of meters from the source (e.g., Gray et al., 1992; MMS, 2007).

Emplacement of the various pipelines, flowlines, and umbilicals will likely to produce localized water quality impacts via increased turbidity and resuspension and remobilization of sediment-associated chemical species. Similarly, FPSO anchor placement will also disturb sediments, creating a localized sediment plume.

Turbidity will diminish water quality for a short period of time (i.e., hours to several days), depending upon the extent of the sediment disturbance and the nature of the sediments. Due to excellent sediment quality, no chemically-related impacts to water quality are expected.

Solid Waste

Accidental loss of debris from support vessels during the Construction Phase may occasionally occur. Should accidental loss occur, local water quality may be affected by the presence of cardboard, plastics, or other items (e.g., tools, gear, hardhats, containers, etc.). Buoyant materials will float and be transported by local currents; heavier items will sink to the seafloor. The occasional and unintentional loss of debris may produce localized effects to water quality, depending upon the source (e.g., floating trash, buckets containing paints or other chemicals). Floating or sinking debris may leach residual chemicals, with minor effects to local water quality.

Chemicals and Hazardous Materials

As noted previously, the flowlines/pipelines will be flooded with seawater containing chemicals (e.g., biocides, oxygen scavengers, corrosion inhibitors) and hydrotested; the small volumes of added chemicals are detailed in Chapter 2. Before startup, the production flowlines and export pipeline will be dewatered. Discharge of seawater and associated chemicals will have a localized effect on water quality, with releases expected to realize dilution and dispersion to ambient levels within tens of meters of their release.

7.2.2.2.4 Support Operations Areas

Discharges

Sanitary and domestic wastes discharged from support vessels operating in Support Operations Areas, if discharging, may affect concentrations of suspended solids, nutrients, and chlorine in the water column as well as generate BOD. These discharges are expected to be diluted rapidly. Impacts would likely be undetectable beyond tens of meters from the source.

Solid Waste

The intentional release of solid waste into the marine environment is prohibited under MARPOL. Should accidental loss occur, local water quality may be affected by the presence of cardboard, plastics, or other items (e.g., tools, gear, hardhats, containers, etc.). Buoyant materials will float and be transported by local currents; heavier items will sink to the seafloor. The occasional and unintentional loss of debris may produce localized effects to water quality, depending upon the source (e.g., floating trash, buckets containing paints or other chemicals). Floating or sinking debris may leach residual chemicals, with minor effects to local water quality.

7.2.2.2.5 Summary

Discharges associated with construction activities in the Offshore Area, Nearshore Hub/Terminal Area, Pipeline Area, and Support Operations Areas are expected to produce localized water quality impacts via the discharge of treated sanitary wastes, domestic wastes, and miscellaneous discharges.

Emplacement of the breakwater and pilings in the Nearshore Hub/Terminal Area, anchoring of the FPSO and laying of pipelines, flowlines and umbilicals in the Pipeline Area, and drilling and drilling-related discharges in the Offshore Area will produce local impacts to water quality.

7.2.2.3 Impact Rating

Discharges

Impact intensity for discharges and other sources of turbidity, sediment resuspension, and nutrient enhancement is expected to be low, occurring in the immediate vicinity of the discharge or turbidity-producing activity, and of short-term duration, resulting in a negligible impact consequence. Given the likely nature of this impact, overall impact significance is 1 – Negligible (Table 7-18).

Summary

A summary of impact to water quality from routine activities during the Construction Phase is presented in Table 7-18.

Table 7-18. Impacts to Ambient Water Quality during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Discharges						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Reduction in ambient water quality from discharges and sediment disturbance.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Solid Waste						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Changes in water quality from accidental loss of trash and debris.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible
Chemicals and Hazardous Materials						
Mauritania Senegal	Offshore; Pipeline	Changes in water quality from release of treatment chemicals.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible

7.2.2.4 Mitigation Measures and Residual Impacts

Impacts are rated 1 – Negligible; no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D01: Contractors will be expected to comply with the contract terms that have been established, including HSSE standards and performance requirements.
- D05: Compliance with applicable national and international regulations (MARPOL 73/78, Annex IV and V) for waste and wastewater discharges from offshore project vessels.
- D06: A waste management plan will be developed and implemented to avoid unauthorized waste discharges and transfers, with written procedures for collection, segregation, storage, processing and disposal of waste, including use of equipment and record keeping.

- D07: Waste not permitted to be discharged at sea (such as waste chemicals, cooking oils or lubricating oils, biomedical waste) will be transported onshore for transfer to an approved disposal facility[89] (in-country or an international provider).
- D08: Ballast water will be discharged according to IMO International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM), where applicable.
- D09: Discharges of SBDF[90] mud and cuttings will be managed. SBDF cuttings will only be discharged once the performance targets of 6.9 g/100 g retained "synthetic on cuttings" on wet solids averaged over the whole well discharge can be satisfied. The concentration of SBDF on cuttings will be monitored on the drillship. No excess or spent SBDF will be discharged to the sea. Spent or excess SBDF that cannot be re-used during drilling operations will be brought back to shore for disposal. If mineral oil base drilling fluid (OPDF[91]) were to be selected, cuttings contaminated with mineral oil base drilling fluid at a concentration greater than 1% by weight mineral oil on dry cuttings will not be discharged. No OPDF will be discharged as whole fluid.
- D10: Selection of drilling chemicals will be in accordance with the BP chemical selection and waste management standards to reduce potential for environmental effect. During planning of drilling activities, where feasible, lower toxicity drilling muds and biodegradable and environmentally friendly additives within muds, cements and completion fluids will be preferentially used. If barite is used as weighting agent, it will not contain more than Hg: max 1 mg/kg dry weight in stock barite and Cd: max 3 mg/kg dry weight in stock barite.
- D11: Completion and well workover fluids to be discharged overboard will be tested to confirm the fluids are suitable for discharge as required by applicable national and international regulations. Fluids that do not meet the specification would either be treated offshore or transported onshore for transfer to an approved disposal facility[92] (in-country or an international provider).
- D12: A pipeline and FLNG hydrotesting plan will be developed and implemented, detailing hydrotesting requirements, and demonstrating, based on an environmental risk assessment approach, the chemical additives to be selected as well as likely concentrations, volumes and frequencies of discharges. The plan will include a strategy to minimize environmental impact.
- D13: A dredging management plan will be developed for large dredging works (breakwater, disposal areas, potential sand borrow areas offshore) and implemented that defines the dredging methodology, identifies and assesses dredged materials disposal options and sites, characterizes the composition and behavior of the sediment to be dredged, and defines the area of influence and the potential mitigation and monitoring measures. In addition, pre- and post-dredged survey will be performed.

7.2.3 Coastal Erosion

High Level Summary

In this section on Coastal Erosion, the impact of one impact producing factor, this being Physical presence, was evaluated. All impacts on Coastal Erosion during the Construction Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

[89] In this document, a treatment center can mean either a center for waste treatment or for final disposal.
[90] SBM: Synthetic Based Muds; SBDF: Synthetic Based Drilling Fluids.
[91] OPDF: Organic-Phase Drilling Fluids.
[92] In this document, a treatment center can mean either a center for waste treatment or for final disposal.

7.2.3.1 Impact Producing Factors and Project Areas

The IPF identified for coastal erosion in Table 7-4 is distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence			●	

Physical presence of the breakwater structure is the only component of this IPF which has the potential to affect coastal erosion; noise associated with construction activities will have no effect on erosional processes. Construction activities in the Offshore Area and Pipeline Area will not have an effect on erosional processes along the Mauritania and Senegal coast because of their distance offshore and the nature of the infrastructure to be installed. Support Operations Areas, located at coastal (port) shore bases and airports, will not realize significant alteration to existing facilities and will not affect coastal erosion.

7.2.3.2 Impact Description

The Construction Phase will involve a multitude of specialized vessels specifically designed to complete various tasks, installation of infrastructure and support operations. Installation of the breakwater in the Nearshore Hub/Terminal Area, within 11 km of the nearest shoreline, has the potential to influence these processes.

The following subsections explain how this IPF will produce impacts in the project areas.

7.2.3.2.1 Offshore Area

Not applicable (see Section 7.2.3.1).

7.2.3.2.2 Nearshore Hub/Terminal Area

Physical Presence

Within the Nearshore Hub/Terminal Area, construction activities will include dredging of the breakwater location (i.e., 250,000 m^3 of sediment to be removed) and placement of rock and pilings to create the breakwater. Dredging of sediments and rock emplacement will occur over approximatively a 22-month period.

As discussed in Section 7.2.2.2.2, sand will also be required (e.g., as founding stratum) for construction of the breakwater. Sand will be sourced from either onshore or offshore. If sourced close to the breakwater, sand removal will produce depressions in the seafloor. Creation of a series of small depressions via sand removal are unlikely to affect coastal dynamics and are not expected to affect coastal erosion.

7.2.3.2.3 Pipeline Area

Not applicable (see Section 7.2.3.1).

7.2.3.2.4 Support Operations Areas

Not applicable (see Section 7.2.3.1).

7.2.3.2.5 Summary

Potential impacts to coastal erosion during the Construction Phase are from physical presence, exclusively at the Nearshore Hub/Terminal Area. Dredging of indigenous sediments within the breakwater footprint, removal of 250,000 m^3 of sediment, and the subsequent placement of rock and piles will occur over approximately a 22-month period, with limited potential for effects on local hydrodynamics and coastal erosion.

7.2.3.3 Impact Rating

Physical Presence

The potential impact of the proposed breakwater on coastline stability (i.e., whether the breakwater will have an effect on coastal erosion) has been evaluated using a coastline evolution model, detailed results of which are presented in Appendices I-2 and I-3. The model results show that the breakwater causes a reduction of the wave heights along part of the modeled study area and a modification to the wave directions. This causes a reduction in the sediment transport rates along the section sheltered by the breakwater, inducing coastline changes. The model results (see Figure 6.5 in Appendix I-3) showed that the presence of the breakwater, once fully installed with predictions over a 10-year period, will produce two effects: 1) accretion or reduction in natural erosion along approximately 8 km of coast southeast of the breakwater which is for the most part currently experiencing erosion, providing a positive impact to the coast along this coastal section; and 2) a maximum increase in coastal erosion rate of 6 m over 10 years relative to the case without the breakwater along approximately 2 km of coast further south, starting at the south end of the Hydrobase neighborhood, producing a negative impact to the coast along this section. The maximum positive shoreline change (accretion) is estimated to be 13 m over 10 years relative to the case without the breakwater. The maximum negative shoreline change (erosion) is estimated to be an additional 6 m over 10 years relative to the case without the breakwater. In view of the predominant current and wave directions, these impacts will be realized in Senegal.

During the relatively short term period during breakwater construction, the consequence of breakwater presence to coastal erosion are minimal. During construction, impact intensity is low, with local extent and short term duration (i.e., tied only to the duration of the construction activities), producing a negligible impact consequence. The likelihood of any effect (i.e., accelerated or altered erosional processes), during the construction period, is rare; if impacts to coastal erosion occur, they would only be evident near the end of construction as the breakwater begins to affect wave structure and long shore current processes. Therefore, the overall impact significance of construction operations to coastal erosion is 1 – Negligible (see Table 7-19 below for details on selected criteria).

Table 7-19. Impacts to Coastal Erosion during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Senegal	Nearshore Hub/ Terminal	Alteration of erosional processes along the Senegal coast.	Nature: Negative and Positive Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Rare	1 – Negligible

7.2.3.4 Mitigation Measures and Residual Impacts

Impacts to coastal erosion from Construction Phase activities are rated 1 – Negligible; no mitigation measures are required.

7.2.4 Sediment Quality

High Level Summary

In this section on Sediment Quality, the impact of three impact producing factors, these being Physical presence, Discharges and Solid waste, was evaluated. The residual impacts on Sediment Quality during the Construction Phase for routine activities were assessed as of negligible or low significance when mitigation measures are applied.

7.2.4.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	
Discharges	●	●	●	
Solid waste	●	●	●	

No impacts to sediment quality in Support Operations Areas are expected as these areas are on shore.

7.2.4.2 Impact Description

The Construction Phase will involve a multitude of specialized vessels specifically designed to complete various tasks, including well drilling and completion, installation of infrastructure, and support operations. These vessels and the associated infrastructure which they will install are the source of the identified IPFs. Physical presence, discharges, and solid waste represent potential sources of impact to sediment quality in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area.

Most of the seafloor in the project area is expected to consist of soft-bottom benthic habitat. Seafloor-disturbing activities during installation germane to effects on sediment quality are resuspension of bottom sediments with produce turbidity and potential transport of sediment-associated contaminants. As described in Section 4.4.1, CSA Ocean Sciences Inc. (2017) conducted an EBS for the project determining that baseline conditions of study area were generally characterized as exhibiting good surficial sediment quality (Appendix D). The EBS addressed characterization of the seabed sediment, with specific reference to grain size, TOC content, metals (aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, mercury, nickel, vanadium, and zinc), hydrocarbon content (TPH and PAHs), and infauna. Sediment metal analytes included potential contaminants associated with offshore oil and gas activities, priority contaminants, and primary mineralogical indicators. PAHs analyzed from EBS sediment samples include 16 USEPA priority contaminants.

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from construction-related vessels are expected to have no impact on sediment quality due primarily to rapid dilution of these discharges in surface waters. The discharges of concern for effecting sediment quality are drilling related and include drilling muds, both WBM and SBDF, and cuttings. Solid waste accidentally lost overboard could potentially affect sediment quality due to chemical leaching.

The following subsections explain how these IPFs will produce impacts to sediment quality in each of the project areas.

7.2.4.2.1 Offshore Area

Physical Presence

The drillship will not be utilizing anchors to maintain position over each wellsite; support vessels operating in the Offshore Area will not utilize anchors. Therefore, the physical presence of the drillship and support vessels will have no effect on deepwater sediment quality within the Offshore Area.

The installation of the subsea production system (SPS, including wellheads, jumpers, trees, manifold centres, flowline jumpers, and in-field flowlines) will disturb sediments causing localized turbidity and potential exposure and transport sediment-associated contaminants during emplacement. Localized turbidity is an effect on water quality, but an artifact of this process could be the transport of potential contaminants entrained within the sediment. Structural emplacement within the Offshore Area will cause localized disturbance of the surficial sediments in proximity to these structures within a footprint estimated to be approximately 0.0418 km^2.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from the drillship and support vessels should have no impact on deepwater sediment quality due to water depth and rapid dilution of these discharges in surface waters.

During the drilling of each well, drilling muds and cuttings discharges at the seafloor and from the drillship will affect sediment quality in relatively close proximity. For each well, it is estimated that 422 m^3 of cuttings will be discharged at the wellhead, while 219 m^3 of cuttings will be discharged from the drillship. Cuttings discharged at the wellhead and from the drillship will be accompanied by an estimated volume of 953 m^3 of WBM and 53 m^3 of adhering SBDF, respectively. Results of the muds and cuttings discharge modeling, detailed in Appendix L, are presented in Figures 7-2 and 7-3 in Section 7.2.5.2.1.

For drilling in the upper two sections (i.e., riserless drilling where muds and cuttings are discharged at the wellbore), these sediments deposit rapidly and surround the drill site forming the more substantial cuttings pile. Seafloor releases of WBM and associated drill cuttings will create a mound with a diameter of several meters to tens of meters around the wellbore. Adding to these accumulations of WBM and cuttings, excess cement slurry used to bond the casing to the walls of the hole will emerge from the hole and accumulate on the seafloor, typically within 10 to 15 m of the wellbore (Shinn et al., 1989). These initial drilling discharges of WBM, associated drill cuttings, and cement slurry, will accumulate on the seafloor and effect sediment quality specific to bottom contours, grain size, and most probably barium concentrations.

After the initial well intervals, the marine riser is set, allowing drilling fluids and cuttings to be returned to the drillship for processing through solids control equipment. Discharges of cuttings (and, for some wells, WBMs) from the drillship accumulate on the seafloor, resulting in changes to bottom contours, sediment grain size, barium concentrations, and, sometimes, other metal concentrations (NRC, 1983; Neff, 1987, 2005; Boothe and Presley, 1989). Concentrations of most metals in drilling fluids are similar to those in marine sediments, but some metals such as cadmium, copper, lead, mercury, and zinc may be elevated and contribute to elevated concentrations in the sediment within a few hundred meters of the well (Boothe and Presley, 1989). Balcom et al. (2012) conducted a study to evaluate the fate and effects of drill cuttings resulting from completion of a development well using a SBDF in deepwater offshore Ghana. The study indicated benthic impacts were limited to within several hundred meters of the wellsite and included increases in hydrocarbon levels and elevated levels of drilling-related metals, in particular barium and cadmium; physico-chemical study metrics were at ambient levels within approximately 500 m of the wellsite. Continental Shelf Associates, Inc. (2006) studied drilling discharge impacts at several sites on the Gulf of Mexico continental slope in water depths of 1033 to 1125 m. Two sites were sampled post-exploration and three sites were sampled post-development. Both WBMs and SBDFs were used at these sites. Cuttings deposits covered a maximum area of 108 ha at one post-development site, compared with about 13 ha for a single exploratory well. At both post-exploration and post-development sites, areas of SBDF cuttings deposition were associated with elevated sediment organic carbon concentrations and anoxic conditions. These changes to sediment quality due to drilling-related discharges may persist for several years, eventually returning to baseline conditions due to normal sediment movement, remixing of sediments by benthic organisms, and sediment deposition.

Concentrations of drill cuttings ingredients tend to decrease with time following deposition of both SBDF and WBM cuttings in sediments near offshore drillsites. Average concentrations in surface sediments decrease with time due to dispersion through bed transport, natural or bioturbated (biologically mediated) vertical mixing in the upper sediment column, burial and dilution by deposition of natural particulate matter, dissolution, and biodegradation. Dissolution affects the concentrations of drill cuttings ingredients in sediments that are slightly soluble in seawater. Slightly soluble cuttings ingredients include barite (under sulfate-reducing conditions); a fraction of the metals adsorbed to barite and clay particles; and several organic drilling mud additives.

The Construction Phase considers the drilling of multiple wells with the potential for cumulative deposition of drilling-related discharges. The proposed drilling activity includes four scheduled drilling sessions: sequential 2021, 2025, 2028, and 2032. CSA Ocean Sciences Inc. (2016) conducted a monitoring study for the deepwater Jubilee Field offshore Ghana that has been in production since 2010. The study findings indicated that the development activities, with the drilling of multiple development wells, affected sediment concentrations of organics and various metals, in particular barium, copper, mercury, lead, and zinc. The sediment levels of these metals do not exceed benchmark values (i.e., ERL and ERM), which indicate there is little or no potential to cause adverse ecological effects. Although the development activities had affected the concentrations of some individual parameters, there was no detectable effects on the infaunal assemblage, which served as the biological impact indicator (CSA Ocean Sciences Inc., 2016).

Metals in drilling fluid discharges exhibit very low bioavailability to marine animals (Neff et al., 1989a). Bioaccumulation of barium has been observed in some studies and not in others. Rarely has bioaccumulation of other metals been observed, and when it has, levels were not high enough to be harmful to animals or their predators (Neff et al., 1989b).

Solid Waste

During construction activities, it is possible that debris (e.g., welding rods, buckets, pieces of pipe, plastic packaging materials) may accidentally fall overboard. Heavier, non-buoyant solid waste will sink and accumulate on the seafloor where it may eventually be colonized by epibiota. Seafloor debris may leach chemicals, causing localized changes in sediment quality. This seafloor debris may provide hard substrate for recruitment of epibiota similar to that provided by Offshore Area seafloor-founded infrastructure. Depending on the amount of exposed surface area available for biotal recruitment, a fouling community may develop that may produce organic material. Effects may include very localized increase in organic content of the sediments.

7.2.4.2.2 Nearshore Hub/Terminal Area

Physical Presences

Within the Nearshore Hub/Terminal Area, sediment quality may be affected by the placement of infrastructure (i.e., breakwater, pilings, etc.). The installation of the breakwater and other bottom-founded infrastructure with any associated anchoring activities will disturb sediments creating area-wide turbidity with potential exposure and transport sediment-associated contaminants during emplacement. Of particular concern is the dredging activity associated with the breakwater installation that is required to remove an estimated 250,000 m^3 of substrate prior to placement of the breakwater materials. Where the EBS for the project conducted by CSA Ocean Sciences Inc. (2017) determined that baseline conditions of the surficial silty-sand sediment exhibited good quality, the deep sediment exposed by the dredging activities is of unknown quality. However, sediments in this region have not been exposed to industrial inputs and it is presumed that these deep sediments exposed from dredging will be of good quality.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from installation and support vessels operating at the Nearshore Hub/Terminal will have no impact on local sediment quality due to rapid dilution of these discharge in surface waters; this rapid dilution and dispersion of these discharges will be facilitated by the shallow water oceanographic conditions.

Solid Waste

It is possible that debris may accidentally fall overboard during construction activities at the Nearshore Hub/Terminal. Heavier, non-buoyant solid waste will sink to the seafloor where the material, depending on size and weight, may it will be subject to on-bottom mobilization due to shallow water oceanographic conditions and near-shore sediment transport processes. Seafloor debris could potentially leach chemicals that may cause localized changes in sediment quality.

7.2.4.2.3 Pipeline Area

Physical Presence

Along the pipeline corridor, and at the FPSO location, sediment quality will be affected via placement of infrastructure (i.e., gas and MEG pipelines, umbilicals) and FPSO anchors. The effects of these activities will be similar as previously described for the Offshore Area (see Section 7.2.4.2.1.). Structural emplacement within the Pipeline Area will cause localized disturbance of the surficial sediments in proximity to these structures within a footprint estimated to be approximately 1.2310 km^2. Effects to sediment quality should be minimal, since the baseline conditions of the surficial sediment within the Pipeline Area exhibited good quality (CSA Ocean Sciences Inc., 2017).

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from the installation and support vessels will have no impact on sediment quality within the Pipeline Area due to dispersion and rapid dilution of these discharges in surface waters.

Solid Waste

It is possible that debris may accidentally fall overboard during construction activities within the Pipeline Area. The impact to sediment quality will be similar as described in Section 7.2.4.2.1.

7.2.4.2.4 Support Operations Areas

Not applicable (see Section 7.2.4.1).

7.2.4.2.5 Summary

Impacts to sediment quality during the Construction Phase are primarily from development drilling and dredging activities. Drilling-related discharges will accumulate on the seafloor and effect sediment quality specific to bottom contours, grain size, and some chemical parameters. Although CSA Ocean Sciences Inc. (2017) determined that baseline conditions for surficial sediments to be of good quality, the deep sediment exposed by the dredging activities will be of unknown quality. Routine discharges and solid waste will have minimal effect on sediment quality during the Construction Phase.

7.2.4.3 Impact Rating

Physical Presence

The consequence of impacts to sediment quality in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area from physical presence include potential exposure and transport of sediment-associated contaminants during emplacement. The overall impact significance is 1 – Negligible due to the intensity of the impact being low with changes unlikely to be noticed against background (see Table 7-20 below for details on selected criteria).

Discharges

Routine, non-drilling related discharges from installation activities in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area are expected to produce very localized impacts through the introduction of organics (sanitary and domestic wastes; food waste) and warm water (cooling water); these impacts will be restricted to surface waters, with a very remote likelihood of reaching the seafloor. The overall impact significance is 1 – Negligible (see Table 7-20 below for details on selected criteria).

Drilling-related discharges from installation activities will be limited to the Offshore Area. Discharged drilling muds and cuttings are expected to produce localized impacts to sediment quality of moderate intensity, within approximately 1,000 m or less of each wellsite. The overall impact significance is 2 – Low (see Table 7-20 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during construction activities may occur in the Offshore Area, Nearshore Hub/Terminal Area, or within the Pipeline Area. These accidental losses are expected to produce very localized impacts to the sediment quality due to potential chemical leaching and localized organic loading associated epibiota recruitment. The overall impact significance is 1 – Negligible (see Table 7-20 below for details on selected criteria).

Summary

A summary of impact to sediment quality from routine activities during the Construction Phase is presented in Table 7-20.

Table 7-20. Impacts to Sediment Quality during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Exposure and transport of sediment-associated contaminants during emplacement.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Discharges						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Effects of routine vessel (non-drilling) discharges during construction.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Mauritania Senegal	Offshore	Changes in bottom contours, grain size, and some chemical parameters from dredging activities and discharge of drilling muds and cuttings discharges.	Nature: Negative Intensity: Moderate Spatial Extent: Immediate vicinity Duration: Short to long term[93]	Minor	Likely	2 – Low
Solid Waste						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Potential chemical leaching of solid waste materials and localized organic loading from epibiota.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible

7.2.4.4 Mitigation Measures and Residual Impacts

Most impacts to sediment quality from Construction Phase activities are rated negligible; no mitigation measures are required. For the single impact determination where a 2 – Low impact was identified, mitigation measures previously noted for Water Quality are applicable, as outlined in Table 7-21. While these mitigation measures are expected to reduce sediment quality impacts, they do not change impact consequence and have no effect on impact likelihood, leaving residual impact at the

93 Recovery of sediment quality following cessation of drilling discharges may require more than 5 years in close proximity (<500 m) to the wellsite.

same level as pre-mitigation. These mitigation measures are in addition to the measures and controls already planned in the project design, summarized as follows:

- D01: Contractors will be expected to comply with the contract terms that have been established, including HSSE standards and performance requirements.
- D05: Compliance with applicable national and international regulations (MARPOL 73/78, Annex IV and V) for waste and wastewater discharges from offshore project vessels.
- D06: A waste management plan will be developed and implemented to avoid unauthorized waste discharges and transfers, with written procedures for collection, segregation, storage, processing and disposal of waste, including use of equipment and record keeping.
- D09: Discharges of SBDF[94] mud and cuttings will be managed. SBDF cuttings will only be discharged once the performance targets of 6.9 g/100 g retained "synthetic on cuttings" on wet solids averaged over the whole well discharge can be satisfied. The concentration of SBDF on cuttings will be monitored on the drillship. No excess or spent SBDF will be discharged to the sea. Spent or excess SBDF that cannot be re-used during drilling operations will be brought back to shore for disposal. If mineral oil base drilling fluid (OPDF[95]) were to be selected, cuttings contaminated with mineral oil base drilling fluid at a concentration greater than 1% by weight mineral oil on dry cuttings will not be discharged. No OPDF will be discharged as whole fluid.
- D10: Selection of drilling chemicals will be in accordance with the BP chemical selection and waste management standards to reduce potential for environmental effect. During planning of drilling activities, where feasible, lower toxicity drilling muds and biodegradable and environmentally friendly additives within muds, cements and completion fluids will be preferentially used. If barite is used as weighting agent, it will not contain more than Hg: max 1 mg/kg dry weight in stock barite and Cd: max 3 mg/kg dry weight in stock barite.
- D13: A dredging management plan will be developed for large dredging works (breakwater, disposal areas, potential sand borrow areas offshore) and implemented that defines the dredging methodology, identifies and assesses dredged materials disposal options and sites, characterizes the composition and behavior of the sediment to be dredged, and defines the area of influence and the potential mitigation and monitoring measures. In addition, pre- and post-dredged survey will be performed.

Table 7-21. Mitigation Measures to Avoid or Reduce Impacts to Sediment Quality from Routine Activities during the Construction Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Changes in bottom contours, grain size, and some chemical parameters from dredging activities and discharge of drilling muds and cuttings discharges.	2 – Low	M03	2 – Low

Notes:

M03: Dredged material and drill cuttings will not be disposed on or near carbonate mounds and away from coastal areas. The proposed pipeline route will avoid sensitive carbonate mounds.

[94] SBM: Synthetic Based Muds; SBDF: Synthetic Based Drilling Fluids.

[95] OPDF: Organic-Phase Drilling Fluids.

7.2.5 Benthic Communities

High Level Summary

In this section on Benthic Communities, the impact of three impact producing factors, these being Physical presence, Discharges and Solid waste, was evaluated. The residual impacts on Benthic Communities during the Construction Phase for routine activities were assessed as of negligible or low significance when mitigation measures are applied.

7.2.5.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	
Discharges	●	●	●	
Solid waste	●	●	●	

With the possible exception of sound from pile driving activities, no noise effects to benthic communities are expected due to the nature of the construction-related sound. However, it is also recognized that there is a lack of documented effects from noise (auditory and physical) on benthic communities. Normandeau Associates, Inc. (2012) and Hawkins et al. (2014) identified the following information gaps: 1) determine how adult invertebrates detect sound and whether sound is used for life-sustaining functions (e.g., reproduction, migration, or feeding); 2) determine if masking of biologically important sounds occurs in adult invertebrates or causes hearing loss; 3) determine if there are potential physiological effects of man-made sound on invertebrates, including those that may not hear sounds; 4) identify anthropogenic sounds that cause behavioral changes in adult invertebrate species; and 5) determine if behavioral changes in response to sounds alter fitness in adult invertebrate species.

Pile driving activity is of particular concern as impulsive sounds generated by pile driving are characterized by a relatively rapid rise time to a high energy pressure value followed by a decay period (Hawkins et al., 2014). Based on a recent review by Hawkins and Popper (2014), there are very limited data addressing hearing by aquatic invertebrates. Available data suggest that the sensing of sound among invertebrates is in the low-frequency bands, and possibly restricted to only the particle motion component of the sound field (e.g., Mooney et al., 2010, 2012). It is important to note that particle motion is believed to be the predominant mechanism for determining pressure changes for invertebrates. Hawkins et al. (2014) refers to impacts to invertebrates from intense impulsive sound as produced from pile driving and various informational gaps to adequately characterize these impacts.

No impacts to benthic communities in Support Operations Areas are expected as these areas are on shore.

7.2.5.2 Impact Description

The Construction Phase will involve a multitude of specialized vessels specifically designed to complete various tasks, including well drilling and completion, installation of infrastructure, and support operations. These vessels and the associated infrastructure which they will install are the source of several IPFs. Physical presence (including sound from pile driving), discharges, and solid waste represent potential sources of impact to benthic communities in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area.

Most of the seafloor in the project area is expected to consist of soft-bottom benthic habitat. The conditions concerning the benthic infaunal assemblages within the project areas were characterized during the 2016 EBS conducted by CSA Ocean Sciences Inc. (Appendix D). Activities of primary concern to the benthic communities are seafloor-disturbing activities and drilling-related discharges. The United States Bureau of Ocean Energy Management (BOEM, 2012) interpreted information provided by Cranswick (2001) was used to estimate an area of seafloor disturbance between 0.5 hectares (ha) and 1.0 ha km^{-1} for pipeline or flowline installation; the higher amount of sediment disturbance is based on the requirement for active construction to bury pipelines in water depth of <61 m (BOEM, 2012). These estimates are somewhat more conservative than the 0.32 ha km-1 of sediment disturbance from passive deployment of pipeline assumed by Cranswick (2001). Based on the upper value for benthic disturbance of 1.0 ha km^{-1} from subsea infrastructure, a lateral distance of potentially impacted habitat of 5 m on either side of the centerline of the structure can be assumed. Therefore, a structure with a linear dimension of 1 m would produce a sediment disturbance footprint of 10 m^2 (1 m x 10 m); a multiplication factor of 10. Similarly, a multiplication factor of 5 would be applied as based on the lower value for benthic disturbance of 0.5 ha km^{-1} from subsea infrastructure. Estimates of benthic disturbance, for this assessment, considers area occupied by passively deployed infrastructure conservatively multiplied by a factor of 5 and for active construction activities considers a multiplication factor of 10.

The utilization of various sourced vessels has the possibility of regionally introducing invasive species. The establishment of pelagic and epibenthic biota within and on project vessels could remain viable during transit from another international location outside of the project region. There are two main pathways for the introduction of alien invasive species into new environments associated with offshore projects and operations and they are biofouling and ballast (water or sediment).

The following subsections explain how these IPFs will produce impacts to benthic communities in each of the project areas.

7.2.5.2.1 Offshore Area

Physical Presence

The drillship will not be utilizing anchors to maintain position over each wellsite; support vessels operating in the Offshore Area will not utilize anchors. Therefore, the physical presence of the drillship and support vessels will have no effect on deepwater benthic communities present within the Offshore Area.

The installation of the SPS (i.e., wellheads, jumpers, trees, manifold centres, flowline jumpers, and in-field flowlines) will disturb local sediments and indigenous benthic communities during emplacement. Benthic communities present immediately below the SPS infrastructure will be crushed; emplacement of this infrastructure will disturb sediments in the immediate vicinity via sediment suspension and redeposition. Estimates of benthic disturbance, for this assessment, considers area occupied by infrastructure conservatively multiplied by a factor of 5; this factor has been applied to the Offshore Area with passive deployment of subsea structure to estimate the areal extent of sediment disturbance. The area affected by SPS and in-field flowline emplacement via crushing and loss of benthos is estimated to be 0.0044 km^2; the area to be disturbed by construction activities outside the SPS infrastructure footprint is estimated to be approximately 0.022 km^2. Total area of benthic community impacts associated with Construction Phase physical presence from crushing and sediment disturbance in the Offshore Area is estimated to be 0.0264 km^2 (0.0044 km^2 and 0.022 km^2).

Effects to benthic communities will be variable within the area of sediment disturbance outside the SPS infrastructure footprint based on sediment displacement and deposition due to infrastructure emplacement. There will most likely be a gradient of decreasing sediment deposition with increasing distance from the infrastructure. Smit et al. (2008) evaluated the significance of depositional thickness on impacts to benthic communities. Quantified estimates from the study indicated median (50%) and low (5%) effects levels of 54 mm and 6.3 mm of sediment deposition, respectively. That is, 54 mm is the thickness estimated to adversely affect 50% of the benthos in the study, and a sediment burial thickness of 6.3 mm affected 5% of the studied benthos.

Benthic animals, to a certain extent, are also able to migrate through several centimeters of sediment following burial (Maurer et al., 1986), thereby reducing the impact from death or loss to short-term stress. Soft bottom benthic communities disturbed by sediment deposition eventually will be recolonized through larval settlement and migration from adjacent areas. Recovery of areas with thickest sediment deposition may require several years while other areas with relatively light deposition requiring significantly less time for recovery. Benthic community recovery is dependent on the nature of the indigenous fauna, their tolerance to burial, their life history characteristics (e.g., spawning and settlement characteristics), and their relative abundance in the deposition areas.

The drillship could be a source for potential invasive species via ballast water and hull established fouling community. This potential impact would be of concern if the drillship was coming from another international location outside of the tropical/subtropical North Atlantic Ocean. Mitigation for the potential invasive species impacts associated with ballast water could be addressed under the IMO Ballast Water Management Convention with exchange of ballast water mid-ocean or installation of an on-board ballast water treatment system.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from the drillship and support vessels will have no impact on deepwater benthic communities due to water depth and rapid dilution of these discharges in surface waters.

During the drilling of each well, drilling muds and cuttings discharges at the seafloor and from the drillship will affect benthic communities in relatively close proximity. Typical biological effects of drilling discharge smothering of benthic communities include sediment anoxia, direct loss (through burial), and changes in the texture and physical/chemical properties of the sediments. For each well, it is estimated that 422 m^3 of cuttings and will be discharged at the wellhead, while 219 m^3 of cuttings will be discharged from the drillship. Cuttings discharged at the wellhead and from the drillship will be accompanied by an estimated volume of 953 m^3 of WBM and 53 m^3 of adhering SBDF, respectively.

Results of the muds and cuttings discharge modeling, detailed in Appendix L, are presented in Figures 7-2 and 7-3, reflecting the anticipated deposition patterns for a single, representative well expected during both dry (November-April) and wet (May-October) seasons, respectively.

For drilling in the upper two sections (i.e., riserless drilling where muds and cuttings are discharged at the wellbore), there is little noticeable seasonal difference in the footprint shape and extent following the discharge. These sediments deposit rapidly during the first few days of operations and surround the drill site forming the more substantial cuttings pile. Discharges from the drillship for the lower well sections do reflect seasonal differences (e.g., the overall footprint [to 0.1 mm] is larger by ~20% during the May-October timeframe (wet season), and extends north and east from the drilling location), as evident in Figures 7-2 and 7-3. These seasonal differences are best reflected in a comparison of two variables – the maximum extent of deposition and total area affected – both based on relative thickness thresholds (Table 7-22).

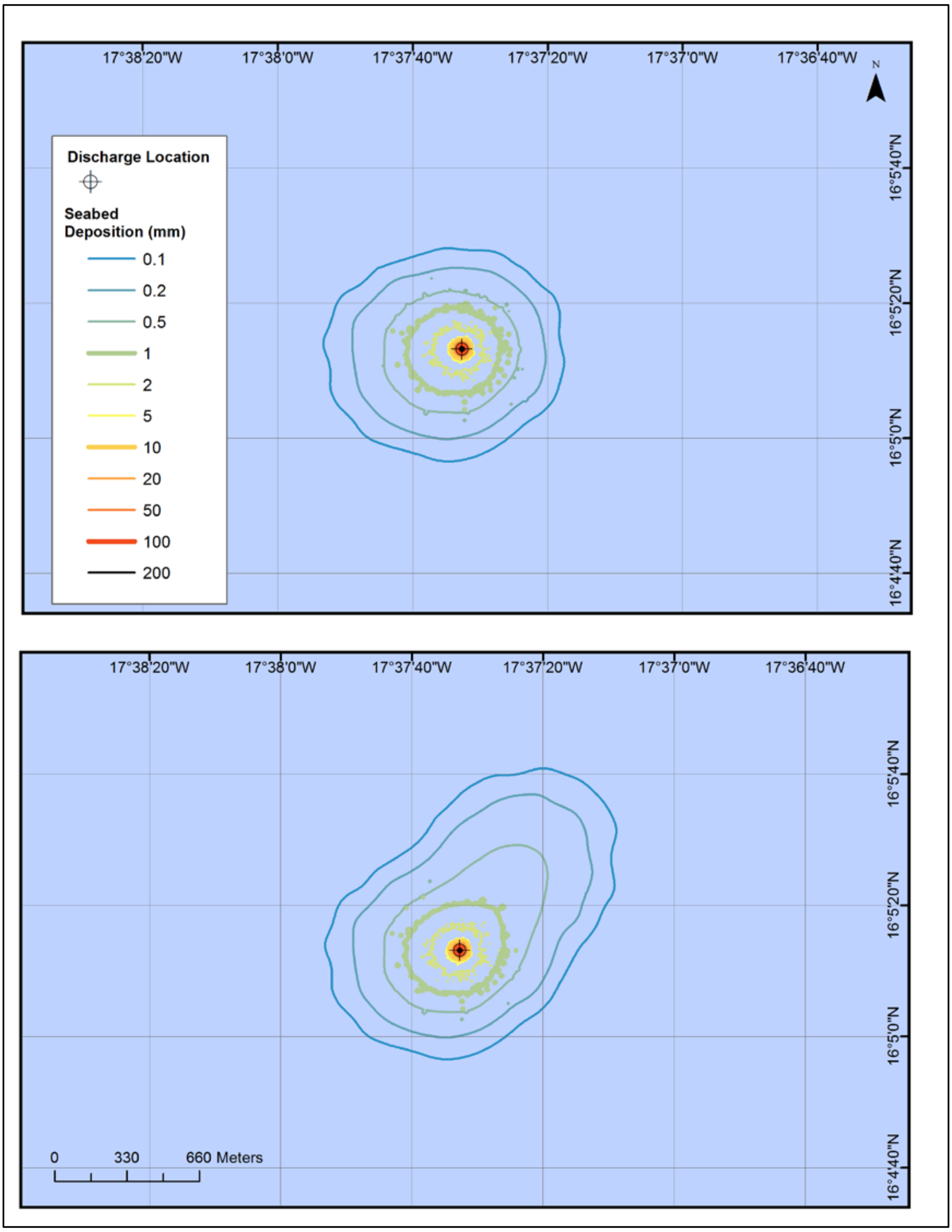


Figure 7-2. Predicted Thickness of Drilling Discharges at a Representative Well in the GTA Field during the November-April Timeframe (Dry Season).

Top: deposition resulting from the riserless drilling intervals (Sections 1 and 2). Bottom: deposition resulting from all drilling intervals.

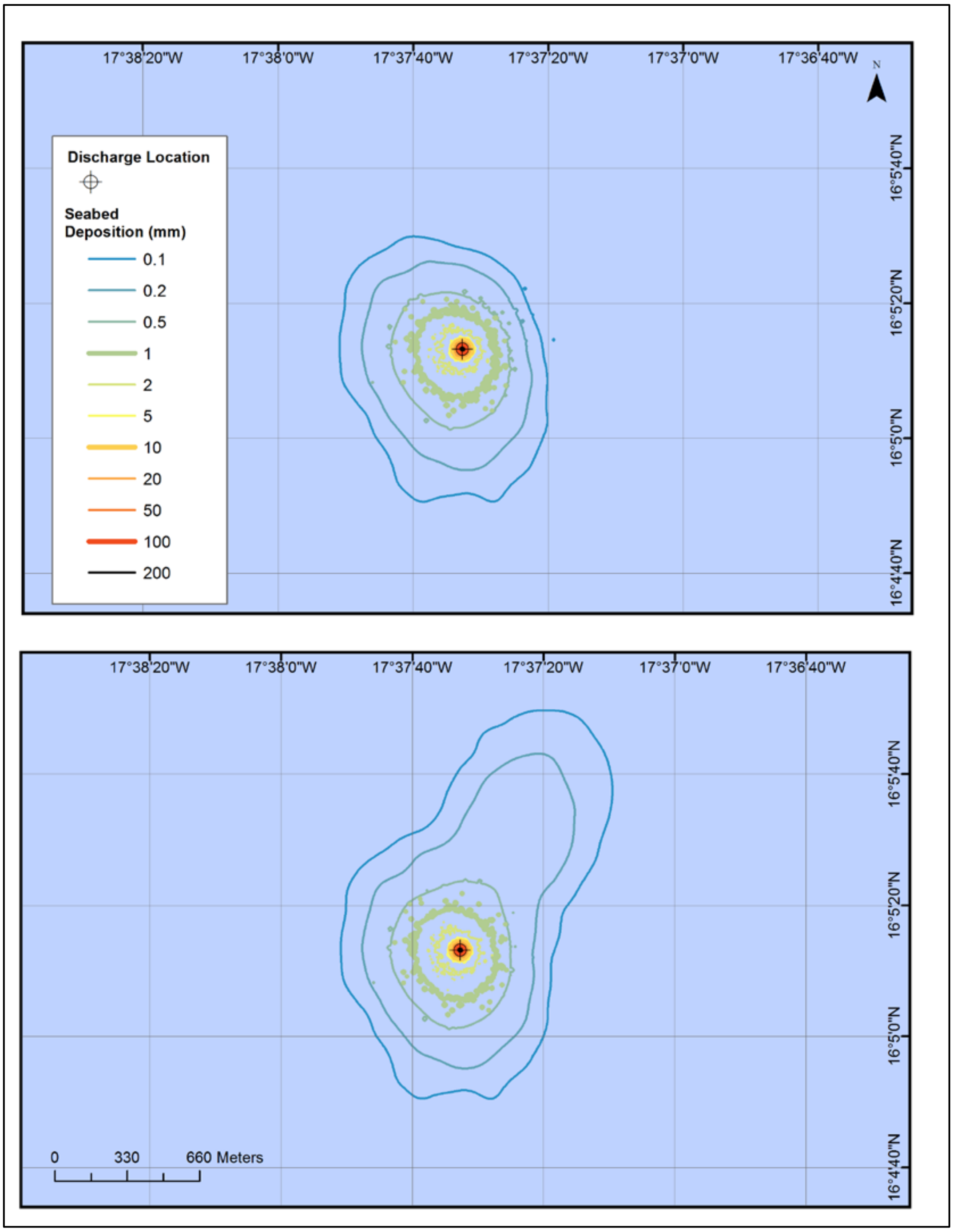


Figure 7-3. **Predicted Thickness of Drilling Discharges at a Representative Well in the GTA Field during the May-October Timeframe (Wet Season).**

Top: deposition resulting from the riserless drilling intervals (Sections 1 and 2). Bottom: deposition resulting from all drilling intervals.

Table 7-22. Maximum Extent of Thickness Contours (Distance from Release Sites) and Area of Deposition for Each Season for a Single Well.

Deposition Thickness Interval (mm)	Maximum Extent from the Well (m)		Cumulative Area Exceeding Thickness Interval (km^2)	
	Dry Season (November-April)	Wet Season (May-October)	Dry Season (November-April)	Wet Season (May-October)
0.1	960	1220	1.218	1.429
0.5	580	370	0.395	0.294
1	250	240	0.152	0.124
5	70	65	0.0099	0.0098
10	50	50	0.0059	0.0057
50	26	26	0.0019	0.0019
100	19	19	0.0010	0.0010

For the November-April timeframe (dry season), the maximum predicted cumulative drilling discharge deposition for a single well is 260 mm in the area immediately adjacent to the wellhead. Deposition of 100 mm extends up to 19 m from the well and covers a maximum aerial extent of 0.0010 km^2; deposition at 10 mm extends to 50 m and covers a maximum area of 0.0059 km^2; and deposition at a thickness of 1 mm extends a maximum of 250 m and covers 0.152 km^2 of the seabed.

For the May-October timeframe (wet season), the maximum predicted cumulative drilling discharge deposition is 240 mm. Very similar to the dry season spatial distribution, drilling discharge deposition of 100 mm extends up to 19 m from the well and covers a maximum aerial extent of 0.0010 km^2; deposition at 10 mm extends to 50 m and covers a maximum area of 0.0057 km^2; and deposition at a thickness of 1 mm extends a maximum of 240 m and covers 0.124 km^2 of the seabed.

Adopting the approach of Smit et al. (2008) for effects thresholds and applying further extrapolations for other muds and cuttings thickness levels generated by the muds and cuttings discharge model (i.e., 0.1, 0.5, and 1 mm), the following considerations (i.e., effects criteria) are noted:

- A thickness of 54 mm of muds and cuttings may be expected to affect 50% of the benthic species; this level of deposition is conservatively applied using the 50 mm results predicted by the discharge model;
- A thickness of 10 mm might be expected to affect 10% of the benthic species;
- A thickness of 6.3 mm would be expected to affect 5% of benthic species; this level is conservatively applied using the 5 mm model results; and
- A thickness of 1 mm might affect <5% but more than 1% of benthic species.

For all 12 wells in the GTA Field, the total area to realize a deposition of 1 mm or more of discharged muds and cuttings with expected effects to the benthic communities is estimated to range from 1.488 to 1.824 km^2.

Benthic community effects of drilling discharges have been reviewed extensively by the NRC (1983), Neff (1987), Hinwood et al. (1994), Neff (2005), and Neff (2010), among others. Most discharged muds and cuttings settle within a very small footprint immediately adjacent to the discharge points of drilled wells. Due to the low toxicity of most drilling fluids, the main mechanism of impact to benthic communities is increased sedimentation, possibly resulting in burial or smothering. Sedimentation effects and benthic community recovery have been assessed by several authors including Ellis et al. (2012) and Paine et al. (2014). Impacts may also arise from changes in grain size, hypoxia or anoxia resulting from burial, minor changes in sediment chemistry, and/or toxicity.

The effects resulting from the drilling of multiple wells, and the potential for cumulative deposition, have also been evaluated (see Appendix L). Considering the nature of the proposed drilling activity (i.e. four scheduled drilling sessions: sequential 2021, 2025, 2028, and 2032), there is potential for less accumulation in areas of potential overlap assuming that the benthic communities can recover between drilling sessions (Figure 7-4). Jones et al. (2012) conducted a study to assess recovery of megabenthos from physical disturbance from exploratory drilling activities which indicated this benthic community has partial recovery within a 3-year period. However, drilling-associated effects were detectable even after 10 years following drilling activities. Jones et al. (2012) qualified the findings of the study, reporting that megabenthos may recover more slowly than the benthic macroinfauna. Santos et al. (2009) conducted a study to assess the effects of drilling fluid and cuttings discharges on deep-sea macrobenthic communities offshore Brazil; findings of the study indicted recolonization and probable recovery of most of the site within one year following cessation of drilling.

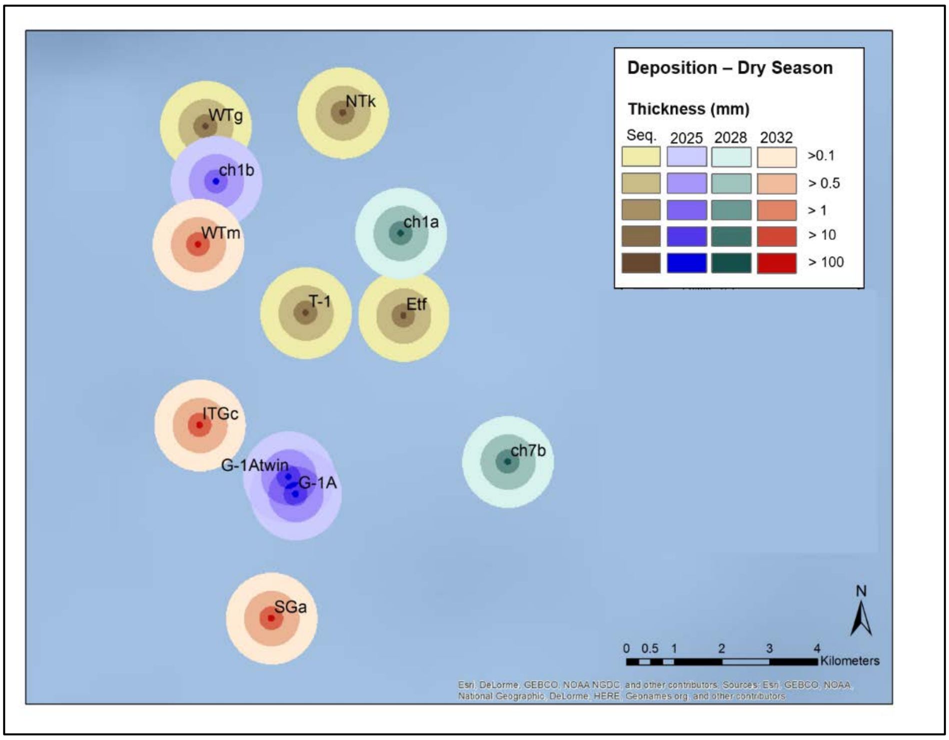
Drilling sessions are scheduled approximately three to five years apart and recovery times in the deep sea can potentially take many years. Of the four scheduled drilling sessions, there is no spatio-temporal overlap between the wells scheduled to be drilled in 2028 or in 2032 for either seasonal scenario. For the sequential wells (2021), there is 1.9% overlap for the May-October timeframe (wet season) only. The largest amount of spatio-temporal overlap occurred for the 2025 wells, with 28.7% and 35.9% overlap during the November-April and May-October timeframes, respectively. This overlap, even of the 0.1-mm depositional areas, will lead to elevated deposition thicknesses that may cause increased benthic community mortality and/or effect recovery capabilities, for a small percentage of the affected seafloor area.

Most benthic fauna live in the upper few centimeters of sediment, with benthic communities composed of varying feeding guilds – filter feeders, surface deposit feeders, subsurface deposit feeders, and carnivores. Deposit feeders, in particular, are recognized for their ability to process/ingest or move sediment during tube building and feeding (i.e., bioturbation). The maximum depth of bioturbation for soft bottom benthic communities is in the range of 4 to 5 cm for most infauna, although larger infaunal burrowers are known to extend 20 cm or more into the sediment.

Deposition of muds and cuttings will result in a localized decrease in the infaunal and megafaunal community, attributed to burial, sediment grain size changes, and an influx of organic material (i.e., producing localized areas of hypoxia or anoxia). Recovery of the benthic community will begin immediately following cessation of drilling discharges. Effects to the benthic community may be expected to persist for several years, with the severity of the impact likely correlated with the thickness and organic load of drilling muds and cuttings deposited on the seabed, local environmental conditions, and reproductive cycle of the benthic fauna. Impacts of drilling discharges on sediment quality would primarily be in the form of increased barite concentrations and changes in grain size.

Deposition of SBDF-associated cuttings, in the thickest sections, could also result in anoxic conditions within the sediment (Continental Shelf Associates, Inc., 2006; Balcom et al., 2012). Concentrations of most metals in the proposed drilling fluids would be similar to those in marine sediments (Neff et al., 1989a,b). During evaluation of the fate and effects of drill cuttings resulting from completion of a development well in deepwater offshore Ghana using NADF, Balcom et al. (2012) documented elevation of some drilling-related metals, in particular barium and cadmium, within 500 m of drilling activities.

Metals in drilling fluid discharges exhibit very low bioavailability to marine animals (Neff et al., 1989a). Bioaccumulation of barium has been observed in some studies and not in others. Rarely has bioaccumulation of other metals been observed, and when it has, levels were not high enough to be harmful to animals or their predators (Neff et al., 1989b). The sediment quality impacts of drill cuttings and muds discharges, would, therefore, not have any indirect impacts on benthic communities and benthic fauna.



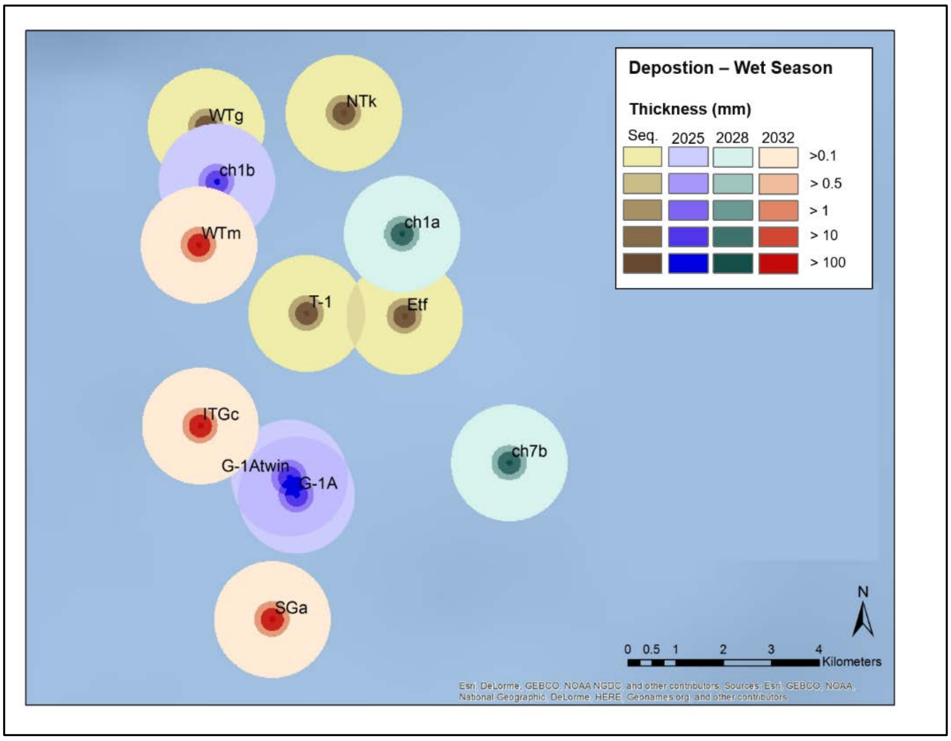


Figure 7-4. Temporal Depiction of Cumulative Deposition based on the Drill Schedule for the Dry (November-April; top) and Wet Seasons (May-October; bottom) Scenarios.

Spatial overlap is only depicted for wells scheduled for drilling within the same timeframe: sequential (2021), 2025, 2028, or 2032.

Solid Waste

During construction activities, it is possible that debris (e.g., welding rods, buckets, pieces of pipe, plastic packaging materials) may accidentally fall overboard. Heavier, non-buoyant solid waste will sink and accumulate on the seafloor where it may eventually be colonized by epibiota. Seafloor debris may leach chemicals, causing localized changes in benthic communities. The addition of debris to the seafloor will add physical structure on the otherwise flat, soft bottom seafloor. This will provide hard substrate for epibiota similar to that provided by Offshore Area seafloor-founded infrastructure.

7.2.5.2.2 Nearshore Hub/Terminal Area

Physical Presence

Within the Nearshore Hub/Terminal Area, benthic communities will be affected via placement of infrastructure (i.e., breakwater, pilings, etc.). The installation of the breakwater and other bottom-founded infrastructure with any associated anchoring activities will disturb local sediments and indigenous benthic communities during emplacement. The breakwater installation will require dredging to remove an estimated 250,000 m^3 of substrate prior to placement of the breakwater materials; these procedures of substrate removal and material placement are sequential and assumed to have a similar footprint concerning impacts to benthic communities.

Benthic communities present immediately below the breakwater and other Nearshore Hub/Terminal infrastructure will be crushed; emplacement will disturb sediments in the immediate vicinity of the infrastructure footprint via sediment suspension and redeposition. The area affected by seafloor-founded infrastructure emplacement via crushing and loss of benthos in the Nearshore Hub/Terminal Area is estimated to be 0.1635 km^2, including 0.16 km^2 for the breakwater and 0.0035 km^2 for other bottom-founded structures. For the Nearshore Hub/Terminal Area construction associated with large infrastructures of non-linear dimensions, a conservative sediment disturbance multiplication factor seems more appropriate than the 5 factor used for the Offshore and Pipeline Areas; the application of a more conservative multiplication factor is very uncertain. The higher and more conservative multiplication factor of 10 is due primarily to the high level of sediment transport within the nearshore shallow-water environment; the area expected to be disturbed by sediment displacement and redistribution is estimated to be 1.635 km^2. Total area of benthic community impacts associated with Construction Phase physical presence from crushing and sediment disturbance in the Nearshore Hub/Terminal Area is 1.8 km^2 (0.1635 km^2 and 1.635 km^2).

The use of the multiplication factor to estimate area of sediment disturbance from Nearshore Hub/Terminal Area construction is intended to account for uncertain fate of dredge material. In the absence of a definitive dredge plan, the assumption is the material will be side cast adjacent to direct dredging operations. Some of the dredge material, if considered suitable, could be used for filling caisson during breakwater construction.

Similar to other project areas, there will be a loss of benthos within the infrastructure footprint due to complete burial and smothering from emplaced structures. There will be variable levels of benthic community effects within the area of sediment disturbance outside the area of infrastructure emplacement. Benthic community effect thresholds due to sediment deposition and post-depositional recovery are discussed in Section 7.2.5.2.1. Shallow water oceanographic conditions and near-shore sediment transport processes may reduce the overall effects of localized sediment disturbances and facilitate a more expeditious recovery of the benthic community following those disturbances from infrastructure emplacement.

Pile driving will be conducted in the Nearshore Hub/Terminal Area during the Construction Phase. These activities will probably have localized impacts on the soft bottom benthic communities. Pile driving can generate longitudinal ground-borne sound waves within the seabed sediments that are more likely to affect bottom-living invertebrates than the sounds in the water column (Hawkins et al., 2014).

The impacts from the FLNG associated with potential invasive species are as described for the Offshore Area drillship.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from installation and support vessels operating at the Nearshore Hub/Terminal will have no impact on local benthic communities due to rapid dilution of these discharge in surface waters, similar to discharge-related impacts in offshore waters.

Solid Waste

It is possible that debris may accidentally fall overboard during construction activities at the Nearshore Hub/Terminal Area. The impacts will be similar to those described in Section 7.2.5.2.1. However, shallow water oceanographic conditions and near-shore sediment transport processes may significantly reduce the potential for solid waste to add physical structure to the seafloor topography within the Nearshore Hub/Terminal Area. Mobilization of solid waste in the Nearshore Hub/Terminal Area will limit the potential for colonization by epibiota.

7.2.5.2.3 Pipeline Area

Physical Presence

Along the pipeline corridor, and at the FPSO location, benthic communities will be affected via placement of infrastructure (i.e., gas and MEG pipelines, umbilicals) and FPSO anchors. The installation of the FPSO anchors and associated pipelines and umbilicals will disturb local sediments and indigenous benthic communities during emplacement. This disturbance will occur both at the FPSO location (i.e., from anchors and linear infrastructure) and along the full extent of the pipeline corridor (i.e., from linear infrastructure).

Benthic communities present immediately below each FPSO anchor and linear infrastructure will be lost due to complete burial and smothering from the emplaced structures. Anchor and linear infrastructure emplacement will displace and redistribute sediments in the immediate vicinity of the emplaced structures. The area affected by FPSO anchors and linear infrastructure via crushing and loss of benthos within the Pipeline Area is estimated to be 0.1296 km^2. Using the 5 multiplication factor based on the estimates provided by BOEM (2012), the area expected to be disturbed by sediment displacement and redistribution from construction activities is estimated to be 0.65 km^2. Total area of benthic community impacts associated with Construction Phase physical presence from crushing and sediment disturbance in the Pipeline Area is 0.78 km^2 (0.1296 km^2 and 0.65 km^2).

Similar to other project areas, there will be a loss of benthos within the infrastructure/FPSO anchoring footprint due to complete burial and smothering from emplaced structures. There will be variable levels of benthic community effects within the area of sediment disturbance outside the area of structure emplacement. Benthic community effect thresholds due to sediment deposition and post-depositional recovery are discussed in Section 7.2.5.2.1. The overall effects of localized sediment disturbances and benthic community recovery rate may be variable within the Pipeline Area due to differences in oceanographic conditions and sediment transport processes related to water depth and distance from shore.

Geophysical surveys combined with targeted drop-down camera deployment have confirmed the location of carbonate mounds in the area. If the FPSO anchor or linear infrastructure would be located close to these seabed features, there is the potential for loss of specific hard-substrate benthic communities. The proposed pipeline route has been adjusted to avoid this environmentally sensitive feature.

Pile driving will be conducted in the Pipeline Area in proximity to the FPSO during the Construction Phase. These activities will probably have localized impacts on the soft bottom benthic communities. Pile driving can generate longitudinal ground-borne sound waves within the seabed sediments that are more likely to affect bottom-living invertebrates than the sounds in the water column (Hawkins et al., 2014).

The impacts from the FPSO associated with potential invasive species are as described for the Offshore Area drillship.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from the installation and support vessels will have no impact on benthic communities within the Pipeline Area due to water depth and rapid dilution of these discharges in surface waters.

Solid Waste

It is possible that debris may accidentally fall overboard during construction activities within the Pipeline Area. The impacts will be similar to those described in Section 7.2.5.2.1.

7.2.5.2.4 Support Operations Areas

Not applicable (see Section 7.2.5.1).

7.2.5.2.5 Summary

Table 7-23 provides a summary of the total area where benthic communities will be affected during the Construction Phase as a result of physical presence from infrastructure emplacement and drilling discharges. There will be localized impacts to benthic communities in proximity to pile driving activities. Utilization of foreign vessels could potentially introduce aquatic invasive species to the region.

Table 7-23. Area of Seafloor and Associated Benthic Communities which May Be Affected by Construction Phase Activities for each Project Area.

Project Area	Total Area Affected (km^2)	
Physical Presence – All		
Area/Effect	*Loss/Crushing*	*Disturbance*
Offshore Area	0.0044	0.022
Nearshore Hub/Terminal Area	0.1635	1.635
Pipeline Area	0.1296	0.65
Total Area	2.60	
Routine Discharges – Drilling		
Area/Effect	*Area of Deposition (1 mm threshold), 12 wells*	
	Dry Season (November-April)	*Wet Season (May-October)*
Offshore Area	1.824	1.488

7.2.5.3 Impact Rating

Physical Presence

The consequence of impacts to benthic communities in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area from physical presence include disturbance due to sound, crushing of benthos immediately below infrastructure and anchors and disturbance of benthic communities in close proximity to emplaced structures due to sediment resuspension and deposition, disturbances to benthic communities in proximity of pile driving activities, and potential introduction of aquatic invasive species. Dredging operations will also remove seafloor sediments and associated benthic communities within the breakwater footprint. Soft bottom benthic communities in the project area, as well as regionally and globally, are considered ubiquitous. The benthic communities within the project areas, as characterized by CSA Ocean Sciences Inc. (2017) during the Ahmeyim/Guembeul EBS, had infauna assemblages with diversity, abundance, and taxonomic composition broadly similar to patterns observed for the region (Thiel, 1982; Duineveld et al., 1993; Le Leouff and von Cosel, 1998; Dabi, 2015; CSA, 2016). The proportional abundance of polychaetes, crustaceans, bivalves, and gastropods in the samples reflects the general phylogenetic pattern found off West Africa and other shelf-slope areas with similar substrates and water depths (Thiel, 1982; Duineveld et al., 1993; Le Leouff and von Cosel, 1998; Michel et al., 2011). Based on these findings, there should be no regional effect on benthic community productivity or diversity due to the disturbance of several square kilometers of soft bottom environment. On a local basis, the disturbance and loss of less than 3 km^2 of soft bottom environment and associated benthic community is not significant; there will be relative rapid recovery of these communities following the sediment disturbance. Recovery of hard-bottom benthic communities may take longer. Impact intensity from physical presence is low to moderate; moderate impact intensity is specific to the Nearshore Hub/Terminal Area in proximity to dredging activities with possible thick deposition of side cast materials. The extent and duration of impacts from physical presence are immediate vicinity and short term to long term, respectively. As a result, impact consequence is negligible for low intensity impacts and minor for moderate intensity impacts. Given the likely nature of these impacts, the overall impact significance is 1 – Negligible for the Offshore and Pipeline Areas and 2 – Low for the Nearshore Hub/Terminal Area (see Table 7-24 below for details on selected criteria).

Concerning the impact from invasive species, this has the potential for moderate intensity (University of Connecticut, 2018), regional influence, and long-term duration which contribute to a moderate consequence. Given the remote nature of this impact, the overall impact significance is 2 – Low (see Table 7-24 below for details on selected criteria).

Discharges

Routine, non-drilling related discharges from construction activities in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area are expected to produce very localized impacts through the introduction of organics (sanitary and domestic wastes; food waste) and warm water (relatively low volume of cooling water from construction-related vessels); these impacts will be restricted to surface waters, with a very remote likelihood of reaching the seafloor and associated benthic communities. Impact intensity from routine, non-drilling related discharges is low, with extent and duration being the immediate vicinity and short term, respectively. As a result, impact consequence is negligible. Given the likely nature of this impact, the overall impact significance is 1 – Negligible (see Table 7-24 below for details on selected criteria).

Drilling-related discharges from installation activities will be limited to the Offshore Area. Discharged drilling muds and cuttings are expected to produce localized impacts, within 1,200 m or less of each wellsite. Impact intensity from drilling related discharges is low, with extent and duration being the immediate vicinity and long term, respectively. As a result, impact consequence is negligible. Given the likely nature of this impact, the overall impact significance is 1 – Negligible (see Table 7-24 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during construction activities may occur in the Offshore Area, Nearshore Hub/Terminal Area, or within the Pipeline Area. These accidental losses are expected to produce very localized impacts to the benthos via potential chemical leaching and possibly provide hard substrate for epibiota recruitment. Impact intensity from the accidental loss of debris is low, with extent and duration being the immediate vicinity and short term, respectively. As a result, impact consequence is negligible. Given the likely nature of this impact, the overall impact significance is 1 – Negligible (see Table 7-24 below for details on selected criteria).

Summary

A summary of impact to benthic communities from routine activities during the Construction Phase is presented in Table 7-24.

Table 7-24. Impacts to Benthic Communities during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Crushing of benthic communities below infrastructure; disturbance to benthic communities from resuspension and deposition of sediments; disturbances to benthic communities from noise from pile driving.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term (sediment disturbance and noise) to Long term (crushing[96])	Negligible	Likely	1 – Negligible
Mauritania Senegal	Nearshore Hub/ Terminal	Disturbance to benthic communities from resuspension and deposition of sediments in close proximity to dredging activities.	Nature: Negative Intensity: Moderate Spatial Extent: Immediate vicinity Duration: Short term	Minor	Likely	2 – Low
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Introduction of aquatic invasive species.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Long term	Moderate	Remote	2 – Low

[96] Long term has been selected for the crushing of benthic communities by infrastructure as the impact is permanent and is also applicable to hard-substrate benthic communities, where present.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Discharges						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Effects of routine vessel (non-drilling) discharges during construction.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Remote	1 – Negligible
Mauritania Senegal	Offshore	Burial, anoxia/hypoxia and sediment chemistry changes from drilling muds and cuttings discharges.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term[97]	Negligible	Likely	1 – Negligible
Solid Waste						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Addition of hard substrate and potential leaching for accidental loss of solid waste from construction vessels.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible

7.2.5.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-25) and available mitigation measures are identified. Mitigation measures are in addition to the measures and controls already planned in the project design, summarized as follows:

- D01: Contractors will be expected to comply with the contract terms that have been established, including HSSE standards and performance requirements.
- D05: Compliance with applicable national and international regulations (MARPOL 73/78, Annex IV and V) for waste and wastewater discharges from offshore project vessels.
- D06: A waste management plan will be developed and implemented to avoid unauthorized waste discharges and transfers, with written procedures for collection, segregation, storage, processing and disposal of waste, including use of equipment and record keeping.
- D08: Ballast water will be discharged according to IMO International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM), where applicable.

[97] Although recovery of the benthic community will begin immediately following cessation of drilling discharges. Because drilling sessions are scheduled approximately three to five years apart, potential cumulative effects have been considered and a long term duration has been selected for the burial of benthic communities.

- D09: Discharges of SBDF[98] mud and cuttings will be managed. SBDF cuttings will only be discharged once the performance targets of 6.9 g/100 g retained “synthetic on cuttings” on wet solids averaged over the whole well discharge can be satisfied. The concentration of SBDF on cuttings will be monitored on the drillship. No excess or spent SBDF will be discharged to the sea. Spent or excess SBDF that cannot be re-used during drilling operations will be brought back to shore for disposal. If mineral oil base drilling fluid (OPDF[99]) were to be selected, cuttings contaminated with mineral oil base drilling fluid at a concentration greater than 1% by weight mineral oil on dry cuttings will not be discharged. No OPDF will be discharged as whole fluid.

- D10: Selection of drilling chemicals will be in accordance with the BP chemical selection and waste management standards to reduce potential for environmental effect. During planning of drilling activities, where feasible, lower toxicity drilling muds and biodegradable and environmentally friendly additives within muds, cements and completion fluids will be preferentially used. If barite is used as weighting agent, it will not contain more than Hg: max 1 mg/kg dry weight in stock barite and Cd: max 3 mg/kg dry weight in stock barite.

- D13: A dredging management plan will be developed for large dredging works (breakwater, disposal areas, potential sand borrow areas offshore) and implemented that defines the dredging methodology, identifies and assesses dredged materials disposal options and sites, characterizes the composition and behavior of the sediment to be dredged, and defines the area of influence and the potential mitigation and monitoring measures. In addition, pre- and post-dredged survey will be performed.

Table 7-25. Mitigation Measures to Avoid or Reduce Impacts to Benthic Communities from Routine Activities during the Construction Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Disturbance to benthic communities from resuspension and deposition of sediments in close proximity to dredging activities.	2 – Low	M03	1 – Negligible
Introduction of aquatic invasive species.	2 – Low	None	2 – Low

Notes:

M03: Dredged material and drill cuttings will not be disposed on or near carbonate mounds and away from coastal areas. The proposed pipeline route will avoid sensitive carbonate mounds.

7.2.6 Plankton & Fish and Other Fishery Resources

High Level Summary

In this section on Plankton & Fish and Other Fishery Resources, the impact of three impact producing factors, these being Physical presence, Discharges and Solid waste, was evaluated. All impacts on Plankton & Fish and Other Fishery Resources during the Construction Phase for routine activities were assessed as positive or as negative with a negligible significance. No mitigation measures were required.

[98] SBM: Synthetic Based Muds; SBDF: Synthetic Based Drilling Fluids.
[99] OPDF: Organic-Phase Drilling Fluids.

7.2.6.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	
Discharges	●	●	●	
Solid waste	●	●	●	

No impacts to plankton and fish and other fishery resources in Support Operations Areas are expected as these areas are on shore.

7.2.6.2 Impact Description

The details of construction, equipment, and areal coverage for the Construction Phase are discussed in Chapter 2. A screening of different IPFs associated with these activities indicated that for plankton, fish, and other fishery resources the following should be considered: physical presence, discharges, and solid waste. Although there is little specific information on any of these impacts in relation to plankton, fish, and other fishery resources, the following discussion will assume that at least some members of the regional plankton, fish, and invertebrates assemblages, including the demersal and pelagic categories discussed in Sections 4.5.1 and 4.5.4 and Appendix M, could be affected in some way by construction.

7.2.6.2.1 Offshore Area

Physical Presence

The offshore construction activities will involve the physical presence of a drillship and various support vessels. The SPS will be installed by deploying wellheads, jumpers, flowlines, and other bottom-founded structures in water depths of ~2,600 m. These activities will disturb about 0.05 km^2 of seafloor around the infrastructure array of the offshore area footprint (see Chapter 2, Table 2-3). Infrastructure placed on the seafloor will displace demersal fishes such as grenadiers, cusk-eels, and cutthroat eels from small areas and a minor loss of epifaunal and infaunal invertebrate prey items would also occur; additional discussion regarding the impacts on benthic communities is provided in Section 7.2.5. Bathypelagic and demersal fishes can be expected to move out of the construction areas while each well is being completed or during infrastructure emplacement due to noise, bottom disturbance, and elevated turbidity. Following these limited disturbances, displaced fish are likely to return and others will be attracted to the added infrastructure (Jones et al., 2012; Gates and Jones, 2012; Gates et al., 2017).

It is well known that objects such as logs or seaweed floating in the open ocean will attract and concentrate fishes (e.g., Gooding and Magnuson, 1967; Relini et al., 1994; Castro et al., 2002; USGS, 2002). Viewed in this way, such objects are called fish aggregating devices (FADs). FADs may be floating or moored and are regularly used by fishers to attract and catch tunas and other oceanic fishes (Castro et al., 2002; USGS, 2002). Oil and gas structures as well as stationary or slowly moving vessels act as FADs (e.g., USGS, 2002; Rostad et al., 2006). Open ocean fisheries employ FADs to attract tunas, dolphinfishes, and other target species (see Section 4; Appendix E-2). At the Offshore Area, the species most likely attracted to vessels will be skipjack (*Katsuwonus pelamis*) and yellowfin tuna (*Thunnus albacares*). Other fishes known from the region such as silky sharks (*Carcharhinus falciformis*), dolphinfishes (*Coryphaena* spp.), wahoos (*Acanthocybium solandri*), frigate tunas (*Auxis* spp.), billfishes (Istiophoridae), jacks (e.g., *Caranx* spp., *Seriola* spp., and *Elagatis bipinnulata*), triggerfishes (*Canthidermis* sp. and *Balistes* sp.), and chubs (*Kyphosus* spp.) would likely associate with FADs at the Offshore Area. Attraction to offshore structures may negatively affect individuals of these species by disrupting normal feeding and/or spawning migrations (USGS, 2002). Smaller fishes tend to aggregate directly beneath a floating object whereas larger species will circle the object at some distance away. Tunas ranged between 1.8 km to 9 km from a FAD with some variation among age classes (USGS, 2002).

The aggregation of fishes and invertebrates due to bottom-founded infrastructure and the FAD effect of the surface activities and structures will generate a discrete and novel habitat where none currently exists. This coupled with the exclusionary zone set around the area could lead to relaxed fishing pressure and positive benefit to resident species. This idea has been suggested for deepwater oil and gas structures but not researched (Macreadie et al., 2011; Cordes et al., 2016).

Vessels and construction activities at the Offshore Area will generate sound. Broadband (wide frequency range) sound pressure levels (SPL) at the source for most small, diesel-powered vessels are expected to be in the range of 170 to 180 dB re 1 µPa at 1 m (rms); SPLs will vary depending upon vessel size and speed. These sounds will gradually attenuate with distance from their source (see Section 2.12.4). Fishes exposed to continuous sound (such as that produced by vessels) increases their tolerance to the sounds and, in some cases, shifts hearing thresholds (Radford et al., 2014, 2016; Holles et al., 2013). While individuals are known to habituate to repeated exposure, it is not clear how such habituation of individuals may affect their populations (Edmonds et al., 2016).

Vertical Seismic Profile (VSP) surveys may be required to evaluate the geological structure of one or more wells. VSP operations involve deploying an acoustic sound source from the drillship or another vessel, while a number of receivers (geophones) are positioned at different levels within the drilled hole to measure the travel time. VSP operations are not expected to last more than one day. Impacts to plankton and fish and fishery resources are expected to be short term and localized.

Another consequence of vessel presence is lighting. Support vessels and the drillship will have navigation lights, anchor lights, and deck lights. Lights can attract zooplankters (particularly crustaceans), cephalopods (squids) and fishes (Keenan et al., 2007; Bolton et al., 2017), potentially disrupting normal behavior and potentially increasing the risk of predation. These effects will be restricted to the immediate vicinity of the vessel for the duration of drilling operations in the Offshore Area.

Discharges

Domestic wastes (sanitary and food), bilge water, deck drainage, and ballast water will be routinely discharged by the drillship and support vessels during construction at the Offshore Area. These discharges have no toxic components and will rapidly dilute; additional discussion of discharge volumes is presented in Section 7.2.2 and Chapter 2.

Discharges of drilling muds and cuttings resulting from drilling operations (at the drillship and wellheads) have the greatest potential for affecting plankton, fishes, and fishery resources. Trace metal and hydrocarbon constituents of drilling fluids can be toxic to all life stages of fishes and zooplankton if exposed to high enough concentrations (e.g., Kingsford, 1996; Koski, et al., 2017). Planktonic organisms appear to be at greatest risk, while juveniles and adults fishes passing through a discharge will not be adversely affected. The majority of fish eggs and larvae will be located in the upper 100 m of the water column and not directly exposed to discharges at the wellsites. However, surface discharges would affect the immediate water column environment around the drillship; surface discharges of SBDF cuttings are discussed in Section 7.2.5. Surface discharges of SBDF cuttings will disperse as they settle through the water column; minimal turbidity is expected. Therefore, minimal effects to plankton and fishes are expected; any effects will be limited to a very small radius around the discharge that will vary with current and sea conditions.

Ballast water discharges from vessels coming from foreign waters could potentially inoculate the area with invasive plankton species or planktonic eggs and larvae of non-native fishes or invertebrates. Support vessels coming from international ports will follow IMO (2004) Ballast Water Convention guidelines where applicable.

Discharges of muds and cuttings are expected to cover an area of approximately 1.2 to 1.4 km^2 (minimum deposition thickness: 0.01 mm). During muds and cuttings deposition, benthic fishes will be displaced by turbidity. Deepwater benthic-feeding fishes would also be displaced from small areas by seafloor structures such as anchors, manifolds, and wellheads. Some minor loss of benthic (epifaunal and infaunal) food items would also occur due to burial by muds and cuttings. As described in Section 7.2.5.1 benthic organisms will be lost from an area of about 0.152 km^2.

Solid Waste

During construction activities, debris such as welding rods, buckets, pipe segments, and other materials may accidentally fall overboard. Dense, solid waste objects will fall to the seafloor where it would be colonized by epibiota and possibly small fishes. Seafloor debris could leach chemicals into the surrounding water potentially affecting local benthic organisms. Effects on demersal fishes and invertebrates are expected to be negligible.

7.2.6.2.2 Nearshore Hub/Terminal Area

Physical Presence

Construction of the breakwater in 33 m water depths at the Nearshore Hub/Terminal Area involves crane-barges, tugboats, supply vessels, and other support vessels. Construction activities will include pile driving and rock emplacement necessary for construction of the breakwater. Vessels will be diesel-powered with sound characteristics similar to those described above for the Offshore Area. The breakwater is envisioned as a rubble mound foundation built around metallic or concrete caissons. The rubble mound foundation will require a significant amount of foundation material (rock and sand).

The breakwater area will represent a 0.16 km^2 loss of seafloor area available to benthic feeding invertebrates (crabs, shrimps, octopus, and squids) and fishes (e.g., sciaenids, haemulids, and sparids). Dredging and placement of boulders will elevate turbidity in the construction area which will temporarily affect the water column. Elevated turbidity can impair feeding by zooplankton, invertebrates, and fishes (Kjelland et al., 2015; Wilber and Clarke, 2001) but its effect at the construction area will be temporary and localized.

At the Nearshore Hub/Terminal Area, the FAD effect will be prevalent during construction as stationary and slowly moving vessels work in the area. Fish species attracted to the vessels may differ from those expected to occur at the Offshore Area (see Section 7.2.6.2.1). The regionally important fishery species, round sardine (*Sardinella aurita*), is known to aggregate around moored structures (Klima and Wickham, 1971) and will likely occur around the construction vessels at the Nearshore Hub/Terminal Area. Other species from the region such as little tunny (*Euthynnus alletteratus*), jack Crevalle (*Caranx hippos*), cobia (*Rachycentron canadum*), dolphinfishes, skipjack tunas, and frigate tunas are expected to associate with vessels during construction at the Nearshore Hub/Terminal Area. The FAD effect may divert some individuals from feeding or spawning areas or concentrate smaller prey individuals making them more vulnerable to predators (USGS, 2002). The zone restricted from fishing surrounding the construction area would possibly serve as a refuge for some species. As mentioned above for the Offshore Area, this could serve as a marine protected area providing some positive benefits to local populations (Mccreadie et al., 2011; Cordes et al., 2016).

As discussed above for the Offshore Area, sound from vessel activities will be in the frequency range of hearing for fishes and may affect some individuals in the vicinity of the source. In contrast to the relatively low level, low frequency, and continuous sound from vessel engines, sound from pile driving is high level, impulsive and repetitive, ranging from 210 to 250 dB re 1 μPa at 1 m, root mean square (rms) (see Chapter 2, Table 2-33). These exposure levels can, at close range, cause anatomical damage or mortality in fishes; at greater distances, fish hearing may be affected, potentially masking ecologically relevant sounds (Dahl et al., 2015; Halvorsen et al., 2012a, 2012b). Most fish species will likely move away from the initial exposure to this loud sound source and therefore not be subjected to sound levels that may result in lethal anatomical damage (Dahl et al., 2015).

Behavioral responses of fishes to less intensive sounds are complex and not well understood for most species (Hawkins et al., 2015). Resident or site-attached fishes will likely move some distance from the construction activities and return once the construction ceases. Migratory species would also be expected to avoid such areas by moving until conditions meet their individual tolerances or preferences. Migratory species with an affinity for structures would likely return or new individuals would recolonize the breakwater once the construction ends. Overall, effects of noise from construction-related activities would be relatively short term but could mask important communications among species and individuals during the period (e.g., Hawkins et al., 2015).

The presence of construction vessels during night time will introduce light into the environment. Night lights will enhance the attraction of some squids, plankton, and ichthyoplankton to the construction vessels (Martins and Perez, 2006; Hanlon et al., 1979). Light affinity of squids is well known and night lighting is a common way of attracting them for harvest (Solomon and Ahmed, 2016). Sardines (*Sardinella* spp.), anchovies (Engraulidae), cutlassfishes (*Trichiurus* sp.), zooplankton and ichthyoplankton are attracted by lights as well (Martins and Perez, 2006: Keenan et al., 2007). The response to lights varies among species – some will be attracted, others repelled by bright light (Barker, 2016). The congregation of invertebrates, fishes, and plankton resulting from light attraction may also attract their predators.

Discharges

Routine discharges at the Nearshore Hub/Terminal will consist of deck drainage, bilge water, ballast water, and sanitary wastes from vessels operating during the Construction Phase. These discharges will rapidly dilute. Discharges will not contain toxic components. No impacts are expected for plankton, fishes, and other fishery resources for routine discharges associated with construction activities.

As stated above in Section 7.2.6.2.1, support vessels entering the region from foreign waters will follow IMO (2004) Ballast Water Convention guidelines where applicable to prevent introduction of invasive planktonic organisms.

Solid Waste

During construction activities, debris may accidentally fall overboard. Dense, solid waste objects will fall to the seafloor where they may be colonized by epibiota and possibly small fishes. Seafloor debris could leach chemicals into the surrounding water potentially affecting local benthic organisms. Because the amount of material that may accidentally be lost is small, the effects on demersal fishes and invertebrates is expected to be negligible.

7.2.6.2.3 Pipeline Area

Physical Presence

The pipeline corridor extends from the offshore wellsites up the slope to the Nearshore Hub/Terminal, the latter of which is located at 33 m water depth. Along this route, installation of the FPSO moorings and anchors will take place in 120 m water depth. Mooring construction involves pile driving and other seafloor disturbances (see Chapter 2). The laying of the flowlines and pipeline will require multiple installation vessels. The FPSO moorings and the pipeline footprint will disturb the seafloor and displace bottom feeding fishes.

Sound will be generated by support vessels working in the pipeline area, such as the pipelay barge, and pile driving. As mentioned above under the Nearshore Hub/Terminal Area description, sound from pile driving can be lethal to fishes and close range and trigger behavioral responses over a much greater range (Dahl et al., 2015). Driving piles for the FPSO mooring system is expected to take about 18 days. Construction activities and associated sound may initially repel fishes and other fishery resources (crabs, shrimps, squids, and octopus), but these will likely return following the disruption (Jones et al., 2012).

As noted previously, the presence of lighted construction vessels during night time will attract select fish and invertebrates species, as well as their predators.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, etc.) from installation and support vessels operating in the Pipeline Area will dilute rapidly and not impact plankton, fishes, and other fishery resources. Discharges will be rapidly dispersed within tens of meters from the discharge.

Support vessels entering the region from foreign waters will follow IMO (2004) Ballast Water Convention guidelines when applicable to prevent introduction of invasive planktonic organisms.

Solid Waste

Solid waste accidentally lost overboard along the pipeline route or at the FPSO is not expected to affect plankton, fishes, and other fishery resources.

7.2.6.2.4 Support Operations Areas

Not applicable (see Section 7.2.6.1).

7.2.6.2.5 Summary

Operation of construction-related vessels and installation of infrastructure may result in both positive and negative impacts to plankton and fish and other fishery resources within the Offshore Area, Pipeline Area and Nearshore Hub/Terminal Area. At these locations, negative impacts may be expected from physical presence resulting in increased turbidity and elevated noise levels, and likely displacement of benthic fishes and possible loss of prey. Pile driving noise is high level and repetitive, and is very likely to force fishes to move away from the pile driving location. Positive impacts may be expected via attraction (e.g., FAD effect).

The discharge of drilling muds and cuttings will likely displace benthic fishes, and may affect their prey. Noise may temporarily displace fish from the immediate vicinity of construction operations. The accidental loss of debris may provide limited colonization space, and may also leach chemicals into the immediate environment.

7.2.6.3 Impact Rating

Physical Presence

The consequence of impacts to plankton, fishes, and other fishery resources in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area from physical presence include loss of seafloor feeding areas immediately below infrastructure and anchors (FPSO area only), disturbance of benthic prey in close to construction areas due to sediment resuspension and deposition. Sound from routine vessel activity may cause fishes to temporarily move from or avoid those areas. Bottom-founded and surface structures will attract fishes and invertebrates at all project areas. Attraction may divert individuals from normal feeding and spawning routes or areas. Exclusionary zones around the construction areas may protect attracted individuals from fishing pressure and would be a positive effect. Nightlights on vessels will attract plankton, some fishes, and some squids. Pile driving at the Nearshore Hub/Terminal can at close range cause anatomical damage to adult and juvenile fishes. The overall impact significance is 1 – Negligible (see Table 7-26 below for details on selected criteria).

Discharges

The interaction between marine water quality and marine flora and fauna is complex. In general, significant alterations in water quality may have an effect on marine flora and/or fauna, depending upon the nature of the host environment, the physical and/or chemical alteration being realized, the motility and sensitivity of the organisms present, and the degree and extent of exposure. It is important to note that impacts to water quality tend to be localized and transitory, particularly in open ocean systems; ambient oceanographic conditions will work to dilute and disperse discharges, with chemical contaminants moving away from the source.

Routine, non-drilling related discharges from construction activities in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area are expected to produce very localized impacts through the introduction of organics (sanitary and domestic wastes; food waste). These impacts will be restricted to surface waters and may affect plankton, some fishes and squids over a small area around each discharge. The overall impact significance is 1 – Negligible (see Table 7-26 below for details on selected criteria).

Drilling-related discharges from construction activities will be limited to the Offshore Area. Discharged drilling muds and cuttings are expected to produce localized impacts, within 1 km or less of each wellsite. The overall impact significance is 1 – Negligible (see Table 7-26 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during construction activities may occur in the Offshore Area, Nearshore Hub/Terminal Area, or within the Pipeline Area. These accidental losses are expected to cause very localized impacts to some fishes via potential chemical leaching; solid waste may also provide habitat similar to that provided by the infrastructure being installed. The overall impact significance is 1 – Negligible (see Table 7-26 below for details on selected criteria).

Table 7-26. Impacts to Plankton &Fish and Other Fishery Resources during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Displacement of benthic-feeding fishes from infrastructure footprint, avoidance of vessel, pile driving, and VSP noise, attraction/ repulsion of fishes to and from structures and vessels as artificial reefs and FADs.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term (sediment disturbance, pile driving, VSP)	Negligible	Likely	1 – Negligible
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Protection from fishing pressure of some fishes and invertebrates species attracted to the project infrastructures where the exclusion safety zones will be applied.	Not applicable	Not applicable	Not applicable	Positive
Discharges						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Effects of routine vessel (non-drilling) discharges during construction; introduction of invasive planktonic organisms in ballast water.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Mauritania Senegal	Offshore	Burial or alteration of benthic food sources for demersal fishes by drill muds and cuttings may affect plankton.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Likely	1 – Negligible

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Solid Waste						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Addition of hard substrate and potential leaching for accidental loss of solid waste from construction vessels.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible

7.2.6.4 Mitigation Measures and Residual Impacts

Impacts to plankton and fish and other fishery resources from Construction Phase activities are rated 1 – Negligible; no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D01: Contractors will be expected to comply with the contract terms that have been established, including HSSE standards and performance requirements.
- D05: Compliance with applicable national and international regulations (MARPOL 73/78, Annex IV and V) for waste and wastewater discharges from offshore project vessels.
- D06: A waste management plan will be developed and implemented to avoid unauthorized waste discharges and transfers, with written procedures for collection, segregation, storage, processing and disposal of waste, including use of equipment and record keeping.
- D07: Waste not permitted to be discharged at sea (such as waste chemicals, cooking oils or lubricating oils, biomedical waste) will be transported onshore for transfer to an approved disposal facility[100] (in-country or an international provider).
- D08: Ballast water will be discharged according to IMO International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM), where applicable.

7.2.7 Marine Flora

High Level Summary

In this section on Marine Flora, the impact of three impact producing factors, these being Physical presence, Discharges and Solid waste, was evaluated. All impacts on Marine Flora during the Construction Phase for routine activities were assessed as positive or as negative with a negligible significance. No mitigation measures were required.

[100] In this document, a treatment center can mean either a center for waste treatment or for final disposal.

7.2.7.1 Impact Producing Factors and Project Areas

The IPFs identified for marine flora resources in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Discharges		●	●	
Solid waste		●	●	

No impacts to marine flora in the Offshore Area and in Support Operations Areas are expected. Due to local water depth of the Offshore Area (approximately 2,700 to 2,800 m) and the attenuation of ambient light with depth, the seafloor within the Offshore Area is aphotic and does not support marine flora. The Support Operations Areas are located onshore and construction activities would not impact marine flora.

7.2.7.2 Impact Description

The following subsections explain how these IPFs will produce impacts in each of the project areas.

7.2.7.2.1 Offshore Area

Not applicable (see Section 7.2.7.1).

7.2.7.2.2 Pipeline Area

As described in Chapter 2, dual production flowline will extend from the Offshore Area to the FPSO. From the FPSO, a separate 30” (OD) export pipeline will extend to the Nearshore Hub/Terminal Area. A fiber optic cable will also be laid parallel to the gas export pipeline.

The laying of the flowlines and pipeline will require multiple installation vessels. Dynamically positioned pipelay vessels are expected to be used to install the production flowline from the deepwater field location to the 1,200 m water depth contour and will then install the export pipeline from a depth of 120 m to roughly 33 m at the Nearshore Hub/Terminal.

Physical Presence

The physical disturbance of seafloor during pipelaying operations during the Construction Phase may impact algal communities only at depths of the export pipeline route that are within the photic zone (which depends on ambient water clarity). The installation of the export pipeline in photic zone depths may bury macroalgae. The seafloor in this area is composed of unconsolidated sediments and it is likely that macroalgae are found only on areas of exposed rock or on exposed shell fragments. Conversely, the installation of the export pipeline in this area will serve as a positive impact for marine flora, as the pipes will provide suitable substrate for colonization by macroalgae in areas of unconsolidated sediment.

Discharges

Routine discharges from construction vessels within the pipeline area include sanitary and domestic wastes, food waste, deck drainage, cooling water, etc. It is possible that sparse algal communities may occur only at the shallowest depths of the pipeline route, and only on areas of exposed rock or on exposed shell fragments. It is not likely that discharges from pipelaying vessels and the FPSO would reach the seafloor. Components of routine discharges may be toxic to marine flora or may introduce sources of nutrients for marine bacteria, which may locally inhibit or otherwise impact marine flora. It is anticipated that these negative effects would only occur in waters rich in suspended or dissolved organic matter (Berland et al., 1972).

Solid Waste

Proposed Construction Phase activities will generate trash comprising paper, plastic, wood, glass, and metal. Accidentally discarded material could reach the seafloor and smother marine flora. However, all vessels performing work are expected to implement and comply with MARPOL 73/78., Annex V, which is designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the release of solid debris into the offshore waters may occur but is expected to be accidental. Therefore, the likelihood of this event is rare.

7.2.7.2.3 Nearshore Hub/Terminal Area

Physical Presence

The Nearshore Hub/Terminal Area is located in 33 m of water on the Mauritania and Senegal maritime border; the seafloor in this area is composed of unconsolidated sediments and it is likely that macroalgae are found only on areas of exposed rock or on exposed shell fragments. The construction of structures associated with the Nearshore Hub/Terminal may bury macroalgae. However, the installation of these structures, such as the breakwater structure will constitute a positive impact for marine flora, providing significant suitable substrate for colonization by macroalgae in areas of unconsolidated sediment. Seagrasses, if present, will be restricted to very shallow areas close to the shore at some considerable distance (>10 km) from the Nearshore Hub/Terminal Area and beyond the reach of any sediment plume induced by the project during construction activities.

Invasive marine algal and plant species may be transferred to the Nearshore Hub/Terminal Area from project-related vessels. The two logical pathways for introduction of non-indigenous algae and plants include vessel ballast water and vessel hulls (biofouling).

Discharges

Routine discharges from construction vessels within the Nearshore Hub/Terminal Area include sanitary and domestic wastes, food waste, deck drainage, cooling water, etc. They will have no impact on local marine flora due to rapid dilution of these discharge in surface waters, similar to discharge-related impacts for the Pipeline Area.

Solid Waste

It is possible that debris may accidentally fall overboard during construction activities at the Nearshore Hub/Terminal. The impact to marine flora will be similar to that described in Section 7.2.7.2.2 (i.e., smothering).

7.2.7.2.4 Support Operations Areas

Not applicable (see Section 7.2.7.1).

7.2.7.2.5 Summary

Operation of construction-related vessels and installation of infrastructure (exclusively within the photic zone) may result in both positive and negative impacts within the Pipeline Area and Nearshore Hub/Terminal Area. At these locations, negative impacts may be expected from physical disturbance resulting in increased turbidity and possible smothering of existing macroalgae. Positive impacts may be expected via the addition of new hard substrate upon which new macroalgae may settle and grow. Similar positive impacts are expected with the potential addition of new substrate at the marine-related Support Operations Areas.

7.2.7.3 Impact Rating

Physical Presence

Marine flora are not present within the Offshore Area and the section of the Pipeline Area between the wells and the FPSO; consequently, there are no impacts to marine flora within these areas. The consequence of impacts to marine flora in the inner reaches of the Pipeline Area and Nearshore Hub/Terminal Area from physical presence include habitat loss or alteration immediately below infrastructure and pipelines, and related disturbance of marine flora in close proximity due to sediment resuspension and deposition. The intensity of these impacts is low, as marine flora are not expected to occur in abundance within the footprint of project infrastructure, although impacts to these communities are likely.

Project vessels from other areas may introduce non-indigenous algae and plants to structures and seafloor within the photic zone of the project area. Introductions of non-indigenous and invasive marine flora species are problematic in some areas (Pederson et al., 2017). The likelihood of this potential impact is remote.

The extent of these negative impacts to marine flora is expected to be restricted to the immediate vicinity of construction activities. The duration of construction-related impacts is short term. Therefore, the overall impact significance is 1 – Negligible (see Table 7-27 below for details on selected criteria).

The installation of project infrastructure (production flowlines, Nearshore Terminal/Hub structures, and any construction within the Port for Supply Base marine operations) into the project area will introduce suitable hard substrate for attachment and colonization by marine flora. These structures will constitute a positive impact for the resource during the life of the project or for as long as the structures remain. The extent of this positive impact to marine flora is expected to be restricted to the immediate vicinity of construction activities. The duration of this construction-related impact is long term. Therefore, the overall impact is Positive (see Table 7-27 below for details on selected criteria).

Discharges

Routine, non-drilling related discharges from installation activities in the inner reaches of the Pipeline Area, and Nearshore Hub/Terminal Area are expected to produce very localized impacts through the introduction of organics (sanitary and domestic wastes; food waste) and warm water (cooling water) during commissioning; these impacts will be restricted to surface waters, with a very remote likelihood of reaching the seafloor and associated marine flora communities. The intensity of these impacts is low, as marine flora are not expected to occur in abundance within the footprint of project infrastructure, and impacts to these communities from routine discharges during construction activities are remote. The extent of these impacts to marine flora would be restricted to the immediate vicinity of construction activities, and the duration of construction-related impacts would be short term. Therefore, the overall impact significance is 1 – Negligible (see Table 7-27 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during construction activities may occur in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, or within the Support Operations Area. These accidental losses are expected to be minimal but may produce very localized impacts to marine flora via potential chemical leaching and providing hard substrate for epibiota similar to that provided by the infrastructure being installed. These potential impacts could only occur at the Nearshore Hub/Terminal Area and new construction associated with vessel operations at the shore base. The intensity of these impacts is low, and impacts to these communities from accidental discharges of solid waste and routine discharges during construction activities are likely. The extent of these impacts to marine flora is expected to be restricted to the immediate vicinity of construction activities. The duration of construction-related impacts is short term. Therefore, the overall impact significance is 1 – Negligible (see Table 7-27 below for details on selected criteria).

Summary

A summary of impact to marine flora communities from routine activities during the Construction Phase is presented in Table 7-27.

Table 7-27. Impacts to Marine Flora Communities during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Crushing of marine flora below infrastructure; disturbance to marine flora communities from resuspension and deposition of sediments.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term (sediment disturbance) to Long term (crushing[101])	Negligible	Likely	1 – Negligible
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Introduction of hard substrate suitable for colonization by marine flora.	Not applicable	Not applicable	Not applicable	Positive
Discharges						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Effects of routine vessel (non-drilling) discharges during construction reaching seafloor marine flora communities.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Remote	1 – Negligible
Solid Waste						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Smothering and potential leaching for accidental loss of solid waste from construction vessels.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible

[101] Long term has been selected for the crushing of marine flora by infrastructure as the impact is permanent.

7.2.7.4 Mitigation Measures and Residual Impacts

Impacts being rated 1 – Negligible or Positive; no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D01: Contractors will be expected to comply with the contract terms that have been established, including HSSE standards and performance requirements.
- D06: A waste management plan will be developed and implemented to avoid unauthorized waste discharges and transfers, with written procedures for collection, segregation, storage, processing and disposal of waste, including use of equipment and record keeping.
- D08: Ballast water will be discharged according to IMO International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM), where applicable.
- D14: Commitment to building Hub at 10 km from shore with one intended benefit of limiting impact on the seagrass beds.

7.2.8 Birds

High Level Summary

In this section on Birds, the impact of four impact producing factors, these being Physical presence, Discharges, Solid waste and Helicopter traffic, was evaluated. The residual impacts on Birds during the Construction Phase for routine activities were assessed as of low significance.

7.2.8.1 Impact Producing Factors and Project Areas

The IPFs identified for bird resources in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	●
Discharges	●	●	●	
Solid waste	●	●	●	●
Helicopter traffic	●	●	●	●

Routine discharges are not expected from facilities and vessels associated with Support Operations Areas. Therefore, no impacts from discharges to coastal and marine birds are expected.

7.2.8.2 Impact Description

The Construction Phase will involve a multitude of specialized vessels specifically designed to complete various tasks, including well drilling and completion, installation of infrastructure, and support operations.

The following subsections explain how these IPFs will produce impacts in each of the project areas.

7.2.8.2.1 Offshore Area

Physical Presence

The Construction Phase within the Offshore Area will include the presence of several vessel types, including a drillship, vessels associated with the installation of infrastructure (wellheads, jumpers, manifolds and flowlines); pipe-laying vessel(s) and support vessels. A detailed description of these vessels is found in Chapter 2.

The physical presence of vessels within the Offshore Area that are associated with the Construction Phase of the project may result in vessel strikes with individual birds, or may disturb or attract individual birds or groups of birds. Some seabird species, such as members of the Procellariidae, Laridae, and Pelicanoididae, are commonly attracted to offshore structures and vessels. Bird mortality has been documented as a result of light-induced attraction and subsequent collision with vessels or structures (Montevecchi et al., 1999; Wiese et al., 2001; Black, 2005; Montevecchi, 2006). Marine birds that occur within the project area and exhibit this behavior are typically petrels, with bird strikes typically occurring at night and occasionally resulting in mortality (Black, 2005). Migrating birds may also be attracted to vessels and structures during daylight hours. Some birds may use the vessel as a place to rest during migrations and others may remain aboard the vessel, oftentimes perishing before the vessel reaches shore. Vessels must display navigational lights that are internationally recognized (Convention on the International Regulations for Preventing Collisions at Sea (72 COLREGS) or the Inland Navigation Rules (33 CFR Subchapter E), but may also utilize lighting as necessary for illuminating decks during operations. The latter lighting illuminates surrounding waters and so may provide an attraction for birds for resting aboard the vessel or for foraging (fishes, squid, or zooplankton), there is a very low potential for bird collision since the proposed vessels will be stationary or will move relatively slowly (7.4-11.1 km/hr [4-6 kn]). Impacts to migrating birds that are attracted to project vessels are very low. Therefore, impacts from bird collisions on a vessel are not expected to be significant to either individual birds or their populations.

Marine birds, such as gulls, terns, some tubenoses (procellariids) and jaegers, may also be attracted to stationary vessels, structures, and moving vessels as a foraging strategy, it has particularly been noted with commercial fishing vessels. Stationary vessels in offshore waters such as the drillship may function as Fish Aggregation Devices (FADs) and so may attract various pelagic fish and squid species, as well as provide a safe platform for resting or roosting birds that forage on these pelagic resources. Moving vessels (or stationary vessels using dynamic positioning (DP) equipment may injure or kill pelagic fish from contact with the moving hull or propellers, therefore, ship-following by marine birds is a common behavior. Overall, given the low potential for collision or gear entanglement, any impacts from attraction to stationary or moving vessels are not expected to result in mortality or serious injury to individual birds.

Some project vessels may also disturb individual or groups of marine birds; however, it is anticipated that these disturbances would consist of short-term displacement of individuals away from the vessel or vessel aggregation. No significant impacts to these birds are expected.

Sound from vessels associated with the Construction Phase within the Offshore Area may disturb marine birds. Vessels are one of the main contributors to overall noise in the sea (NRC, 2003a; Jasny et al., 2005). The Construction Phase vessels would contribute to the overall noise environment by transmitting noise through both air and water. Underwater noise produced by vessels is a combination of narrow-band (tonal) and broadband sound. Tones typically dominate up to about 50 Hz, whereas broadband sounds may extend to 100 kHz. According to Southall (2005) and Richardson et al. (1995), vessel noise typically falls within the range of 100-200 Hz. Sounds produced by individual vessels can contribute to overall ambient noise levels in the marine environment on variable spatial scales. Birds have a relatively restricted hearing range, and data suggest their range of hearing for airborne sounds is from a few hundred hertz to about 10 kHz (Dooling and Popper, 2000). There are limited data regarding bird hearing range for underwater noise, and there is no evidence that birds use underwater sound.

Some marine birds (such as petrels, shearwaters, and gulls) either rest on the water surface, skim the water surface, or shallow-dive for only short durations. Members of these families would not come in contact with underwater sound generated from Construction Phase vessels, or the contact would be for such a short time (seconds per dive) that it would result in little disruption of behavioral patterns or other non-injurious effects. Diving seabirds including some terns, pelicans, and gannets) may be slightly more susceptible to underwater sound. These species commonly plunge dive for prey species; however, these dives rarely last more than a few seconds. Overall, marine birds would either not be exposed to underwater noise generated from Construction Phase vessels, or any exposure would be for such a short time that it would result in little disruption of behavioral patterns or other non-injurious effects.

Flaring from the drillship is proposed only during drill stem testing and well completion. It is possible that terrestrial migrant birds or seabirds may be incinerated following their attraction to and disorientation from an active gas flaring event. Information on mortality rates associated with collision and incineration of seabirds remains uncertain (Ronconi et al., 2015). Despite the flaring being of short duration, some mortality of birds associated with flaring cannot be ruled out.

Discharges

Routine discharges from construction vessels within the Offshore Area include sanitary and domestic wastes, food waste, deck drainage, cooling water, etc. During the drilling of each well, drilling muds and cuttings will be discharged at or near the seafloor. Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in sub-surface currents. Therefore, it is not likely that marine birds will encounter discharged materials from Construction Phase vessels.

Solid Waste

Plastic is found in the surface waters of all of the world's oceans and poses a potential hazard to most marine life, including seabirds through entanglement or ingestion (Laist, 1987). The ingestion of plastic by marine and coastal birds can cause obstruction of the gastrointestinal tract, which can result in mortality. Plastic ingestion can also include blockage of the intestines and ulceration of the stomach. In addition, plastic accumulation in seabirds has also been shown to be correlated with the body burden of polychlorinated biphenyls (PCBs), which can cause lowered steroid hormone levels and result in delayed ovulation and other reproductive problems (Pierce et al., 2004).

Construction Phase activities will generate trash comprising paper, plastic, wood, glass, and metal. Most trash is associated with galley and offshore food service operations. All vessels associated with Construction Phase activities will comply with MARPOL 73/78. Within MARPOL Annex V, Regulations for the Control of Pollution by Garbage from Ships, which comprise regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

Helicopter Traffic

Potential impacts to marine and coastal birds from aircraft traffic include disturbances from physical presence, and collision. Sound generated by project-related helicopters that are directly relevant to birds include airborne sounds from passing aircraft for both individual birds on the sea surface and birds in flight above the sea surface. Helicopters generate sound from their engines, airframe, and rotors. The dominant tones are generally below 500 Hz (Richardson et al., 1995), which is within the auditory range of birds. Aircraft sound entering the water depends on aircraft altitude, the aspect (direction and angle) of the aircraft relative to the receiver, and sea surface conditions. The level and frequency of sounds propagating through the water column are affected by water depth and seafloor type (Richardson et al., 1995). Because of the expected airspeed (250 km/hr [135 kn]), sound generated by helicopters is expected to be brief in duration (Komenda-Zohnder et al., 2003); however, birds can be disturbed up to 1 km away from an aircraft (Efroymson et al., 2000).

The physical presence of low-flying helicopters can disturb marine birds, including those on the sea surface as well as those in flight. Behavioral responses to flying aircraft include flushing the sea surface into flight or rapid changes in flight speed or direction. These behavioral responses can cause collision with the survey aircraft. However, Efroymson et al. (2000) reported that the potential for bird collision decreases for aircrafts flying at speed greater than 150 km/hr. In addition, the FAA recommends that aircraft fly at a minimum altitude of 610 m or more above ground over noise sensitive areas such as National Parks, National Wildlife Refuges, Waterfowl Production Areas, and Wilderness Areas (USDOT, FAA, 2004).

Helicopter personnel transfer is only expected for changeout during well drilling (i.e., airport to the drillship), or during emergencies. Based on this schedule and helicopter flight protocols, impacts to birds are expected to be infrequent, short-term, and not severe to local populations.

7.2.8.2.2 Pipeline Area

Physical Presence

The physical presence of vessels within the pipeline area that are associated with the Construction Phase of the project (i.e., construction vessels and the FPSO) may result in vessel strikes with individual birds, or may disturb or attract individual birds or groups of birds. As discussed in Section 7.2.8.2.1, some seabird species are commonly attracted to offshore structures and vessels, and bird mortality has been documented as a result of light-induced attraction and subsequent collision with vessels or structures. Nonetheless, there is a very low potential for bird collision since the proposed vessels will be stationary or will move relatively slowly during construction operations.

Birds may also be attracted to stationary vessels, structures, and moving vessels as a foraging strategy, and stationary vessels such as the FPSO may function as Fish Aggregation Devices (FADs) and so may attract various pelagic fish and squid species, as well as provide a safe platform for resting or roosting birds that forage on these pelagic resources. Moving vessels (or stationary vessels using dynamic positioning (DP) equipment may injure or kill pelagic fish from contact with the moving hull or propellers. Therefore, ship-following by marine birds is a common behavior. Given the low potential for collision or gear entanglement, any impacts from attraction to stationary or moving vessels are not expected to result in mortality or serious injury to individual birds.

Some project vessels may also disturb individual or groups of marine birds; however, it is anticipated that these disturbances would consist of short-term displacement of individuals away from the vessel or vessel aggregation. No significant impacts to these birds are expected.

As discussed in Section 7.2.8.2.1, sound from vessels associated with the Construction Phase within the Pipeline Area may disturb marine birds. Some marine birds (such as petrels, shearwaters, and gulls) either rest on the water surface, skim the water surface, or shallow-dive for only short durations and so would not come in contact with underwater vessel and equipment noise generated from Construction Phase vessels, or the contact would be for such a short time that it would result in little disruption of behavioral patterns or other non-injurious effects. Diving seabirds (including some terns, pelicans, and gannets) may be more susceptible to underwater sound generated from Construction Phase vessels and equipment.

Discharges

Routine discharges from construction vessels within the offshore area are discussed in Section 7.2.8.2.1. Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in sub-surface currents. Therefore, it is not likely that marine birds will encounter discharged materials from Construction Phase vessels.

Solid Waste

Potential impacts to birds from solid debris in offshore waters are discussed Section 7.2.8.2.1. All vessels associated with Construction Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

Helicopter Traffic

Potential impacts to marine and coastal birds from aircraft traffic include disturbances from physical presence, and collision. Helicopter traffic directly relevant to birds are discussed above in Section 7.2.8.2.1. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the FPSO).

7.2.8.2.3 Nearshore Hub/Terminal Area

Physical Presence

Within the Nearshore Hub/Terminal Area, marine birds may be disturbed during the installation of infrastructure (i.e., breakwater, pilings, etc.). The construction of the nearshore hub/terminal will use a variety of vessels, such as a heavy construction vessel to drive foundation piles, and for breakwater construction. Rocks for construction of the breakwater will be transported to the construction site via rock dumper vessel or barge, likely operating 24 hours/day for 12-18 months. The physical presence of these vessels and construction activities aboard these vessels may impact marine birds. Impacts from physical disturbance are expected to include avoidance of or displace from the construction area by individuals or groups of birds, while some birds may be attracted to lights and structures. When considering the length of time estimated for construction, it is expected that some birds may become accustomed to the presence of these vessels and construction activities. Because these activities are either static or moving slowly, it is expected that disturbances will not significantly affect local populations.

Construction activities will generate both in-air and underwater noise that may impact marine birds. Impact pile driving is a method used to install piles for marine and inland water construction projects using impact hammers. The installation of hollow steel piles in this manner can produce high sound levels in the surrounding waters and as in the air. The intensity of sound from pile driving depends on several factors, including the impact hammer type, energy output, and height above the ground, pile material and dimensions (diameter, wall thickness, length, etc.), soil type and ground surface. In air, measured sound pressure levels at 50 feet from pile drivers averaged 110 dB re 20 µPa peak (WSDOT, 2007). Examples of peak underwater sound pressure levels measured from impact pile driving are on the order of 220 dB re 1 µPa at a range of ~10 m from 0.75-m-diameter piles (Reinhall and Dahl, 2011) and on the order of 200 dB re 1 µPa at a range of 300 m from piles that are 5 m in diameter (Lippert and von Estorff, 2014). Pile driving activities may cause behavioral disturbances in marine birds; specifically, startle behavior and displacement or avoidance from the construction area. Plunge diving species may be exposed to potentially harmful sound levels if foraging is carried out near the construction location.

Construction activities, particularly the construction of the breakwater, will disturb local sediments and water quality. In addition to the quarry rock, the breakwater is also anticipated to require either metallic or concrete caissons (estimated at 18). Ballast material will be required to fill the caissons (estimated quantity detailed in Section 2.7.2) and sand for potential replacement of the soft ground as founding stratum. The breakwater will require seafloor preparation and a foundation of rock. As discussed in Section 7.2.5, the area affected by seafloor-founded infrastructure emplacement (via crushing) in the Nearshore Hub/Terminal Area is estimated to be 0.1635 km^2, including 0.16 km^2 for the breakwater and 0.0035 km^2 for other bottom-founded structures; the area expected to be disturbed is estimated to be 1.5583 km^2. The total area affected by seafloor disturbance in the Nearshore Hub/Terminal Area is 1.72 km^2. These activities, particularly dredging of unsuitable seabed for the installation of the breakwater and other bottom-founded infrastructure will affect marine bird foraging within the proximity of the construction area. This, in addition to effects from physical presence, may result in the displacement of birds from the area around the Nearshore Hub/Terminal during the construction period.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from installation and support vessels operating at the Nearshore Hub/Terminal are the same as those discussed for the Offshore Area (Section 7.2.8.2.1). Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in sub-surface currents. Therefore, it is not likely that marine birds will encounter discharged materials from Construction Phase vessels.

Solid Waste

Potential impacts to birds from solid debris in offshore waters is discussed Section 7.2.8.2.1. All vessels associated with Construction Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

7.2.8.2.4 Support Operations Areas

Physical Presence

Support operations infrastructure may disturb birds within both coastal and inshore (terrestrial) habitats. Infrastructure will include a supply base in Dakar and/or Nouakchott, and heliports in airports at Dakar and Nouakchott. The supply base will include equipment and material storage areas, and operations and maintenance centers. The base will support the arrival and departure of project support vessels, and will support loading/offloading supplies and equipment being transported to and from the drillship, the FPSO and the hub/terminal area. The potential impacts to birds from supply base operations may be more difficult to assess, as many species or individuals of species are likely to become more accustomed to the presence of the fixed base structures and activities. There are expected to be two or three personnel transfers per week by crew boat for the FPSO and the hub/terminal from the shore base and, the operation of the crew boat(s) may also occur on a 24 hour per day, 7 days per week, 365 days per year basis. The transit of these vessels to and from the supply base may startle and temporarily displace coastal and marine birds. In addition, other activities at the supply base (i.e., equipment and material storage, and maintenance) may disturb birds but these effects are not expected to be significant for local bird populations.

Helicopter Traffic

Helicopter traffic associated with the transfer of personnel to the FPSO and nearshore hub may affect local birds, including terrestrial species, and coastal and marine species. The potential effects of helicopters to birds are discussed in Section 7.2.8.1 and include physical presence (collisions and disturbances) and noise. Helicopter support will be based out of the airports in Dakar and/or Nouakchott. Helicopter personnel transfer is only expected for changeout during well drilling (i.e., airport to the drillship), or during emergencies (e.g., landing aboard the FPSO or QU Platform). Based on this schedule and helicopter flight protocols discussed in Section 7.2.8.2.1, impacts to birds are expected to be infrequent, short-term, and not severe to local populations.

Discharges

Not applicable (see Section 7.2.8.1).

Solid Waste

Potential impacts to birds from solid debris is discussed Section 7.2.8.2.1. All operations (shore base and crew boat) associated with Construction Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage. Therefore, the amount of trash and debris released in nearshore waters would be minimal and only accidental. In addition, the shore base and crew boats would implement a waste management plan that would include guidance for marine debris awareness. Impacts to coastal and marine birds from solid waste is not expected to be significant to local bird populations.

7.2.8.2.5 Summary

Operation of construction-related vessels and helicopters, and installation of infrastructure may result in negative impacts to birds present in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area, and to a lesser extent at the Support Operations Areas. Physical presence and noise may disturb birds, while the presence of vessels and accessible infrastructure may attract birds. Discharges and the accidental loss of solid waste has the potential to adversely affect birds in proximity to these sources, while helicopter traffic and associated noise may be sources for disturbance.

7.2.8.3 Impact Rating

Physical Presence

The physical presence of equipment and construction in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, and the Support Operations Areas may present both positive and negative impacts to birds, including short-term behavioral alterations and possible displacement. During construction, these activities may cause short term avoidance or displacement of some individual marine birds from discrete areas. Similarly, construction activities at the supply base may similarly affect some coastal and terrestrial birds. It is difficult to accurately predict the degree of bird avoidance of these areas during the construction period, considering the variability in behavioral responses by birds to anthropogenic activities and the fact that the construction is largely static in location. Therefore, the intensity of these negative impacts is low, as these impacts are expected not to affect the integrity of marine, coastal, and some terrestrial birds or their use of the environment. These impacts during construction activities are likely to occur, although their extent is expected to be restricted to the immediate vicinity of construction activities. The duration of construction-related impacts is short term. The significance of these negative impacts is 1 – Negligible (see Table 7-28 below for details on selected criteria).

Flaring from the drillship during well stem testing and well completion may incinerate some terrestrial migrant birds or seabirds that are attracted to or disoriented by the flare. The numbers of mortalities are uncertain, but it is not expected to cause population level effects. Impact intensity is moderate and local, and the effects are short term, resulting in a minor impact consequence. The likelihood of this impact during the Construction Phase is occasional. Therefore, overall impact significance to birds is 2 – Low.

Individual marine birds (particularly gulls and terns) may be attracted to construction activities such as drilling and offshore construction. As discussed above, the drillship (during drilling) may attract prey species for marine birds and would provide structure for roosting. Similarly, offshore support vessels and structures would similarly provide structure. Some marine birds may be attracted to construction activities that may move prey species into shallow depths. The change of behavior would be regarded as a negative impact, with a low impact intensity in the immediate vicinity of the vessels and facilities and short term in nature, and resulting in a negligible impact consequence. Given the likely nature of this impact, overall impact significance is 1 – Negligible.

Discharges

Routine, non-drilling related discharges from installation activities in the Offshore Area, Pipeline Area, and the Nearshore Hub/Terminal Area are expected to produce very localized impacts through the introduction of organics (sanitary and domestic wastes; food waste) and warm water (cooling water); these impacts will be restricted to surface waters. The volumes and frequency of these discharges is not expected to impact bird prey items, such as fishes and benthic organisms (in nearshore waters). The intensity of these impacts is low, possibly affecting only few individuals, and impacts to bird communities from routine discharges during construction activities are remote. The extent of these impacts to birds is expected to be restricted to the immediate vicinity of construction activities. The duration of construction-related impacts is short term. Therefore, the overall impact significance is 1 – Negligible (see Table 7-28 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during construction activities may occur in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, or within the Support Operations Areas. These accidental losses are expected to be minimal but may produce very localized impacts to marine and coastal birds via ingestion of small particles (plastic) or entanglement in debris. The intensity of these impacts is moderate, as ingestion or entanglement would likely result in mortality to individual birds. These impacts, however, are remote. The extent of these impacts to birds is restricted to the immediate vicinity of construction activities. The duration of construction-related impacts is short term. Therefore, the overall impact significance to local bird communities is 1 – Negligible (see Table 7-28 below for details on selected criteria).

Helicopter Traffic

Potential impacts to marine and coastal birds from aircraft traffic include disturbances from physical presence and collision. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the FPSO or QU Platform). Based on this schedule and helicopter flight protocols, impacts to birds are expected to be infrequent, short-term, and not severe to local populations. The intensity of these impacts is low, consisting of possible collisions with individual birds and behavioral alterations to individuals or groups of birds. Collisions between helicopters and birds are considered remote, whereas disturbances are likely. The extent of impacts to birds from helicopter traffic is restricted to the flight path from the shore base to the drillship (immediate vicinity) and the duration of construction-related impacts is short term. Therefore, the overall impact significance is 1 – Negligible (see Table 7-28 below for details on selected criteria).

Summary

A summary of impact to birds from routine activities during the Construction Phase is presented in Table 7-28.

Table 7-28. Impacts to Bird Communities during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Avoidance or displacement from areas under construction for some species; Noise disturbances from construction activities, particularly pile driving.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Mauritania Senegal	Offshore	Incineration of individual birds from well stem test flaring at the drillship.	Nature: Negative Intensity: Moderate Spatial Extent: Immediate vicinity Duration: Short term	Minor	Occasional	2 – Low
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Attraction to structures during construction.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Discharges						
Mauritania Senegal	Nearshore/ Hub Terminal; Pipeline; Support Operations	Direct or indirect effects of routine vessel (non-drilling) discharges during construction.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible
Solid Waste						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Accidental release of solid waste from construction vessels resulting in impacts from ingestion by or entanglement of marine and coastal birds.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Remote	1 – Negligible

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Helicopter Traffic						
Mauritania Senegal	Offshore; Pipeline: Nearshore Hub/ Terminal; Support Operations.	Displacement and avoidance of helicopters in offshore waters and when approaching heliports.	Nature: Negative Intensity: Low Spatial Extent: Localized Duration: Short-term	Negligible	Likely	1 – Negligible

7.2.8.4 Mitigation Measures and Residual Impacts

Summary of existing measures inherent to design and operational controls:

- D01: Contractors will be expected to comply with the contract terms that have been established, including HSSE standards and performance requirements.
- D05: Compliance with applicable national and international regulations (MARPOL 73/78, Annex IV and V) for waste and wastewater discharges from offshore project vessels.
- D06: A waste management plan will be developed and implemented to avoid unauthorized waste discharges and transfers, with written procedures for collection, segregation, storage, processing and disposal of waste, including use of equipment and record keeping.
- D15: The FLNG and FPSO will be designed, constructed, and operated to avoid routine flaring[102].
- D16: Lighting will be reduced to the extent that worker safety and safe & secure operations is not compromised. Reduction of light may include avoiding use of unnecessary lighting, shading, and downward lighting where possible.
- D17: Development and implementation of a wildlife handling and rescue protocol for the FLNG and FPSO vessels and project patrol boats.
- D29: Develop and implement a flaring protocol with the intention to meet defined operational combustion performance.

For those impacts rated 1 – Negligible, no mitigation measures are required. Table 7-29 outlines the available mitigation measures recommended to reduce impact consequence or likelihood associated with construction-related impacts to birds.

Table 7-29. Mitigation Measures to Avoid or Reduce Impacts to Birds from Routine Activities during the Construction Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Incineration of individual birds from well stem test flaring at the drillship.	2 – Low	None	2 – Low

[102] Routine flaring is defined in Section 7.3.1.

By avoiding routine flaring as part of design and operational controls, the probability of the occasional incineration of individual birds is much reduced, but not remote. The residual impact remains of low significance.

7.2.9 Marine Mammals

High Level Summary

In this section on Marine Mammals, the impact of five impact producing factors, these being Physical presence, Vessel movements, Discharges, Solid waste and Helicopter traffic, was evaluated. The residual impacts on Marine Mammals during the Construction Phase for routine activities were assessed as of negligible significance when mitigation measures are applied.

7.2.9.1 Impact Producing Factors and Project Areas

The IPFs identified for marine mammal in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	●
Vessel movements	●	●	●	●
Discharges	●	●	●	
Solid waste	●	●	●	●
Helicopter traffic	●	●	●	●

7.2.9.2 Impact Description

The following subsections explain how these IPFs will produce impacts in each of the project areas.

The Construction Phase within the Offshore Area will include the presence of several vessel types, including a drillship, vessels associated with the installation of infrastructure (wellheads, jumpers, manifolds and flowlines), and support vessels. A detailed description of these vessels is found in Section 2.2.1.

Several project-related IPFs identified for marine mammals during construction activities include the effects of sound. These include physical presence of and sound from drilling, pile driving, seismic survey (VSP), vessel and helicopter activities. A background of information on anthropogenic sound and its effects on marine mammals is presented in Appendix G and summarized below.

Natural or anthropogenic sounds can adversely affect marine mammals. Richardson et al. (1995) proposed four conceptual zones of influence of anthropogenic sounds on marine mammals, which in order of decreasing distances from a sound source include the zone of audibility, zone of masking, zone of responsiveness, and zone of hearing loss, discomfort, or injury.

These zones of influence can be used to broadly describe the nature of potential response and impact from acoustic exposure.

For this discussion, four effect categories from anthropogenic sound are discussed: 1) mortality and non-auditory physiological effects, 2) auditory effects – hearing threshold shift, 3) auditory masking, and 4) stress, disturbance, and behavioral responses.

Direct physical injury, which may result in mortality, might occur at close range to a sound source due to exposure to high levels of impulsive sound, characterized by rapid changes in pressure and shock wave, such as explosives (e.g., effects on gas-filled cavities; embolism; Ketten, 1995; Landsberg, 2000); however, no mortality or mortal injury from exposure to sound from air gun sources (commonly used during E&P activities such as seismic surveys, vertical seismic profiling and site or geohazard surveys) has been documented in any marine mammal. Considering the potential mitigation measures that may be implemented, it is highly unlikely that any marine mammal would be exposed to levels sufficient to cause mortality.

The minimum sound level an animal can hear at a specific frequency is called the hearing threshold. Too much exposure to sound at a certain amplitude at a specific frequency might cause a shift in the animal's hearing threshold. Threshold shifts can be reversible (i.e., temporary threshold shift [TTS]) or irreversible (i.e., permanent threshold shift [PTS]) (Finneran et al., 2005; Southall et al., 2007). Several important factors relate to the type and magnitude of hearing loss, including exposure level, accumulation of acoustic energy, frequency content, duration, and temporal pattern of exposure. A range of mechanical effects and metabolic processes within the auditory system underlie TTS and PTS.

Data indicate that TTS onset in marine mammals is more closely correlated with the cumulative SEL (SEL_{cum}) and should be considered a primary measure of potential impact, not just the single strongest pulse (L_{pk}) (National Science Foundation [NSF] and U.S. Geological Survey [USGS], 2011). The SEL_{cum} metric integrates the total received sound energy over time; it represents the accumulation of acoustic energy and is advantageous because it accounts for cumulative sound exposure, sounds of differing duration, and different sound signal types. It also allows for comparison between different sound exposures based on total energy.

Auditory masking is defined as an auditory process by which the hearing threshold for a signal of interest is raised by the presence of other signals or general background noise (masking noise) (ISO18405:2017). Sound can affect hearing and partially or completely reduce an individual's ability to effectively communicate; detect important predator, prey, and/or conspecific signals; and detect important environmental features associated with spatial orientation (Clark et al., 2009). Spectral, temporal, and spatial overlap between a masking noise and a signal to be detected by the sender/receiver determines the extent of interference; the greater the overlap, the greater the potential for masking. Although masking effects have been documented in a number of species, it is difficult to quantify the survival or reproductive consequences of masking on an individual or on the population (Wood et al., 2012).

Stress in marine mammals from exposure to sound typically involves the sympathetic nervous system. Romano et al. (2004) noted that no quantitative approach to estimating changes in mortality or fecundity because of stress has been identified, and that qualitative effects may include increased susceptibility to disease and early termination of pregnancy. Wright and Kuczaj (2007) note that there are large data gaps regarding specific physiological effects that chronic, repetitive, or even acute exposure to anthropogenic sound may have on cetaceans and other marine mammals, referencing prior efforts conducted to summarize stress-related studies (e.g., Fair and Becker, 2000; Nowacek et al., 2007).

Disturbance is one of the main concerns of the potential impacts of anthropogenic sound on marine mammals, which may be manifest as behavioral response or changes in normal behavior (e.g., cessation of feeding; alteration of migratory pathway, etc. Behavioral responses of marine mammals to anthropogenic sound exposure have been reviewed on several occasions over the past decade (e.g., Nowacek et al., 2007; Southall et al., 2007; NSF and USGS, 2011; Gomez et al., 2016). One determination common to these reviews is that behavioral responses, even within a species, vary greatly as a function of biological and environmental parameters. Wartzok et al. (2003) categorized these biological and environmental parameters into 1) internal, animal-specific factors that affect an individual's response to anthropogenic sounds; and 2) external factors related to the context of exposure that mediate the probability of different types of behavioral responses.

Existing data suggest that mysticetes have better hearing sensitivities than odontocetes at lower frequencies, and several studies suggest potential avoidance of a source at received SPLs of approximately 120 dB re 1 µPa (rms) during migration (e.g., a 0.5 probability of avoidance by gray whales of a continuous sound source was observed by Malme et al. [1988]).

Acoustic responses of cetaceans to sound source used during seismic surveys include reduced vocalization rates (Goold, 1996) or cessation of singing (McDonald et al., 1995). Other short-term vocal adjustments observed across taxa exposed to elevated ambient sound levels include shifting call frequency, increasing call amplitude or duration, and ceasing to call (Nowacek et al., 2007).

7.2.9.2.1 Offshore Area

Marine mammals that occur or may occur within the project areas are discussed in Section 4.5.6. The Offshore Area may support mysticete whales, sperm whale, *Kogia* spp., beaked whales, pilot whale, pygmy killer whale, false killer whale, melon-headed whale, Risso's dolphin, *Stenella* spp., rough-toothed dolphin and Fraser's dolphin.

Physical Presence

Impacts to marine mammals from drilling, and construction and support vessels include behavioral disturbance from the physical presence of these vessels, and sounds generated by drilling and installation operations. The physical presence of support vessels and construction activities in offshore and shelf waters may lead to short term avoidance of these areas by individuals and groups of marine mammals.

Construction activities in all three areas (Offshore, Pipeline, and Nearshore Hub/Terminal) would generate sounds that could disturb marine mammals. Underwater sounds are classified according to whether they are continuous or impulsive in character. Continuous sounds occur without pauses and are typically produced by the ambient environment, ships, or rotating machinery such as pumps. Impulsive sounds are of short duration and occur singly, irregularly, or as part of a repeating pattern. The periodic impacts from a piling rig or a geophysical survey result in a patterned impulsive sequence. Pulses typically sound like clicks or bangs and may include a broad range of frequencies (Government of South Australia, 2012).

Sounds produced during drilling activities are classified as continuous, or non-pulsed. These sounds include strong tonal components at low frequencies (<500 Hz), including infrasonic frequencies in at least some cases (Richardson et al., 1995). Machinery sounds can be continuous or transient, and variable in intensity. Source levels vary with the type of drilling rig and the water depth. Source levels for drillship have been reported to be as high as 191 dB re 1 µPa m (rms) during drilling (Richardson et al., 1995). The range of audibility radii is based on the sound source level and local attenuation from factors such as water depth, seafloor characteristics, and sea state conditions (Farcas et al., 2016).

The current acoustic sub-injurious threshold established by NMFS for continuous sounds is 120 dB_{rms} re 1 µPa. This threshold was based on avoidance responses observed in whales, specifically from research on migrating gray whales and bowhead whales (Malme et al., 1983, 1984, 1988; Richardson et al., 1986, 1990; Richardson and Malme, 1993; Dahlheim and Ljunblad, 1990). It is expected that sound levels above this threshold value would elicit alterations of behavior, i.e., changes in swimming direction or speed. However, studies indicate that the sensitivity of marine mammals to drilling sound varies between and within species (Richardson et al., 1990). The distance at which sound levels decrease to below this or any other sound threshold level is dependent on the source levels for a given sound source and environmental parameters such as water depth, sound speed profile and seabed conditions. Measurements of unweighted drilling sounds from a drillship off Greenland found the distance to the 120 dB_{rms} re 1 µPa. isopleth (at a depth of 100 m) at approximately 8 km from the source (Kyhn et al., 2011).

During the Construction Phase within the Offshore Area, Vertical Seismic Profile (VSP) surveys may be required (Section 2.12.4). The type of sounds produced by seismic air gun sound sources (including VSP surveys) are intermittent, or pulsed. Sound sources used during seismic surveys can potentially result in auditory impairment (PTS or TTS), auditory masking-related effects, stress, disturbance, and behavioral responses in marine mammals (Richardson et al., 1995; NRC, 2003a; 2005; Nowacek et al., 2007; Southall et al., 2007). Behavioral responses vary, but may include changes in feeding; diving behavior; swimming speed and direction; calling frequency, duration, and intensity; avoidance of an ensonified area; or no response. Available mitigation guidelines for offshore seismic surveys, such as those outlined by the JNCC (2017) or BOEM (2016) may decrease the potential for marine mammals to be present within a prescribed auditory exclusion zone around the seismic source array (usually 500 m from the source array). However, the zone of potential behavioral and disturbance responses will extend well beyond the exclusion zone.

Acoustic sound sources for proposed VSP surveys include air guns. Calculated radial distances to any of the acoustic threshold isopleths (i.e., NMFS SPL thresholds) from a source such as an air gun array are dependent upon the size and orientation of the sound source and the physical characteristics of the marine environment and sediments (e.g., water column stratification, water depth, and nature of the seafloor). As an example of the variability in acoustic propagation from an offshore seismic source, an example of modeled propagation variability is presented in Table 7-30. Acoustic propagation from a described seismic source to two acoustic thresholds (180 dB SPL [rms] and 160 dB SPL [rms]) was modeled at several locations along the eastern seaboard of the United States as part of an assessment of potential impacts from high energy seismic air gun sounds on marine resources for the Bureau of Ocean Energy Management (BOEM, 2017); it should be noted that the size of the air gun array for a VSP survey is typically smaller than the 5,400 in^3 array characterized in Table 7-30, which would produce smaller radial distances. The 180 dB SPL (rms) threshold corresponded with a now dated acoustic threshold for injury in marine mammals due to impulsive sound, whereas the 160 dB SPL (rms) threshold corresponds with the current acoustic threshold for behavioral effects in marine mammals. Each acoustic modeling scenario was characterized by a unique combination of parameters. The main variables in the environment configuration included the bathymetry and the sound velocity profile in the water column. The geoacoustic properties of the sea bottom were directly correlated with the water depth of the modeling site. The major factor that affects sound propagation in different areas throughout the modeled area was the water depth.

Table 7-30. Summary of the Predicted Threshold Radii (in Meters) for the 180 and 160 dB SPL (rms) for a 5,400 in^3 Air Gun Array Source.

Scenario	Water Depth (m)	Season	Air Gun Array 5,400 in^3			
			Radius to 180 dB SPL (rms)		Radius to 160 dB SPL (rms)	
			R_{max}	$R_{95\%}$	R_{max}	$R_{95\%}$
1	2,560	Winter	876	827	5,720	5,184
2	3,200	Spring	855	829	5,322	5,026
3	3,200	Summer	853	827	5,320	5,013
4	3,010	Fall	871	846	5,360	5,098
5	3,580	Fall	845	819	5,450	5,069

Abbreviations: Rmax – maximum radius; R95% - radius calculated for 95% of the modeling exercises.

Source: BOEM, 2017

Most marine mammal species that are likely to occur within the region are cetaceans, with one pinniped. The vast majority of these species fall within the low- or mid-frequency hearing category (Table 4-7). While low-frequency cetaceans would be expected to hear air guns, the mid-frequency cetacean species have auditory bandwidths that overlap only slightly with the frequencies of maximum air gun output. For most of the mid-frequency cetacean species, including the sperm whale, the injury criteria proposed by Southall et al. (2007) and general conclusions on behavioral response would be expected to be applicable; direct recent information on behavioral responses in sperm whales to seismic air guns is available (e.g., Miller et al., 2009). For the mysticete whales that may occur in the area (blue whale, fin whale, humpback whale, sei whale, and Bryde’s whale), as is the case for all low-frequency cetaceans, no direct information regarding hearing is available. Information on the auditory response of mysticetes has been approximated through anatomical studies of dead animals and modeled from other vertebrate hearing. It is therefore possible that auditory threshold models for mysticetes do not represent their entire auditory response capabilities.

Overall, the potential for impacts of noise related to VSP surveys on marine mammals varies depending on the characteristics of the seismic source array, differences in sound propagation relative to the physical environment, and biological factors, including the hearing frequency range of marine mammal species, its state of activity, individual hearing loss, previous exposure to anthropogenic sound types, life history stage, reproductive status, and health status. Past studies on the reactions of animals to anthropogenic sound have shown widely varied responses, depending on the individual, context, age, gender, and activity in which the animals were engaged (Simmonds et al., 2003). Sound from offshore seismic operations, including VSP surveys, could alter the behavior of cetaceans (Gordon et al., 2004; Castellote and Llorens, 2016), although the ability to detect and measure any change in behavior or determine the critical factors that drive a change in behavior are difficult to determine. Some factors may be related to the sound exposure, such as received level and proximity of the source, but the elicited behavior may also depend on other factors (e.g., social context, physical environment; see Cato et al., 2016).

The survey design and duration of possible VSP survey(s) associated with the proposed project is unknown at this time; however, the survey area will probably be limited, and the duration of the survey is not expected to extend beyond a 10- to 12-day period.

Vessel Movements

Impacts to marine mammals from construction and support vessels include the potential for vessel strike with individual mammals, behavioral disturbance from the movement of these vessels, and sound generated by these vessels.

Movement of Project-Related Vessels

Many marine mammal species may be vulnerable to physical disturbance from or collisions (ship strike) with moving vessels (Laist et al., 2001; Douglas et al., 2008; Pace, 2011). Most reports of collisions involve large whales, but collisions with smaller species also occur (van Waerebeek et al., 2007). Laist et al. (2001) provides records of the following vessel types associated with collisions with whales (listed in descending order): tanker/cargo vessels; whale watch vessels; passenger linslowers; ferries; naval vessels; recreational vessels; USCG vessels; fishing vessels; research vessels; dredges; and pilot boats. Most severe and lethal whale injuries involved large ships of lengths greater than 80 m. Vessel speed was also found to be a significant factor, with most (89%) of the records involving vessels moving at 14 kn (26 km/hr) or greater. There are reports of collisions between moving vessels and most of the listed species that occur within the project area, particularly the fin whale (IWC, 2011).

Marine mammal species of concern for possible ship strike with all vessels operating at speed include primarily slow-moving species and deep-diving species while on the surface (e.g., sperm whales, pygmy/dwarf sperm whales, and beaked whales). Generally, it is assumed that the probability of this encounter, and thus impact, is very low. Certain cetacean species, including dolphin species (e.g., *Tursiops truncatus* and *Stenella* spp.), actively approach vessels moving at speed to swim within the pressure wave produced by the vessel's bow.

Underwater Sound

The types of sound produced by construction vessels are non-pulsed, or continuous. As discussed in Section 7.2.8.2.1, vessel sounds are a combination of narrow-band (tonal) and broadband sound (Richardson et al., 1995).

The current acoustic sub-injurious threshold established by NMFS for continuous sounds is 120 dB_{rms} re 1 µPa. It is anticipated that the supply vessel remaining on standby near the drillship will produce lower but continuous sound levels compared to the drillship, as it is expected to be idling while on station. These sound levels are expected to be within the audible range for all cetacean and pinniped species above current NMFS 120 dB_{rms} re 1 µPa threshold for non-injurious harassment by continuous sound sources at a substantial distance from the source (NMFS, 2016).

The effects of sound produced by moving vessels associated with construction activities on marine mammals are difficult to assess because of the uncertainty of existing background and future project vessel-related sound levels, and the variability of observed behavioral responses, both between and among species. Several species of small toothed cetaceans have been observed to avoid boats when they are approached to within 0.5-1.5 km (0.3-0.9 mi), with occasional reports of avoidance at greater distances (Richardson et al., 1995). Reports of responses of cetacean species to moving power vessels are variable, both between species and duration. Most beaked whales tend to avoid approaching vessels (e.g., Würsig et al., 1998) and may dive for an extended period when approached by a vessel (e.g., Kasuya, 1986). Northern bottlenose whales (*Hyperoodon ampullatus*), on the other hand, are sometimes quite tolerant of slow-moving vessels (Reeves et al., 1993; Hooker et al., 2001). Dolphins may tolerate boats of all sizes, often approaching and riding the bow and stern waves (Shane et al., 1986). At other times, dolphin species that are known to be attracted to boats will avoid them. Such avoidance is often linked to previous boat-based harassment of the animals (Richardson et al., 1995). Coastal bottlenose dolphins that are the object of whale watching activities have been observed to swim erratically (Acevedo, 1991), remain submerged for longer periods of time (Janik and Thompson, 1996; Nowacek et al., 2001), display less cohesiveness among group members (Cope et al., 1999), whistle more frequently (Scarpaci et al., 2000), and be restless often (Constantine et al., 2004) when boats were nearby. Pantropical spotted dolphins (*Stenella attenuata*) and spinner dolphins (*S. longirostris*) in the eastern tropical Pacific, where they have been targeted by the tuna fishing industry because of their association with these fish, show avoidance of survey vessels up to 11 km away (Au and Perryman, 1982; Hewitt, 1985), whereas spinner dolphins in the Gulf of Mexico were observed bowriding the survey vessel in all 14 sightings of this species during one survey (Würsig et al., 1998). Harbor porpoises tend to avoid boats. In the Bay of Fundy, Polacheck and Thorpe (1990) found harbor porpoises to be more likely to be swimming away from the transect line of their survey vessel than swimming toward it and more likely to be heading away from the vessel when they were within 400 m of it. Similarly, off the west coast of North America, Polacheck and Thorpe (1990) observed harbor porpoises avoiding a survey vessel by moving rapidly out of its path within 1 km of that vessel.

From these reports, it is conservative to assume that sound associated with Construction Phase vessels may, in some cases, elicit behavioral changes in individual marine mammals that are in close proximity to these vessels. These behavioral changes may include evasive maneuvers such as diving or changes in swimming direction and/or speed. Vessel and equipment noise is transitory and generally does not propagate at great distances from the vessel.

Discharges

Routine discharges from construction vessels within the Offshore Area include sanitary and domestic wastes, food waste, deck drainage, cooling water, etc. During the drilling of each well, drilling muds and cuttings will be discharged at or near the seafloor.

Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in sub-surface currents. Therefore, it is not likely that marine mammals will encounter discharged materials from Construction Phase vessels.

Solid Waste

Lost and discarded marine debris, particularly those items made of synthetic materials, is a major form of marine pollution. The types of objects most commonly encountered in offshore waters include plastic bags, wrappers, bottles, cups, and raw plastic pellets; synthetic rope; glass bottles; metal cans; lumber; and cigarette butts (Laist, 1996, 1997; Barnes et al., 2009; Gregory, 2009). Factors that account for recent increases in marine debris include unlawful disposal practices, proliferation of synthetic materials that are resistant to degradation in the marine environment, and increasing numbers of people using and disposing of more synthetic items. Marine debris poses two types of potentially negative impacts to marine biota, including marine mammals: (1) entanglement, and (2) ingestion. Records suggest that entanglement is a far more likely cause of mortality to marine mammals than ingestion-related interactions. Entanglement records for marine mammals show that entanglement is most common in pinnipeds, less common in mysticete cetaceans, and rare among odontocete cetaceans (Laist et al., 1999). Entanglement data for mysticete cetaceans may reflect a high interaction rate with active fishing gear rather than with marine debris. Abrasion and chafing scars from rope and line have been reported on numbers of photographed North Atlantic right whales in the western North Atlantic. These scars were attributed to entanglement in fishing gear (USDOC, NMFS, 2005). Entanglement records for odontocete cetaceans that are not clearly related to bycatch in active fisheries are almost absent (Laist, 1996).

It is anticipated that construction activities will generate trash made of paper, plastic, wood, glass, and metal. Most of this trash is associated with galley and offshore food service operations. All vessels associated with Construction Phase activities will comply with MARPOL 73/78. Within MARPOL Annex V, Regulations for the Control of Pollution by Garbage from Ships, which comprise regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

Helicopter Traffic

It is expected that drilling activities would be supported by a helicopter between the drillship and onshore supply base.

Sounds generated by project-related aircraft that are directly relevant to marine mammals include both airborne sounds to individual mammals resting on the sea surface and underwater sounds from air-to-water transmission from passing aircraft. Helicopters generate noise from their engines, airframe, and rotors. The dominant tones are generally below 500 Hz (Richardson et al., 1995) and is within the auditory range of all marine mammals. Richardson et al. (1995) reported received sound pressure levels (in water) from aircraft flying at altitudes of 152 m were 109 dB re 1 µPa for a Bell 212 helicopter. Helicopters are about 10 dB louder than fixed-wing aircraft of similar size (Richardson et al., 1995). Penetration of aircraft noise into the water is greatest directly below the aircraft; at angles greater than 13º from the vertical, much of the sound is reflected and does not penetrate into the water (Richardson et al., 1995). The duration of underwater sound from passing aircraft is much shorter in water than air; for example, a helicopter passing at an altitude of 152 m that is audible in air for 4 min may be detectable underwater for only 38 s at 3 m depth and for 11 s at 18 m depth (Richardson et al., 1995). Levels of noise received underwater from passing aircraft depend on the aircraft's altitude, the aspect (direction and angle) of the aircraft relative to the receiver, receiver depth and water depth, and seafloor type (Richardson et al., 1995). Because of the relatively high expected airspeed (250 km/hr) and these physical variables, aircraft-related noise (including both airborne and underwater noise) is expected to be brief in duration.

The movement of low-flying aircraft can also disturb marine mammals, particularly individuals resting on the sea surface. Observations made from low altitude aerial surveys report behavioral responses of marine mammals are highly variable and range from no observable reaction to diving or rapid changes in swimming speed or direction (Efroymson et al., 2002; Smultea et al., 2008). Minke whales have responded to helicopters at an altitude of 230 m by changing course or slowly diving (Leatherwood et al., 1982). Observational data of marine mammals exposed to sound from other sources (i.e., non-aircraft) may also be relevant in evaluating aircraft-based noise exposure impacts. For example, Frankel and Clark (1998) note that humpback whales exposed to low frequency sound may be responding to features of the source of the sound such as sound gradient or changes in the frequency spectrum rather than to the level itself.

7.2.9.2.2 Pipeline Area

Marine mammals that may occur within the Pipeline Area include the same species as described within the Offshore Area (Section 7.2.9.2.1), plus bottlenose dolphin and Atlantic humpback dolphin. The Mediterranean monk seal may also transit through this area.

The Construction Phase within the Pipeline Area will include the presence of several vessel types, including pipe-laying vessel(s) and support vessels, and vessels supporting the installation of the FPSO. A detailed description of these vessels is found in Section 2.2.2.

Physical Presence

Impacts to marine mammals from construction and support vessels within the Pipeline Area include behavioral disturbance from the physical presence of these vessels, and sounds generated by installation operations. Pipelaying activities are expected to generate continuous, transient, and variable sound levels. In other areas, the 120-dB re 1 μPa at 1 m (rms) isopleth for pipelaying activities was predicted to extend 6.0 kilometers from the source, encompassing an area of 113 square kilometers (Port Dolphin Energy LLC, 2012). Sounds produced during pipelaying activities would be continuous and activities would progress slowly through the pipeline route. It is anticipated that these sounds may result in disturbances to some marine mammals, although these disturbances are expected to include short term avoidance or displacement behavior, only.

Vessel Movements

Impacts to marine mammals from construction and support vessels include the potential for vessel strike with individual mammals, behavioral disturbance from the movement of these vessels, and sounds generated by these vessels.

As discussed in Section 7.2.9.2.1, marine mammal species, particularly large whales and deep-diving species, may be vulnerable to physical disturbance from or collisions (ship strike) with moving vessels. Generally, it is assumed that the probability of this encounter, and thus impact, is very low. Certain cetacean species, including dolphin species (e.g., *Tursiops truncatus* and *Stenella* spp.), actively approach vessels moving at speed to swim within the pressure wave produced by the vessel's bow. Most of the project-related vessel traffic associated with Pipeline Area construction will travel at relatively slow speeds and so it is unlikely that construction activities will result in vessel collisions with marine mammals.

As discussed in Section 7.2.9.2.1, construction activities would generate vessel sounds that could disturb marine mammals. Sound source levels from construction vessels, including the pipelaying vessels and FPSO installation support vessels described in Section 2.2.2 are expected to be relatively low. Broadband source levels for most vessels are anticipated to be in the range of 170 to 180 dB re 1 μPa at 1 m (rms) (Richardson et al., 1995), which are within the audible range for all cetacean and pinniped species and, near the source, exceed current NMFS threshold for non-injurious harassment by continuous sound sources (NMFS, 2016).

The effects of sounds produced by moving vessels associated with construction activities on marine mammals are difficult to assess because of the uncertainty of existing background and future project vessel-related sound levels, as well as the variability of observed behavioral responses, both between and among species. From these reports, it is conservative to assume that noise associated with construction may, in some cases, elicit behavioral changes in individual marine mammals that are in close proximity to these vessels. These behavioral changes may include evasive maneuvers such as diving or changes in swimming direction and/or speed. Vessel and equipment noise is transitory and generally does not propagate at great distances from the vessel.

Discharges

Routine discharges from construction vessels within the pipeline area are discussed in Section 7.2.8.2.1. Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in sub-surface currents. Therefore, it is not likely that marine mammals will encounter discharged materials from Construction Phase vessels.

Solid Waste

Potential impacts to marine mammals from solid debris in offshore waters are discussed Section 7.2.9.2.1. All vessels associated with Construction Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

Helicopter Traffic

Sound generated by project-related helicopters that are directly relevant to marine mammals are discussed above in Section 7.2.9.2.1. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the FPSO). Based on this schedule and helicopter flight protocols discussed in Section 7.2.9.2.1, impacts to marine mammals are expected to be infrequent and result only in behavioral disturbances, such as avoidance (diving).

7.2.9.2.3 Nearshore Hub/Terminal Area

Marine mammals that may occur within the Nearshore Hub/Terminal Area include species that may occur within continental shelf waters, particularly Atlantic spotted dolphin, bottlenose dolphin, and Atlantic humpback dolphin, and possibly the Mediterranean monk seal.

The Construction Phase within the Pipeline Area will include the presence of several vessel types, including a heavy construction vessel, tugs, and support vessels, and supply vessels. A detailed description of these vessels is found in Section 2.2.3.

Physical Presence

Impacts to marine mammals from construction activities and support vessels within the Nearshore Hub/Terminal Area include behavioral disturbance from the physical presence of installation vessels, and both underwater and airborne sound generated by installation operations.

Impact pile driving is discussed in Section 7.2.8.2.3 Examples of peak underwater sound pressure levels measured from impact pile driving are approximately 220 dB re 1 μPa at a range of ~10 m from 0.75-m-diameter piles (Reinhall and Dahl, 2011) and approximately 200 dB re 1 μPa at a range of 300 m from piles that are 5 m in diameter (Lippert and von Estorff, 2014). Most of the sound energy usually occurs at lower frequencies between 100 Hz and 1 kHz; therefore, these sounds are audible to low and mid frequency cetaceans and pinnipeds (Mediterranean monk seal). These sound impulses of pile driving activities may disrupt marine mammal behavior at ranges of many kilometers and have the potential to induce hearing impairment at close range (Dahl et al., 2015). It is likely that marine mammals would avoid areas with injurious sound levels; therefore, the most significant consequences from pile driving to marine mammal populations are likely to occur as a result of a behavioral response rather than direct physical injury or mortality.

Vessel Movements

Within the Nearshore Hub/Terminal Area, marine mammals may be impacted by vessel movement and noise associated with the installation of infrastructure (i.e., breakwater, pilings, etc.). Rocks for construction of the breakwater will be transported to the construction site via rock dumper vessel or barge, likely operating 24 hours/day for 12-18 months.

As discussed in Section 7.2.9.2.1, marine mammal species may be vulnerable to physical disturbance from or collisions (ship strike) with moving vessels. Generally, it is assumed that the probability of this encounter, and thus impact, is very low. Most local cetacean species that are likely to occur near the Nearshore Hub/Terminal Area are dolphins which may easily evade moving vessels and may, on occasion, actively approach a vessel moving at speed to swim within the pressure wave produced by the vessel’s bow. Most of the project-related vessel traffic associated with Pipeline Area construction will travel at relatively slow speeds and so it is unlikely that construction activities will result in vessel collisions with marine mammals.

As discussed in Section 7.2.9.2.1, construction activities would generate vessel noise that could disturb marine mammals. Broadband source levels for most vessels are anticipated to be in the range of 170 to 180 dB re 1 μPa at 1 m (rms) (Richardson et al., 1995), which are within the audible range for all cetacean and pinniped species Distances to the current NMFS threshold for non-injurious harassment by continuous sound sources may extend substantial distances from the sources, and animals within this zone may experience some behavioral disturbances (NMFS, 2016).

The effects of noise produced by moving vessels associated with construction activities on marine mammals are difficult to assess because of the uncertainty of existing background and future project-related vessel noises, as well as variability of observed behavioral responses, both between and among species. From these reports, it is conservative to assume that noise associated with construction may, in some cases, elicit behavioral changes in individual marine mammals that are in close proximity to these vessels. These behavioral changes may include evasive maneuvers such as diving or changes in swimming direction and/or speed. Vessel and equipment noise is transitory and generally does not propagate at great distances from the vessel.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from installation and support vessels operating at the Nearshore Hub/Terminal are the same as those discussed for the Offshore Zone (Section 7.2.8.2.1). Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in sub-surface currents. Therefore, it is not likely that marine mammals will encounter discharged materials from Construction Phase vessels.

Solid Waste

Potential impacts to marine mammals from solid debris in offshore waters is discussed Section 7.2.9.2.1. All vessels associated with Construction Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

Helicopter Traffic

Potential impacts to marine mammals from aircraft traffic include disturbances from sound and movement. Sound generated by project-related helicopters that are directly relevant to marine mammals are discussed above in Section 7.2.9.2.1. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the QU platform). Based on this schedule and helicopter flight protocols discussed in Section 7.2.9.2.1, impacts to marine mammals are expected to be infrequent and result only in behavioral disturbances, such as avoidance (diving).

7.2.9.2.4 Support Operations Areas

Marine mammals that may occur within nearshore and inner shelf waters adjacent to Support Operations Areas include species that may occur within continental shelf waters, particularly Atlantic spotted dolphin, bottlenose dolphin, and Atlantic humpback dolphin. The Mediterranean monk seal may also transit through this area.

The Construction Phase within the Support Operations Areas will include the presence of supply boats and crew boats operating from the shore base. A detailed description of these vessels is found in Section 2.2.4.

Physical Presence

Impacts to marine mammals from construction activities and support vessels within the Support Operations Areas may result from planned dock construction within the port to accommodate vessel traffic during the project period. As discussed in Section 2.2.4, the facilities will include an access trestle, a quay/jetty for embarkation and disembarkation of personnel (floating or fixed), and wave protection for berthing. These construction activities at the Nearshore Hub/Terminal will generate both in-air and underwater noise that may impact marine mammals.

It is not certain if pile driving will be needed for the construction of the access trestle. Impact pile driving is discussed in Section 7.2.8.2.3. Most of the sound energy usually occurs at lower frequencies between 100 Hz and 1 kHz; therefore, these sounds are audible to low and mid frequency cetaceans and pinnipeds (Mediterranean monk seal). These sound impulses of pile driving activities may disrupt marine mammal behavior at ranges of many kilometers and have the potential to induce hearing impairment at close range. It is likely that marine mammals would avoid sound levels that may result in injury impacts; therefore, the most significant consequences from pile driving to marine mammal populations are likely to occur as a result of a behavioral response rather than direct physical injury or mortality.

Vessel Movements

Support operations infrastructure may disturb marine mammals within near coastal and inner shelf habitats. The supply base will support the arrival and departure of project support vessels, and will support loading/offloading supplies, equipment, and personnel being transported to and from the drillship, the FPSO and the hub/terminal area. There are expected to be two or three personnel transfers per week by crew boat for the FPSO and the Nearshore Hub/Terminal Area from the shore base and, the operation of the crew boat(s) may also occur on a 24 hour per day, 7 days per week, 365 days per year basis.

As discussed in Section 7.2.9.2.1, the transit of these vessels to and from the supply base may impact marine mammals by movement/vessel strike and disturbance due to sound. Generally, it is assumed that the probability of vessel strike, and thus impact, is very low. Most local cetacean species that are likely to occur near the Supply Base are dolphins and pinnipeds, which may easily evade moving vessels and the former may, on occasion, actively approach a vessel moving at speed to swim within the pressure wave produced by the vessel’s bow. Although most of the project-related vessel traffic associated with the supply base during Construction Phase activities will travel at relatively high speeds, it is unlikely that this vessel traffic will result in vessel collisions with marine mammals.

As discussed in Section 7.2.9.2.1, vessel operations from the supply base during the Construction Phase will generate sounds that could disturb marine mammals. Broadband source levels for most vessels are within the audible range for all cetacean and pinniped species and, distances to the current NMFS threshold for non-injurious harassment by continuous sound sources (NMFS, 2016) may extend for substantial distances from the source.

The effects of sounds produced by moving vessels associated with construction activities on marine mammals are difficult to assess because of the uncertainty of existing background and future project vessel-related sound levels, as well as variability of observed behavioral responses, both between and among species. From these reports, it is conservative to assume that sounds associated with vessel traffic may, in some cases, elicit behavioral changes in individual marine mammals that are in close proximity to these vessels. These behavioral changes may include evasive maneuvers such as diving or changes in swimming direction and/or speed.

Discharges

Routine discharges are not expected from facilities and vessels associated with supply bases. Therefore, no impacts from discharges to coastal and marine mammals are expected.

Solid Waste

Potential impacts to marine mammals from solid debris is discussed Section 7.2.9.2.1. All operations (shore base and crew boat) associated with Construction Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage Therefore, the amount of trash and debris released in nearshore waters would be minimal and only accidental. In addition, the shore base and crew boats would implement a waste management plan that would include guidance for marine debris awareness. Impacts to marine mammals from solid waste is not expected to be significant to local populations.

Helicopter Traffic

Helicopter traffic associated with the transfer of personnel to the drillship, as well as for emergencies aboard the FPSO and nearshore hub, may affect local marine mammals, particularly near the drillship and FPSO during landings and take offs. The potential effects of helicopters to marine mammals are discussed in Section 7.2.9.1 and include disturbance prompted by noise during overflights. Helicopter support will be based out of the airports in Dakar and/or Nouakchott. Helicopter personnel transfer is only expected for changeout during well drilling (i.e., airport to the drillship), or during emergencies (e.g., landing aboard the FPSO or QU Platform).

7.2.9.2.5 Summary

Operation of construction-related vessels and helicopters, and installation of infrastructure may result in varying levels of negative impacts (depending on species hearing sensitivity and presence) to marine mammals that may be present in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area, and to a lesser extent at the Support Operations Areas. Physical presence may disturb marine mammals, either through low intensity sound exposure (e.g., vessel operations, drilling) or limited high intensity sound exposure (i.e., VSP surveys at the Offshore Area; pile driving at the Nearshore Hub/Terminal Area). Vessel movements and sound in all areas may result in auditory impairment, short-term behavioral alterations, and short-term displacement from (or attraction to) discrete construction areas. Vessel collisions with marine mammals are possible but very unlikely. Discharges and the accidental loss of solid waste has the potential to adversely affect marine mammals, while helicopter traffic may be sources for disturbance.

7.2.9.3 Impact Rating

Physical Presence

Drilling activities within the Offshore Area may disturb marine mammals by disturbances associated with the physical presence of the drillship and support vessels, and associated underwater sound. VSP survey(s) in offshore waters will generate sounds at levels that may result in auditory injury (PTS) or impairment (TTS) if a marine mammal were present and were to remain within close proximity to the VSP location. Some level of behavioral alteration may occur at further distances away. However, PTS/injury of marine mammals from VSP surveys is unlikely, as animals are expected to move away from the active sound source. Physical presence of construction and support vessels and associated sounds within the Pipeline Area may disturb marine mammals. The extent of these impacts to marine mammals is expected to be local and of short term duration. The intensity of the impact would be low. Therefore, the overall impact significance is 1 – Negligible (see Table 7-31 below for details on selected criteria).

Construction activities associated with the Nearshore Hub/Terminal will include several sound sources, including dredging and crushing of hard substrate within the construction footprint, installation of the breakwater, including caissons, and the driving of steel piles. Pile driving activities are expected to create behavioral alterations, principally avoidance and short term displacement from the area of ensonification (extending some distance beyond the Nearshore Hub/Terminal construction Area) for the duration of the pile driving activities. These impacts are expected to be limited to behavioral alterations; specifically avoidance and temporary displacement. The intensity of these impacts is moderate, as effects due to sound, particularly from pile driving activity, is expected to displace many individual marine mammals from the area surrounding the Nearshore Hub/Terminal, and the VSP survey (Offshore Area) would displace individuals from the area surrounding the well site during the survey period. Impacts from physical presence of construction and construction activities, and other sound sources (including drilling and vessel traffic) are considered low. Based on activities discussed in Chapter 2, these impacts are likely to occur. The extent of these impacts to marine mammals is expected to be limited within the immediate vicinity, although sound from pile driving and the VSP survey are local. The duration of construction-related impacts is short term. Therefore, the overall impact significance is 2 – Low (see Table 7-31 below for details on selected criteria).

Vessel Movements

The consequence of impacts to marine mammals in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, and the Support Operations Areas from vessel movement include potential auditory injuries or impairment, short-term behavioral alterations, and short-term displacement from (or attraction to) discrete construction areas. Vessel collisions with marine mammals are possible but very unlikely, based on normal construction vessel speeds. The intensity of these impacts is low, as they are limited to behavioral alterations; specifically avoidance and temporary displacement. Based on activities discussed in Chapter 2, these impacts are likely to occur. The extent of these impacts to marine mammals is expected to be limited within the immediate vicinity. The duration of construction-related impacts is short term. In the event a project vessel strikes a marine mammal resulting in injury or mortality, the impact intensity would be moderate. The extent, in this case, would also be restricted to the immediate vicinity and the duration would be short term (impacts would not be felt by the local population during the life of the project. The consequence of the impact would be Minor, but the likelihood would be remote. Therefore, in this case, the overall impact significance is 1 – Negligible (see Table 7-31 below for details on selected criteria).

Discharges

Routine, non-drilling related discharges from installation activities in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, and the nearshore areas of the Support Operations Areas supply base are expected to produce very localized impacts through the introduction of organics (sanitary and domestic wastes; food waste) and warm water (cooling water); these impacts will be restricted to surface waters, with a very remote likelihood of reaching the seafloor and associated benthic communities. The volumes and frequency of these discharges is not expected to impact marine mammal prey items, such as fishes. Based on activities discussed in Chapter 2, the likelihood of impacts is occasional. The extent of these impacts to marine mammals are expected to be limited within the immediate vicinity. The duration of construction-related impacts is short term. The consequence of the impact would be Negligible; therefore, the overall impact significance is 1 – Negligible (see Table 7-31 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during construction activities may occur in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, or within the Support Operations Areas. These accidental losses are expected to be minimal but may produce very localized impacts to marine mammals via ingestion of small particles (plastic) or entanglement in debris. The extent of these impacts to marine mammals are expected to be limited within the immediate vicinity. The duration of construction-related impacts is short term. The consequence of the impact would be minor, but the likelihood would be remote. Therefore, the overall impact significance is 1 – Negligible (see Table 7-31 below for details on selected criteria).

Helicopter Traffic

Potential impacts to marine mammals from aircraft traffic include disturbances from physical presence. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the FPSO or QU Platform). The intensity of these impacts is low, as they are limited to behavioral alterations; specifically avoidance and temporary displacement. Based on activities discussed in Chapter 2, these impacts are likely to occur. The extent of these impacts to marine mammals is expected to be limited within the immediate vicinity. The duration of construction-related impacts is short term. The consequence of the impact would be negligible. Therefore, the overall impact significance is 1 – Negligible (see Table 7-31 below for details on selected criteria).

Summary

A summary of impact to marine mammals from routine activities during the Construction Phase is presented in Table 7-31.

Table 7-31. Impacts to Marine Mammals during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore Pipeline; Nearshore Hub/ Terminal; Support Operations	Avoidance or displacement from areas under construction for some species; Behavioral disturbances from construction activities, particularly pile driving and VSP survey.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Likely	1 – Negligible
		Auditory impairment due to sound from construction activities, particularly pile driving and VSP survey.	Nature: Negative Intensity: Moderate Spatial Extent: Local Duration: Short term	Minor	Likely	2 – Low
Vessel Movements						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Potential auditory injuries or impairment, short-term behavioral alterations, and short-term displacement from discrete construction areas.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Low	Likely	1 – Negligible
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Potential vessel strike resulting in marine mammal injury or mortality.	Nature: Negative Intensity: Moderate Spatial Extent: Immediate Vicinity Duration: Short term	Minor	Rare	2 – Low

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Discharges						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Direct and indirect effects of routine vessel (non-drilling) discharges during construction.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Remote	1 – Negligible
Solid Waste						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Accidental release of solid waste from construction vessels resulting in impacts from ingestion by or entanglement of marine mammals.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Remote	1 – Negligible
Helicopter Traffic						
Mauritania Senegal	Offshore; Pipeline; Support Operations	Displacement and avoidance of helicopters in offshore waters and when approaching heliports.	Nature: Negative Intensity: Low Spatial Extent: Immediate Vicinity Duration: Short-term (also infrequent)	Negligible	Likely	1 – Negligible

7.2.9.4 Mitigation Measures and Residual Impacts

Table 7-32 outlines the available mitigation measures recommended to reduce impact consequence or likelihood associated with construction-related impacts to marine mammals.

Table 7-32. Mitigation Measures to Avoid or Reduce Impacts to Marine Mammals from Routine Activities during the Construction Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Auditory impairment due to sound from construction activities, particularly pile driving and VSP survey.	2 – Low	M04, M05, M07	1 – Negligible
Potential vessel strike resulting in marine mammal injury or mortality.	2 – Low	M06	1 – Negligible

Notes:

M04: Seismic survey mitigation measures to be implemented during VSP survey(s) with the aim of minimizing the acoustic exposures to marine mammals (e.g. gradually increasing seismic source elements over a period of approximately 30 minutes until the operating level is achieved before any VSP activity begins).

M05: Sound mitigation measures will be implemented during pile driving (e.g. soft-starting [gradually increasing hammer power]).

M06: Vessel operators will implement vessel strike avoidance protocols to reduce the potential for vessel strike with marine mammals and sea turtles (including injured/dead protected species reporting).

M07: Collection and analysis of acoustic data from the area to determine background sound levels and marine mammal presence/absence, and underwater sound modeling to determine distances to various thresholds.

7.2.10 Sea Turtles

High Level Summary

In this section on Sea Turtles, the impact of five impact producing factors, these being Physical presence, Vessel movements, Discharges, Solid waste and Helicopter traffic, was evaluated. The residual impacts on Sea Turtles during the Construction Phase for routine activities were assessed as of negligible significance when mitigation measures are applied.

7.2.10.1 Impact Producing Factors and Project Areas

The IPFs identified for sea turtles in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	●
Vessel movements	●	●	●	●
Discharges	●	●	●	●
Solid waste	●	●	●	●
Helicopter traffic	●	●	●	●

7.2.10.2 Impact Description

The following subsections explain how these IPFs will produce impacts in each of the project areas.

Several project-related IPFs identified for sea turtles during construction activities include physical presence (including underwater [and some airborne] sounds from drilling activities, pile driving, and seismic [VSP] surveys), vessels, and helicopters. A background of information on anthropogenic sound and its effects on sea turtles is presented in Appendix G, and summarized below.

Very little is known about the extent to which sea turtles use their auditory environment. Much of the earlier research on the hearing capacity of sea turtles was limited to gross morphological dissections (i.e., post-mortem observations of organ and tissue damage; Wever, 1978; Lenhardt et al., 1985). More recent research has focused on measuring hearing capacity (e.g., Bartol et al., 2003; Lavender et al., 2012). Based on the functional morphology of the ear, it appears that sea turtles receive sound through the standard vertebrate tympanic middle ear path. Electrophysiological studies on hearing have shown that sea turtle hearing is most sensitive in the low frequency range, from at least 100 Hz (lowest frequency tested) to no greater than 900 Hz.

Based on existing information, it is assumed that auditory impacts such as TTS or PTS could occur in sea turtles. Few studies have looked at hair cell damage in reptiles, and studies do not indicate precisely if sea turtles are able to regenerate injured sensory hair cells (Warchol, 2011). In general, sound levels below TTS and PTS onset may have the potential to mask relevant sounds in the environment or induce simple behavioral changes in sea turtles such as evasive maneuvers (e.g., diving or changes in swimming direction and/or speed). Because sea turtles appear to be low frequency specialists, the potential masking noises would fall mainly within the range of 50-1,000 Hz; however, there are no quantitative data demonstrating masking effects for sea turtles. Limited data exist on noise levels that may induce behavioral changes in sea turtles. Avoidance reactions to seismic signals have been observed at levels between 166 and 179 dB re 1 µPa rms (Moein et al., 1995; McCauley et al., 2000a); however, both of these studies were done in a caged environment, so the extent of avoidance could not be monitored. Some experiments report a habituation effect to air guns, and from these results, it was not clear whether this lack of behavioral response was a result of behavioral habituation, or physical effects from TTS or PTS.

7.2.10.2.1 Offshore Area

Physical Presence

The Construction Phase within the Offshore Area will include the presence of several vessel types, including a drillship, vessels associated with the installation of infrastructure (wellheads, jumpers, manifolds and flowlines), and support vessels. A detailed description of these vessels is found in Section 2.2.1. It also considers the drilling operations.

Impacts to sea turtles from drilling, and construction and support vessels within the Offshore Area include behavioral disturbance from the physical presence of these vessels, and sound generated by drilling and installation operations. The physical presence of the drillship, support vessels, and construction activities in offshore and shelf waters may lead to short term avoidance of these areas by individuals and groups of marine mammals.

Construction activities would generate equipment sounds that could disturb sea turtles. Sounds produced by drilling are discussed in Section 7.2.9.2.1and include strong tonal components at low frequencies (<500 Hz), and so may be audible to sea turtles. Source levels vary with the type of drilling rig and the water depth. Source levels for drillships have been reported to be as high as 191 dB re 1 µPa (rms) during drilling; therefore, it is expected that sea turtles would detect drilling-related sounds within a radius of audibility that would be based on the sound source level and local attenuation from factors such as water depth, seafloor characteristics, and sea state conditions. Because there are no hearing criteria for sea turtles, NMFS, during their Section 7 ESA consultations, typically apply the criteria for marine mammals to evaluate the potential for similar impacts. Based on the 120dB_{rms} re 1 µPa acoustic threshold established by NMFS for behavioral response to continuous sounds for marine mammals, if turtles are present, some behavioral responses may occur within the 120-dB acoustic radii.

During the Construction Phase within the Offshore Area, Vertical Seismic Profile (VSP) surveys may be required (Section 2.12.4). Sound sources used during surveys can potentially result in auditory impairment (PTS or TTS), potential auditory masking-related effects, stress, disturbance, and behavioral responses in sea turtles (e.g., Moein et al., 1994; McCauley et al., 2000a,b; Weir, 2007). Based on very limited information, it is not certain to what effect seismic survey sound may contribute to the onset of stress effects in sea turtles. As previously noted in Section 7.2.9.2.4, most of the sound energy usually occurs at lower frequencies between 100 Hz and 1 kHz; therefore, these sounds are audible to sea turtles. Sound impulses of pile driving activities may disrupt sea turtle behavior at ranges of several hundred meters and have the potential to induce hearing impairment at close range. Behavioral responses vary, but may include changes in feeding; diving behavior; swimming speed and direction; avoidance of an ensonified area; or no response. Available mitigation guidelines for offshore seismic surveys, such as those outlined by the BOEM (2016) may decrease the potential for sea turtles to be present within a prescribed auditory exclusion zone around the seismic source array (usually 500 m from the source array). However, the zone of potential behavioral and disturbance responses will extend well beyond the exclusion zone.

Overall, the potential for impacts of sounds related to VSP surveys on sea turtles varies depending on the characteristics of the VSP seismic source array, differences in sound propagation relative to the physical environment, and biological factors, such as the turtle's state of activity, individual hearing loss, previous exposure to anthropogenic sound types, life history stage, reproductive status, and health status. In turtles, acoustic disturbance could potentially lead to exclusion from key habitats, interruption of behaviors (such as those necessary for breeding, foraging or thermoregulation [basking]), and possibly inciting responses which may lead to changes to foraging duration, swim speed, dive depth and duration, and restricting access to the surface to breathe (Nelms et al., 2016).

The survey design and duration of the proposed VSP survey is unknown at this time; however, the survey area will probably be limited, and the duration of the survey is not expected to extend beyond a 10- to 12-day period. Overall, based on survey type and implementation of mitigation measures, it is likely that PTS onset exposures to sea turtles in the region will be very limited or non-existent; although small numbers of TTS onset exposures may be possible. Behavioral effect exposures, however, may occur throughout the survey period, including avoidance and temporary displacement from the survey area (area of ensonification).

Vessel Movements

Support vessel movement has the potential for vessel strike with individual turtles, causing injury or mortality. Propeller and collision injuries to turtles arising from their interactions with boats and ships are common (Euroturtle, 2018). There have been no documented sea turtle collisions with drilling and service vessels, although it is possible that such collisions with small or submerged sea turtles may go undetected, particularly during periods of poor weather and during the night.

Sea turtles spend at least 20 to 30% of their time at the surface for respiration, basking, feeding, orientation, and mating (Lutcavage et al., 1996). Because sea turtles spend most of their lives submerged, a collision between a project-related vessel and a sea turtle within the project area is unlikely but possible. Collisions would be limited to relatively fast-moving vessels such as supply vessels and crew boats.

Vessel sounds are discussed in Section 7.2.9.2.1. Tones typically dominate up to about 50 Hz, whereas broadband sounds may extend to 100 kHz. Therefore, vessel sounds would be audible to all sea turtle species. Broadband source levels for most small ships (a category that would include support vessels) are anticipated to be in the range of 170-180 dB re 1 μPa at 1 m (Richardson et al., 1995). For this analysis, it is expected that the proposed additional volume of vessel traffic associated with construction activities within the Offshore Area would constitute a significant increase to existing vessel traffic within the project area. Within an open ocean environment, it is assumed that turtles would move away from sources of vessel sounds before injurious received levels were reached. Therefore, impacts to sea turtles from vessel sounds is expected to be limited to behavioral alterations, only.

Discharges

Routine discharges from construction vessels within the offshore area include sanitary and domestic wastes, food waste, deck drainage, cooling water, etc. During the drilling of each well, drilling muds and cuttings will be discharged at or near the seafloor.

Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in sub-surface currents. Therefore, it is not likely that sea turtles will encounter discharged materials from Construction Phase vessels.

Solid Waste

Lost and discarded solid waste, or marine debris, is discussed in Section 7.2.9.2.1. Marine debris poses two types of negative impacts to sea turtles: (1) entanglement, and (2) ingestion. USDOC, NMFS and USDOI, FWS (2008) note that loggerhead turtles have been found entangled in a wide variety of materials, including steel and monofilament line, synthetic and natural rope, plastic onion sacks, and discarded plastic netting. From 1997-2005, 1.6% of stranded loggerheads found on Atlantic and Gulf of Mexico beaches were entangled in fishing gear. Monofilament line appears to be the principal source of entanglement for loggerheads in U.S. waters (0.9%; 1997-2005 average), followed by pot/trap line (0.4%; 1997-2005 average) and fishing net (0.3%; 1997-2005 average). Less than 1% of stranded sea turtles in 2005 were found entangled in other marine debris (NMFS, unpublished data, as cited in USDOC, NMFS and USDOI, FWS, 2008).

All vessels associated with Construction Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

Helicopter Traffic

Helicopters are a potential source of aircraft sounds during drilling operations, as it is expected that drilling activities would be supported by a helicopter between the drillship and onshore supply base.

Potential IPFs to sea turtles from aircraft traffic include received noise and physical (visual) disturbance. Both IPFs are discussed in Section 7.2.9.2.1. Sounds generated by project-related helicopters are generally below 500 Hz (Richardson et al., 1995) and is within the auditory range of sea turtles. Levels of noise received underwater from passing aircraft depend on the aircraft's altitude, the aspect (direction and angle) of the aircraft relative to the receiver, receiver depth and water depth, and seafloor type (Richardson et al., 1995). Because of the relatively high expected airspeed (250 km/hr) and these physical variables, aircraft-related sounds (including both airborne and underwater-transmitted sounds) are expected to be brief in duration, and effects to sea turtles are expected to include short-term behavioral disruptions (diving, or changes in surface swimming speed and direction).

The physical presence of low-flying aircraft can also disturb sea turtles, particularly for those individuals that may be resting on the sea surface for short periods of time. Personal observations made from low altitude aerial surveys report behavioral responses of sea turtles to aircraft are highly variable and range from no observable reaction to diving or rapid changes in swimming speed or direction. Effects from project helicopter traffic is expected to be limited to short-term behavioral alterations.

7.2.10.2.2 Pipeline Area

Physical Presence

The Construction Phase within the Pipeline Area will include the presence of several vessel types, including pipe-laying vessel(s) and support vessels, and vessels supporting the installation of the FPSO. A detailed description of these vessels is found in Section 2.2.1.

Impacts to sea turtles from construction and support vessels within the Pipeline Area include behavioral disturbance from the physical presence of these vessels, and sounds generated by installation operations. Pipelaying activities are discussed in Sections 2.2.2, and 7.2.9.2.2. Generally, sounds from pipelaying activities would be continuous and activities would progress slowly through the pipeline route. It is anticipated that sounds from construction activities within the Pipeline Area would result in distances to some sea turtles, although these disturbances are expected to include short term avoidance or displacement behavior, only.

Vessel Movements

As discussed in Section 7.2.10.2.1, sea turtle species may be vulnerable to physical disturbance from moving vessels. There have been no documented sea turtle collisions with drilling and service vessels, although it is possible that such collisions with small or submerged sea turtles may go undetected, particularly during periods of poor weather and during the night. Construction vessels along the pipeline route are expected to transit slowly; however, support vessels may move at greater speeds. Sea turtles spend at least 20 to 30% of their time at the surface for respiration, basking, feeding, orientation, and mating (Lutcavage et al., 1996). Because sea turtles spend most of their lives submerged, a collision between a project-related vessel and a sea turtle within the project area is unlikely. In addition, the risk of vessel strikes on sea turtles is expected to be minimized because of the typical slow speed of support vessels, which allows the turtle to actively avoid being struck by an approaching vessel. Any project-related vessel strike with a sea turtle is expected to result in the death of the turtle. However, considering the relatively slow operational speed of these vessels, vessel strikes are expected to be minimal.

As discussed in Section 7.2.10.2.1, construction activities in the pipeline area would generate vessel and equipment sounds that could disturb sea turtles. Underwater sounds are discussed in Section 7.2.9.2. Vessel sounds are a combination of narrow-band (tonal) and broadband sound (Richardson et al., 1995). Tones typically dominate up to about 50 Hz, whereas broadband sounds may extend to 100 kHz. Therefore, vessel sounds are within the audible range of all sea turtle species.

It is anticipated that the construction and supply vessel sound levels are within the audible range for sea turtles. When these vessels are on standby, they will produce lower but continuous sound levels. As a proxy threshold for behavioral disturbances from continuous sound sources, the current NMFS threshold for non-injurious harassment by continuous sound sources for marine mammals is 120 dB_{rms} re 1 µPa (NMFS, 2016), and it is likely that the isopleth for this received level extends a substantial distance from the source. The most likely effects of vessel and equipment sounds on sea turtles would include behavioral changes and possibly auditory masking. Such sounds are transitory and generally do not propagate at great distances from the vessel, and the source levels are too low to cause death or injuries such as auditory threshold shifts. Based on existing studies on the role of hearing in sea turtle ecology, it is unclear whether masking would realistically have any effect on sea turtles. Behavioral responses to vessels have been observed but are difficult to attribute exclusively to responses to noise rather than to visual or other cues. It is conservative to assume that noise associated with project vessels may elicit behavioral changes in individual sea turtles near these vessels. These behavioral changes may include evasive maneuvers such as diving or changes in swimming direction and/or speed. This evasive behavior is not expected to adversely affect these individuals or the population.

For this analysis, it is expected that the proposed additional volume of vessel traffic associated with construction activities within the pipeline area would constitute a significant increase to existing vessel traffic within the project area.

Discharges

Routine discharges from construction vessels within the pipeline area are discussed in Section 7.2.8.2.1. Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in sub-surface currents. Therefore, it is not likely that sea turtles will encounter discharged materials from Construction Phase vessels.

Solid Waste

Potential impacts to sea turtles from solid debris is discussed Section 7.2.10.2.1. All vessels associated with Construction Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

Helicopter Traffic

As discussed in Section 7.2.10.2, potential impacts to sea turtles from project-related helicopter traffic include disturbances from noise and physical presence, and collision. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the FPSO). Based on this schedule and helicopter flight protocols discussed in Section 7.2.10.1, impacts to sea turtles are expected to be infrequent, short-term, and not severe to local populations.

7.2.10.2.3 Nearshore Hub/Terminal Area

Physical Presence

Within the Nearshore Hub/Terminal Area, sea turtles may be impacted by activities associated with the installation of infrastructure (i.e., breakwater, pilings, etc.). The construction of the nearshore hub/terminal will use a variety of vessels, such as a heavy construction vessel to drive foundation piles, and for breakwater construction. Rocks for construction of the breakwater will be transported to the construction site via rock dumper vessel or barge, likely operating 24 hours/day for 12-18 months. The physical presence of these vessels and construction activities aboard these vessels may impact sea turtles. Impacts from physical disturbance are expected to include avoidance of or displace from the construction area by individual turtles. When considering the length of time estimated for construction, it is expected that some turtles may become accustomed to the presence of these vessels and construction activities. Because these activities are either static or moving slowly, it is expected that disturbances will not significantly affect local populations.

Construction activities will generate both in-air and underwater sound that may impact sea turtles. Impact pile driving is discussed in Section 7.2.8.2.3. The installation of hollow steel piles in this manner can produce high sound levels in the surrounding waters and as in the air. Typical source sound levels range from 170 to 225 dB re 1 μPa2·s (sound exposure level, SEL) for a single pulse, and peak sound pressure levels of 190 to 245 dB re 1 μPa. Most of the sound energy usually occurs at lower frequencies between 100 Hz and 1 kHz; therefore, these sounds are audible to all sea turtle species. As in the case of marine mammals, sound impulses from pile driving activities may disrupt the behavior of sea turtles at ranges of many kilometers (Tougaard et al., 2009; Brandt et al., 2011) and have the potential to induce hearing impairment at close range (Madsen et al., 2006).

It is likely that sea turtles would avoid areas with injurious sound levels; therefore, the most significant consequences from pile driving to sea turtle populations are likely to occur as a result of a behavioral response rather than direct physical injury or mortality.

Vessel Movements

As discussed in Section 7.2.10.2.1, sea turtle species may be vulnerable to physical disturbance from moving vessels. Vessel strikes with support vessels may also occur. Because sea turtles spend most of their lives submerged, a collision between a project-related vessel and a sea turtle within the project area is unlikely. In addition, the risk of vessel strikes on sea turtles is expected to be minimized because of the typical slow speed of support vessels. Any project-related vessel strike with a sea turtle is expected to result in the death of the turtle. However, considering the relatively slow operational speed of these vessels, vessel strikes are expected to be minimal.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from installation and support vessels operating at the Nearshore Hub/Terminal are the same as those discussed for the Offshore Zone (Section 7.2.10.2.1). Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in sub-surface currents. Therefore, it is not likely that sea turtles will encounter discharged materials from Construction Phase vessels.

Solid Waste

Potential impacts to sea turtles from solid debris is discussed Section 7.2.10.2.1. All vessels associated with Construction Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

Helicopter Traffic

As discussed in Section 7.2.10.2, potential impacts to sea turtles from project-related helicopter traffic include disturbances from physical presence, and collision. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the QU platform). Based on this schedule and helicopter flight protocols discussed in Section 7.2.10.1, impacts to sea turtles are expected to be infrequent and result only in behavioral disturbances, such as avoidance (diving).

7.2.10.2.4 Support Operations Areas

Physical Presence

Impacts to sea turtles from physical presence at the Support Operations Areas are not likely. Shore base operations are not expected to introduce significant sound levels in harbor waters.

Vessel Movements

Support operations may disturb sea turtles within near coastal and inner shelf habitats. The supply base will support the arrival and departure of project support vessels, and will support loading/offloading supplies, equipment, and personnel being transported to and from the drillship, the FPSO and the hub/terminal area. There are expected to be two or three personnel transfers per week by crew boat for the FPSO and the hub/terminal from the shore base and, the operation of the crew boat(s) may also occur on a 24 hour per day, 7 days per week, 365 days per year basis.

As discussed in Section 7.2.10.2.1, the transit of these vessels to and from the supply base may impact sea turtles by movement/vessel strike and underwater sound. There have been no documented sea turtle collisions with drilling and service vessels, although it is possible that such collisions with small or submerged sea turtles may go undetected, particularly during periods of poor weather and during the night. Because sea turtles spend most of their lives submerged, a collision between a project-related vessel and a sea turtle within the project area is unlikely.

As discussed in Section 7.2.10.2.1, vessel operations from the supply base during the Construction Phase will generate vessel sounds that could disturb sea turtles. For this analysis, it is expected that the proposed additional volume of vessel traffic would constitute a significant increase to existing vessel traffic within the project area. It is conservative to assume that noise associated with vessel traffic may, in some cases, elicit behavioral changes in individual sea turtles that are in close proximity to these vessels. These behavioral changes may include evasive maneuvers such as diving or changes in swimming direction and/or speed.

Discharges

Routine discharges are not expected from facilities and vessels associated with supply bases. Therefore, no impacts from discharges to sea turtles are expected.

Solid Waste

Potential impacts to sea turtles from solid debris is discussed Section 7.2.10.2.1. All operations (shore base and crew boat) associated with Construction Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage Therefore, the amount of trash and debris released in nearshore waters would be minimal and only accidental. In addition, the shore base and crew boats would implement a waste management plan that would include guidance for marine debris awareness. Impacts to sea turtles from solid waste is not expected to be significant to local populations.

Helicopter Traffic

Helicopter traffic associated with the transfer of personnel to the drillship, FPSO, and nearshore hub may affect local sea turtles, particularly within nearshore waters near the heliport(s). The potential effects of helicopters to sea turtles are discussed in Section 7.2.10.2.1 and include disturbance prompted by noise during overflights. Helicopter support will be based out of the airports in Dakar and/or Nouakchott. Helicopter personnel transfer is only expected for changeout during well drilling (i.e., airport to the drillship), or during emergencies (e.g., landing aboard the FPSO or QU Platform).

7.2.10.2.5 Summary

Operation of construction-related vessels and helicopters, and installation of infrastructure may result in negative impacts to sea turtles in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area, and to a lesser extent at the Support Operations Areas. Physical presence may disturb marine mammals, either through low intensity sound exposure (e.g., vessel operations, drilling) or limited high intensity sound exposure (i.e., VSP surveys at the Offshore Area; pile driving at the Nearshore Hub/Terminal Area). It is presumed that vessel movements in all areas may result in auditory injuries or impairment if turtles are present and are in close proximity to the sound source. Short-term behavioral alterations and short-term displacement from (or attraction to) discrete construction areas may also occur. Vessel collisions with sea turtles are possible but very unlikely. Discharges and the accidental loss of solid waste has the potential to adversely affect sea turtles, while helicopter traffic may be a source of disturbance.

7.2.10.3 Impact Rating

Physical Presence

Sounds from drilling activities within the Offshore Area may disturb sea turtles, although few individuals are expected in these continental slope waters. VSP survey(s) in offshore waters will generate sounds at levels that may result in auditory injury (PTS) or impairment (TTS), and may result in behavioral alteration of sea turtles within the Offshore Area. Construction activities associated with the Nearshore Hub/Terminal will include several sources of sound, including dredging and crushing of hard substrate within the construction footprint, installation of the breakwater, including caissons, and the driving of steel piles. Pile driving activities are expected to create behavioral alterations, principally avoidance and short-term displacement from the area of ensonification (extending some distance beyond the Nearshore Hub/Terminal construction Area) for the duration of the pile driving activities. These impacts are expected to be limited to behavioral alterations; specifically avoidance and temporary displacement. The intensity of these impacts is moderate, as effects of sound, particularly from pile driving activities, are expected to displace individual sea turtles from the area surrounding the Nearshore Hub/Terminal, and the VSP survey (Offshore Area) would displace individuals from the area surrounding the well site during the survey period. Impacts from physical presence of construction and construction activities, and other sources of sound (including drilling, vessel, and various construction activities) are considered low. Based on activities discussed in Chapter 2, these impacts are likely to occur. The extent of these impacts to sea turtles is expected to be limited within the immediate vicinity, although sound from pile driving and the VSP survey are local. The duration of construction-related impacts is short term. Therefore, the overall impact significance is 2 – Low (see Table 7-33 below for details on selected criteria).

Vessel Movements

The consequence of impacts to sea turtles in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, and the Support Operations Areas from vessel movement include potential auditory injuries or impairment, short-term behavioral alterations, and short-term displacement from discrete construction areas. Vessel collisions with sea turtles are possible but unlikely, based on normal construction vessel speeds. The chances for collisions between crew boats and sea turtles are greater due to greater vessel speeds and travel at night. The movement of project-related vessels within the project areas will likely result in behavioral disturbances to sea turtles, specifically avoidance and temporary displacement.

The intensity of behavioral effect impacts is low and, based on activities discussed in Chapter 2, behavioral disturbance impacts are likely to occur. The extent of these impacts to sea turtles are expected to be limited within the immediate vicinity. The duration of construction-related behavioral impacts is short term.

In the event a project vessel strikes a sea turtle resulting in injury or mortality, the impact intensity would be moderate. The extent, in this case, would be local and the duration would be long term (impacts would be felt by the local population during the life of the project). The consequence of the impact would be Moderate, but the likelihood would be rare. Therefore, in this case, the overall impact significance is 1 – Negligible for behavioral effect impacts and 2 – Low for vessel strikes (see Table 7-33 below for details on selected criteria).

Discharges

Routine, non-drilling related discharges from installation activities in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, and the nearshore areas of the Support Operations Areas supply base are expected to produce very localized impacts through the introduction of organics (sanitary and domestic wastes; food waste) and warm water (cooling water); these impacts will be restricted to surface waters, with a very remote likelihood of reaching the seafloor and associated benthic communities. The volumes and frequency of these discharges are not expected to impact sea turtles or their prey/food items, such as fishes, benthic invertebrates, and seagrasses. Based on activities discussed in Chapter 2, the likelihood of impacts is occasional. The extent of these impacts to sea turtles are expected to be limited within the immediate vicinity. The duration of construction-related impacts is short term. The consequence of the impact would be Negligible; therefore, the overall impact significance is 1 – Negligible (see Table 7-33 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during construction activities may occur in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, or within the Support Operations Areas. These accidental losses are expected to be minimal but may produce very localized impacts to sea turtles via ingestion of small particles (plastic) or entanglement in debris. The extent of these impacts to sea turtles are expected to be limited within the immediate vicinity. The duration of construction-related impacts is short term. The consequence of the impact would be minor, but the likelihood would be remote. Therefore, the overall impact significance is 1 – Negligible (see Table 7-33 below for details on selected criteria).

Helicopter Traffic

Potential impacts to sea turtles from aircraft traffic include disturbances from physical presence. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the FPSO or QU Platform). The intensity of these impacts is low, as they are limited to behavioral alterations; specifically avoidance and temporary displacement. Based on activities discussed in Chapter 2, these impacts are likely to occur. The extent of these impacts to sea turtles are expected to be limited within the immediate vicinity. The duration of construction-related impacts is short term. The consequence of the impact would be negligible. Therefore, the overall impact significance is 1 – Negligible (see Table 7-33 below for details on selected criteria).

Summary

A summary of impact to sea turtles from routine activities during the Construction Phase is presented in Table 7-33.

Table 7-33. Impacts to Sea Turtle Communities during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal	Avoidance or displacement from areas under construction for some species; attraction to other species as a foraging strategy; Noise disturbances from construction activities, particularly pile driving and VSP surveys; loss of foraging habitats from proposed construction.	Nature: Negative Intensity: Moderate Spatial Extent: Local Duration: Short term	Minor	Likely	2 – Low
Vessel Movements						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Potential auditory injuries or impairment, short-term behavioral alterations, and short-term displacement from (or attraction to) discrete construction areas.	Nature: Negative Intensity: Low Spatial Extent: Immediate Vicinity Duration: Short term	Negligible	Likely	1 – Negligible
		Potential vessel strike resulting in sea turtle injury or mortality.	Nature: Negative Intensity: Moderate Spatial Extent: Local Duration: Long term	Moderate	Rare	2 – Low
Helicopter Traffic						
Mauritania Senegal	Offshore; Pipeline; Support Operations	Displacement and avoidance of helicopters in offshore waters and when approaching heliports.	Nature: Negative Intensity: Low Spatial Extent: Immediate Vicinity Duration: Short-term (also infrequent)	Negligible	Likely	1 – Negligible

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Discharges						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Support Operations	Direct and indirect effects of routine vessel (non-drilling) discharges during construction.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible
Solid Waste						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Accidental release of solid waste from construction vessels resulting in impacts from ingestion by or entanglement of sea turtles.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Remote	1 – Negligible

7.2.10.4 Mitigation Measures and Residual Impacts

Table 7-34 outlines the available mitigation measures recommended to reduce impact consequence or likelihood associated with construction-related impacts to sea turtles.

Table 7-34. Mitigation Measures to Avoid or Reduce Impacts to Sea Turtle Communities from Routine Activities during the Construction Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Avoidance or displacement from areas under construction for some species; attraction to other species as a foraging strategy; Noise disturbances from construction activities, particularly pile driving and VSP surveys; loss of foraging habitats from proposed construction.	2 – Low	M04, M05, M07	1 – Negligible
Potential vessel strike resulting in sea turtle injury or mortality.	2 – Low	M06	1 – Negligible

Notes:

M04: Seismic survey mitigation measures to be implemented during VSP survey(s) with the aim of minimizing the acoustic exposures to marine mammals (e.g. gradually increasing seismic source elements over a period of approximately 30 minutes until the operating level is achieved before any VSP activity begins).

M05: Sound mitigation measures will be implemented during pile driving (e.g. soft-starting [gradually increasing hammer power]).

M06: Vessel operators will implement vessel strike avoidance protocols to reduce the potential for vessel strike with marine mammals and sea turtles (including injured/dead protected species reporting).

M07: Collection and analysis of acoustic data from the area to determine background sound levels and marine mammal presence/absence, and underwater sound modeling to determine distances to various thresholds.

7.2.11 Threatened Species and Protected Areas

High Level Summary

In this section on Threatened Species and Protected Areas, the impact of six impact producing factors, these being Physical presence, Vessel movements, Emissions, Discharges, Solid waste and Helicopter traffic, was evaluated. The residual impacts on Threatened Species and Protected Areas during the Construction Phase for routine activities were assessed as of negligible or low significance when mitigation measures are applied.

7.2.11.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Vessel movements	●	●	●	
Emissions		●	●	●
Discharges	●	●	●	●
Solid waste	●	●	●	●
Helicopter traffic	●	●	●	●

7.2.11.2 Impact Description

There are seven protected areas that are either within or adjacent to the core or extended study areas (two protected areas in Mauritania and five protected areas in Senegal). Additionally, the UNESCO Senegal River Delta Transboundary Biosphere Reserve includes areas in both Mauritania and Senegal.

As noted in Chapter 4 (Tables 4-26 and 4-27), there are a total of 10 Critically Endangered species and 18 Endangered species identified on the IUCN Red List which may be present in the coastal zone or nearshore and offshore waters of the core and extended study areas. Critically Endangered species include two marine and coastal bird species, two sea turtle species, and six demersal soft bottom and hard bottom fish species. Endangered species include four marine mammal species, one sea turtle species, nine demersal soft and hard bottom fish species, and four pelagic fish species.

A summary of their likelihood of presence in the core and extended study area and within one or more of the project areas is provided in Table 7-35. Species highlighted in green below are either likely or possibly may occur in the study area. When likelihood of presence is considered, only six Critically Endangered and 14 Endangered species may be expected in the study area.

Table 7-35. Presence of IUCN-Listed Critically Endangered and Endangered Species in the Core or Extended Study Areas and within the Project Areas.

Common or Species Name	Presence in the Core or Extended Study Areas	Presence in the Project Area(s)
Critically Endangered Species (IUCN)		
Fishes (demersal, hard bottom)		
Atlantic Goliath Grouper	Likely	Nearshore Hub/Terminal
Fishes (demersal, soft bottom)		
Common Skate	Unlikely	Offshore; Pipeline
Smalltooth Sawfish	Possible	Nearshore Hub/Terminal
Largetooth Sawfish	Unlikely	Nearshore Hub/Terminal; Pipeline
Sawback Angel Shark	Possible	Offshore; Pipeline
Smoothback Angel Shark	Possible	Offshore; Pipeline
Marine and Coastal Birds		
Balearctic Shearwater	Possible	Offshore; Pipeline
Northern Bald Ibis	Very unlikely	Support Operations
Marine Mammals		
None	--	--
Sea Turtles		
Hawksbill sea turtle	Possible	Pipeline; Nearshore Hub/Terminal; Support Operations
Kemp’s ridley sea turtle	Unlikely	Pipeline; Nearshore Hub/Terminal; Support Operations
Endangered Species (IUCN)		
Fishes (demersal, hard bottom)		
Dusky Grouper	Likely	Nearshore Hub/Terminal
Fishes (demersal, soft bottom)		
Daisy Stingray	Unlikely	Nearshore Hub/Terminal
Blackchin Guitarfish	Likely	Nearshore Hub/Terminal
Senegalese Hake	Likely	Nearshore Hub/Terminal; Pipeline
Cassava Croaker	Likely	Nearshore Hub/Terminal
Undulate Skate	Unlikely	Nearshore Hub/Terminal; Pipeline
Common Guitarfish	Likely	Nearshore Hub/Terminal; Pipeline
African Wedgefish	Possible	Nearshore Hub/Terminal
White Skate	Unlikely	Pipeline
Fishes (pelagic)		
Whale Shark	Likely	Nearshore Hub/Terminal; Offshore; Pipeline
Scalloped Hammerhead	Likely	Offshore; Pipeline
Great Hammerhead	Likely	Offshore; Pipeline
Atlantic Bluefin Tuna	Possible	Offshore; Pipeline
Marine and Coastal Birds		
None	--	--
Marine Mammals		
Northern sei whale	Very unlikely	Offshore; Pipeline

Common or Species Name	Presence in the Core or Extended Study Areas	Presence in the Project Area(s)
Northern blue whale	Possible; seasonal	Offshore; Pipeline
Northern fin whale	Possible in Mauritania; Very unlikely in Senegal	Offshore; Pipeline
Mediterranean monk seal	Likely	Nearshore Hub/Terminal; Support Operations
Sea Turtles		
Green sea turtle	Transient, Possible	Pipeline; Nearshore Hub/Terminal; Support Operations; possibly Offshore

The following subsections explain how IPFs identified in Table 7-4 may impact protected areas or threatened species during the Construction Phase.

7.2.11.2.1 Offshore Area

Vessel Movements

Support vessels may pass protected areas when transiting to and from the Offshore Area. While there are no protected areas located within or near the Offshore Area, there are several EBSAs and several that may be impacted by transiting vessels to the Offshore Area from Dakar, Senegal, or Nouakchott, Mauritania. The Coastal Habitat of the Neritic Zone of Mauritania and Extreme North of Senegal EBSA, Cold Water Reef EBSA, Cayar Canyon EBSA, Cayar Seamount Complex EBSA, and the Convergence Zone of the Canary-Guinea Currents EBSA are located between the Offshore Area and either Dakar, Senegal or Nouakchott, Mauritania. Waves generated by vessels may erode unprotected shorelines, especially in areas that are already subject to natural erosion processes like is often seen in the west African region. However, due to the nature (i.e., duration, vessel routes) of support vessel operations, impacts to protected areas or other areas of conservation interest from noise disturbance are anticipated to be negligible. Vessel transits through the EBSAs could result in periodic disruption of individual marine mammals, sea turtles, or birds within the EBSAs. However, it is likely that individuals would experience, at most, a short term behavioral disruption.

Critically Endangered or Endangered species which may occur in the Offshore Area include sawback angel shark, smoothback angel shark, whale shark, scalloped hammerhead, great hammerhead, Atlantic Bluefin tuna, Balearctic shearwater, and green sea turtle. Vessel transits could result in periodic disruption of individual listed fishes, turtles, and birds. VSP surveys will also introduce low frequency sound energy into the marine environment around one or more of the offshore wells. VSP survey duration is brief. It is likely that individuals would experience, at most, a short term behavioral disruption.

Support vessel operators are expected to follow all applicable maritime navigation rules and would normally follow the most direct route (weather conditions permitting) between the Offshore Area and the shore base. Support vessels are expected to use existing routes into port including well-traveled shipping lanes. Vessel operators normally maintain a watch for obstructions during transit, including large marine mammals.

Discharges

Routine discharges from the drillship and support vessels in the Offshore Area will produce localized areas of reduced water quality, including increases in total suspended solids, nutrients, and chlorine. All discharges are expected to be diluted rapidly due to the open ocean location of the Offshore Area.

WBM discharges that will occur during drilling portions of the Construction Phase do not contain oil. Cuttings drilled with SBDF with contain small amounts of residual drilling fluid but are not expected to produce a plume due to the low miscibility of the residual drilling fluids in water. It is highly unlikely that any routine discharges from the drillship or support vessels in the Offshore Area will reach any protected area. The nearest protected area to the Offshore Area is the Saint-Louis Marine Protected

Area (approximately 50 km to the east), while the nearest EBSA is the Cayar Seamount Complex (approximately 20 km to the south). Deposition of discharged muds and cuttings of 0.1 mm or more will be limited to 1.2 km or less, while burial impacts will be limited to several hundred meters, from each wellsite (see Section 7.2.5).

Discharge of ballast water or biofouling from internationally sourced support vessels or the drillship could result in the introduction of non-native species in the project area. If any non-native species becomes established and invasive, it could result in disruptions to habitat or food availability which could impact threatened species and/or the ecological health of protected areas. Mitigation for the potential invasive species impacts associated with ballast water could be addressed under the IMO Ballast Water Management Convention with exchange of ballast water mid-ocean or installation of an on-board ballast water treatment system.

Routine discharges from the drillship and support vessels, and discharges of drilling muds and cuttings, are expected to produce similar impacts to threatened species as those noted for marine mammals, sea turtles, fishes, and birds – i.e., minimal effects. Any effects will be limited to a very small radius around the discharge that will vary with current and sea conditions.

The greatest likelihood of any potential contact would be from transiting support vessels that will travel through EBSAs on their way to Dakar or Nouakchott.

Solid Waste

No solid waste will be intentionally discharged in the Offshore Area. However, accidental loss of debris from the drillship or support vessels during the Construction Phase may occasionally occur and currents could transport debris through protected areas or onto coastal protected areas. Floating debris may become hazardous to marine mammals, sea turtles, birds, or fish (including threatened species) due to the risk of entanglement or ingestion. Marine debris that washes ashore may foul beaches, adversely affect the aesthetics of natural coastal areas, and provide an entanglement or ingestion hazard for coastal fauna.

Helicopter Traffic

Helicopter traffic may impact coastal and marine species found within protected areas either due to sound and visual disturbance. Due to the expected altitude and intermittent nature of helicopter trips to the Offshore Area, potential impacts to species within protected areas are mainly expected to be short-term behavioral changes.

Helicopter traffic and impacts of sound on threatened species will be similar to those noted for marine mammals, sea turtles, fishes, and birds. Sound generated by project-related aircraft that are directly relevant include both airborne sounds to individuals resting on the sea surface (e.g., marine mammals, sea turtles, birds) and underwater sounds from air-to-water transmission from passing aircraft.

7.2.11.2.2 Nearshore Hub/Terminal Area

Physical Presence

Portions of the Nearshore Hub/Terminal Area are in close proximity to several protected areas, including Diawling National Park and the Saint-Louis Marine Protected Area, and the Senegal River Delta Transboundary Biosphere Reserve. As described in Section 4.5.9, one EBSA, the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal, is partially located within the Nearshore Hub/Terminal Area.

Despite the close proximity of the Nearshore Hub/Terminal Area to several protected areas and EBSAs, it is unlikely that the presence or sound from the drillship and support vessels will have substantial impacts. The portion of the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal that is within the Nearshore Hub/Terminal Area may experience an increase level of ambient sound due to the presence of the construction and other support vessels during the installation of piles, piping, walkways, and other components. Additionally, the temporary flotel used to house construction workers is expected to be present in the area until more permanent housing for workers in completed on the FLNG vessel.

Among threatened species, several may be expected to be present near the Nearshore Hub/Terminal Area, including nine fish species, two sea turtle species, and one marine mammal species (Table 7-35). Impacts to these threatened species from physical presence will be similar to those previously discussed for marine mammals, sea turtles, and fishes – short term behavioral disruptions.

Vessel Movements

As detailed in Section 2.1, substantial vessel activity is expected during the Construction Phase in the Nearshore Hub/Terminal Area, which includes a small portion of the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal EBSA and is near Diawling National Park and the Saint-Louis Marine Protected Area and the Senegal River Delta Transboundary Biosphere Reserve. It is expected that fauna within these areas may be subject to short-term behavior disruptions to the transiting vessels and associated sound that will occur due to construction activities within the Nearshore Hub/Terminal Area.

The impact of vessel movements on threatened species will likely be limited to marine mammals, sea turtles, and birds. Impacts from physical disturbance are expected to include avoidance of, or displacement from, the construction area by individuals or perhaps groups of threatened marine mammals or sea turtles. When considering the length of time estimated for construction, it is expected that some individuals may become accustomed to the presence of these vessels and construction activities. Because these activities are either static or moving slowly, it is expected that disturbances will not significantly affect local populations.

Emissions

Emissions from project vessels in the Nearshore Hub/Terminal Area during the Construction Phase have the potential to increase airborne contaminants in nearby areas of conservation interest, including the Saint-Louis Marine Protected Area, Langue-de-Barbarie National Park, Guembeul Natural Reserve, and the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal EBSA. Primary air contaminants typically associated with emissions from internal combustion engines are PM, SO_x, NO_x, VOCs, and CO. Depending on prevailing winds at the time of emissions, increased concentrations of these contaminants could occur in any protected area or area of conservation interest that is downwind.

Air emissions dispersion modeling (see Appendix J) did not encompass activities associated with the Construction Phase. Estimates of construction-related emissions and application of BOEM thresholds have been presented in Section 7.2.1; results indicate that with the exception of NOx and SO2 emissions, construction-related emissions in the Nearshore Hub/Terminal Area are sufficiently low that onshore air quality impacts are not expected. Impacts of elevated levels of NO_x and SO_2 reaching shore from construction and installation activities at the Nearshore Hub/Terminal and FPSO could include periods of short-term onshore exposure. Onshore receptors may include coastal and estuarine habitats (e.g., Senegal River estuary) and upland terrestrial habitats.

Any impacts to threatened species from project-related emissions would be limited. Reductions in local air quality associated with construction activities will be limited to the area around the Nearshore Hub/Terminal. As a result, only limited impacts to threatened birds, sea turtles, and marine mammals may be expected from diminished air quality; no impacts to threatened fish are expected.

Discharges

Routine discharges from the installation and support vessels in the Nearshore Hub/Terminal Area during Construction will produce localized areas of reduced water quality, including temporary increases in total suspended solids, nutrients, and chlorine. All discharges are expected to be diluted rapidly. The Saint-Louis Marine Protected Area is nearby (approximately 4 km to the south of the Nearshore Hub/Terminal Area), but it is expected that all discharges will be thoroughly dispersed and diluted before reaching the Marine Protected Area and impacts are considered unlikely.

Among threatened species, the discharges resulting from the support of construction operations are expected to affect threatened species in a similar fashion as other, non-listed species. Threatened fishes, birds, sea turtles, and marine mammals could be affected by discharges in the immediate vicinity of the discharge, but widespread impacts are not likely. Minimal effects to plankton and fishes are expected, while marine birds, sea turtles, and marine mammals are unlikely to encounter discharged materials from Construction Phase vessels. The impacts from potential invasive species will be similar as described for the Offshore Area.

Solid Waste

No solid waste will be intentionally discharged in the Nearshore Hub/Terminal Area. However, accidental loss of debris from the drillship or support vessels may occasionally occur during the Construction Phase and currents could transport debris through protected areas or onto coastal IBAs, EBSAs. Given the vicinity to shore of the Nearshore Hun/Terminal Area, floating debris may quickly wash ashore and may foul beaches, adversely affect the aesthetics of natural coastal areas, and provide an entanglement or ingestion hazard for coastal fauna. Debris that remains offshore could pose entanglement or ingestion hazards to marine fauna located within offshore protected areas or other areas of conservation interest such as the Saint-Louis Marine Protected Area.

Construction Phase activities will generate trash comprising paper, plastic, wood, glass, and metal. The amount of trash and debris dumped nearshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. For threatened species present in the Nearshore Hub/Terminal Area, the accidental loss of solid waste and debris may result in entanglement or ingestion for marine mammals and sea turtles. The potential for impact to fishes and birds is considered to be limited.

Helicopter Traffic

It is not expected that helicopters will be utilized in the Nearshore Hub/Terminal Area during the Construction Phase, but helicopters may fly over the area when transiting to the Offshore Area. As stated in Section 7.2.11.1.1, any potential impacts to species within protected areas or other areas of conservation interest are mainly expected to be short-term behavioral changes.

Helicopter traffic impacts on threatened species present at the Nearshore Hub/Terminal Area are not expected, as helicopter flights to this area are not expected.

7.2.11.2.3 Pipeline Area

Physical Presence

The physical installation of the pipeline in the Pipeline Area could affect the live bottom carbonate mound areas that are present in the Pipeline Area (see Section 4.5.3.2). Installation of the pipeline will result in temporary, but localized increased water turbidity would could smother live bottom communities in the vicinity of the installation activities. As shown in Figure 4-16, the proposed pipeline route has been routed to avoid lithoherm and canyon features and any direct impacts to these communities from the pipeline installation are not expected to be significant.

Impacts to threatened species from physical presence will be similar to those previously discussed for marine mammals, sea turtles, and fishes – short term behavioral disruptions.

Vessel Movements

Vessels in the Nearshore Hub/Terminal Area during the Construction Phase will include the pipelay vessel and the umbilical installation vessel. It is not expected that vessel movement will impact the live bottom carbonate mounds located within the Pipeline Area. Vessels transiting to the Pipeline Area from supply bases may travel in the vicinity of protected areas such as the Saint-Louis Marine Protected Area or through one of several EBSAs located offshore Dakar or Nouakchott. As discussed in Section 7.2.11.1.1, some erosion may occur in coastal areas due to vessel wakes and fauna within protected areas may experience behavioral disturbances.

The impact of vessel movements on threatened species will likely be limited to marine mammals, sea turtles, and birds. Impacts from physical disturbance are expected to include avoidance of or displace from the construction area by individuals or groups of threatened marine mammals or sea turtles.

Emissions

Emissions in the Pipeline Area as a result of construction and installation of the FPSO will result in air contaminants typically associated with internal combustion engines including PM, SO_x, NO_x, VOCs, and CO. Depending on prevailing winds at the time of emissions, increased concentrations of these contaminants could occur any protected area or area of conservation interest that is downwind.

Any impacts to threatened species from project-related emissions would be limited. Reductions in local air quality associated with construction activities will be limited to the area around the area of operations within the Pipeline Area. As a result, only limited impacts to threatened birds, sea turtles, and marine mammals may be expected from diminished air quality; no impacts to threatened fish are expected.

Discharges

Routine discharges from the pipelay vessel and umbilical installation vessel in the Pipeline Area will produce localized areas of reduced water quality, including increases in total suspended solids, nutrients, and chlorine. All discharges are expected to be diluted rapidly due to the open ocean location of the Pipeline Area. Slight, temporary increases in total suspended solids, nutrients, and chlorine could occur in offshore protected areas such as the Saint-Louis Marine Protected Area.

Among threatened species, the discharges resulting from the support of construction operations are expected to affect threatened species in a similar fashion as other, non-listed species. Threatened fishes, birds, sea turtles, and marine mammals could be affected by discharges in the immediate vicinity of the discharge, but widespread impacts are not likely. Minimal effects to plankton and fishes are expected, while marine birds, sea turtles, and marine mammals are unlikely to encounter discharged materials from Construction Phase vessels. The impacts from potential invasive species will be similar as described for the Offshore Area.

Solid Waste

No solid waste will be intentionally discharged in the Pipeline Area during the Construction Phase. As discussed in Section 7.2.11.1.1, accidental loss of debris from the drillship or support vessels may occasionally occur as result in an entanglement or ingestion hazard for marine fauna. If debris washed ashore, waste could result in the fouling of beaches, negative effects on the aesthetics of natural coastal areas, and result in an entanglement or ingestion hazard for coastal fauna.

For threatened species present in the Pipeline Area, the accidental loss of solid waste and debris may result in entanglement or ingestion for marine mammals and sea turtles. The potential for impact to fishes and birds is considered to be limited.

Helicopter Traffic

It is not expected that helicopters will be utilized in the Pipeline Area during the Construction Phase, but helicopters may fly over the area when transiting to the Offshore Area. As stated in Section 7.2.11.1.1, any potential impacts to species within protected areas or other areas of conservation interest are mainly expected to be short-term behavioral changes.

Helicopter traffic impacts on threatened species will be similar to those noted for marine mammals, sea turtles, fishes, and birds. Sound generated by project-related aircraft that are directly relevant include both airborne sounds to individuals resting on the sea surface (e.g., marine mammals, sea turtles, birds) and underwater sounds from air-to-water transmission from passing aircraft.

7.2.11.2.4 Support Operations Areas

Emissions

As discussed in Section 7.2.11.1.1, emissions in the Support Operations Areas will result in air contaminants typically associated with internal combustion engines including suspended particulate matter (PM), sulfur oxides (SO_x), nitrogen oxides (NO_x), volatile organic compounds (VOCs), and carbon monoxide (CO). Depending on prevailing winds at the time of emissions, increased concentrations of these contaminants could occur any protected area or area of conservation interest that is downwind. Any impacts to threatened species from project-related emissions would be limited. Reductions in local air quality associated with construction activities will be limited to vessel movements in support of construction activities in other project areas. As a result, only limited impacts to threatened birds, sea turtles, and marine mammals may be expected from diminished air quality; no impacts to threatened fish are expected.

Discharges

Routine discharges from the pipelay vessel and umbilical installation vessel in the Support Operations Areas will produce localized areas of reduced water quality, including increases in total suspended solids, nutrients, and chlorine. Slight, temporary increases in total suspended solids, nutrients, and chlorine could occur in offshore protected areas near the Support Operations Areas such as the Coastal Habitats of the Neritic Zone of Mauritania and the extreme north of Senegal EBSA near Nouakchott or the Convergence Zone of the Canary-Guinea Currents EBA near Dakar.

Among threatened species, the discharges resulting from the support of construction operations are expected to affect threatened species in a similar fashion as other, non-listed species. Threatened fishes, birds, sea turtles, and marine mammals could be affected by discharges in the immediate vicinity of the discharge, but widespread impacts are not likely. Minimal effects to plankton and fishes are expected, while marine birds, sea turtles, and marine mammals are unlikely to encounter significant amounts of discharged materials from Construction Phase vessels.

Solid Waste

No solid waste will be intentionally discharged in the Support Operations Areas during the Construction Phase. As discussed in Section 7.2.11.1.1, accidental loss of debris from support vessels may occasionally occur as result in an entanglement or ingestion hazard for marine fauna. If debris washed ashore, waste could result in the fouling of beaches, negative effects on the aesthetics of natural coastal areas, and result in an entanglement or ingestion hazard for coastal animals.

Accidental loss of trash and debris is anticipated, some of which could float on the water surface. For threatened species present in the Support Operations Areas, the accidental loss of solid waste and debris may result in entanglement or ingestion for marine mammals and sea turtles. The potential for impact to fishes and birds is considered to be limited.

Helicopter Traffic

Helicopter take-offs and landings will occur during the Construction Phase from airports at Dakar and Nouakchott in the Support Operations Areas. Noise associated with helicopter flights may result in short-term behavioral changes to species within protected areas or other areas of conservation interest that are along the flight path between the airports and the Offshore Area. However, due to the altitude at which the helicopters are expected to fly and the intermittent nature of the helicopter trips, significant impacts are not expected.

Helicopter traffic impacts on threatened species will be similar to those noted for marine mammals, sea turtles, fishes, and birds. Sound generated by project-related aircraft that are directly relevant include both airborne sounds to individuals resting on the sea surface (e.g., marine mammals, sea turtles, birds) and underwater sounds from air-to-water transmission from passing aircraft.

7.2.11.2.5 Summary

Construction-related vessel and helicopter activities, and installation of infrastructure may result in negative impacts to protected areas near the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area from physical presence, discharges, solid waste, and helicopter traffic. Emissions from the Nearshore Hub/Terminal Area may also diminish air quality in proximal protected areas or areas of conservation interest from construction emissions.

Operation of construction-related vessels and helicopters, and installation of infrastructure may result in negative impacts to threatened species in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area, and to a lesser extent at the Support Operations Areas. Physical presence may disturb listed marine mammals and turtles, either through low intensity sound exposure (e.g., vessel operations, drilling) or limited high intensity sound exposure (i.e., VSP surveys at the Offshore Area; pile driving at the Nearshore Hub/Terminal Area). Vessel movements in all areas may result in auditory injuries or impairment, short-term behavioral alterations, and short-term displacement from (or attraction to) discrete construction areas. Vessel collisions with listed marine mammals or turtles are possible but very unlikely. Discharges and the accidental loss of solid waste has the potential to adversely affect marine mammals and sea turtles, while helicopter traffic and associated noise may be sources for disturbance. Utilization of foreign vessels could potentially introduce aquatic invasive species to the region.

7.2.11.3 Impact Rating

Physical Presence

The impacts to protected areas and other areas of conservation interest from the physical presence from the support vessels in the Construction Phase will be limited to the Nearshore/Hub Terminal Area where there are protected areas or other areas of conservation interest in close proximity. No significant impacts are expected to the live bottom carbonate mound communities in the Pipeline Area due to the routing of the pipeline to avoid these features. Consequences are expected to be limited to short-term behavioral disturbances to marine or terrestrial fauna due to the distance between the areas of project activity in the Construction Phase and the nearest protected areas or other areas of conservation interest. Therefore, the overall impact significance is 1 – Negligible (see Table 7-36 below for details on selected criteria).

Impacts to threatened species will be identical to those identified for marine mammals, sea turtles, birds and fish. Drilling activities (Offshore Area) may disturb marine mammals, sea turtles, and fish by disturbances associated with the physical presence of the drillship and support vessels, along with VSP survey(s) that may result in auditory injury (PTS) or impairment (TTS); sound exposure likely will result in behavioral alteration in all threatened species that may be present. Construction activities within the Pipeline Area may disturb threatened species by disturbances associated with the physical presence of construction and support vessels and associated noises. Construction activities associated with the Nearshore Hub/Terminal will include several sources of sound, including dredging and crushing of hard substrate within the construction footprint, installation of the breakwater, including caissons, and the driving of steel piles. Pile driving activities are expected to create behavioral alterations, principally avoidance and short-term displacement from the area of ensonification (extending some distance beyond the Nearshore Hub/Terminal construction Area) for the duration of the pile driving activities. These impacts are expected to be limited to behavioral alterations; specifically avoidance and temporary displacement. The intensity of these impacts is moderate, as effects from sound, particularly from pile driving activities, may displace threatened species from the area surrounding the Nearshore Hub/Terminal. Impacts from physical presence of construction and construction activities, and other sources of sound (including drilling, vessel, and various construction activities) are considered low. Based on activities discussed in Chapter 2, these impacts are likely to occur. The extent of these impacts to threatened species is expected to be limited within the immediate vicinity, although noise from pile driving and the VSP survey are local. The duration of construction-related impacts is short term. Therefore, the overall impact significance is 2 – Low (see Table 7-36 below for details on selected criteria).

Vessel Movements

Impacts to protected areas and other areas of conservation interest from vessel movements may occur due to operations in the Offshore, Nearshore/Hub Terminal, or Pipeline Area. The primary impact would be due to incremental coastal erosion caused by vessel wakes, or behavioral disturbances due to vessel noise. Due to the nature (i.e., duration, vessel routes) of support vessel operations, impact consequence to fauna in protected areas or other areas of conservation interest from noise disturbance is anticipated to be negligible. Although coastal erosion is possible, vessels will depart from established supply bases that are located in developed, industrial areas and impacts on protected areas from coastal erosion are not expected. Therefore, the overall impact significance is 1 – Negligible (see Table 7-36 below for details on selected criteria).

The consequence of impacts to threatened species (primarily marine mammals and turtles; to a lesser extent fish and birds) present in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, and the Support Operations Areas from vessel movement include potential auditory injuries or impairment, short-term behavioral alterations, and short-term displacement from (or attraction to) discrete construction areas. Vessel collisions with threatened marine mammals or sea turtles are possible but very unlikely, based on normal construction vessel speeds. The intensity of these impacts is low, as they are limited to behavioral alterations; specifically avoidance and temporary displacement. The extent of these impacts to threatened species is expected to be limited to the immediate vicinity of construction activities, with the duration short term. In the event a project vessel strikes a threatened marine mammal or sea turtle resulting in injury or mortality, the impact intensity would be moderate. The extent, in this case, would also be restricted to the immediate vicinity and the duration would be short term (impacts would not be felt by the local population during the life of the project). The consequence of the impact would be minor, but the likelihood would be remote. Therefore, in this case, the overall impact significance is 1 – Negligible (see Table 7-36 below for details on selected criteria).

Emissions

Emissions from project vessels may cause an increase in airborne contaminants in protected areas or other areas of conservation interest that are downwind of the location of emissions. Emissions from construction and installation activities in the Nearshore/Hub Terminal and Support Operations Areas may cause reduced air quality in protected areas or other areas of conservation interest due to the proximity to shore and nearby protected areas. There are no protected areas in the vicinity of the Offshore Area and impacts from emissions in that area are not expected. Based on distance between the emissions source and the nearest protected areas or other areas of conservation interest and the low potential for associated impacts on marine or terrestrial fauna, the overall impact significance is rated 1 – Negligible (see Table 7-36 below for details on selected criteria).

The likelihood of emission-related impacts to threatened species is considered remote; impact intensity is low, local in extent, and of short term duration, resulting in a negligible impact. Given the remote nature of this impact, overall impact significance is 1 – Negligible (see Table 7-36 below for details on selected criteria).

Discharges

Routine effluent discharges may produce localized areas of reduced water quality, including increases in total suspended solids, nutrients, and chlorine. While expected to be localized to the area in the vicinity of the discharge, discharges from transiting vessels to any of the project areas could result in temporary impacts to water quality in protected areas or other areas of conservation interest. Due to the expected rapid dispersion of effluent discharges, and lack of protected areas in the immediate vicinity of discharge locations in any project area, the overall impact significance is 1 – Negligible (see Table 7-36 below for details on selected criteria).

Discharge of ballast water could result in the introduction of non-native species that could become established and invasive. If it occurred, a new invasive species could impact threatened species and/or protected areas by disrupting habitat or food availability for native species. The intensity of such impacts would be moderate. Based on the long-term and regional nature of such an impact, the overall impact significance to threatened species and protected areas would be 2 – Low.

Other impacts to threatened species from discharges are not expected. The extent of any potential impacts to threatened species is expected to be limited to the immediate vicinity of the discharges. The duration of construction-related impacts from discharges is short term and the consequence of the impact would be negligible. Given the occasional likelihood of impacts, the overall impact significance to threatened species from discharges is 1 – Negligible (see Table 7-36 below for details on selected criteria).

Solid Waste

The accidental discharge of solid waste from vessels operating in any of the project areas during the Construction Phase could potentially impact fauna in offshore protected areas or wash ashore and foul beaches and present an ingestion or entanglement hazard for terrestrial species within protected areas or other areas of conservation interest. Based on the rarity of debris being lost overboard and the low likelihood of significant impacts even if occasional debris is lost, the overall impact significance is 1 – Negligible (see Table 7-36 below for details on selected criteria).

Accidental losses are expected to be limited but may produce very localized impacts to threatened species, particularly listed marine mammals, sea turtles, and birds, via ingestion of small particles (plastic) or entanglement in debris. The extent of these impacts to threatened species is expected to be limited to the immediate vicinity and of short duration; given a low impact intensity, impact consequence is Negligible. Given an occasional likelihood, overall impact significance is 1 – Negligible (see Table 7-36 below for details on selected criteria).

Helicopter Traffic

Helicopters will be used to service the drillship in the Offshore Area. Sound from helicopter traffic could potentially cause short-term behavioral disruptions to fauna in either offshore or terrestrial protected areas or other areas of conservation interest. Due to the number of helicopter trips expected to occur in support of proposed drilling operations and the expected flight paths, altitude, and intermittent nature of helicopter flights, impact consequence to protected areas and other areas of conservation interest considered negligible. The overall impact significance is 1 – Negligible (see Table 7-36 below for details on selected criteria).

For threatened species, intensity of impact from helicopter traffic is low, as it is limited to behavioral alterations (avoidance and temporary displacement). Impact intensity to threatened species is considered to be low, limited to the immediate vicinity and of short-term duration. The consequence of this impact would be negligible; given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-36 below for details on selected criteria).

Summary

A summary of impacts to protected areas or other areas of conservation interest and threatened species from routine activities during the Construction Phase is presented in Table 7-36.

Table 7-36. Impacts to Threatened Species and Protected Areas or Other Areas of Conservation Interest during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Nearshore Hub/ Terminal	Behavioral disturbances to fauna within protected areas or other areas of conservation interest.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal	Physical injuries and disturbances to threatened species.	Nature: Negative Intensity: Moderate (VSP; pile driving) Spatial Extent: Immediate vicinity to Local (VSP; pile driving) Duration: Short term	Minor	Likely	2 – Low
Vessel Movements						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Coastal erosion due to vessel wakes; behavioral disturbances to fauna within protected areas or other areas of conservation interest.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Disturbance, possible auditory injury, vessel strike to threatened species from vessels in operation.	Nature: Negative Intensity: Low to Moderate Spatial Extent: Immediate vicinity Duration: Short term	Negligible to Minor	Remote to Occasional	1 – Negligible to 2 – Low

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Emissions						
Mauritania Senegal	Nearshore Hub/ Terminal; Support Operations	Increase in airborne contaminants in protected areas or other areas of conservation interest.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Likely	1 – Negligible
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Emission-related impacts to threatened species.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Remote	1 – Negligible
Discharges						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Temporarily decrease water quality in protected areas or other areas of conservation discharge near the discharge location.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Remote	1 – Negligible
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Temporarily decrease water quality and effects on threatened species.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Introduction of non-native or invasive species.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Long term	Moderate	Remote	2 – Low

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Solid Waste						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Potential entanglement or ingestion by fauna in protected areas; fouling of coastal areas in protected areas.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Rare	1 – Negligible
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Potential entanglement or ingestion by threatened species.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Occasional	1 – Negligible
Helicopter Traffic						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Behavioral disturbances to fauna within protected areas or other areas of conservation interest.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Occasional	1 – Negligible
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Behavioral disturbances to threatened species.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Likely	1 – Negligible

7.2.11.4 Mitigation Measures and Residual Impacts

Most impacts to Protected Areas are rated 1 - Negligible and therefore no mitigation measures are required. Of note, however, is the fact that by positioning the project facilities offshore at some distance of the protected areas, direct and indirect impacts from routine activities are largely avoided. Furthermore, the probability of introduction of invasive species will be reduced by adherence to IMO Ballast Water Management Regulations, where applicable (e.g., see Section 7.2.7.4).

Table 7-37 outlines the available mitigation measures recommended to reduce impact consequence or likelihood associated with construction-related impacts to threatened species.

Table 7-37. Mitigation Measures to Avoid or Reduce Impacts to Threatened Species from Routine Activities during the Construction Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Physical injuries and disturbances to threatened species.	2 – Low	M04, M05, M07	2 – Low
Disturbance, possible auditory injury, vessel strike to threatened species from vessels, operations.	2 – Low	M06	2 – Low
Introduction of non-native or invasive species.	2 – Low	None	2 – Low

Notes:

M04: Seismic survey mitigation measures to be implemented during VSP survey(s) with the aim of minimizing the acoustic exposures to marine mammals (e.g. gradually increasing seismic source elements over a period of approximately 30 minutes until the operating level is achieved before any VSP activity begins).

M05: Sound mitigation measures will be implemented during pile driving (e.g. soft-starting [gradually increasing hammer power]).

M06: Vessel operators will implement vessel strike avoidance protocols to reduce the potential for vessel strike with marine mammals and sea turtles (including injured/dead protected species reporting).

M07: Collection and analysis of acoustic data from the area to determine background sound levels and marine mammal presence/absence, and underwater sound modeling to determine distances to various thresholds.

7.2.12 Biodiversity

High Level Summary

In this section on Biodiversity, the impact of six impact producing factors, these being Physical presence, Vessel movements, Emissions, Discharges, Solid waste and Helicopter traffic, was evaluated. The residual impacts on Biodiversity during the Construction Phase for routine activities were assessed as of negligible significance when mitigation measures are applied.

7.2.12.1 Impact Producing Factors and Project Areas

As discussed in Chapter 4, the characteristics for biodiversity represent a suite of previously identified resources – i.e., fish and other fishery resources, marine mammals, sea turtles, birds, threatened species, and protected areas. Biodiversity IPFs consequently represent a combination of IPFs identified for those resources that contribute to biodiversity. Refer to Sections 7.2.6 and 7.2.8 through 7.2.11 for detailed discussion of impact determinations for these resources.

7.2.12.2 Impact Description

The Construction Phase will involve a multitude of specialized vessels specifically designed to complete various tasks, including well drilling and completion, installation of infrastructure (i.e., SPS; pipelines, flowlines, and umbilicals; FPSO; breakwater and terminal facilities), and support operations. These vessels and the associated infrastructure which they will install are the source of several IPFs. Physical presence, vessel movements, emissions, discharges, solid waste, and helicopter traffic represent potential sources of impact to biodiversity resources in the project areas.

Table 7-38 summarizes the impact determinations for each of these biodiversity resources.

Table 7-38. Summary of Impact Determinations for Various Components of Biodiversity during the Construction Phase.

IPF	Fish and Other Fishery Resources	Marine Mammals	Sea Turtles	Birds	Threatened Species	Protected Areas
Physical presence	Positive and 1 – Negligible	1 – Negligible to 2 – Low	2 – Low	1 – Negligible to 2 – Low	2 – Low	1 – Negligible
Vessel movements	-	1 – Negligible to 2 – Low	1 – Negligible to 2 – Low	-	1 – Negligible to 2 – Low	1 – Negligible
Emissions	-	-	-	-	1 – Negligible	1 – Negligible
Discharges	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible to 2 – Low	1 – Negligible to 2 – Low
Solid waste	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible
Helicopter traffic	-	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible

7.2.12.3 Mitigation Measures and Residual Impacts

The majority of impacts to biodiversity resources resulting from construction activities were rated 1 - Negligible and therefore no mitigation measure was required. Noise-related impacts to marine mammals, and to a lesser extent to sea turtles, before mitigation, were rated 2 – Low, as was the potential impact to marine mammals and sea turtles resulting from vessel strike. Table 7-32 (Section 7.2.9.4) summarizes the proposed mitigation measures to avoid or reduce impacts to marine mammals resulting from construction activities, which also apply to sea turtles.

7.2.13 Land & Seabed Occupation and Use

High Level Summary

In this section on Land & Seabed Occupation and Use, the impact of one impact producing factor, this being Physical presence, was evaluated. All impacts on Land & Seabed Occupation and Use during the Construction Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

7.2.13.1 Impact Producing Factors and Project Areas

The IPF identified for this resource in Table 7-4 is distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	●

7.2.13.2 Impact Description

The following subsections explain how this IPF will potentially produce impacts in each of the project areas.

7.2.13.2.1 Offshore Area

Physical Presence

The drillship will not be utilizing anchors to maintain position over each wellsite and support vessels operating in the Offshore Area will not utilize anchors. Therefore, the physical presence of the drillship and support vessels will have no effect on the seabed of the Offshore Area.

The installation of the SPS will entail the occupation of less than 0.01 km^2 of the seabed. No anthropogenic activities have been identified on that portion of the seabed.

The only potential anthropogenic activities on the seabed offshore Mauritania and Senegal are submarine telecommunication cables. As indicated on Figures 4-30 and 4-38 of Chapter 4, all telecommunication cables are far from the proposed wells except one, MainOne, which is located a few kilometers to the west of all project infrastructures.

Noise associated with the construction activities will not affect the submarine telecommunication cables.

7.2.13.2.2 Nearshore Hub/Terminal Area

Physical Presence

Within the Nearshore Hub/Terminal Area, the installation of the breakwater and other bottom-founded infrastructure will entail the occupation of 0.16 km^2 of the seabed. No anthropogenic activities have been identified on that portion of the seabed.

7.2.13.2.3 Pipeline Area

Physical Presence

Along the pipeline corridor, and at the FPSO location, the placement of infrastructure (i.e., gas and MEG pipelines, umbilicals) and FPSO anchors will entail the occupation of a small portion of the seabed. The area affected by FPSO anchors and linear infrastructure within the Pipeline Area is estimated to be 0.13 km^2. No anthropogenic activities have been identified on that portion of the seabed.

7.2.13.2.4 Support Operations Areas

Physical Presence

The project does not include any onshore facilities except for the Support Operations Areas, i.e. supply base facilities.

The supply base facilities will be located inside existing port and airport facilities in Dakar and/or Nouakchott. No land acquisition will be required in Dakar, Nouakchott or any other locations in Mauritania or Senegal. Therefore, the physical presence of the supply base facilities will have no effect on the land occupation in the Support Operations Areas. In addition, the expected noise levels associated with the supply base facilities will be similar to existing noise levels inside the ports and thus will not affect the land occupation and use.

7.2.13.2.5 Summary

Table 7-39 provides a summary of the total seafloor area occupied during the Construction Phase as a result of infrastructure emplacement (physical presence).

Table 7-39. Area of Seabed Used by Installation Activities by Project Area for the Construction Phase.

Project Area	Seabed Occupied in km^2
Offshore Area	<0.01
Nearshore Hub/Terminal Area	0.16
Pipeline Area	0.13
Total	<0.30

7.2.13.3 Impact Rating

Physical Presence

The impacts of the physical presence of project infrastructures to seabed occupation and use in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area include a modification in current seabed occupation on a very small area: <0.30 km^2. This modification will have no interference with other users since no anthropogenic activities have been identified in the concerned seabed area. The intensity of the impact is low. The small adverse changes on the seabed are unlikely to be noticed. The extent of the impact will be limited to the infrastructure footprint. While the seabed occupation will be initiated during the Construction Phase, the presence of the infrastructures will last during the Operations Phase of the project and beyond since most of the structures laying on the seabed will remain there even after decommissioning. Therefore, its duration is considered here for the whole life of the project and beyond as the impact is permanent. Based on the combination of these criteria, the consequence of the impact will be negligible. Even if this impact is likely to happen, its overall significance is rated 1 – Negligible. Details are provided in Table 7-40.

Table 7-40. Impacts to Land & Seabed Occupation and Use during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Nearshore / Hub Terminal; Pipeline	Modifications in current seabed occupation on an area <0.30 km^2 due to presence of project infrastructures.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term (permanent)	Negligible	Likely	1 - Negligible

7.2.13.4 Mitigation Measures and Residual Impacts

The impact being rated 1 – Negligible, no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D18: The seabed in the project areas has been mapped as part of an extensive geophysical and geotechnical survey carried out by the project. The survey has confirmed that the project seabed infrastructure does not pose a risk to the submarine telecommunication cables.

- D19: The relevant maritime, port or shipping authorities will be notified of all permanent offshore facilities, as well as safety zones and routine shipping routes to be used by project-related vessels. Permanent facility locations will be demarcated on nautical charts.

7.2.14 Maritime Navigation

High Level Summary

In this section on Maritime Navigation, the impact of three impact producing factors, these being Physical presence, Exclusion safety zones and Vessel movements, was evaluated. The residual impacts on Maritime Navigation during the Construction Phase for routine activities were assessed as of negligible or low significance when mitigation measures are applied.

7.2.14.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	
Exclusion safety zones	●	●	●	
Vessel movements	●	●	●	

Exclusion safety zones around the infrastructures are addressed together with the physical presence of those infrastructures since they combine to interfere with maritime navigation.

7.2.14.2 Impact Description

The following subsections explain how the IPFs will potentially produce impacts in each of the project areas.

7.2.14.2.1 Offshore Area

Physical Presence and Exclusion Safety Zones

For the purpose of vessel and operation safety, non-project vessels will be required to remain outside of a 500-m radius exclusion safety zone around the drillship and SPS installation vessels. Though this exclusion safety zone will ensure maritime safety, it might affect existing navigation and shipping routes.

The drillship and the SPS installation vessels will be located about 125 km offshore. As indicated in Sections 4.6.7.1 and 4.7.7.1, there is a maritime traffic corridor offshore the Mauritanian and Senegalese coasts used mostly for shipping activities between Africa and Europe. As shown on Figures 4-29 and 4-37, the project Offshore Area is located within this maritime traffic corridor. Maritime traffic level within this corridor, comprised mainly of cargo vessels and tankers, is moderate. No pirogues (artisanal fishing boats) are present in the Offshore Area where water depths are approximately 2,700 to 2,800 m.

The physical presence of the drillship at the drilling location and the exclusion safety zone around the drillship might interfere with existing maritime shipping routes. However, the exclusion safety zone is small: with a radius of 500 m, its area is <1 km^2. The drilling will be done one well at a time. As indicated in Table 2-4 in Chapter 2, drilling the 12 wells could last up to about 700 days, discontinuously over a period of several years. No exclusion safety zone is associated with the wells after their drilling.

During the Construction Phase, another 500-m exclusion safety zone will be applied around the SPS installation vessels. As indicated in Section 2.3.1, the duration of the installation of the SPS is estimated to approximately five months. No exclusion safety zone is associated with the SPS after its installation.

Vessel Movements

For drilling operations, support vessels will include one supply vessel and one standby vessel transiting between the drillship and the Ports of Dakar and/or Nouakchott.

The standby vessel will remain on station, adjacent to the drillship, to monitor the exclusion safety zone, while the supply vessel will transit between an onshore supply base and the wellsite. As indicated in Table 2-4 of Chapter 2, one round trip per week to the Ports of Dakar and/or Nouakchott is expected for the supply vessel during the drilling operations.

For the SPS installation, 10 installation and support vessels will be used (see details in Table 2-3 of Chapter 2). It is assumed that two support vessels will transit between the SPS location and the Ports of Dakar and/or Nouakchott on a weekly basis.

No pirogues (artisanal fishing boats) are present in the Offshore Area where water depths are approximately 2,700 to 2,800 m. However, artisanal fishing boats could be present in the navigation corridors that will be used by the support vessels transiting between the wellsites and the Ports of Dakar and/or Nouakchott, notably in nearshore waters.

7.2.14.2.2 Nearshore Hub/Terminal Area

Physical Presence and Exclusion Safety Zones

During all phases of the project, it is expected that the physical presence of the breakwater and the exclusion safety zone around it will cover a surface of 3.24 km^2 with currently planned distances of 500 m X 600 m around the breakwater. This exclusion safety zone will be located about 10 km from the coast on the Mauritania and Senegal maritime border.

As shown on Figures 4-29 and 4-37 in Chapter 4, the Nearshore Hub/Terminal Area is located in a low traffic density. It is out of the maritime navigation and shipping corridor offshore Mauritanian and Senegalese coasts. Therefore, no interference of the breakwater and its exclusion safety zone is expected with the existing offshore maritime navigation and shipping corridor.

However, interference with the navigation of pirogues is expected. The Nearshore Hub/Terminal Area is located in an artisanal fishing area with a concentration of pirogues as shown on Figures 4-35 and 4-36 in Chapter 4. The pirogues will need to adjust their navigation routes to avoid the Nearshore Hub/Terminal and its exclusion safety zone around the breakwater.

While this interference will start during the Construction Phase, it will last during all phases of the project and beyond (permanent impact).

Vessel Movements

The construction of the breakwater and other jetty structures will last around 25 to 30 months. As indicated in Table 2-1 of Chapter 2, it is planned that 29 vessels will be used during a number of days varying between 20 to 660. Most of those vessels are construction vessels but they will also include support vessels.

It is expected that the construction vessels will generally stay within the exclusion safety zone around the breakwater. However, the support vessels will get in and out of the exclusion safety zone on a regular basis: the two supply vessels could transit to/from the Ports of Dakar and/or Nouakchott every three days and the two crew boats every six days.

7.2.14.2.3 Pipeline Area

Physical Presence and Exclusion Safety Zones

At the FPSO location, a 500-m exclusion safety zone will be established around the FPSO. Additionally, a 500-m moving exclusion safety zone will be established around large construction vessels during the installation of the pipeline. The 500-m exclusion safety zones might interfere with maritime navigation.

As shown on Figures 4-29 and 4-37 in Chapter 4, most of the Pipeline Area is located in a low maritime traffic density area. However, the western section of the Pipeline Area, close to the SPS, is located within the maritime navigation and shipping corridor offshore Mauritanian and Senegalese coasts where traffic density is moderate. With a radius of 500 m around the vessels, the exclusion safety zone will be <1 km^2. As indicated in Section 2.5, the pipeline installations vessels and their exclusion safety zone will be moving progressively in a linear way along the pipeline corridor for a total period estimated at 171 days. No exclusion safety zone is associated with pipelines after their installation.

The FPSO will be installed in the Pipeline Area, at a distance of approximately 40 km from the coast on the Mauritania and Senegal maritime border in 120 m water depth. The location of the FPSO is out of the maritime navigation and shipping corridor offshore Mauritanian and Senegalese coasts. Therefore, no interference of the FPSO and its exclusion safety zone is expected with existing maritime shipping routes.

However, being located in a 120-m water depth and relatively close from the coast, the FPSO could interfere with the navigation of pirogues since artisanal fishing is generally conducted in water depths up to 200 m. This interference will start during the Construction Phase, but it will last the whole life of the project.

Vessel Movements

During the estimated 171 days required for installation of the pipeline, about 10 installation and support vessels will be used (Table 2-3). It is assumed that two of the support vessels will transit to the Ports of Dakar and/or Nouakchott on a weekly basis.

The FPSO will be constructed outside of Mauritania or Senegal and will be towed to the final location. Typically, 15 vessels are required for hook up and commissioning of the FPSO (Table 2-2 in Section 2.5). This operation will require about 60 days. During that period, the two supply vessels will transit to the Ports of Dakar and/or Nouakchott every three days and the two crew boats every six days.

During the Construction Phase, the risks of project vessels interfering with non-project vessels in the Pipeline Area are similar to those in the Nearshore Hub/Terminal Area. However, the risks of interference with pirogues will diminish when the pipeline installation vessels work in water depths over 200 m.

7.2.14.2.4 Support Operations Areas

Physical Presence and Exclusion Safety Zones

The activities conducted at the ports and airports of Dakar and/or Nouakchott of will have no impact on maritime navigation.

Vessel Movements

An estimated total of 13 support vessels will be moving in and out of the Ports of Dakar and Nouakchott during the Construction Phase. These movements and their noise will not be noticeable against background traffic in these ports.

7.2.14.2.5 Summary

Table 7-41 provides a summary of exclusion safety zones as a result of physical infrastructure emplacement. Table 7-42 provides a summary of the estimated number of project vessels and Table 7-43 provides an estimation of the number of support vessels that will be transiting to the Ports of Dakar and/or Nouakchott.

Table 7-41. Area of Exclusion Safety Zones by Project Area for the Construction Phase.

Project Area	Estimated Exclusion Safety Zones in km^2
Offshore Area	2 x <1 km^2
Nearshore Hub/Terminal Area	<3.25 km^2
Pipeline Area	2 x <1 km^2
Total	<7.25 km^2

Table 7-42. Project Vessels by Project Area for the Construction Phase.

Project Area	Estimated Number of Project Vessels	Estimated Maximum Duration
Offshore Area	13	Up to about 700 days, discontinuously over a period of several years
Nearshore Hub/Terminal Area	29	Up to 660 days for some of the vessels
Pipeline Area	25	Up to 171 days for some of the vessels
Total	67	Up to 660 days for some of the vessels

Table 7-43. Support Vessels Transiting Regularly to the Ports of Dakar and/or Nouakchott by Project Area for the Construction Phase.

Project Area	Estimated Number of Project Vessels
Offshore Area	3
Nearshore Hub/Terminal Area	4
Pipeline Area	6
Total	13

7.2.14.3 Impact Rating

Physical Presence and Exclusion Safety Zones

The impacts of the physical presence of project infrastructures and their exclusion safety zones in the Offshore Area and Pipeline Area includes interference with existing offshore maritime navigation and shipping.

The physical presence and exclusion safety zone could entail two exclusion safety zones of <1 km^2 each during the five-month period where SPS installation and drilling will partly be conducted simultaneously. Except for that five-month period, there will only be one <1 km^2 exclusion safety zone in the Offshore Area and it will be discontinuous.

As planned by the project, proper information on the exact project vessels location and operation calendar will be provided to mariners through standard international and national communication channels. In Mauritania, information will be provided through the Department of Merchant Marine Activities and in Senegal it will be provided through the National Agency on Maritime Affairs.

Standard communication procedures will enable offshore maritime traffic and shipping to go around the exclusion safety zones without significantly modifying their usual maritime route. The intensity of the impact will be low. Its extent will be limited to the exclusion safety zones around project infrastructures. Except for the exclusion safety zone around the FPSO that will be maintained during all the project, the duration of the impact will be short term. Based on the combination of these criteria, the consequence of the impact will be negligible. Even if this impact is likely to happen, its overall significance is rated 1 – Negligible (details are provided in Table 7-44).

In the Pipeline Area and in the Nearshore Hub/Terminal Area, the physical presence of project infrastructures and their exclusion safety zones will interfere with the navigation of artisanal fishing boats. The pirogues will need to adjust their navigation routes to avoid two exclusion safety zones: a <1 km^2 zone around the FPSO and a <3.25 km^2 zone around the breakwater. However, these exclusion safety zones being located on the maritime border, the size of the exclusion safety zones for the fishermen operating in each country will be divided by two: <0.5 km^2 around the FPSO and <1.6 km^2 around the breakwater.

As planned by the project, information will be provided to the local fishing communities to communicate and record the exclusion safety zones and applicable navigational charts. This communication procedure will enable pirogues to avoid the exclusion safety zones. The pirogues navigate in a very large area in Mauritanian and Senegalese waters. The need to avoid one <0.5 km^2 area located about 40 km from the coast and one <1.6 km^2 area located 10 km from the coast, will not significantly modify their multiple navigation routes. The intensity of the impact will be low and its extent will be limited to the immediate vicinity of the project infrastructures. The impact will last during the whole life of the project. Based on the combination of these criteria, the consequence of the impact will be negligible. Even if this impact is likely to happen, its overall significance is rated 1 – Negligible (details are provided in Table 7-44).

Vessel Movements

Vessel movements in the Offshore Area, the Nearshore Hub/Terminal Area and the Pipeline Area could potentially entail risks of collision notably with non-project vessels. While this subject is discussed in the present section, a more comprehensive assessment is provided in Chapter 8.

To comply with international regulation, it is assumed that all project vessels will follow the Convention on International Regulations for Preventing Collisions at Sea (COLREGs) adopted by the IMO. These rules cover things such as steering/sailing, lights and shapes, light and sound signals, international distress signals, and signals with other vessels in close proximity, including fishing boats.

To reduce the risks of collision with non-project vessels, the project design includes exclusion safety zones. As detailed in Section 2.4, the exclusion safety zone established around all project facilities and the navigation rules for project vessels will minimize collision potential during all project phases. Designated travel and approach plans will be used to manage project vessels and the designated exclusion safety zones will be enforced with project patrol boats.

In addition, the boundaries of the exclusion safety zone around the breakwater will be demarcated through the use of:

- Marker buoys equipped with audio and visual warnings effective by both day and night in the prevailing sea conditions;
- Long life (LED or similar) bulbs;
- Anchored at pre-set intervals;

- Positioned to demarcate shipping lanes used for entry/exit and exclusion safety zones around fixed assets; and
- Tamper-proof design, anti-climb and not suitable for small vessels to use as a mooring.

To deter incursion to the exclusion safety zone around the Nearshore Hub/Terminal Area, a minimum of one project patrol boat will be used to control this area.

However, a risk of collision could also happen between pirogues and support vessels transiting out of the exclusion safety zones. The total number of support vessels is estimated at 13. Out of these 13, 4 will transit from the Nearshore Hub/Terminal Area where a concentration of pirogues has been noted. Pirogues are particularly sensitive to a collision incident. These small boats have no reflectors or communication systems. Additionally, they lack radar equipment, lighting and life-saving equipment. Therefore, there is a risk of collision between the support vessels and these pirogues, particularly at night and in nearshore waters. Such a collision could entail fatalities of fishermen.

The movements of the support vessels are unlikely to be noticed or measurable against background vessel traffic coming in and out of the Ports of Dakar and/or Nouakchott. As seen in Sections 4.6.7.1 and 4.7.7.1, the maritime traffic is moderate in the Port of Nouakchott and it is high in the Port of Dakar. The Port of Nouakchott receives about 400 ships per year and the Port of Dakar registered more than 2,700 in 2017. Thus, the movements of the support vessels in nearshore waters when approaching the Ports of Dakar and/or Nouakchott will not cause any significant additional collision risks for pirogues in these waters.

The movements of the four support vessels transiting from the Nearshore Hub/Terminal Area will be more noticeable since the current background traffic in this area is limited to pirogues. In addition to the movements of these 4 support vessels, the 25 construction vessels will need to move in and out the exclusion safety zone at certain times, minimally at the beginning and at the end of their assignments. Project vessel movements in and out the Nearshore Hub/Terminal Area will increase the traffic in that area. This will entail an increase of risks of collision due to the concentration of pirogues and the absence of other background traffic. The consequences of a collision could include fatalities. The same risk will apply in the Pipeline Area when the pipeline installation vessels work in water depths <200 m; pirogues could be present in these waters.

The intensity of the impact is considered high since a collision could potentially result in fatalities. Its extent is limited to the areas where the project activities are conducted. The duration of the impact is considered long term: in case of a fatality, the impact would be irreversible. Based on the combination of these criteria, the consequence of the impact will be moderate. The likelihood of the impact is considered occasional as a collision could happen more than one time. As a result, the overall significance of the impact is rated 3 – Medium (details are provided in Table 7-44).

Table 7-44. Impacts to Maritime Navigation during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence and Exclusion Safety Zones						
Mauritania Senegal	Offshore; Pipeline	Roundabout for maritime shipping vessels to avoid one or two <1 km^2 areas due to project infrastructures and their exclusion safety zones.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 - Negligible
Mauritania Senegal	Pipeline; Nearshore / Hub Terminal	Roundabout for pirogues to avoid in each country one <0.5 km^2 exclusion safety zone located 40 km from the coast and one <1.6 km^2 exclusion safety zone located 10 km from the coast due to project infrastructures and their exclusion safety zones.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term (permanent)	Negligible	Likely	1 - Negligible
Vessel Movements						
Mauritania Senegal	Pipeline; Nearshore / Hub Terminal	Risk of collision between project vessels and pirogues due to project vessels movements.	Nature: Negative Intensity: High Spatial Extent: Immediate vicinity Duration: Long term (potentially irreversible in case of a fatality)	Moderate	Occasional	3 - Medium

7.2.14.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-45) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the measures and controls already planned in the project design, summarized as follows:

- D19: The relevant maritime, port or shipping authorities will be notified of all permanent offshore facilities, as well as safety zones and routine shipping routes to be used by project-related vessels. Permanent facility locations will be demarcated on nautical charts.
- D20: Project vessels will follow the Convention on International Regulations for Preventing Collisions at Sea (COLREGs) adopted by the IMO.

- D21: Main project vessels will be equipped with Universal Shipborne Automatic Identification System (AIS), a system of transponders installed on vessels which transmit over two dedicated digital marine VHF channels.
- D22: Standard communication procedures will be used in international maritime traffic and shipping, aided by project patrol boats or standby vessels near the drilling, pipelay and Nearshore Hub/Terminal Area to prevent collision with larger vessels.
- D23: Information will be provided to the national industrial fishing fleet of both Mauritania and Senegal to communicate and record the exclusion safety zones and applicable navigational charts.

Table 7-45. Mitigation Measures to Avoid or Reduce Impacts to Maritime Navigation from Routine Activities during the Construction Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Risk of collision between project vessels and pirogues due to project vessels movements.	3 - Medium	M08, M09, M10, M11, M12, M13, M14, M15, M16, M17, M18, M19	2 - Low

Notes:

M08: Develop and implement a training and awareness program targeting local fishing communities on the specific maritime safety rules associated with the project.

M09: Provide regular notices to mariners in the appropriate form and language to artisanal fishermen on project infrastructure, associated exclusion safety zones, travel and approach plans and the approximate timing of project activities.

M10: Equip the support vessels and other project vessels that regularly move outside the construction or operational exclusion safety zones with radar or infrared systems[103] that can detect small fishing vessels during poor visibility/night time.

M11: Provide adequate lighting aboard the support vessels and other project vessels that regularly move outside the construction or operational exclusion safety zones with the intent of maintaining high visibility during poor visibility/night time. These vessels will also feature searchlights that can be used to shine on or signal approaching pirogues and foghorns for audible signaling.

M12: Having a project patrol boat to monitor the exclusion safety zones, including patrolling ahead of the approach or exiting of larger project vessels into or out of the exclusion safety zones.

M13: Using the services of local fishermen liaison officers (FLOs) aboard the project patrol boats in the areas of artisanal fishing.

M14: Equipping the support vessels and the project patrol boat with lifesaving appliances approved by the Convention for Safety of Life at Sea (SOLAS) and IMO, which can be used to assist in rescuing fishermen in the water in line with international maritime protocols or in the event of an accident involving a pirogue with a project vessel. Assist with the rescue of any fishermen involved in a collision with a project vessel or following the capsizing of their vessel due to ship wake.

M15: In case of a collision, BP will inform as soon as possible the relevant national authorities: the Mauritanian Coast Guard (Garde Côte Mauritanienne) in Mauritania and HASSMAR in Senegal.

M16: Ensuring that each project vessel keeps records of maritime safety incidents with pirogues and other vessels, including near misses, and that these are subsequently shared with the project. BP will monitor maritime safety incidents and adjust, if required, project specific maritime safety rules, security and search & rescue arrangements in place.

M17: Establishing a grievance mechanism easily accessible to fishing communities members that includes monitoring of claims and the resolution thereof.

M18: Maintaining a community liaison officer (CLO) for N'Diago and Saint-Louis to provide a direct link with the fishing communities.

M19: Collaboration with a community council of formally nominated representatives of local key stakeholders from N'Diago and Saint-Louis set up to review local fishing communities' concerns and grievances related to the project.

[103] The detection of wooden pirogues by radar would be at a closer distance than the detection of a metal boat, but the pirogues and the metallic structures (e.g. engines) on them would be detectable by radar.

7.2.15 Industrial Fisheries

High Level Summary

In this section on Industrial Fisheries, the impact of three impact producing factors, these being Physical presence, Exclusion safety zones and Vessel movements, was evaluated. All impacts on Industrial Fisheries during the Construction Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

7.2.15.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●		
Exclusion safety zones	●	●		
Vessel movements	●	●		

Potential displacement of fish due to moving away from sound source is addressed under Section 7.2.6. Exclusion safety zones around the infrastructures are addressed together with the physical presence of those infrastructures since they combine to potentially interfere with industrial fisheries.

7.2.15.2 Impact Description

The following subsections explain how the IPFs will potentially produce impacts in each of the project areas.

7.2.15.2.1 Offshore Area

Physical Presence and Exclusion Safety Zones

For the purpose of vessel and operation safety, non-project vessels, including industrial fishing boats, will be required to remain outside of a 500-m radius exclusion safety zone around the drillship and SPS installation vessels. Though this exclusion safety zone will ensure maritime safety, it might affect industrial fishing activities.

As indicated in Section 7.2.14.2, the exclusion safety zone around the drillship is small: with a radius of 500 m, the exclusion safety zone area is <1 km^2. Drilling the 12 wells could last up to about 700 days, discontinuously over a period of several years. No exclusion safety zone is associated with the wells after their drilling.

During the Construction Phase, another 500-m exclusion safety zone will be applied around the SPS installation vessels during approximately five months. No exclusion safety zone is associated with the SPS after its installation.

As indicated in Sections 4.6.6.2 and 4.7.6.2, industrial fishing activities occurs in a very large area of Mauritania and Senegal waters. The industrial fleet covers the entire EEZs of Mauritania and Senegal. As shown on Figures 4-28 and 4-34 in Chapter 4, there is no specific concentration of industrial fishing activities in the Offshore Area located along the Mauritania and Senegal border. Therefore, any temporary loss of up to 2 areas of <1 km^2 is unlikely to be noticed or measurable against background industrial fishing grounds.

Vessel Movements

As indicated in Section 7.2.1.4, two support vessels will be used during drilling operations. Additionally, 10 vessels will be used for the SPS installation. Those 12 vessels are unlikely to be noticed are measurable against background maritime traffic in the Offshore Area. Therefore, no interference is expected with industrial fishing boats in that area.

7.2.15.2.2 Nearshore Hub/Terminal Area

The physical presence of the breakwater, the exclusion safety zone around it and the vessel movements in the Nearshore Hub/Terminal Area will have no impacts on industrial fishing activities since none is conducted in this area.

7.2.15.2.3 Pipeline Area

Physical Presence and Exclusion Safety Zones

As indicated in Section 7.2.14.2, a 500-m exclusion safety zone will be established around the pipeline and FPSO installation related vessels.

With a radius of 500 m, the exclusion safety zone area around the vessels will be <1 km^2. The pipeline installations vessels and their exclusion safety zones will be moving progressively in a linear way inside the pipeline corridor along the Mauritania-Senegal maritime border for a total period estimated at 171 days. No exclusion safety zone is associated with pipelines after their installation.

The FPSO will be installed in the Pipeline Area, at a distance of approximately 40 km from the coast on the Mauritania and Senegal maritime border in 120 m water depth. With a radius of 500 m, the exclusion safety zone around the FPSO will be <1 km^2. While this exclusion safety zone will start during the Construction Phase, it will last during all phases of the project.

Any temporary or long-term loss of up to 2 areas of <1 km^2 in a corridor along the Mauritania and Senegal maritime border is unlikely to be noticed or measurable against background industrial fishing grounds in Mauritania and Senegal.

Vessel Movements

During the estimated 171 days required for installation of the pipeline, about 10 installation and support vessels will be used. Additionally, 15 vessels are required for hook up and commissioning of the FPSO during about 60 days.

The temporary presence of those 25 vessels will be concentrated within the exclusion safety zones. The 4 support vessels that will be transiting in and out of the safety zones on a regular basis are unlikely to be noticed or measurable against background maritime traffic in the portion of the Pipeline Area where industrial fishing activities could potentially occur. Therefore, no interference is expected with industrial fishing boats in the Pipeline Area.

7.2.15.2.4 Support Operations Areas

The Support Operations Areas being on shore, the activities conducted in those areas will have no impact on industrial fishing activities.

7.2.15.2.5 Summary

Table 7-46 provides a summary of exclusion safety zones as a result of physical infrastructure emplacement which will preclude any industrial fishing activities.

Table 7-46. Potential Temporary Industrial Fishing Grounds Losses by Project Area for the Construction Phase.

Project Area	Estimated Potential Industrial Fishing Ground Losses in km^2
Offshore Area	2 x <1 km^2
Nearshore Hub/Terminal Area	Not applicable
Pipeline Area	2 x <1 km^2
Total	<4 km^2

7.2.15.3 Impact Rating

Physical Presence and Exclusion Safety Zones

The impacts of the physical presence of project infrastructures and their exclusion safety zones in the Offshore Area and Pipeline Area include interference with existing potential industrial fishing grounds in the Mauritanian and the Senegalese waters. In both countries, the industrial fleet consists mainly in foreign boats. Therefore, any impact on the industrial fishing activity is considered for the industry as a whole, with no country specific considerations.

The potential loss of fishing grounds is estimated at <4 km^2 and those losses would be temporary and discontinuous, except around the FPSO (Pipeline Area). Once the FPSO is installed, the loss of <1 km^2 of potential industrial fishing grounds will last during the whole life of the project.

As indicated in Section 7.2.14.3, proper information on the exact project vessels location and operation calendar will be provided to mariners through standard international and national communication channels. In Mauritania, information will be provided through the Department of Merchant Marine Activities and in Senegal it will be provided through the National Agency on Maritime Affairs.

Standard communication procedures will enable industrial fishing boats to avoid the exclusion safety zones without significantly modifying their potential fishing grounds. The intensity of the impact will be low and its extent will be limited to the exclusion safety zones. The impact will be short term except for the loss of potential fishing grounds around the FPSO which will last during the whole life of the project. Based on the combination of these criteria, the consequence of the impact will be negligible. Even if the impact is likely to happen and it is rated 1 – Negligible (details are provided in Table 7-47).

Table 7-47. Impacts to Industrial Fisheries during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence and Exclusion Safety Zones						
Mauritania Senegal	Offshore; Pipeline	Loss of potential industrial fishing grounds of up to <4 km^2 due to project infrastructures and their exclusion safety zones.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term to Long term	Negligible	Likely	1 – Negligible

7.2.15.4 Mitigation Measures and Residual Impacts

Impacts being rated 1 – Negligible, no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D19: The relevant maritime, port or shipping authorities will be notified of all permanent offshore facilities, as well as safety zones and routine shipping routes to be used by project-related vessels. Permanent facility locations will be demarcated on nautical charts.
- D20: Project vessels will follow the Convention on International Regulations for Preventing Collisions at Sea (COLREGs) adopted by the IMO.
- D21: Main project vessels will be equipped with Universal Shipborne Automatic Identification System (AIS), a system of transponders installed on vessels which transmit over two dedicated digital marine VHF channels.
- D22: Standard communication procedures will be used in international maritime traffic and shipping, aided by project patrol boats or standby vessels near the drilling, pipelay and Nearshore Hub/Terminal Area to prevent collision with larger vessels.
- D23: Information will be provided to the national industrial fishing fleet of both Mauritania and Senegal to communicate and record the exclusion safety zones and applicable navigational charts.

7.2.16 Artisanal Fisheries and Related Activities

High Level Summary

In this section on Artisanal Fisheries and Related Activities, the impact of three impact producing factors, these being Physical presence, Exclusion safety zones and Vessel movements, was evaluated. The residual impacts on Artisanal Fisheries and Related Activities during the Construction Phase for routine activities were assessed as of negligible or low significance when mitigation measures are applied.

7.2.16.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Exclusion safety zones		●	●	
Vessel movements		●	●	

The exclusion safety zones are addressed together with the physical presence of the infrastructures since they combine to potentially interfere with artisanal fisheries and related activities. Potential displacement of fish due to moving away from sound source is addressed under Section 7.2.6. As indicated in Section 2.12.2, the primary sources of airborne sound from vessels and construction facilities are use of machinery, such as engines, generators, pumps, cranes, etc. Airborne sound generated by any activities associated with the facilities will be managed by the project. The airborne sound levels at all facilities are required to meet the applicable occupational health working limits which in turn is unlikely to result in unacceptable sound level for other sea users, especially since they will be kept out of a 500 m exclusion safety zone.

7.2.16.2 Impact Description

The following subsections explain how the IPFs will potentially produce impacts in each of the project areas.

7.2.16.2.1 Offshore Area

The physical presence of project infrastructures, their exclusion safety zones and the vessel movements in the Offshore Area during the Construction Phase will have no impacts on artisanal fishing activities since none is conducted in this area located in approximately 2,700 to 2,800 m water depth about 125 km from the coast.

7.2.16.2.2 Nearshore Hub/Terminal Area

Physical Presence and Exclusion Safety Zones

The physical presence of the breakwater and the exclusion safety zone around it in the Nearshore Hub/Terminal Area during the Construction Phase could affect artisanal fishing grounds and obstruct access to the fishing grounds.

As indicated in Section 7.2.14.2, it is expected that the physical presence of the breakwater and the exclusion safety zone around it will cover an area of 3.24 km^2 with currently planned distances of 500 m X 600 m around the breakwater. The breakwater will be located about 10 km from the coast on the Mauritania and Senegal maritime border. It is expected that half of the breakwater and its exclusion safety zone will be located in Mauritanian and half of it will be located in Senegal. Therefore, any fishing ground loss or obstruction to fishing grounds for artisanal fisheries in the Nearshore Hub/Terminal Area would be around 1.6 km^2 in each country.

As detailed in Sections 4.6.6.4 and 4.7.6.3, artisanal fishing occurs in very large areas in Mauritania and Senegal. While there are some important similarities in artisanal fisheries in the two countries, there are also distinctive features that need to be accounted to assess the impacts of the breakwater and its exclusion safety zone on the fishing grounds.

In Mauritania, artisanal fishing is conducted along the entire coast and, outside of Banc d'Arguin, no spatial constraints are imposed. Except for the Banc d'Arguin area, there are no community-based customary claims to stretches of shoreline or areas immediately adjacent to coastal villages. There are no traditional systems that define ownership, access to and use of fishing resources or fishing grounds in the maritime waters. Few fishermen operate in proximity to the Mauritania-Senegal maritime border as the waters there are less rich than they are farther north. In general, the southern fishing zone is of little interest for Mauritanian artisanal fishermen. Productivity indicators for artisanal fishing per zone in Mauritania indicate that the southern fishing zone, in which the breakwater is located, only accounts for 2% of national catches. The Mauritanian fishermen potentially operating in this zone are those living in N'Diago. In April 2017, fishermen in N'Diago indicated that they usual travel upwards of 35 km north of N'Diago to practice their activity. Therefore, very few Mauritanian fishermen are expected to operate on the maritime border where the Nearshore Hub/Terminal Area is located.

Like those of Mauritania, Senegalese fishermen can fish wherever they want in Senegalese waters, regardless of the village or the city they live in. There are no community-based customary claims to stretches of shoreline or areas immediately adjacent to coastal villages. There are no traditional systems that define ownership, access to and use of fishing resources or fishing grounds in Senegalese maritime waters. Specific fishing grounds shift as a function of the movements of fishery resources, seasonal movements in particular. Consequently, the locations of the specific fishing grounds are not static and data on fishing grounds must be interpreted at a high level. Nevertheless, Figure 4-35 in Chapter 4 shows that there is a very large number of fishing grounds in Senegalese coastal waters and some of them are concentrated in the Saint-Louis Nearshore Hub/Terminal Area where the breakwater will be located. Additionally, Figure 4-36 of Chapter 4 shows a large number of pirogues operate in this area.

In Senegal, Saint-Louis is by far the main locality in terms of number of fishermen. Saint-Louis fishermen operate offshore Saint-Louis, including on the Mauritania-Senegal maritime border, but they also fish all along the coast and in neighboring countries. Similarly, fishermen from other coastal villages of the Grande Côte also travel and their fishing grounds could potentially include locations offshore Saint-Louis. Fishermen do not limit themselves to waters close to the locality where they live. The important geographical mobility of the Senegalese fishermen makes the analysis of their fishing grounds complex.

Trying to link fishing grounds to catches adds to the complexity. Saint-Louis is by far the main locality of the Grande Côte in terms of quantities of fish products landed with over 52% of the catches. However, the products landed in Saint-Louis only contributes to 37% of the commercial value of the products landed on the Grande Côte. Finally, the fish landings occur wherever it is more convenient for the fishermen. For instance, fishermen from Saint-Louis could fish offshore Cayar and land their catches in another location where it would be accounted for. While it is reasonable to assume that most fishermen fishing offshore Saint-Louis probably live in this city, they are not the only Senegalese fishermen in that area. Therefore, no fishing ground losses can be linked to one specific coastal community. The fishing ground losses analysis needs to consider the larger area of the coastal waters.

Vessel Movements

The construction of the breakwater will last around 25 to 30 months. As indicated in Table 2-1 of Chapter 2, it is planned that 29 vessels will be used during a number of days varying between 20 to 660. Most of those vessels are construction vessels but they will also include support vessels.

The impact of project vessels movements on the navigation of artisanal fishing boats includes risks of collision in the Nearshore Hub/Terminal Area which have been assessed in Section 7.2.14.2. Additionally, project vessels movements could interact with artisanal fishermen nets. Due to the large number of fishing nets deployed in the coastal waters offshore Saint-Louis and the length of the nets (up to 500 m), the fishing nets could be difficult to avoid for project vessels coming in/out of the Nearshore Hub/Terminal Area. There is a risk for project vessels to cross over fishing nets and buoys and, in some cases, damaging them. This would entail fishing gear losses for artisanal fishermen. This risk is mainly associated with the four support vessels as they will be coming in and out of the exclusion safety zone on a regular basis. However, it could also include the 25 construction vessels when entering or exiting the exclusion safety zone.

7.2.16.2.3 Pipeline Area

Physical Presence and Exclusion Safety Zones

As indicated in Section 7.2.14.2., a 500-m exclusion safety zone will be established around the pipeline and FPSO installation related vessels.

With a radius of 500 m, the exclusion safety zone around the vessels will be <1 km^2. The pipeline installations vessels and their exclusion safety zone will be moving progressively in a linear way inside the pipeline corridor along the Mauritania-Senegal maritime border for a total period estimated at 171 days. During this period, the moving exclusion safety zone of <1 km^2, half of it in Mauritania and half of it in Senegal, will have no interference with potential artisanal fishing grounds when in water depths over 200 m. In shallower waters, the moving exclusion safety zone around the vessels could interfere with potential artisanal fishing grounds.

Once installed, the physical presence of the pipeline will have no impacts on artisanal fisheries. As indicated in Section 2.1.3, prevention measures, included in the project design, will be implemented to protect the subsea infrastructure, including the pipeline, from interference with fishing gears. Therefore, there will be no interference between the pipeline and fishing nets.

The FPSO will be installed in the Pipeline Area, at a distance of approximately 40 km from the coast on the Mauritania and Senegal maritime border in 120 m water depth. With a radius of 500 m, the exclusion safety zone around the FPSO will be <1 km^2. While this exclusion safety zone will start during the Construction Phase, it will last during the whole life of the project. It is expected that half of FPSO and its exclusion safety zone will be located in Mauritania and half of it will be located in Senegal. Therefore, any fishing ground losses for artisanal fisheries around the FPSO would be less than 0.5 km^2 in each country.

Vessel Movements

The impact of vessel movements on the navigation of artisanal fishing boats and risks of collision in the Pipeline Area have been assessed in Section 7.2.14.2. In the portion of the pipeline in water depths <200 m, the project vessels movements could interact with artisanal fishermen nets. There is a risk for project vessels to cross over fishing nets and buoys and in some cases, damaging them. This would entail fishing gear losses for artisanal fishermen. All 25 project vessels are concerned since the exclusion safety zone where construction vessels will be located will be moving along the pipeline corridor.

7.2.16.2.4 Support Operations Areas

The Support Operations Areas being on shore, the activities conducted in those areas will have no impact on artisanal fishing activities.

7.2.16.2.5 Summary

Table 7-48 provides a summary of exclusion safety zones as a result of physical infrastructure emplacement which will preclude any artisanal fishing activities. Table 7-49 summarizes the number of project vessels that could potentially interfere with fishing gears.

Table 7-48. Potential Artisanal Fishing Grounds Losses by Project Area for the Construction Phase.

Project Area	Estimated Potential Artisanal Fishing Ground Losses in km^2 –Two Countries	Estimated Potential Artisanal Fishing Ground Losses in km^2 –Per Country
Offshore Area	Not applicable	Not applicable
Nearshore Hub/Terminal Area	<3.25 km^2	About 1.6 km^2
Pipeline Area	<1 km^2	<0.5 km^2
Total	<4.25 km^2	About 2.1 km^2

Table 7-49. Project Vessels Potentially Interfering with Artisanal Fishing Gears by Project Area for the Construction Phase.

Project Area	Estimated Number of Project Vessels	Estimated Maximum Duration
Offshore Area	Not applicable	Not applicable
Nearshore Hub/Terminal Area	29, including 4 support vessels	Up to 660 days for some of the vessels
Pipeline Area	25, including 6 support vessels	Up to 171 days for some of the vessels
Total	54, including 10 support vessels	Up to 660 days for some of the vessels

7.2.16.3 Impact Rating

Physical Presence and Exclusion Safety Zones

The impacts of the physical presence of project infrastructures and their exclusion safety zones in the Nearshore Hub/Terminal Area and in Pipeline Area include interference with existing potential artisanal fishing grounds in Mauritania and Senegal.

The loss of access to potential fishing grounds around the FPSO and the breakwater will start during the Construction Phase and it will last during the 20-year Operations Phase.

The loss of access to <1 km^2 of potential fishing grounds around the FPSO is of little concern since the FPSO is located about 40 km from the shore. While there might be some artisanal fishing activities going on in the area, it would be marginal. As indicated on Table 4-40 in Chapter 4, the main artisanal fishing grounds in the Saint-Louis area are located less than 15 km from the coast. Therefore, the loss <0.5 km^2 of potential artisanal fishing grounds around the FPSO located about 40 km from the coast is unlikely to be noticeable. It is also unlikely to be noticeable in regard to potential artisanal fishing grounds in Mauritania since the southern fishing zone is of little interest for Mauritanian artisanal fisheries.

The loss of access to <3.25 km^2 of potential artisanal fishing grounds around the breakwater could affect artisanal fishing, but the loss would be split each side of the border. As a result, the access to about 1.6 km^2 of potential fishing grounds will be lost in each country.

In Mauritania, the consequence of losing access to about 1.6 km^2 of potential artisanal fishing grounds on the maritime border is not significant since very few Mauritanian fishermen fish in this area. In Senegal, the consequence of losing access to 1.6 km^2 could be more significant than in Mauritania since a large number of artisanal fishermen fish along the maritime border.

The effect of losing access to about 1.6 km^2 of potential fishing grounds in the ocean is difficult to measure. There are no measured estimations of the artisanal fishing grounds on the Grande Côte in general and in the Saint-Louis area in particular. As indicated in Section 4.7.6.3, existing data provide the location of the main fishing grounds. However, there are no data allowing a quantitative estimation of the size or the productivity of those fishing grounds, and the concentration of fishing efforts on them.

A quantitative estimation of the fishermen fishing grounds would require, for instance, data on the concentration of fishing effort along the Grande Côte and in the Saint-Louis area, which may be targeting specific depths and specific species as well as data on difference in substrates, seasonality, upwelling events, etc., and data on distance from community/ fish landing area.

With the higher concentration of fishing spots on the map around Saint-Louis indicated on Figure 4-35 in Chapter 4, one can assume that there is more fishing in this area, and therefore losing access to fishing grounds around the breakwater may have a proportionally larger consequence. However, the obstruction of access of fishermen to the exclusion safety zone does not mean that the fishery resources will disappear from that area. Section 7.4.6.3 show that the exclusion safety zone may protect attracted individuals from fishing pressure which in turn could have a positive effect on the reproduction of fishery resources. As a result, the loss of access to 1.6 km^2 would not necessarily translate into a loss of fishing catches off Saint-Louis.

The obstruction of access to a specific fishing ground could potentially increase the fishing efforts in areas not designated as exclusion areas. Some favored fishing spots may be subjected to an increase in fishing effort, which in turn could contribute to overfishing.

However, the impact of losing access to1.6 km^2 offshore Saint-Louis is compounded by the fact that the Mauritanian government recently has denied access of Senegalese fishermen to fishing grounds in Mauritanian waters. This has likely increased the fishing effort off Saint-Louis since early 2017. If a new fishing agreement allowing Senegalese artisanal fishermen to fish in Mauritanian waters is found, the fishing effort off Saint-Louis would likely decrease.

The above assessment shows that there are a lot of uncertainties around the consequences for Saint-Louis fishermen of losing access to potential fishing grounds in the exclusion safety zone around the breakwater. Losing access to a specific fishing ground, especially limited to a 1.6 km^2 area, is unlikely to be reflected on artisanal fishing catches offshore Saint-Louis, let along offshore the Grande Côte. Consequently, the intensity of the impact on artisanal fishing catches is considered low. However, the perception of the loss could be a significant issue for Saint-Louis fishermen and this is discussed in Section 7.2.26.

As a result of this assessment, the intensity of the impact of the project on artisanal fishing grounds in both countries will be low. The extent will be limited to the exclusion safety zones. It will start during the Construction Phase and it will last during the whole Operations Phase. Based on the combination of these criteria, the consequence of the impact will be negligible. While the impact is likely to happen, its overall significance is rated 1-Negligible (details are provided in Table 7-50).

In a similar manner, the Construction Phase of the project should not entail any loss of catches. As explained in Section 7.2.6, the impacts of the project on plankton, fishes and other fishery resources during the Construction Phase will be negligible. As a result, no indirect impacts are expected on artisanal fisheries.

Because no losses of catches are expected and due to the very small size of potential artisanal fishing ground loss in each country, no impact on activities related to artisanal fisheries such as fish transformation by women are anticipated.

While the impact of the project on fishing grounds and fishery resources is rated negligible, the perception of the impact by local fishermen might be very different. Perceived loss of fishing grounds and catches by fishermen and other community members whose revenues are based on artisanal fisheries is discussed in Section 7.2.26 (Social Climate).

Vessel Movements

In addition to the risk of collision that has been addressed in Section 7.2.14.2, the impact of project vessels movements includes risks of artisanal fishing gear losses in the Nearshore Hub/Terminal Area and in a portion of the Pipeline Area. The risks are associated with the 54 project vessels that will be in these two areas during the Construction Phase. The intensity of the impact is considered moderate as it could cause adverse changes that will be noticeable and could potentially affect several people. The extent is limited to the areas where project activities will be conducted. The duration will be limited to the Construction Phase. Based on the combination of these criteria, the consequence of the impact will be minor. Because the impact is likely to happen, its overall significance is rated 2 – Low.

Table 7-50. Impacts to Artisanal Fisheries and Related Activities during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence and Exclusion Safety Zones						
Mauritania Senegal	Nearshore/ Hub Terminal	Loss of potential artisanal fishing grounds of up to <3.25 km^2, i.e. about 1.6 km^2 in each country, due to project infrastructures and their exclusion safety zones.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 - Negligible
Vessel Movements						
Mauritania Senegal	Nearshore/ Hub Terminal; Pipeline	Potential loss of artisanal fishing gears (nets and buoys) due to project vessels movements in artisanal fishing areas.	Nature: Negative Intensity: Moderate Spatial Extent: Immediate vicinity Duration: Short term	Minor	Likely	2 - Low

7.2.16.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-51) and potential applicable mitigation measures are identified.

These measures are in addition to the existing measures inherent to design and operational controls:

- D19: The relevant maritime, port or shipping authorities will be notified of all permanent offshore facilities, as well as safety zones and routine shipping routes to be used by project-related vessels. Permanent facility locations will be demarcated on nautical charts.
- D23: Information will be provided to the national industrial fishing fleet of both Mauritania and Senegal to communicate and record the exclusion safety zones and applicable navigational charts.

Table 7-51. Mitigation Measures to Avoid or Reduce Impacts to Artisanal Fisheries and Related Activities from Routine Activities during the Construction Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Potential loss of artisanal fishing gears (nets and buoys) due to project vessels movements in artisanal fishing areas.	2 - Low	M09, M12, M13, M17, M18, M19, M20, M21, M22, M23, M24, M27	2 - Low

Notes:

M09: Provide regular notices to mariners in the appropriate form and language to artisanal fishermen on project infrastructure, associated exclusion safety zones, travel and approach plans and the approximate timing of project activities.

M12: Having a project patrol boat to monitor the exclusion safety zones, including patrolling ahead of the approach or exiting of larger project vessels into or out of the exclusion safety zones.

M13: Using the services of local fishermen liaison officers (FLOs) aboard the project patrol boats in the areas of artisanal fishing.

M17: Establishing a grievance mechanism easily accessible to fishing communities members that includes monitoring of claims and the resolution thereof.

M18: Maintaining a community liaison officer (CLO) for N'Diago and Saint-Louis to provide a direct link with the fishing communities.

M19: Collaboration with a community council of formally nominated representatives of local key stakeholders from N'Diago and Saint-Louis set up to review local fishing communities' concerns and grievances related to the project.

M20: Develop and implement a framework for interaction with artisanal fisheries, with provisions covering engagement with local communities on access to fishing grounds, grievance and recourse mechanism for damage to fishing gear, environmental awareness building, livelihood enhancement and the role of community liaison officers.

M21: Project vessels to record incidents with fishing gears and report them to the project.

M22: To the extent feasible, establish a maritime corridor or speed restrictions for project vessels within artisanal fishing areas.

M23: Implement an environmental awareness building program in association with local schools and community groups.

Although impacts on artisanal fisheries are low, the following additional measures are also planned in the context of the need for awareness building of the actual environmental impacts associated with the project and the need to address perceived impacts:

- M24: Provide technical assistance to mutually agreed marine resource research programs notably the national oceanographic research centers of both countries (CRODT and IMROP).
- M27: Developing a social investment program to enhance project benefits for the directly affected N'Diago and Saint-Louis communities, including livelihood enhancement activities.

7.2.17 Other Coastal & Sea-Based Activities

High Level Summary

In this section on Other Coastal & Sea-Based Activities, the impact of three impact producing factors, these being Physical presence, Exclusion safety zones and Vessel movements, was evaluated. All impacts on Other Coastal & Sea-Based Activities during the Construction Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

7.2.17.1 Impact Producing Factors and Project Areas

In addition to potentially impacting submarine telecommunication cables, maritime navigation and fisheries, the project could potentially impact other coastal and sea-based activities (or features): tourism and recreation, shipwrecks and other oil and gas activities.

The IPFs identified for these resources in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	
Exclusion safety zones	●	●	●	
Vessel movements	●	●	●	

The assessment of Tourism and Recreation in Mauritania (Section 4.6.7.2) and in Senegal (Section 4.7.7.2) shows that no tourism or recreational activities, including deep-sea sport fishing, are conducted in the project Offshore Area, Pipeline Area or Nearshore Hub/Terminal Area. Therefore, no project interference is expected with tourism and recreation during the Construction Phase.

Additionally, Figures 4-31 and 4-39 in Chapter 4 indicate that there are no known shipwrecks in the project Offshore Area, Pipeline Area or Nearshore Hub/Terminal Area. This has further been confirmed through the geophysical surveys carried out along the pipeline route during the design phase. Therefore, no project interference is expected with any shipwreck during the Construction Phase.

Potential impacts on oil and gas activities are discussed below.

7.2.17.2 Impact Description

The following subsections explain how the IPFs will produce impacts in each of the project areas.

7.2.17.2.1 Offshore Area

Physical Presence and Exclusion Safety Zones

The Offshore Area is located within the limits of Block C8 in Mauritania and within the limits of Block Saint-Louis Offshore Profond in Senegal, which are under BP’s licenses. Therefore, the physical presence of the drillship, its noise and its exclusion safety zone will have no interference with oil and gas exploration activities potentially conducted by other operators.

Vessel Movements

For the reasons indicated above, the vessel movements in the Offshore Area will have no impacts on oil and gas activities other than those conducted by BP.

7.2.17.2.2 Nearshore Hub/Terminal Area

Physical Presence and Exclusion Safety Zones

The Nearshore Hub/Terminal Area covers an area split each side of the Mauritania and Senegal maritime border. Appendix H provides a map with the licensed blocks off the Mauritanian coast and a similar map for the licensed blocks off the Senegalese coast.

On the Mauritania side, the Nearshore Hub/Terminal Area is located in Block C32, which is not currently under license. However, the license could be given to an oil and gas operator in the future. On the Senegalese side, the Nearshore Hub/Terminal Area is located in Block Saint-Louis Offshore. Oranto Petroleum Ltd (Oranto) holds a license for this block.

The physical presence of the breakwater and its exclusion safety zone could interfere future oil and gas exploration activities conducted in Block C32 by an oil and gas operator and/or conducted in Block Saint-Louis Offshore by Oranto.

The physical presence of the breakwater and its exclusion safety zone would prevent any oil and gas exploration activities in a <3.5 km^2 area, i.e. about 1.6 km^2 in Block C32 in Mauritania and 1.6 km^2 in Block Saint-Louis Offshore in Senegal.

Vessel Movements

The project vessel movements in the Nearshore Hub/Terminal Area could potentially disturb other oil and gas exploration activities. Disturbance would mainly come from the support vessels as they will be coming in and out of the exclusion safety zone on a regular basis.

7.2.17.2.3 Pipeline Area

Physical Presence and Exclusion Safety Zones

In Mauritania, the Pipeline Area crosses three blocks: C8, under a BP license; and C1 and C-32, which are not currently under license. In Senegal, the Pipeline Area crosses Block Saint-Louis Offshore Profond, under a BP license, and Block Saint-Louis Offshore, under a Oranto license.

In Blocks C8 and Saint-Louis Offshore Profond, the physical presence of the drillship, its noise and its exclusion safety zone will have no interference with oil and gas exploration activities potentially conducted by other operators since those blocks are under BP's licenses.

In the portion of the Pipeline Area located within blocks which are not under BP's license, any potential impact of the physical presence of infrastructures, noise and exclusion safety zones would be similar to the potential impacts identified in the Nearshore Hub/Terminal Area.

The physical presence of the FPSO and its exclusion safety zone would prevent any oil and gas exploration activities in a <1 km^2 area, i.e. <0.5 km^2 in Block C1 in Mauritania and <0.5 km^2 in Block Saint-Louis Offshore in Senegal.

The pipeline installation vessels and their exclusion safety zone would not entail any preclusion of other oil and gas exploration activities. The exclusion safety zone will be moving progressively in a linear way along the pipeline corridor for a total period estimated at 171 days, and no exclusion safety zone is associated with pipelines after their installation.

The only limitation would be for exploratory drilling activities conducted right over the installed pipeline of 30-inch (about 76 cm) diameter that will extend from the FPSO to the breakwater. It is assumed that exclusion of exploratory drilling inside this very narrow corridor would not be significant for other oil and gas exploration activities.

Vessel Movements

Any potential impact of the vessel movements in the Pipeline Area would be identical to the potential impact identified in the Nearshore Hub/Terminal Area. The vessel movements in the Pipeline Area could potentially disturb other oil and gas exploration activities.

7.2.17.2.4 Support Operations Areas

Activities planned at the Support Operations Areas will have no interference with any potential offshore oil and gas activities.

7.2.17.2.5 Summary

Table 7-52 provides a summary of the total area precluded from any other potential oil and gas exploration activities during the Construction Phase as a result of the physical presence of infrastructures and their exclusion safety zone. About 2.1 km^2 would be precluded from other oil and gas exploration activities in each country: a <0.5 km^2 area located about 40 km from the shore and about 1.6 km^2 located 10 km from the shore. This preclusion will start during the Construction Phase and it will last during the whole life of the project.

Table 7-52. Area Precluded from Potential Other Oil and Gas Exploration Activities by Project Area for the Construction Phase.

Project Area	Total Estimated Area in km^2 Precluded from Potential Other Oil and Gas Exploration Activities	Estimated Area in km^2 Precluded from Potential Other Oil and Gas Exploration Activities-Per Country
Offshore Area	Not applicable	Not applicable
Nearshore Hub/Terminal Area	<3.25 km^2	About 1.6 km^2
Pipeline Area	<1 km^2	<0.5 km^2
Total	<4.25 km^2	About 2.1 km^2

While project vessel movements in the Nearshore Hub/Terminal Area and the Pipeline Area could potentially disturb other oil and gas exploration activities, disturbance would mainly come from the support vessels as they will be coming in and out of the exclusion safety zones on a regular basis. However, the project support vessels movements would unlikely be noticed by other oil and gas exploration vessels against background maritime traffic.

7.2.17.3 Impact Rating

Any future oil and gas exploration activity in the blocks were the breakwater and the FPSO are located would need to avoid two small areas (<0.5 km^2 and about 1.6 km^2) in each country where exploration will be precluded.

It is assumed that these exclusion safety zones would not prevent the potential identification of areas in Mauritania and Senegal where hydrocarbons could be trapped in oil or gas-filled geological large structures. Therefore, the intensity of the impact is considered low. The extent is limited to about 2.1 km^2 in each country. The duration would be long term. Based on the combination of these criteria, the consequence of the impact would be negligible. Even if this impact is likely to happen, its overall significance is rated 1 – Negligible (details are provided in Table 7-53).

Table 7-53. Impacts to Other Coastal & Sea-Based Activities during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence and Exclusion Safety Zones						
Mauritania Senegal	Nearshore / Hub Terminal; Pipeline	Preclusion of potential future oil and gas exploration activities in two small areas in each country (<0.5 km^2 and about 1.6 km^2) due to project infrastructures and their exclusion safety zones.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 - Negligible

7.2.17.4 Mitigation Measures and Residual Impacts

Impacts being rated 1 – Negligible, no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D19: The relevant maritime, port or shipping authorities will be notified of all permanent offshore facilities, as well as safety zones and routine shipping routes to be used by project-related vessels. Permanent facility locations will be demarcated on nautical charts.
- D25: The seabed has been mapped as part of an extensive geophysical and geotechnical survey carried out by the project. The survey has not identified any shipwrecks or other maritime heritage on the seabed. Further seabed surveys are foreseen prior to dredging taking place.

7.2.18 Employment & Business Opportunities

High Level Summary

In this section on Employment & Business Opportunities, the impact of two impact producing factors, these being Vessel movements and Onshore logistic activities, was evaluated. All impacts on Employment & Business Opportunities during the Construction Phase for routine activities were assessed as positive.

7.2.18.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Vessel movements	●	●	●	
Onshore logistic activities				●

As the project is being conducted at sea, much of the employment will be offshore. Employment at sea opportunities are considered under the IPF “Vessel movements”. While employment opportunities offshore cover activities in the Offshore Area, the Pipeline Area and the Nearshore Hub/Terminal Area, they are discussed together under the Nearshore Hub/Terminal Area.

7.2.18.2 Impact Description

The following subsections explain how the IPFs will produce impacts in each of the project areas.

7.2.18.2.1 Offshore Area

Vessel Movements

As indicated in Section 7.2.18.1, the description of the impacts of vessel movements in the Offshore Area is discussed together with the impacts of the vessel movements in the Nearshore Hub/Terminal Area in Section 7.2.18.2.2.

7.2.18.2.2 Nearshore Hub/Terminal Area

Vessel Movements

As indicated in Section 2.13, the amount of manpower required on vessels for the Construction Phase is estimated to be 1,500.

Provision of all the primary vessels will be through the EPCI contractors. Specialist vessels will generally be owned by the selected EPCI contractor and they will be provided with their own specialized international personnel. However, the EPCI contractors will conduct market exercises for the support vessels that could be rented in Mauritania and/or Senegal. Contractor will be required to give local sourcing consideration in finalizing their execution plan,

Based on information in Section 2.5, an estimation of 16 support vessels will be needed during the Construction Phase. Table 7-54 shows that the total manpower needs for these 16 vessels is 116 people. It is not known at this time how many support vessels could be rented in Mauritania and/or Senegal. If a fourth of them are rented in-country, the employment opportunities could reach up to about 30 people.

Table 7-54. Estimation of Manpower Needs on Support Vessels.

Vessel	Number Used	POB/Vessel	Total POB	Days Used
Offshore Area				
Project patrol boat	1	7	7	56
Standby vessel	1	14	14	81
Nearshore Hub/Terminal Area				
Support boat	6	6	36	660
Project patrol boat	1	7	7	660
Standby vessel	1	15	15	660
Crew boat	2	4	8	110
Pipeline Area				
Project patrol boat	1	7	7	60
Standby vessel	1	14	14	60
Crew boat	2	4	8	20
Total	16		116	2367

The support vessel contracts could create temporary business opportunities for the National companies from whom the support vessels will be contracted.

The number of National third parties that could be contracted to provide support vessels is not known yet but will form part of further project development assessment. Based on the number of support vessels that will be required for the project and the assumption that up to a quarter of the support vessels, it is estimated that about 4 vessels could be contracted in Mauritania and/or Senegal if available. Therefore, it is assumed that 1-2 National companies could be contracted to provide these support vessels.

Since the support vessels will be operating out of the Ports of Dakar and/or Nouakchott, it is also reasonable to assume that most of the positions will be filled in by people living in these two cities. Therefore, it is assumed that the estimated up to 30 people required for the positions on the support vessels contracted in Mauritania and/or Senegal will be filled in at a National level.

In addition, Community Liaison Officers and Fishing Liaison officers will be recruited in the local communities of N'Diago and Saint-Louis. This could account for up to 20 positions. They will be supporting all offshore activities as required.

7.2.18.2.3 Pipeline Area

Vessel Movements

As indicated in Section 7.2.18.1, the description of the impacts of vessel movements in the Pipeline Area is discussed together with the impacts of the vessel movements in the Nearshore Hub/Terminal Area in Section 7.2.18.2.2.

7.2.18.2.4 Support Operations Areas

Onshore Logistic Activities

While most of project activities will be conducted offshore, some onshore logistic activities will be conducted at the supply bases in the Ports of Dakar and/or Nouakchott. Onshore logistic activities will also be conducted at the airports in Dakar and Nouakchott for arriving and departing project personnel.

The project will require manpower for onshore logistics in Dakar and/or Nouakchott. As indicated in Section 2.13, the manpower needs for onshore logistics during the Construction Phase is estimated between 20 to 50 people. It is assumed that these needs will last during the whole Construction Phase. These 20 to 50 people will be direct employees as well as third party contractors. It is not known at this time how many of these employees will be National, but it is assumed that part of them will be Mauritanian and/or Senegalese. It is assumed that up to half of the personnel, i.e. up to 25 people, could be contracted in Mauritania and/or Senegal if available. Recruitment will follow BP diversity and inclusion principles to target diverse candidates for example female, and personnel from different backgrounds.

As indicated previously, the project proponent will put in place an in-country employment and procurement policy. Since the onshore logistics will be conducted out of Dakar and/or Nouakchott, it is assumed that most of the positions will be filled in by people living in these two cities. Therefore, it is assumed that the up to 25 National workers required for onshore logistics in Mauritania and/or Senegal will be recruited at a National level.

The onshore logistics will create temporary business opportunities for the National companies who will provide services as third party contractors. While the number of potential National third party contractors is not known yet, the manpower required (up to 25 people) suggests that 2-3 National companies will be contracted in total.

Additionally, BP's local procurement management policy detailed in Section 2.13 indicates that BP will focus on developing opportunities in Mauritania and Senegal to support the supply chain for the project. Section 2.13 provides a preliminary list of target services that could potentially be sourced in Mauritania or Senegal:

- Subsea contractor scope:
  - movement of personnel and goods offshore to vessels;
  - provision of food and other provisions;
  - bunkering for construction vessels;

  - final fabrication and load-out of spools; and
  - storage, spares inventory management & logistics.
- FPSO contractor scope:
  - logistic services for equipment, materials for offshore commissioning activities;
  - personnel mobilization and demobilization travel, inland transportation, onshore accommodation and security services;
  - bunkering and fuels for construction vessels;
  - provision of food and other consumables during Offshore commissioning activities; and
  - administrative services such as VISA, Meet and Greet, immigration process, etc.
- Hub/Terminal contractor scope. The first 5 opportunities are agreed during Contractor Selection the rest will be developed during FEED:
  - Caisson Fabrication;
  - Rock Supply;
  - soil replacement material supply;
  - ballasting materials supply;
  - logistics bases;
  - Installation and Construction support services;
  - movement of personnel and goods offshore to vessels;
  - provision of food and other provisions;
  - bunkering for construction vessels;
  - Hotels & Accommodation; and
  - Environmental monitoring program.

At this stage of the project planning, it is difficult to quantify the business opportunities and indirect employment that could be created to support the supply chain. However, this procurement approach could ultimately create a multiplier effect within the communities and promote retained value in Mauritania and/or Senegal. Quantitative evidence shows that local content has positive effects on local economies that can be measured by calculating the direct, indirect and induced effects of operations. The multiplier effect for Economic Impact and Human Capital Development varies from one country to another. In Algeria for instance, the multiplier effect in 2010 was 1.84 for Economic Impact and 2.43 for Human Capital Development. In Angola, the multiplier effect in 2011 was 1.32 for Economic Impact and 2.80 for Human Capital Development (SAIPEM, 2018). While the project budget dedicated to local procurement is not known at this stage, quantitative evidence shows that the local procurement approach will have a positive multiplier effect.

7.2.18.2.5 Summary

Table 7-55 provides a summary of employment opportunities in the Construction Phase and Table 7-56 provides a summary of business opportunities during this phase. Since the project onshore logistics and support vessels will be located in Dakar and/or Nouakchott, the employment and business opportunities are likely to be concentrated in these two cities.

Table 7-55. Potential National Employment Opportunities by Project Area for the Construction Phase.

Project Area	Estimated Number of Positions and Duration
Offshore Area	Up to 30 people on support vessels during 20 to 660 days Up to 20 people (FLOs/CLOs) during 3 to 5 years
Nearshore Hub/Terminal Area	
Pipeline Area	
Support Operations Areas	Up to 25 people during 3 to 5 years

Table 7-56. Potential National Business Opportunities by Project Area for the Construction Phase.

Project Area	Estimated Number of Business Opportunities and Duration
Offshore Area	1-2 support vessel providers
Nearshore Hub/Terminal Area	
Pipeline Area	
Support Operations Areas	2-3 service providers for onshore logistics

7.2.18.3 Impact Rating

The project could provide employment opportunities for up to 25 people during 3 to 5 years on shore and an additional up to 30 people during 20 to 660 days on support vessels. These employment opportunities will be split between Mauritania and Senegal, and they will likely be concentrated in two cities: Dakar and Nouakchott. Additionally, up to 20 people could be recruited from Saint-Louis and N'Diago areas for CLOs and FLOs positions.

The population of working age is about 2 million people in Dakar and over 580 000 people in Nouakchott. While the employment opportunities created by the project will not have a significant impact on the cities employment figures, they will be beneficial for up to 85 people, resulting in a positive impact (Table 7-57).

There are a lot of uncertainties on the profile that will be required for the employment opportunities onshore and offshore. As a result, it is not possible to determine if these opportunities will create equal employment opportunities for women and for men. However, there is usually an under-representation of women on vessels. It could also be the case for this project. Due to the limited number of offshore employment opportunities that will be created, any gender imbalance would have limited consequence on the overall employment situation of women.

Business opportunities could concern up to about 3-5 National services providers likely in Dakar and/or Nouakchott during the Construction Phase. Due to the small number of business opportunities and the limited scope of services that will be provided, the potential contracts will not have a significant impact on business opportunities in Dakar and Nouakchott. However, they will be beneficial to the concerned third-party contractors, resulting in a positive impact (Table 7-57).

Additionally, the local procurement policy that will be implemented to support the supply chain for the project will create additional business and indirect employment opportunities. Ultimately, this could create a multiplier effect within the communities and promote retained value in Mauritania and/or Senegal. While this cannot be quantified at this stage of the project, the result will be beneficial and it will result in a positive impact (Table 7-57).

Table 7-57. Impacts to Local Employment & Business Opportunities during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Vessel Movements and Onshore Logistic Activities						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Employment opportunities for up to 25 people onshore in Dakar and/or Nouakchott, up to 30 people on vessels, and up to 20 people from Saint-Louis and N'Diago as community and fisheries liaison officers.	Not applicable	Not applicable	Not applicable	Positive
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Business opportunities for up to 3-5 National services providers in Dakar and/or Nouakchott for onshore logistics services and vessels.	Not applicable	Not applicable	Not applicable	Positive
Mauritania Senegal	Support Operations	Business opportunities, indirect employment and multiplier effects that could be created through local procurement policy to support the supply chain for the project.	Not applicable	Not applicable	Not applicable	Positive

7.2.18.4 Mitigation Measures and Residual Impacts

No mitigation measures are required.

7.2.19 Population and Demography

High Level Summary

In this section on Population and Demography, the impact of one impact producing factor, this being Onshore logistic activities, was evaluated. No impacts are anticipated on Population and Demography during the Construction Phase for routine activities.

7.2.19.1 Impact Producing Factors and Project Areas

The IPF identified for this resource in Table 7-4 is distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Onshore logistic activities				●

Activities conducted in the Offshore Area, the Pipeline Area and the Nearshore Hub/Terminal Area do not have the potential to affect National and local demography of Mauritania and Senegal. Therefore, they are not discussed further in this section.

7.2.19.2 Impact Description

The following subsections explain how this IPF will produce impacts in each of the project areas.

7.2.19.2.1 Offshore Area

Not applicable (see Section 7.2.19.1).

7.2.19.2.2 Nearshore Hub/Terminal Area

Not applicable (see Section 7.2.19.1).

7.2.19.2.3 Pipeline Area

Not applicable (see Section 7.2.19.1).

7.2.19.2.4 Support Operations Areas

Onshore Logistic Activities

Onshore logistic activities of large projects have the potential to change the demography of local communities with an influx of population: an influx of workers in the project area and an influx of jobseekers.

Large onshore projects, especially in small towns or villages, often entail population influx. This is the case, for instance, with some mining projects. Mining projects hire a large number of skilled and unskilled people and they are often located in back country locations. The arrival of a large number of workers, often mostly male and expatriate, suddenly increases the number of inhabitants, changes the male/female ratio and the ratio between local people and foreigners. Additionally, these projects have the potential to attract a large number of unemployed people, generally young men, who settle in the project area hoping for job opportunities. The influx of jobseekers also modifies the local demography. However, it is unlikely that the current project will entail any population influx.

During all project phases, including the Construction Phase, most of the project activities will be conducted from vessels offshore. As indicated in Section 2.13.1, the total amount of manpower required on vessels for the Construction Phase is estimated to 1,500. The vessels will be rented by the project proponent with their own specialized personnel. The personnel will be living aboard those vessels to which they will be transported by support vessels or helicopters. They will be working back-to-back on monthly assignments and they will be flying in/out of Dakar and/or Nouakchott from/to their home countries. In some cases, flight schedules to home countries might require a one night stayover in a hotel in Dakar or Nouakchott. As a result, there will be a very limited presence of project offshore workers in Mauritania and Senegal.

The presence of workers on shore will also be very limited. The onshore logistic activities will be conducted in the Support Operations Areas located in Dakar and/or Nouakchott. As indicated in Section 7.2.18, the project could hire up to 25 people in Dakar and/or Nouakchott during 3 to 5 years and additional 30people in these cities. This small number of employment opportunities in Dakar and/or Nouakchott is unlikely to entail any population influx and changes in local demography in the two cities that count respectively over 3 million and around 1 million inhabitants.

No impact is anticipated on the population and local demography of N'Diago and Saint-Louis. No transit through those locations are planned for the offshore workers. Additionally, no project Support Operations Areas are planned in N'Diago and Saint-Louis, and limited employment or business opportunities will be created in these locations. Consequently, no population influx and changes in local demography are expected in N'Diago and Saint-Louis.

7.2.19.2.5 Summary

No impacts are anticipated on population and demography.

7.2.19.3 Impact Rating

Not applicable (see Section 7.2.19.2.5)

7.2.19.4 Mitigation Measures and Residual Impacts

Not applicable (see Section 7.2.19.5).

7.2.20 Community Livelihoods

High Level Summary

In this section on Community Livelihoods, the impact of three impact producing factors, these being Physical presence, Exclusion safety zones and Onshore logistic activities, was evaluated. No impacts are anticipated on Community Livelihoods during the Construction Phase for routine activities.

7.2.20.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Exclusion safety zones		●	●	
Onshore logistic activities				●

The three IPFs identified above could impact community livelihoods indirectly. The two first ones (physical presence and exclusion safety zones) could impact negatively artisanal fisheries and related activities on which the coastal communities livelihood is largely based. Since the impacts on the communities livelihood are indirect, the distinction between Pipeline Area and Nearshore Hub/Terminal Area is irrelevant. Therefore, impacts of these two IPFs on community livelihoods are considered globally in the impact description under the Nearshore Hub/Terminal Area.

The third IPF (onshore logistic activities) has the potential to positively impact employment and business opportunities in the Support Operations Areas. Therefore, it has the indirect potential to impact community livelihoods positively. Additionally, this onshore logistic activity has the potential to entail an influx of workers in the project area which in turn could result in an increase of living costs for local communities. An influx of workers, notably expatriates, has been associated in other projects with increases in prices of land, housing, food and services. This price inflation has the potential to impact community livelihoods negatively.

7.2.20.2 Impact Description

The following subsections explain how the project's impacts on artisanal fisheries and on employment and business opportunities could produce indirect impacts on community livelihoods.

7.2.20.2.1 Offshore Area

Not applicable (see Section 7.2.20.1).

7.2.20.2.2 Nearshore Hub/Terminal Area

Sections 4.6.5.2 and 4.6.6.4 provide a detailed description of the economic activities and the means of subsistence of the coastal communities in Mauritania, notably N'Diago. Sections 4.7.5.2 and 4.7.6.3 provide a similar description for the coastal communities of Senegal, notably Saint-Louis.

In Mauritania, the economy of the coastal villages and camps south of Nouakchott is almost exclusively linked to artisanal fisheries. With 1,240 inhabitants, N'Diago is the most important of those locations and the closest to the Nearshore Hub/Terminal Area (16 km). N'Diago counts 136 fishermen. The majority of them operate off the coast of Nouadhibou or Nouakchott where the fishery resources are much more plentiful. They live in Nouadhibou or Nouakchott and come back on a regular basis to N'Diago where they have their families. However, some fishermen living in N'Diago operate in the waters north of N'Diago and they land their catches in this location. In N'Diago, several dozen women are involved in the fresh fish trade. They sell their products in the border city of Saint-Louis, whereas other women are engaged in artisanal fish processing.

In Senegal, the economy of Saint-Louis (230,801 inhabitants) is heavily based on artisanal fishing and tourism. The fishing communities of Saint-Louis, located on the Langue de Barbarie and close to the Nearshore Hub/Terminal Area (13 km), count 70,532 inhabitants. Most of them make their living out of artisanal fisheries and related activities. These communities count approximately 22,000 fishermen, 1,000 women involved in artisanal fish processing and at least a similar number involved in fresh fish trade, and 150 fish mongers.

Loss of fishery resources catches due to project activities during the Construction Phase could potentially impact the means of subsistence of the fishing communities members notably:

- The 136 fishermen of N'Diago and the 22,000 fishermen of Saint-Louis;
- Several dozens of women of N'Diago engaged in artisanal fish processing and approximately 1,000 women involved in this activity in Saint-Louis;
- Similar numbers of women involved in fresh fish trade in N'Diago and Saint-Louis; and
- Additional community members involved in other activities related to artisanal fisheries: fish monging, fish transportation, etc.

Any loss of means of subsistence for these community members would affect the livelihood of their families and the communities as a whole. Since fishermen from other coastal communities of the Grande Côte also fish in the waters offshore Saint-Louis, any loss of fishery resources catches due to project activities during the Construction Phase could also have ramifications on these communities livelihoods.

The assessment of the impacts of the project on artisanal fisheries and related activities during the Construction Phase has been made in Section 7.2.16. The assessment demonstrates that the project should not entail any loss in fishery resources catches in Mauritania and Senegal. As a result, no impacts are expected on the means of subsistence of the fishermen and the other community members involved in activities related to artisanal fisheries.

While no impacts are anticipated on community livelihoods, the perception of the impact by local communities might be very different. Perceived loss of fishing grounds and catches by community members whose means of subsistence are based on artisanal fisheries is discussed in Section 7.2.26 (Social Climate).

7.2.20.2.3 Pipeline Area

Not applicable (see Section 7.2.20.1).

7.2.20.2.4 Support Operations Areas

Significant employment and business opportunities have the potential to improve community livelihoods. The assessment of the impacts of the project on employment and business opportunities during the Construction Phase has been made in Section 7.2.18. The results show that since the project onshore logistic activities will be located in Dakar and/or Nouakchott, the project will have limited impacts on local employment in N'Diago or Saint-Louis. Similarly, limited impacts are anticipated on business opportunities in these two locations. As a result, employment and business opportunities will have no impacts on the livelihood of local communities of N'Diago or Saint-Louis. While the employment and business opportunities in Dakar and/or Nouakchott identified in Section 7.2.18 will be beneficial, their number will not be important enough to change the livelihood of the communities in these two big cities.

The assessment of the impacts of the project on population and demography during the Construction Phase has been made in Section 7.2.19. The results show that the project will have no impact on the population and demography of Dakar and Nouakchott. Additionally, it will entail no population influx in N'Diago or Saint-Louis. Therefore, no changes in local demography and no price inflation are expected in these locations. No further impacts are anticipated on the communities livelihood.

7.2.20.2.5 Summary

No impacts are anticipated on community livelihoods.

7.2.20.3 Impact Rating

Not applicable (see Section 7.2.20.2.5).

7.2.20.4 Mitigation Measures and Residual Impacts

Although no impacts are anticipated on community livelihoods, the project recognizes the need for awareness building of the actual environmental impacts associated with the perceived impacts. As such, some of the mitigation measures identified for the artisanal fisheries and related activities that will also have a ripple effect on the community livelihoods have been identified:

- M20: Develop and implement a framework for interaction with artisanal fisheries, with provisions covering engagement with local communities on access to fishing grounds, grievance and recourse mechanism for damage to fishing gear, environmental awareness building, livelihood enhancement and the role of community liaison officers.

- M23: Implement an environmental awareness building program in association with local schools and community groups.
- M24: Provide technical assistance to mutually agreed marine resource research programs notably the national oceanographic research centers of both countries (CRODT and IMROP).
- M27: Developing a social investment program to enhance project benefits for the directly affected N'Diago and Saint-Louis communities, including livelihood enhancement activities.

7.2.21 Community Health, Safety and Security

High Level Summary

In this section on Community Health, Safety and Security, the impact of six impact producing factors, these being Physical presence, Exclusion safety zones, Vessel movements, Helicopter traffic, Onshore logistic activities and Presence of foreign workers, was evaluated. The residual impacts on Community Health, Safety and Security during the Construction Phase for routine activities were assessed as of low significance when mitigation measures are applied.

7.2.21.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Exclusion safety zones		●	●	
Vessel movements		●	●	
Helicopter traffic				●
Onshore logistic activities				●
Presence of foreign workers				●

The activities conducted in the Offshore Area do not have the potential to affect community health, safety and security since there are no community sea users in the Offshore Area.

The physical presence of the infrastructures and the vessels movements during the Construction Phase have the potential to impact the safety of communities' sea users. The only communities' sea users in the Pipeline Area and the Nearshore Hub/Terminal Area are the artisanal fishermen and the impacts of these IPFs have been addressed in Section 7.2.14 (Maritime Navigation).

The noise from the infrastructures and from the vessels during the Construction Phase does not have the potential to impact the health of communities. The Nearshore Hub/Terminal Area is the closest area from the coast. It is located about 10 km from the coast. The airborne sound levels at all facilities being required to meet the applicable occupational health working limits, the noise at these facilities will not be heard from the shore. The only community members in the vicinity of the Pipeline Area and the Nearshore Hub/Terminal Area are the artisanal fishermen. The potential impact of noise on artisanal fishermen has been addressed in Section 7.2.16 (Artisanal Fisheries and Related Activities). Therefore, no further impacts from infrastructures and vessels noise are expected on community health.

7.2.21.2 Impact Description

The following subsections explain how the IPFs will produce impacts in each of the project areas.

7.2.21.2.1 Offshore Area

Not applicable (see Section 7.2.21.1).

7.2.21.2.2 Nearshore Hub/Terminal Area

Exclusion Safety Zones

For the purpose of vessel and operation safety, exclusion safety zones will be established around the breakwater and the main construction vessels. This exclusion safety zone will ensure maritime safety for project vessels and non-project vessels. Stand by vessels will remain on station to monitor exclusion safety zone.

As indicated in Section 7.2.14.3., the boundaries of the exclusion safety zone around the breakwater will be demarcated during the Construction Phase through the use of:

- marker buoys equipped with audio and visual warnings effective by both day and night in the prevailing sea conditions;
- long life (LED or similar) bulbs;
- anchored at pre-set intervals;
- positioned to demarcate shipping lanes used for entry/exit and exclusion safety zones around fixed assets; and
- tamper-proof design, anti-climb and not suitable for small vessels to use as a mooring.

These use of the above methods of demarcation will be reviewed during the Operations Phase.

Additionally, a minimum of one project patrol boat will be used to control the area to deter incursion to the exclusion safety zone.

With all these measures already included in the project design, it is unlikely that artisanal fishermen could enter the exclusion safety zone inadvertently. Based on similar projects, it is however possible that some could try to make their way through the exclusion safety zone to fish in the area.

In such case, it is assumed that the project personnel will follow security protocols, which may include informing or involving the authorities of Mauritania and/or Senegal.

7.2.21.2.3 Pipeline Area

Exclusion Safety Zones

For the purpose of vessel and operation safety, a 500-m exclusion safety zone will be established around the pipeline and FPSO installation related vessels. This exclusion safety zone will ensure maritime safety for project vessels and non-project vessels. Stand by vessels will remain on station to monitor exclusion safety zone.

The enforcement of the exclusion safety zones will be done by the stand by vessels. To deter incursion to the exclusion safety zones, they will use maritime communication procedures. It is however possible that some artisanal fishermen could try to make their way through the exclusion safety zone to fish in the area.

If some artisanal fishermen in the Pipeline Area refuse to respect the exclusion safety zone, the project procedure will be identical to the one in the Nearshore Hub/Terminal Area.

7.2.21.2.4 Support Operations Areas

Helicopter Traffic

During the Construction Phase, helicopters will be used to transport project personnel to the drillship. Helicopter traffic has the potential to create nuisance for people surrounding the Dakar and the Nouakchott airports and impact their health. The weekly schedule for the helicopters charter flights at the Dakar and/or Nouakchott airports still needs to be determined. Based on similar projects, it is estimated that the helicopters could fly in/out of one of these airports up to five times per week over the course of the drilling activities. Drilling of each well could last up to 80 days per well, i.e. about 3 months per well. Drilling the 12 wells could last up 36 months, discontinuously over a period of several years. During each of these months, about 200 passengers will be arriving from their home countries and 200 passengers will be coming back from the drillship by helicopter to fly back to their home countries by airplane.

The Dakar and Nouakchott airports are international airports. As indicated in Sections 4.6.10.3 and 4.7.10.3, the Nouakchott Oum Tounsy airport is located 20 km northwest of the capital and it has a capacity of 2 million passengers per year. The Dakar Blaise Diagne International airport located 40 km from the capital has a capacity of 3 million passengers per year. The project's helicopter traffic and noise will not be noticeable against background airplane traffic and noise at the airports and in their surroundings. Therefore, the helicopter traffic and noise during the Construction Phase will have no impacts on community health.

Onshore Logistic Activities

Onshore logistic activities including hazardous materials have the potential to affect community health. All the material used by the project, notably the chemicals used for drilling activities will be stored in dedicated storage areas inside the supply bases located inside the Port of Dakar and/or the Port of Nouakchott.

Chemicals (and equipment) will be shipped by boat directly to the port areas. It is assumed that the sites will be fenced and monitored by security services 24/7. In addition, the port areas themselves are guarded and not accessible to the public. Therefore, onshore logistic activities are not anticipated to present any risks to community health in Dakar and/or Nouakchott.

Onshore logistic activities including the use of security personnel to safeguard personnel and property also have the potential to affect community security. In Dakar and/or Nouakchott, it is expected that the project will contract third parties to ensure the security of its premises and its personnel inside the port areas. The unarmed security guards will be working under the security rules of the ports. Therefore, these security arrangements are not anticipated to present any risks to community security in Dakar and/or Nouakchott.

Presence of Foreign Workers

The presence of foreign workers has the potential to affect community health. Based on previous experience with large projects, there is a risk that the presence of single foreigners might contribute to prostitution in the local population and sexually transmitted diseases such as HIV/AIDS. However, this is not an important concern for the current project, as there will be a limited presence of personnel onshore.

As indicated in Section 7.2.19.2.4, during all project phases, including the Construction Phase, most of the project activities will be conducted from vessels offshore. As indicated in Section 2.13.1, the total amount of manpower required on vessels for the Construction Phase is estimated to be 1,500. The vessels will be rented by the project proponent with their own specialized international personnel. The workers will be living aboard those vessels to which they will be transported by support vessels or helicopters. They will be working back-to-back on monthly assignments and they will be flying in/out of Dakar and/or Nouakchott from/to their home countries. In some cases, flight schedules to home countries might require a one-night stayover in a hotel in Dakar or Nouakchott. As a result, there will be a very limited presence of project offshore workers in Mauritania and Senegal.

Due to limited onshore project activities, the presence of foreign onshore workers will also be limited. The project will try to use National workers as much as possible for its onshore logistic activities. It is assumed that the project expatriate personnel in Dakar and/or Nouakchott will account for about half of the 50 people required, i.e. about 25 people. A large number of expatriates live in the two capitals. The presence of 25 foreign workers will not be noticeable against the background presence of expatriates.

Therefore, no impacts on community health are anticipated from the presence of foreign workers during the Construction Phase of the project.

7.2.21.2.5 Summary

The risk of collisions for artisanal fishing boats due to the physical presence of infrastructures and vessels has been assessed in Section 7.2.14. The other IPFs that have the potential to impact the community health, safety and security have been assessed in the current section. All potential impacts have been dismissed except for one.

The enforcement of the exclusion safety zone could present a risk for local community members.

7.2.21.3 Impact Rating

The project personnel will be unarmed and there is no plan to use any force in case an artisanal fisherman refuses to respect the exclusion safety zone. Enforcement of the exclusion safety zones in the Pipeline Area and the Nearshore Hub/Terminal Area will be based on communication procedures. It is possible that some artisanal fishermen will willingly enter the exclusion safety zones to fish in these areas. In such case, no force will be used by project personnel to stop the fishermen from entering the area. The project personnel will follow security protocols, which may involve support from National authorities. Therefore, the project personnel will not present any direct threat to the security of community members.

If some fishermen refuse to get out of the exclusion safety zone, this may lead to a situation where the National authorities become involved and send the public security forces to escort the fishermen out of the area. In this process, there is a risk that the public security forces might use force and harm some artisanal fishermen.

Public security forces are responsible in both countries for patrolling the National maritime waters and to ensure that no illegal activities are conducted including illegal fishing activities. As such, they are armed. The project exclusion safety zones are located in an area where there are frequent incidents between Senegalese fishermen and public security forces, in regard to areas where these fishermen are excluded. Therefore, the enforcement of the project exclusion safety zone could be challenging. The support of public security forces to escort the artisanal fishermen out of the exclusion safety zones could be conflictual and present a risk for local community members.

An incident between the artisanal fishermen and the public security forces could include fatalities. Therefore, the intensity of the impact is considered high. The extent of the impact could be limited to the exclusion safety zones. However, a fatality would likely be followed by public outrage. As a result, the impact could be felt beyond N'Diago and/or Saint-Louis, and considered regional. The impact would be irreversible in case of a fatality. Based on the combination of these criteria, the consequence of the impact would be moderate to severe. Considering that incidents between artisanal fishermen and public security forces are often reported in the area, such an incident is likely to happen during the Construction Phase. As a result, the overall impact significance is rated 3 – Medium to 4 – High (Table 7-58).

Table 7-58. Impacts to Community Health, Safety and Security during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Exclusion Safety Zones						
Mauritania Senegal	Nearshore/ Hub Terminal; Pipeline	Risk of conflicts between artisanal fishermen and public security forces if some fishermen need to be escorted out of the exclusion safety zones.	Nature: Negative Intensity: High Spatial Extent: Immediate vicinity to regional Duration: Short to Long term	Moderate to Severe	Likely	3 - Medium to 4 -High

7.2.21.4 Mitigation Measures and Residual Impacts

Impacts are reported below (Table 7-59) and potential applicable mitigation measures are identified. With the proposed mitigation measures, it is assumed that fatalities could be avoided. As a result, the intensity of the residual impact would be moderate and its extent would be the immediate vicinity of the exclusion safety zones. Its duration would be limited to the time of the incident, and therefore it would be short term. The consequence of the impact would be minor. Such incidents would still be likely to happen. As a result, the overall residual impact significance is rated 2 – Low.

These mitigation measures are in addition to the measures and controls already planned in the project design, summarized as follows:

- D23: Information will be provided to the national industrial fishing fleet of both Mauritania and Senegal to communicate and record the exclusion safety zones and applicable navigational charts.
- D26: A site security plan will be developed that considers the security arrangements for each of the facilities including the modalities of support provided by government.

Moreover, the Inter-state Cooperation Agreement (ICA) requires that the “two states (Mauritania and Senegal) are to consult with a view to jointly setting appropriate security and safety measures for each of the facilities and surrounding areas”.

Table 7-59. Mitigation Measures to Avoid or Reduce Impacts to Community Health, Safety and Security during the Construction Phase from Routine Activities.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Risk of conflicts between artisanal fishermen and public security forces if some fishermen need to be escorted out of the exclusion safety zones.	3 – Medium to 4 – High	M08, M17, M19, M25, M26	2 – Low

Notes:

M08: Develop and implement a training and awareness program targeting local fishing communities on the specific maritime safety rules associated with the project.

M17: Establishing a grievance mechanism easily accessible to fishing communities members that includes monitoring of claims and the resolution thereof.

M19: Collaboration with a community council of formally nominated representatives of local key stakeholders from N'Diago and Saint-Louis set up to review local fishing communities' concerns and grievances related to the project.

M25: The project will seek to work with the public security forces to establish an appropriate response and security framework which may include resource, equipment, training and response protocols.

M26: Include in the security stakeholder engagement plan, provisions around response, management and interface with Public security forces for security incidents scenario such as act of terrorism and unlawful entry in the exclusion safety zones.

7.2.22 Public Infrastructure and Services

High Level Summary

In this section on Public Infrastructure and Services, the impact of four impact producing factors, these being Exclusion safety zones, Vessel movements, Onshore logistic activities and Presence of foreign workers, was evaluated. The residual impacts on Public Infrastructure and Services during the Construction Phase for routine activities were assessed as of negligible significance when mitigation measures are applied.

7.2.22.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Exclusion safety zones	●	●	●	
Vessel movements	●	●	●	
Onshore logistic activities				●
Presence of foreign workers				●

All IPFs identified above could impact public infrastructures and services indirectly. The exclusion safety zones could indirectly impact the National authorities called in to enforce the exclusion safety zones. The risk of collision associated with vessel movements could indirectly impact the National authorities in charge of search and rescue operations. The onshore logistic activities and the presence of foreign workers have the potential to indirectly impact existing port and airport infrastructures, accommodation and health services.

7.2.22.2 Impact Description

The following sections explain how the project's impacts have the potential to produce indirect impacts on public infrastructure and services.

7.2.22.2.1 Offshore Area

Exclusion Safety Zones and Vessel Movements

The project proponent will take care of all operations planned in the Offshore Area during the Construction Phase of the project. The only operation for which a direct support from public services could be required is the handling of an incident with other sea users entering the exclusion safety zone.

Offshore, the other sea users are industrial fishing boats and shipping vessels. Based on similar projects, it is unlikely that other sea users will try to enter the 500 m exclusion safety zone around the drillship and the SPS installation vessels. There is not a significant risk of incident with other sea users or collision. Therefore, it is not expected that the project will need the support from National authorities to handle a security incident or a search and rescue operation offshore.

7.2.22.2.2 Nearshore Hub/Terminal Area

Exclusion Safety Zones and Vessel Movements

The project proponent will take care of all operations planned in the Nearshore Hub/Terminal Area during the Construction Phase of the project. The only operation for which a direct support from public services could be required is the handling of an incident with other sea users entering the exclusion safety zone.

As indicated in Section 7.2.21, the project proponent will manage the enforcement of the exclusion safety zone through communication procedures with other sea users notably the artisanal fishermen. If an artisanal fisherman enters the exclusion safety zone, this may lead to a situation where the National authorities become involved and would likely send the public security forces to escort the fishermen out of the area. The frequency of such incidents is difficult to estimate, but they are likely to happen. The public security forces will need to be ready to handle such an incident 24/7.

The public security forces will also need to be available to handle search and rescue operations if a collision happens in the Nearshore Hub/Terminal Area.

7.2.22.2.3 Pipeline Area

Exclusion Safety Zones and Vessel Movements

The support potentially required from the National authorities for the enforcement of the exclusion safety zones in the Pipeline Area will be the same as in the Nearshore Hub/Terminal Area. However, the FPSO being located about 40 km from the coast, the public security forces would need to cover a longer distance than in the Nearshore Hub/Terminal area to provide support to handle an incident with artisanal fishermen. They would also be called in to handle search and rescue operations.

7.2.22.2.4 Support Operations Areas

Onshore Logistic Activities

The onshore logistic activities will be conducted out of the ports and airports of Dakar and/or Nouakchott. In the ports and airports, space will be rented by the project proponent inside existing infrastructures according to availabilities. The services required for project purposes will be similar to those required from other operators in the ports and airports of the two cities. The project will not put significant additional demands on the ports and airports.

Presence of Foreign Workers

The presence of foreign workers has the potential to put additional demands on accommodation and health care services. However, it is not expected to be the case for the current project.

As indicated in Section 7.2.21, it is expected that the project expatriate personnel in Dakar and/or Nouakchott will account for about 25 people. The project will require onshore accommodations in Dakar and/or Nouakchott for these people during the Construction Phase. The project will rent apartments or hotel rooms for these people.

Additionally, some of the offshore international workers who will be living on the project vessels and transiting through Dakar and/or Nouakchott airports might need to spend on night in a hotel on their way to/from their home country.

Dakar and Nouakchott are large cities with a large number of apartments and hotels. The limited presence of foreign workers will not overburden the existing accommodation facilities of the cities.

Some incidents or accidents requiring medical support may occur offshore, and onshore personnel might also require medical attention. Routine medical needs on the project vessels will be managed by trained paramedics onboard the vessels. Should additional medical attention be needed for a limited number of personnel, arrangements will be made with pre-screened health providers in Dakar and/or Nouakchott. More serious cases will be managed by international medical providers, who will work to source medical care and repatriation of personnel.

With regard to the project proponent HSSE practices, medical support from local providers is not expected to be significant. Therefore, these incidents or accidents will not overburden local health infrastructures and services.

7.2.22.2.5 Summary

Several potential impacts on public infrastructure and services have been assessed but only one could be significant. A direct support from the public security forces could be required for handling incidents with artisanal fishermen entering the exclusion safety zones in the Nearshore Hub/Terminal Area and the Pipeline Area. Their direct support would also be required for search and rescue operations. This will involve having the coastguards available 24/7 during the Construction Phase of the project.

7.2.22.3 Impact Rating

As indicated in Sections 4.6.10.4 and 4.7.10.4, the public security forces of Mauritania and Senegal operate with a small number of vessels. They have limited means with regards to the length of the coast under their responsibility. The availability required from the public security forces to handle project specific incidents could place additional demands on their limited resources if those are not increased and/or decrease their availability for other public services under their responsibility.

The intensity of the impact is moderate; the adverse change would be noticeable and the adverse change could affect several people. The extent of the impact would be local since it could comprise services provided by public security forces beyond the project zone. The impact will be short term. Based on the combination of these criteria, the consequence of the impact would be minor. Considering that the impact is incident is likely to happen during the Construction Phase, its overall significance is rated 2 – Low (details are provided in Table 7-60).

Table 7-60. Impacts to Public Infrastructure and Services during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Exclusion Safety Zones and Vessel Movements						
Mauritania Senegal	Nearshore / Hub Terminal; Pipeline	Placing additional demands on the public security forces limited resources since they will be required to be available 24/7 to handle a safety incident with artisanal fishermen or a search and rescue operation if needed.	Nature: Negative Intensity: Moderate Spatial Extent: Local Duration: Short term	Minor	Likely	2 – Low

7.2.22.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-61) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the measures and controls already planned in the project design, summarized as follows:

- D24: Exclusion safety zones will be demarcated on applicable navigational charts, and a communication procedure will be developed to communicate the location of the exclusion safety zones to the local fishing communities. This is intended to allow pirogues avoid the exclusion safety zones.
- D26: A site security plan will be developed that considers the security arrangements for each of the facilities including the modalities of support provided by government.
- D27: Expat workers and national workers will undergo a briefing to raise awareness on health risks, prevention and available treatment and their responsibilities. There will be an active screening and medical treatment program for workers.
- D28: The nature of the drilling, pipelay, FPSO and FLNG Construction Phase activities will reduce the need for onshore stayovers of personnel.

Moreover, the ICA requires that the “two states (Mauritania and Senegal) are to consult with a view to jointly setting appropriate security and safety measures for each of the facilities and surrounding areas”.

Table 7-61. Mitigation Measures to Avoid or Reduce Impacts to Public Infrastructure and Services during the Construction Phase from Routine Activities.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Placing additional demands on the public security forces limited resources since they will be required to be available 24/7 to handle a safety incident with artisanal fishermen or a search and rescue operation if needed.	2 – Low	M08, M09, M10, M11, M12, M13, M14, M16, M25, M26	1 – Negligible

Notes:

M08: Develop and implement a training and awareness program targeting local fishing communities on the specific maritime safety rules associated with the project.

M09: Provide regular notices to mariners in the appropriate form and language to artisanal fishermen on project infrastructure, associated exclusion safety zones, travel and approach plans and the approximate timing of project.

M10: Equip the support vessels and other project vessels that regularly move outside the construction or operational exclusion safety zones with radar or infrared systems that can detect small fishing vessels during poor visibility/night time.

M11: Provide adequate lighting aboard the support vessels and other project vessels that regularly move outside the construction or operational exclusion safety zones with the intent of maintaining high visibility during poor visibility/night time. These vessels will also feature searchlights that can be used to shine on or signal approaching pirogues and foghorns for audible signaling.

M12: Having a project patrol boat to monitor the exclusion safety zones, including patrolling ahead of the approach or exiting of larger project vessels into or out of the exclusion safety zones.

M13: Using the services of local fishermen liaison officers (FLOs) aboard the project patrol boats in the areas of artisanal fishing.

M14: Equipping the support vessels and the project patrol boat with lifesaving appliances approved by the Convention for Safety of Life at Sea (SOLAS) and IMO, which can be used to assist in rescuing fishermen in the water in line with international maritime protocols or in the event of an accident involving a pirogue with a project vessel. Assist with the rescue of any fishermen involved in a collision with a project vessel or following the capsizing of their vessel due to ship wake.

M16: Ensuring that each project vessel keeps records of maritime safety incidents with pirogues and other vessels, including near misses, and that these are subsequently shared with the project. BP will monitor maritime safety incidents and adjust, if required, project specific maritime safety rules, security and search & rescue arrangements in place.

M25: The project will seek to work with the public security forces to establish an appropriate response and security framework which may include resource, equipment, training and response protocols.

M26: Include in the security stakeholder engagement plan, provisions around response, management and interface with Public security forces for security incidents scenario such as act of terrorism and unlawful entry in the exclusion safety zones.

7.2.23 Women and Vulnerable Groups

High Level Summary

In this section on Women and Vulnerable Groups, the impact of one impact producing factor, this being Presence of foreign workers, was evaluated. No impacts are anticipated on Women and Vulnerable Groups during the Construction Phase for routine activities.

7.2.23.1 Impact Producing Factors and Project Areas

The IPF identified for this resource in Table 7-4 is distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Presence of foreign workers				●

As previously explained, during the Construction Phase, most of the project activities will be conducted from vessels offshore. There are no potential interactions between activities in these project areas and local communities' women and vulnerable groups. Only onshore activities have been retained for a potential impact on women and vulnerable groups.

7.2.23.2 Impact Description

The following subsections explain how this IPF will produce impacts in the Support Operations Areas.

7.2.23.2.1 Offshore Area

Not applicable (see Section 7.2.23.1).

7.2.23.2.2 Nearshore Hub/Terminal Area

Not applicable (See Section 7.2.23.1).

7.2.23.2.3 Pipeline Area

Not applicable (See Section 7.2.23.1).

7.2.23.2.4 Support Operations Areas

The only IPF considered for this discussion is the presence of foreign workers. This discussion is limited to direct impacts to women and vulnerable groups. Indirect impacts to these receptors may ensue from impacts on community livelihoods, community health and safety, and employment and business opportunities, public infrastructure and services. These indirect impacts have been discussed in the respective headings, when required.

Presence of Foreign Workers

Section 4.6.11 and 4.7.11 have provided a description of the situation of women and vulnerable groups in Mauritania and Senegal with more specific information on those living in the coastal fishing communities. The following groups have been identified as vulnerable in the two countries: women, youth, the disabled, HIV positive people/households. Specific vulnerable groups that have considered for Mauritania are the descendants of former slaves and refugees who returned from Senegal in 1989, and for Senegal the communities living on the Langue de Barbarie due to the erosion process that threatens the physical integrity of the dwellings on this narrow strip of land. Women and vulnerable groups generally rely on their families who provide the only significant social safety net in these communities.

In large onshore projects, the presence of foreign workers has the potential to contribute to prostitution in the local population and sexually transmitted diseases such as HIV/AIDS. This is the case, for instance, with some mining projects. Generally speaking, some women and other vulnerable groups are more at risk of prostitution than other members of the population because of their precarious financial situation. In the case of the current project, Section 7.2.24 has already assessed that contribution to prostitution is not a significant concern due to the limited presence of project foreign workers Therefore, no impacts from the presence of foreign workers are expected on women and other vulnerable groups.

7.2.23.2.5 Summary

No impacts are anticipated on women and other vulnerable groups.

7.2.23.3 Impact Rating

Not applicable (see Section 7.2.23.5).

7.2.23.4 Mitigation Measures and Residual Impacts

Although no impacts are anticipated on women and other vulnerable groups, the project recognizes that women and vulnerable groups are at risk of changes to local economy and well-being. As such, some mitigation measures identified for artisanal fisheries and related activities that can have a ripple effect on women and vulnerable groups have been identified:

- M19: Collaboration with a community council of formally nominated representatives of local key stakeholders from N'Diago and Saint-Louis set up to review local fishing communities' concerns and grievances related to the project.
- M20: Develop and implement a framework for interaction with artisanal fisheries, with provisions covering engagement with local communities on access to fishing grounds, grievance and recourse mechanism for damage to fishing gear, environmental awareness building, livelihood enhancement and the role of community liaison officers.
- M23: Implement an environmental awareness building program in association with local schools and community groups.
- M27: Developing a social investment program to enhance project benefits for the directly affected N'Diago and Saint-Louis communities, including livelihood enhancement activities.

7.2.24 Cultural and Archaeological Heritage

High Level Summary

In this section on Cultural and Archaeological Heritage, the impact of one impact producing factor, this being Physical presence, was evaluated. All impacts on Cultural and Archaeological Heritage during the Construction Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

7.2.24.1 Impact Producing Factors and Project Areas

The IPF identified for this resource in Table 7-4 is distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	

Support Operations Areas have not been retained since the supply bases will be located in existing ports and airports locations.

7.2.24.2 Impact Description

The physical presence of infrastructures offshore has a potential to impact cultural and archaeological heritage in the Offshore Area, the Pipeline Ares and the Nearshore Hub/Terminal Area. Therefore, the potential impacts are considered globally in the impact description under one of these areas, the Nearshore Hub/Terminal Area.

7.2.24.2.1 Offshore Area

See Section 7.2.24.2.2.

7.2.24.2.2 Nearshore Hub/Terminal Area

Physical Presence

If there are any marine archaeological artifacts in the vicinity of the planned infrastructures, their installation or construction, including the positioning of the drillship, could impact them through seafloor disturbance.

There are no known underwater archaeological artifacts in the project areas. However, due to the seaway traffic during pre-colonial and colonial transatlantic trade, there is a marine archaeological potential offshore Saint-Louis. This archaeological potential extends both sides of the maritime border and includes the waters offshore N'Diago.

The existing maps of shipwrecks, presented in Sections 4.6.7.3 and 4.7.7.3, cover known shipwrecks. None is reported within the project areas. However, these maps do not include the location of pre-colonial or colonial shipwrecks. The maritime waters in the project areas have the potential to contain shipwrecks that are witnesses of the pre-colonial or colonial history of Mauritania and Senegal.

The likeliness of a precolonial or colonial shipwreck being located exactly where the project infrastructures will be positioned is rare. Geophysical and geotechnical surveys carried out at the proposed locations of the project infrastructure have not revealed any present. However, if present, the infrastructures could destroy the remains of an ancient shipwreck and its archaeological artifacts.

One of the important aspects of Saint-Louis intangible cultural heritage is the protective goddess of the city, Mame Coumba Bang, whose abode is believed to lie near the mouth of the Senegal River. The intangible cultural heritage includes also mystical rituals practiced from an uninhabited location on the Langue de Barbarie, Sal Sal, located in front of the location for the Nearshore Hub/Terminal Area. The project infrastructures planned at least 10 km offshore, their physical presence should not interfere with the intangible cultural heritage of local populations of N'Diago and Saint-Louis.

Finally, the physical presence of the project infrastructures will not interfere with the historical and cultural heritage of the island of Saint-Louis which is a UNESCO world heritage site. The island of Saint-Louis is located on the Senegal River. No project activities will be conducted on the river. Therefore, there is no potential interference between the project infrastructures and the island of Saint-Louis during the Construction Phase.

7.2.24.2.3 Pipeline Area

See Section 7.2.24.2.2.

7.2.24.2.4 Support Operations Areas

Not applicable (see Section 7.2.24.1).

7.2.24.2.5 Summary

The physical installation or construction of project infrastructures on the seafloor could impact marine archaeological artifacts. The maritime waters in the project area have the potential to contain shipwrecks that are witnesses of the pre-colonial or colonial history of Mauritania and Senegal.

However, there is a rare chance that a precolonial or colonial shipwreck would be located exactly where the project infrastructures will be positioned. As indicated in Section 7.2.13.5, the total seabed that will be occupied by the project infrastructures is very limited. It has been estimated at <0.30 km^2.

7.2.24.3 Impact Rating

The physical installation or construction of project infrastructures could destroy the remains of an ancient shipwreck and its archaeological artifacts. The intensity of the impact would be moderate since the adverse change could be noticed. The extent is limited to the infrastructure footprint. The loss would be definitive. Based on the combination of these criteria, the consequence of the impact would be minor. Considering that there is rare probability for this impact to happen, its overall significance is rated 1 – Negligible (details are provided in Table 7-62).

Table 7-62. Impacts to Cultural and Archaeological Heritage during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Nearshore / Hub Terminal; Pipeline	Loss of archaeological artifacts in the presence of a precolonial or colonial shipwreck at the location of project infrastructures.	Nature: Negative Intensity: Moderate Spatial Extent: Immediate vicinity Duration: Long term	Minor	Rare	1 - Negligible

7.2.24.4 Mitigation Measures and Residual Impacts

The impact being rated 1 – Negligible, no mitigation measures are required. Summary of existing measures inherent to design and operational controls includes:

- D25: The seabed has been mapped as part of an extensive geophysical and geotechnical survey carried out by the project. The survey has not identified any shipwrecks or other maritime heritage on the seabed. Further seabed surveys are foreseen prior to dredging taking place.

7.2.25 Landscape and Seascape

High Level Summary

In this section on Landscape and Seascape, the impact of two impact producing factors, these being Physical presence and Vessel movements, was evaluated. No impacts are anticipated on Landscape and Seascape during the Construction Phase for routine activities.

7.2.25.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence			●	
Vessel movements			●	

While this section addresses landscape and seascape, the project will not impact the landscape. The only onshore operations will be support operations conducted inside the ports and airports of Dakar and/or Nouakchott. They will have no effect on the landscape. The only potential impacts considered in this section are those on the seascape. The Offshore Area and Pipeline Area are too far from the coast for the construction activities to be seen.

7.2.25.2 Impact Description

7.2.25.2.1 Offshore Area

Not applicable (see Section 7.2.25.1).

7.2.25.2.2 Nearshore Hub/Terminal Area

Physical Presence and Vessel Movements

The physical presence of infrastructures and vessel movements in the Nearshore Hub/Terminal Area could potentially impact the seascape. However, they will be located about 10 km from the coast. The closest locations, N'Diago and Saint-Louis, are located respectively at 13 and 16 km from the breakwater. The physical presence of infrastructures and vessel movements at these distances are unlikely to be noticed. Therefore, no impact is anticipated on the seascape for the onshore viewers.

The physical presence of infrastructures and vessel movements in the Nearshore Hub/Terminal Area (and also in the Offshore Area and the Pipeline Area) will be observable by other sea users. However, the observations by people navigating or fishing in the surrounding areas will be very localized. It will be limited to their time being in a specific area from which they will have a view on the infrastructures and vessel movements. Consequently, no significant impact on the seascape is anticipated for offshore viewers.

7.2.25.2.3 Pipeline Area

Not applicable (see Section 7.2.25.1).

7.2.25.2.4 Support Operations Areas

Not applicable (see Section 7.2.25.1).

7.2.25.2.5 Summary

No impacts on landscape and seascape are anticipated from routine operations during the Construction Phase of the project.

7.2.25.3 Impact Rating

Not applicable (see Section 7.2.25.5).

7.2.25.4 Mitigation Measures and Residual Impacts

Not applicable (see Section 7.2.25.5).

7.2.26 Social Climate

High Level Summary

In this section on Social Climate, the impact of four impact producing factors, these being Physical presence, Exclusion safety zones, Onshore logistic activities and Presence of foreign workers, was evaluated. The residual impacts on Social Climate during the Construction Phase for routine activities were assessed as of low significance when mitigation measures are applied.

7.2.26.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Exclusion safety zones		●	●	
Onshore logistic activities				●
Presence of foreign workers				●

The IPFs identified above could impact the social climate indirectly. The impact assessment made in Section 7.2.16 shows the physical presence of infrastructures and their exclusion safety zones in the Nearshore Hub/Terminal Area and in the Pipeline Area will have a negligible impact on artisanal fisheries. No losses of catches are expected and no impacts on activities related to artisanal fisheries, such as fish transformation by women, are expected neither.

However, based on other similar projects, there could be a perception of loss of fishing grounds and catches by fishermen and other community members whose revenues are based on artisanal fisheries. This perception could lead to social discontent. Since the impacts of the physical presence of infrastructures and their exclusion safety zones on social climate are indirect, the distinction between Pipeline Area and Nearshore Hub/Terminal Area is irrelevant. Therefore, they are considered globally in the impact description under the Nearshore Hub/Terminal Area.

The onshore logistic activities have been identified as an IPF that could impact the social climate. Again, the impact is indirect. The impact assessment made in Section 7.2.18 shows that the project will create a few employment and business opportunities in Dakar and/or Nouakchott which is a positive impact. However, the absence of employment and business opportunities in N'Diago and Saint-Louis could lead to social discontent in these communities. Therefore, the onshore logistics is considered as an indirect IPF in the impact description under the Support Operations Areas.

The presence of foreign workers has also been identified as an IPF that could lead to social discontent and could impact the social climate. However, the impact assessment made in Section 7.2.19 shows that the presence of foreign workers will not be significant. Therefore, this IPF does not need to be furtherly discussed in the present section.

7.2.26.2 Impact Description

7.2.26.2.1 Offshore Area

Not applicable (see Section 7.2.26.1).

7.2.26.2.2 Nearshore Hub/Terminal Area

Sections 4.6.15 and 4.7.15 provide a portrait of the social climate in the fishing communities neighboring the Nearshore Hub/Terminal Area: N'Diago in Mauritania and Saint-Louis in Senegal. It showed that the social climate in N'Diago, a village of about 1,240 people, is calm. With regard to the perceptions of oil and gas activities, community members are hopeful to be able to take advantage of the present project in terms of employment opportunities and social investments. However, local fishermen fear that fish stocks will decline with project operations and some of them believe that fishing and oil and gas activities are incompatible.

In Saint-Louis (230,801 inhabitants), the social climate is generally calm. However, the social climate in the fishing communities of the Langue de Barbarie, which count 70,532 people has been tense since the beginning of 2017. Three main factors contribute to this tension:

- the termination of the fishing agreement between Mauritania and Senegal and the significant loss of access to fishery resources and associated revenues for the Saint-Louis fishing communities;
- the unresolved problem of the breach in the Langue de Barbarie and associated marine safety issues; and
- the unresolved problem of coastal erosion on the Langue de Barbarie and the associated hazards and risks that homes might be lost.

The absence of solution to the three problems above contributes to social discontent.

Data made public in February 2018 indicate that 52 fishermen of Saint-Louis have drowned during 32 incidents in 2017 alone[104]. Recent data also indicate that despite the ban to fish in Mauritanian waters, Senegalese fishermen violate the regulation on a regular basis[105]. In the last days of January 2018, an altercation between Senegalese fishermen and Mauritanian public security forces offshore N'Diago resulted in one dead fisherman and social unrest in Saint-Louis. Tensions were high in Saint-Louis afterwards. In retaliation, a crowd of fishermen reportedly vandalized and burnt small shops run by Mauritanians in Saint-Louis. Security forces were called in to handle the crowd. As of February 2018, the tensions in the fishing communities of Saint-Louis are still high.

The severity of the problems affecting the fishing communities of Saint-Louis and the events of January 2018 raise the prospect of a volatile social climate. In this context, the fishing community members may show discontent with any project involving the implementation of infrastructures in waters where they currently fish.

As indicated in Sections 6.4.2 and 6.4.4, a large number of stakeholders in Saint-Louis have expressed, during public consultations, the feeling that the current project will compromise or severely impact artisanal fishing activities. While the loss of fishing grounds in the breakwater area and the FPSO area will be negligible and the project will not entail loss in fishing catches, the fishermen are likely to have a different perception of the losses. This perception is likely to be shared by all community members whose revenues are linked to artisanal fisheries, for instance the women fish processors and vendors. Perceived inadequate resolution of grievances may compound the matter. This could lead to discontent and social unrest in the fishing communities of Saint-Louis. Discontent could be expressed in several ways, including fishermen not respecting the exclusion safety zone in the Nearshore Hub/Terminal Area. This has the potential to escalate in conflicts between fishermen, and the project proponent and the National authorities called in to enforce the exclusion safety zones.

[104] Information provided by the Deputy Director of the Direction Nationale de la Protection et de la Surveillance des Pêches and reported on February 2, 2018 in a local news web: https://www.ndarinfo.com/Saint-Louis-En-2017-52-vies-englouties-par-la-mer_a20936.html

[105] A public communication from the Mauritanian authorities in January 2018 states that in 2017 and reported by Senegalese medias, the Mauritanian coast guards have conducted 62 interception operations resulting in the arrest of 108 pirogues and 930 fishermen. End of January 2018, one of the interception operations conducted offshore N'Diago resulted in the arrest of 9 fishermen including one that was fatality shot during the incident (https://www.ndarinfo.com/Meurtre-d-un-pecheur-senegalais-l-armee-mauritanienne-s-explique-et-se-decharge-sur-un-entetement_a20901.html).

7.2.26.2.3 Pipeline Area

See Section 7.2.26.2.

7.2.26.2.4 Support Operations Areas

As indicated in Section 6.4.5, expectations for employment opportunities are high in N'Diago and Saint-Louis. While the project will include employment opportunities in the Support Operations Areas, these opportunities will be located in Dakar and/or Nouakchott. The project will employ up to 15 CLOs and FLOs from N'Diago and Saint-Louis communities.

However, considering the level of expectations in N'Diago and Saint-Louis and the fact that these two communities are the ones neighboring the nearshore facilities, the limited employment opportunities are likely to entail a disappointment in both communities.

In Saint-Louis, the perceived loss of fishing revenues combined to the limited employment opportunities could fuel the current discontent in fishing communities and lead to potential social unrest. This could lead to fishermen making a point entering the Nearshore Hub/Terminal Area exclusion safety zone. On shore, the social discontent could be expressed through the vandalization of public buildings or private properties. It should not be excluded that discontent could be expressed towards breaking in Mauritanian properties or harming Mauritanian Nationals that would serve as scapegoats. While this might seem far-fetched, the 1989 events[106] and the January 2018 events should serve as a reminder that such a scenario is possible.

Additionally, the perception that the project is not providing satisfactory resolution of grievances and/or compensation claims (e.g. for lost gear) or is causing elevated risk of injury/death of fishermen at sea due to presence of project vessels could also lead to social discontent.

7.2.26.2.5 Summary

The perception of loss of fishing grounds and fishing catches combined with the limited employment opportunities could lead to social discontent in N'Diago and Saint-Louis. In Saint-Louis, this has the potential to lead to social unrest.

The perception that the project is not providing satisfactory resolution of grievances and/or compensation claims or is causing elevated risk of injury/death of fishermen at sea due to presence of project vessels could also lead to social discontent.

7.2.26.3 Impact Rating

The social discontent could lead to conflicts and potentially involve fatalities. As a result, its intensity is high. With a risk for social unrest and violent conflicts in the city of Saint-Louis and beyond, the extent of the impact would be local or regional. The duration of the impact is considered short to long term in recognition that potential fatalities would be irreversible. Based on the combination of these criteria, the consequence of the impact would be high. Based on the current situation of social discontent in Saint-Louis fishing communities, it is likely that the impact will happen during the course of the Construction Phase of the project. As a result, this impact is rated 4 – High (details are provided in Table 7-63).

[106] In 1989, a small conflict between a farmer and a herder escalated in a conflict between Mauritania and Senegal with a great number of fatalities and people being deported in both countries.

Table 7-63. Impacts to Social Climate during the Construction Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence, Exclusion Safety Zones, and Onshore Logistic Activities						
Mauritania Senegal	Nearshore/ Hub Terminal; Pipeline; Support Operations	Social discontent in N'Diago and Saint-Louis due to the potential perception of loss of fishing grounds and fishing catches combined with the limited employment opportunities, the perception of unsatisfied grievances and/or compensation claims (e.g. for lost gear), and elevated safety risk for fishermen at sea due to presence of project vessels.	Nature: Negative Intensity: High Spatial Extent: Local to Regional Duration: Short term to Long term	Severe	Likely	4 - High

7.2.26.4 Mitigation Measures and Residual Impacts

The impact is reported below (Table 7-64) and potential applicable mitigation measures are identified. These measures are in addition to the existing measures inherent to design and operational controls such as:

- D19: The relevant maritime, port or shipping authorities will be notified of all permanent offshore facilities, as well as safety zones and routine shipping routes to be used by project-related vessels. Permanent facility locations will be demarcated on nautical charts.
- D24: Exclusion safety zones will be demarcated on applicable navigational charts, and a communication procedure will be developed to communicate the location of the exclusion safety zones to the local fishing communities. This is intended to allow pirogues avoid the exclusion safety zones.

Table 7-64. Mitigation Measures to Avoid or Reduce Social Discontent during the Construction Phase from Routine Activities.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Social discontent in N'Diago and Saint-Louis due to the potential perception of loss of fishing grounds and fishing catches combined with the limited employment opportunities, the perception of unsatisfied grievances and/or compensation claims (e.g. for lost gear), and elevated safety risk for fishermen at sea due to presence of project vessels.	4 - High	M09, M17, M18, M19, M20, M23, M24, M27, M28	2 - Low

Notes:

M09: Provide regular notices to mariners in the appropriate form and language to artisanal fishermen on project infrastructure, associated exclusion safety zones, travel and approach plans and the approximate timing of project activities.

M17: Establishing a grievance mechanism easily accessible to fishing communities members that includes monitoring of claims and the resolution thereof.

M18: Maintaining a community liaison officer (CLO) for N'Diago and Saint-Louis to provide a direct link with the fishing communities.

M19: Collaboration with a community council of formally nominated representatives of local key stakeholders from N'Diago and Saint-Louis set up to review local fishing communities' concerns and grievances related to the project.

M20: Develop and implement a framework for interaction with artisanal fisheries, with provisions covering engagement with local communities on access to fishing grounds, grievance and recourse mechanism for damage to fishing gear, environmental awareness building and livelihood enhancement and the role of community liaison officers.

M23: Implement an environmental awareness building program in association with local schools and community groups.

M24 Provide technical assistance to mutually agreed marine resource research programs notably the national oceanographic research centers of both countries (CRODT and IMROP).

M27: Developing a social investment program to enhance project benefits for the directly affected N'Diago and Saint-Louis communities, including livelihood enhancement activities.

M28: Engaging in an on-going dialogue with national, regional and local authorities to monitor the social climate in the local communities in order to help identify and support, if needed, ad hoc measures to prevent social discontent linked to project activities and its escalation into conflicts.

7.3 Impacts during the Operations Phase for Routine Activities

7.3.1 Air Quality and Greenhouse Gases

High Level Summary

In this section on Air Quality and GHG, the impact of one impact producing factor, this being Emissions, was evaluated. The residual impacts on Air Quality and GHG during the Operations Phase for routine activities were assessed as of low significance when mitigation measures are applied.

7.3.1.1 Impact Producing Factors and Project Areas

The IPF identified for this resource in Table 7-4 is distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Emissions	•	•	•	•

7.3.1.2 Impact Description

The following subsections explain how this IPF will potentially produce impacts in each of the project areas.

7.3.1.2.1 Offshore Area

Emissions

During operations, there will be only limited activity in the Offshore Area, primarily associated with well maintenance. Well maintenance may occur during normal drilling operations using the drillship; if well maintenance is required beyond the drilling windows, it will be conducted by a vessel similar to the drillship or by a dynamically positioned well service vessel. Support services would entail use of existing operational vessels and additional offshore vessels and helicopters, depending on the nature of the well work. Drilling operations which are scheduled to occur in the GTA Field after the Nearshore Hub/Terminal are commissioned have been addressed under assessment of the Construction Phase (see Section 7.2). Well maintenance vessels will produce emissions, increasing ambient levels of contaminants near the area of operations and affecting local air quality.

7.3.1.2.2 Nearshore Hub/Terminal Area

Emissions

During operations in the Nearshore Hub/Terminal Area, air emissions from various sources (e.g., FLNG, LNGCs, support vessels) will increase ambient levels of contaminants near the area of operations. Maximum operation-related emissions calculations are outlined in Appendix B. Air dispersion modeling results for the Nearshore Hub/Terminal are presented in Appendix J.

For the Nearshore Hub/Terminal Area, gas processing, liquefaction, and transport will produce the following emissions on an annual basis (Table 7-65).

Table 7-65. Summary of Operations-Related Emissions, Nearshore Hub/Terminal Area.

Source	NOx t/y	CO t/y	PM10 t/y	PM2.5 t/y	VOC t/y	SO2 t/y	HAP t/y	GHG t/y
FLNG	839.13	1,756	72.34*		113.88	0.00	65.9	754,666
Hub	327.53	45.42	8.73*		24.74	1.05	16.38	861,872
Assist Tugs	142.39	12.41	7.65*		5.30	14.28	0.92	7,668
Service Tug	142.39	12.41	7.65*		5.30	14.28	0.92	7,668
Mooring Lines	142.39	12.41	7.65*		5.30	14.28	0.92	7,668
Project Patrol Boat	141.53	11.79	7.72*		5.36	13.94	0.93	7,485
Crew Boat	314.52	26.21	17.16*		11.91	30.98	2.06	16,634

From: Appendix J

Abbreviations: CO – Carbon Monoxide; GHG – Greenhouse Gas; HAP – Hazardous Air Pollutants; NO_x – Oxides of Nitrogen; PM10 – particulate matter, 10 microns; PM2.5 – particulate matter, 2.5 microns; SO_2 – Sulphur Dioxide; t/y – Tonnes per year; VOC – Volatile Organic Compound.
Footnotes: * - reported as PM

FLNG emission sources include four (4) gas turbines, two (2) gas generators, and three (3) flare pilots; Hub emission sources include two (2) gas generators, an emergency generator, two (2) firewater pumps, and a flare pilot. Support marine vessels for the Hub/FLNG facility consists of three (3) assists tugs, a service tug, a security boat, three (3) mooring line vessels, and a crew boat. Values presented in Table 7-65 are source totals (i.e., emissions for assist tugs are for three assist tugs;

emissions for service tug are for a single service tug). Emission sources are detailed in Appendix J. Operations at the Nearshore Hub/Terminal Area are expected to last 20 years.

Air dispersion modeling completed for the Operations Phase (see Appendix J) estimated that emissions from the proposed operations, including operation of the FLNG do not exceed the WHO guidance levels for SO_2, PM_{10}, and $PM_{2.5}$, and the annual averaging period for NO_2. However, the maximum modeled concentration of 1-hour averaging for NO_2 exceeded WHO guidance levels. In the air modeling report, it was noted that the WHO air guidelines do not have a standard norm for the recommended NO_2 hourly value similar to the U.S. National Ambient Air Quality Standards (NAAQS) used by the U.S. EPA, which uses the three-year average of the 98^{th} percentile of daily maximum NO_2-1h concentrations.

As noted in Section 7.2.1, no air quality standards are currently in place in Mauritania. In Senegal, the Senegal Air Pollution Discharge Standards (Document NS 05-062) thresholds are in units of mg/m^3 which are much more lenient than the $\mu g/m^3$ thresholds from the WHO. Further discussion of the WHO thresholds is presented in Appendix J. Air emissions thresholds established by the International Finance Corporation (IFC; EHS Guidelines, 2007a) and the World Bank Group make reference to current WHO thresholds.

7.3.1.2.3 Pipeline Area

Emissions

During routine operations within the Pipeline Area, air emissions from the FPSO and support vessel engines will increase ambient levels of contaminants near the area of operations. Maximum operations-related emissions calculations are outlined in Appendix B. Air dispersion modeling results for the FPSO, located within the Pipeline Area, are presented in Appendix J.

For the Pipeline Area, gas processing and pipeline transport will produce the following emissions on an annual basis (Table 7-66). FPSO emission sources include two (2) gas turbines, an emergency generator, four (4) firewater pumps, an essential service generator, and two (2) emergency flares. Support marine vessels for the FPSO consists of assist tugs, supply boat, security boat, and crew boat. Values presented in Table 7-66 are source totals (i.e., emissions for assist tugs are for three assist tugs; emissions for security boat are for a single project patrol boat). Emission sources are detailed in Appendix J. The duration of the Operations Phase is based on an anticipated 20 year contract duration of the FLNG vessel.

Table 7-66. Summary of Operations-Related Emissions, Pipeline Area.

Source	NO_x t/y	CO t/y	PM10 t/y	PM2.5 t/y	VOC t/y	SO_2 t/y	HAP t/y	GHG tCO_2eq/y
FPSO	343.51	1,325.4	96.84*		2.4	8.12	0.73	121,618
Assist Tugs	15.71	1.38	0.84*		0.58	1.58	0.1	848
Supply Boat	13.39	1.14	0.72*		0.5	1.33	0.09	713
Project Patrol Boat	141.53	11.79	7.72*		5.36	13.94	0.93	7,485
Crew Boat	89.62	7.47	4.89*		3.39	8.83	0.59	4,739

From: Appendix J

Abbreviations: CO – Carbon Monoxide; GHG – Greenhouse Gas; HAP – Hazardous Air Pollutants; NO_x – Oxides of Nitrogen; PM10 – particulate matter, 10 microns; PM2.5 – particulate matter, 2.5 microns; SO_2 – Sulphur Dioxide; t/y – Tonnes per year; tCO_2//y – tonnes CO_2 equivalent per year; VOC – Volatile Organic Compound.
Footnotes: * - reported as PM

As previously mentioned, air dispersion modeling completed for the Operations Phase (see Appendix J) estimated that emissions from the proposed operations, including operation of the FPSO do not exceed the WHO guidance levels for SO_2, PM_{10}, and $PM_{2.5}$, and the annual averaging period for NO_2.

The maximum modeled concentration of 1-hour averaging for NO_2 exceeded WHO guidance levels if comparing each year separately. In the air modeling analysis (see Appendix J), it was noted that the WHO air guidelines do not have a standard norm for the recommended NO_2 hourly value similar of the standard to the U.S. National Ambient Air Quality Standards (NAAQS) used by the U.S. EPA, which uses the three-year average of the 98^{th} percentile of daily maximum NO_2-1h concentrations. When comparing estimated NO_2 emissions using this equivalent NAAQS standard, the NO_2 emissions are less than the WHO guidance level.

7.3.1.2.4 Support Operations Areas

Emissions

Operations of support vessels through the ports of Nouakchott and Dakar will occur intermittently throughout the Operations Phase. Emissions from support vessels have been accounted for in each of the prior discussions, covering operations in the Nearshore Hub/Terminal Area and Pipeline Area (FPSO). Emissions from support vessels in the Support Operations Areas will be limited due to the relatively short amount of time that support vessels will remain in or near port.

7.3.1.2.5 Summary

Emissions associated with operations in the Offshore Area, Nearshore Hub/Terminal Area, Pipeline Area, and Support Operations Areas are expected to produce localized impacts through the introduction of atmospheric contaminants. Emissions for operations will be below WHO guidance levels, as noted previously.

GHG for all operations activities are projected to amount to 1,799,064 tonnes (CO2 equivalent) per year. By comparison, Mauritania and Senegal GHG emissions in 2014 amounted to 52,960,000 and 136,750,000 Tonnes, respectively (CAIT Climate Data Explorer. 2017).

7.3.1.3 Impact Rating

Emissions

Impact intensity for criteria contaminants are expected to be moderate, occurring on a local level, and of long-term duration, resulting in a moderate impact consequence. Given the likely nature of this impact, overall impact significance is 3 – Medium (see Table 7-67 below for details on selected criteria).

A summary of impact to air quality associated with emissions from routine activities during the Operations Phase is presented in Table 7-67.

Table 7-67. Impacts to Ambient Air Quality during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Emissions						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Reduction in ambient air quality.	Nature: Negative Intensity: Moderate Spatial Extent: Local Duration: Long term	Moderate	Likely	3 – Medium

7.3.1.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-68) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the measures and controls already planned in the project design but summarized here for reference.

Summary of existing measures inherent to design and operational controls:

- D01: Contractors will be expected to comply with the contract terms that have been established, including HSSE standards and performance requirements.
- D02: Compliance with applicable national and international regulations (MARPOL 73/78 Annex VI) and guidelines regarding emissions of nitrogen oxides (NO_x) and Sulphur oxides (SO_x) from main project vessels.
- D04: Volumes of hydrocarbons flared will be recorded.
- D15: The FLNG and FPSO will be designed, constructed, and operated to avoid routine flaring[107].
- D29: Develop and implement a flaring protocol with the intention to meet defined operational combustion performance.
- D30: Implementation of leak detection and repair programs for fugitive emissions.
- D31: Implementation of technically feasible and cost-effective measures to optimize energy efficiency and air emissions on the FPSO and FLNG. This could include where feasible waste heat recovery, flare gas recovery, vapor recovery and selected method of export compression on the FPSO, and boil-off gas recovery and control of fugitive emissions through design of the FPSO and FLNG.
- D32: Use of project-produced gas as preferred fuel for FLNG, FPSO and QU processes instead of diesel or crude oil.
- D33: Aggregate greenhouse gas emissions from all offshore project facilities will be quantified annually in accordance with internationally recognized methodologies. The FPSO and FLNG will have fuel flow or emissions metering systems installed for equipment rated at 10 MW thermal or above. A predictive emission monitoring system (PEMS) will be used on equipment rated 10 MW thermal or above for the calculation of emissions of GHG, SOx and NOx.

[107] Routine flaring is the deliberate flaring of gas to support production under normal conditions.

Table 7-68. Mitigation Measures to Avoid or Reduce Impacts to Air Quality from Routine Activities during the Operations Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Reduction in ambient air quality.	3 – Medium	M01, M02, M29, M30, M31	2 – Low

Notes:

M01: Maintaining routine maintenance procedures to help ensure that engines are operating at defined operational performance and specified emissions levels.

M02: Monitoring fuel consumption as a proxy for measuring performance and emissions. When practical or as required by applicable regulations, vessel operators will be expected to utilize low-sulfur fuels to limit SOx production.

M29: Use of dry low emissions (DLE) gas turbine drivers for the main refrigeration compressors on the FLNG.

M30: Conduct monitoring of baseline air quality prior to the Construction Phase at receptor level to establish ground-level ambient air concentrations. Update air dispersion modeling if necessary when equipment specifications from vendors are available in detailed design phase.

M31: Tug boats and other project support vessels not in operational use and moored at the Hub facility will be connected to electrical power provided by the Hub to the extent practical.

7.3.2 Water Quality

High Level Summary

In this section on Water Quality, the impact of three impact producing factors, these being Discharges, Solid waste and Chemicals and hazardous materials, was evaluated. The residual impacts on Water Quality during the Operations Phase for routine activities were assessed as of negligible or low significance when mitigation measures are applied.

7.3.2.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Discharges	•	•	•	•
Solid waste	•	•	•	•
Chemicals and hazardous materials	•	•	•	

7.3.2.2 Impact Description

The following subsections explain how these IPFs will potentially produce impacts in each of the project areas.

7.3.2.2.1 Offshore Area

Discharges

During operations, there will be only limited activity in the Offshore Area, primarily associated with well maintenance. Well maintenance may occur during normal drilling operations; if well maintenance is required beyond the drilling windows, it will be conducted by a vessel similar to the drillship or by a dynamically positioned well service vessel. Support services would entail use of existing operational vessels and additional offshore vessels and helicopters, depending on the nature of the well work.

Drilling operations which are scheduled to occur in the GTA Field after the Nearshore Hub/Terminal are commissioned have been addressed under assessment of the Construction Phase (see Section 7.2).

Well maintenance vessels will discharge several different wastes, including sanitary and domestic wastes, food waste, and cooling water. Operations-related discharges in the Offshore Area will be diluted rapidly in the open ocean.

Solid Waste

Operation of well maintenance vessels may result in the accidental loss of solid waste or debris. Buoyant materials will float and be transported by local currents; heavier items will sink to the seafloor. The occasional and unintentional loss of debris may produce localized effects to water quality, depending upon the source (e.g., floating trash, buckets containing paints or other chemicals). Floating or sinking debris may leach residual chemicals, with effects to local water quality.

Chemicals and Hazardous Materials

Only limited volumes of chemicals may be released from the Offshore Area. Very small losses of chemicals may occur during well maintenance and workover activities or during the operation of production-related equipment (e.g., valve lubricants, wire-line lubricants, etc.). In all cases where chemicals are released, the amounts are expected to be small and rapidly diluted.

7.3.2.2.2 Nearshore Hub/Terminal Area

Discharges

During operations in the Nearshore Hub/Terminal Area, vessels will discharge several different wastes, including sanitary and domestic wastes, food waste, and cooling water. Operations-related discharges in the Nearshore Hub/Terminal Area will be diluted rapidly in the open ocean. Sanitary and domestic waste from the operations vessels may affect concentrations of suspended solids, nutrients, and chlorine in the water column as well as generate biological oxygen demand (BOD). However, these discharges are expected to be diluted rapidly in the open ocean (USEPA, 2017; MMS, 2007). Impacts would likely be undetectable beyond tens of meters from the source.

Several specialized vessels will also be conducting operations at the Nearshore Hub/Terminal, including the FLNG (operating continuously) and LNGC (visiting periodically), both of which are likely to produce water quality impacts.

Summary discharge information, as detailed in Section 2.10.3, includes the following:

- FLNG cooling water: The total seawater cooling water requirement is 54,000 m^3/hr under normal operations, equivalent to a daily discharge of 1,296,000 m^3. Cooling water will be discharged at a water depth of approximately 3 to 5 m; the temperature differential between the point of intake and the point of discharge is 7°C. The cooling water is discharged laterally and the temperature differential between effluent and ambient is reduced to within 3°C at the edge of the mixing zone, per IFC requirements. The seawater cooling water discharge streams will contain a hypochlorite solution to control marine growth in the installations, with a recommended hypochlorite dosage of 1 ppm at all seawater pump suction points at any given time. Cooling water discharge concentrations from the FLNG will need to comply with the IFC discharge limits associated with chlorine of 0.2 ppm.

- FLNG desalination discharge: discharge of seawater with an elevated salinity and very low concentrations of hypochlorite; seawater demands are 12.2 m^3/hr of seawater, with a brine discharge 7.2 m^3/hr, at a concentration of 60 parts per thousand. Hypochlorite may be added to inhibit marine growth in the system.

- Sanitary wastes from the QU Platform will vary depending on the number of personnel on board; on average, the treated sewage volume (based on 160 personnel onboard) is 45 m^3/day.

Discharges at the Nearshore Hub/Terminal may affect local water quality in several ways – via discharge of warm cooling water, via introduction of organics via treated sewage, and via introduction of chemicals (e.g., hypochlorite).

Solid Waste

Accidental loss of debris from support vessels during the Operations Phase may occasionally occur. Should accidental loss occur, local water quality may be affected by the presence of cardboard, plastics, or other items (e.g., tools, gear, hardhats, containers, etc.). Buoyant materials will float and be transported by local currents; heavier items will sink to the seafloor. The occasional and unintentional loss of debris may produce localized effects to water quality, depending upon the source (e.g., floating trash, buckets containing paints or other chemicals). Floating or sinking debris may leach residual chemicals, with effects to local water quality.

Chemicals and Hazardous Materials

As noted previously, the chemicals to be added to the cooling water discharge include hypochlorite. Cooling water discharge concentrations will need to comply with the IFC discharge limits associated with chlorine of 0.2 ppm. There is potential for these chemicals, when added to the cooling water discharge, to affect water quality within the mixing zone.

7.3.2.2.3 Pipeline Area

Discharges

During operations, sources of discharges will include the FPSO, condensate carrier, and various support vessels. As summarized in Section 2.10.3, key discharges from the FPSO include:

- Treated produced water: continuous discharge of 4.1 m^3/hr, or 99 m^3/day. Oil and grease concentrations will not exceed 42 mg/l (daily maximum), and 29 mg/l (monthly average).
- Cooling water and desalination brine: continuous discharge of 4,000 m^3/hr, or 96,000 m^3/day, with a temperature increase of no more than 3°C at the edge of the zone of initial mixing and dilution.
- Treated sewage, grey water, and macerated food waste: continuous discharges of 1.04 m^3/hr, or 25 m^3/day. Treated effluent will be discharged overboard and will meet MARPOL 73/78 Annex IV standards (i.e., fecal coliforms not to exceed 250 MPN per 100 ml, BOD5 not to exceed 50 mg/l, suspended solids not to exceed 50 mg/l when tested onshore, Suspended Solids not to exceed 100 mg/l above suspended solids content in water used for flushing when tested aboard FPSO.
- Deck drains: intermittent discharges of 0.91 m^3/hr, or 21.9 m^3/day, with discharges complying with MARPOL 73/78 Annex I requirements. Oil and grease concentration in treated oily water to be limited to 15 ppm.

The total maximum daily discharge volume from the FPSO during operations is estimated at 96,146 m^3/day. While cooling water and desalination brine comprise approximately 94% of the discharges originating at the FPSO, the produced water discharge has the greatest potential for impact to water quality.

Modeling of produced water discharges from the FPSO are presented in Appendix K-2. The purpose of the produced water modeling was to: 1) simulate anticipated continuous discharge flow rates and effluent compositions from the FPSO over a 45-day period; 2) provide a quantitative assessment of the environmental risk to the marine environment associated with various discharge scenarios; 3) establish the relative contribution of key contaminants to the environmental exposure risk; and 4) understand the sensitivity of the risk to changes in hydrocarbon component concentrations and production chemicals in the produced water discharge as well as ambient conditions (i.e., background current speed, etc.). The methodology used in the modeling analysis aligned with OSPAR Recommendation 2012/5 for a Risk Based Approach (RBA) to the Management of Produced Water Discharges from Offshore Installations and the OSPAR Guidelines in support of Recommendation 2012/5.

Eight produced water discharge scenarios were modeled. Chemicals considered in the scenarios included naturally occurring compounds (e.g., benzene, toluene ethylbenzene and xylene [BTEX], phenols, dispersed oil, mercury)[108] in several different concentrations, and production chemical additives (e.g., MEG). The purpose of this approach was to identify the change in the total risk associated with added chemicals (i.e., corrosion inhibitors, scale inhibitors, coagulants/flocculants). Corrosion inhibitors are added in the process for integrity and safety; scale inhibitors are added in the process to maintain proper flow, while coagulants/flocculants could be added for produced water treatment efficiency. Modeling considered both low and high current speeds at the discharge point.

The Dose-related Risk and Effect Assessments Model (DREAM) was also used to calculate the dispersion of produced water discharges and to calculate an Environmental Impact Factor (EIF), the latter of which represents the aggregation of predicted effect concentrations (PEC) and predicted no effects concentrations (PNEC) ratios for all contaminants in the discharge into a single integrated risk value; this risk value provides an indication for the probability of environmental damage. As noted in Appendix K-2, a single EIF unit represents a volume of water (defined as 105 m^3) which has the potential to harm ≥5% of the marine species in the receiving environment, if they become exposed to harmful substances arising from the discharge. While the focus on this metric is with plankton and other marine fauna, the results also have applicability to water quality.

Key findings from the modeling study included:

- Substance level modeling of both naturally occurring substances (NOS) and added chemicals in the produced water discharge showed that ≥90% of the environmental exposure risk is attributable to the presence of corrosion inhibitor in the discharge, with minor contributions from benzene (3%-6%), and the chemical flocculent (2%-3%).
- The toxicity of produced water and the calculated environmental exposure risk is highly dependent on the metocean conditions that occur at the time of modeling. During periods of low (benign) current conditions, the environmental exposure risk is higher because the produced water discharge is not diluted and dispersed (i.e., to contaminant concentrations below the PNECs). During periods of high (energetic) currents, dispersion and dilution of the produced water discharge is high and concentrations below PNECs can occur more quickly, reducing the environmental risk.
- The maximum distances from release site where the exposure risk of the NOS discharge is ≥5% for all time steps are 1.93 km and 3.20 km, for the low and high ambient current cases, respectively.
- For the NOS base case with production chemicals, the maximum distance from the release location where the exposure risk is ≥5% for all time steps ranged from 5.31 km to 8.47 km for the low and high ambient current cases respectively.

Modeling results indicate that dispersion and dilution of the produced water discharge, as well as other FPSO discharges, are highly dependent upon ambient current conditions.

[108] Regarding the presence of PAHs in produced water, gas production fields are widely known to have a higher content of low molecular weight aromatic hydrocarbons, such as BTEX in produced water, than water from oil production platforms. BTEX compounds were included in the produced water modeling performed as part of the GTA Phase 1 ESIA.
PAH values, like any naturally occurring substances, can vary significantly from field to field. Studies have been published comparing PAH concentrations from a number of North Sea Oil and Gas platforms (Cofino et al., 1993 and Rφe, 1999). The results show comparable median concentrations for the majority of PAHs compared. International Association of Oil and Gas Producers (IOGP) Report No 1.20/324 Aromatics in produced water; occurrence fate and effects and treatments, 2002 also compared PAH concentrations for oil and gas installations and did not observe significant differences in PAH concentrations within the same regions.
The GTA Phase 1 produced water modelling was completed based on current understanding of the condensed water quality. This understanding is achieved through assessing various tests of reservoir fluids completed during the appraisal drilling campaign and subsequent process modelling. This is the normal approach for oil and gas projects during this engineering design phase where operations have not started and therefore produced water is not available yet. The current understanding is that PAHs would be present at insignificant concentrations compared to other contaminants, such as BTEX.

Operations-related discharges from other vessels operating in the Pipeline Area will be diluted rapidly in the open ocean. Sanitary and domestic waste from the operations vessels may affect concentrations of suspended solids, nutrients, and chlorine in the water column as well as generate BOD. However, these discharges are expected to be diluted rapidly in the open ocean (USEPA, 2017; MMS, 2007). Impacts would likely be undetectable beyond tens of meters from the source.

Solid Waste

Accidental loss of debris from the FPSO or other vessels during the Operations Phase may occasionally occur. Should accidental loss occur, local water quality may be affected by the presence of cardboard, plastics, or other items (e.g., tools, gear, hardhats, containers, etc.). Buoyant materials will float and be transported by local currents; heavier items will sink to the seafloor. The occasional and unintentional loss of debris may produce localized effects to water quality, depending upon the source (e.g., floating trash, buckets containing paints or other chemicals). Floating or sinking debris may leach residual chemicals, with effects to local water quality.

Chemicals and Hazardous Materials

As noted previously, the chemicals present in the produced water discharge include corrosion inhibitors, scale inhibitors, and coagulants/flocculants. Naturally occurring substances in the produced water discharge include BTEX, phenols, dispersed oil and mercury. Discharge of produced water and associated chemicals will have an effect on water quality, primarily from the localized increases in hydrocarbons and associated chemicals (e.g., corrosion inhibitors) found in the produced water.

Chemicals to be added to the FLNG cooling water discharge include hypochlorite, with potential effects on water quality.

No known Mauritania or Senegal national regulations or thresholds are applicable to these discharges of FPSO produced water.

7.3.2.2.4 Support Operations Areas

Discharges

Sanitary and domestic wastes discharged from support vessels operating in Support Operations Areas, if discharging, may affect concentrations of suspended solids, nutrients, and chlorine in the water column as well as generate biological oxygen demand (BOD). These discharges are expected to be diluted rapidly. Impacts would likely be undetectable beyond tens of meters from the source.

Solid Waste

The intentional release of solid waste into the marine environment is prohibited under MARPOL. Should accidental loss occur, local water quality may be affected by the presence of cardboard, plastics, or other items (e.g., tools, gear, hardhats, containers, etc.). Buoyant materials will float and be transported by local currents; heavier items will sink to the seafloor. The occasional and unintentional loss of debris may produce localized effects to water quality, depending upon the source (e.g., floating trash, buckets containing paints or other chemicals). Floating or sinking debris may leach residual chemicals, with effects to local water quality.

7.3.2.2.5 Summary

Discharges associated with operations and activities in the Offshore Area, Nearshore Hub/Terminal Area, Pipeline Area, and Support Operations Areas are expected to produce localized water quality impacts via the discharge of cooling water (high demand at the Nearshore Hub/Terminal), produced water (at the FPSO), and treated sanitary wastes, domestic wastes, and miscellaneous discharges. Accidental loss of trash or debris may also affect local water quality.

7.3.2.3 Impact Rating

Discharges

Impacts to water quality arising from discharges are evaluated separately based on relative volumes being discharged. Impact intensity for most discharges (i.e., all discharges except produced water and FLNG cooling water) is expected to be low, occurring in the immediate vicinity, and of short term to long term duration, resulting in a negligible impact consequence. Given the likely nature of this impact, overall impact significance is 1 - Negligible (see Table 7-69 below for details on selected criteria).

For FPSO produced water and FLNG cooling water discharges, impact intensity is deemed moderate, occurring in the immediate vicinity, and of long-term duration, resulting in a minor impact consequence. Given the likely nature of this impact overall impact significance is 2 – Low (see Table 7-69 below for details on selected criteria).

Solid Waste

Impact intensity associated with accidental loss of trash and debris is low, occurring on a local level, and of short term to long term duration, resulting in a minor impact consequence. Given the likely nature of this impact, overall impact significance is 2 – Low (see Table 7-69 below for details on selected criteria).

Summary

A summary of impact to water quality associated with discharges from routine activities during the Operations Phase is presented in Table 7-69.

Table 7-69. Impacts to Ambient Water Quality during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Discharges						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Reduction in ambient water quality from discharges (except for FPSO produced water and FLNG cooling water).	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term to Long Term	Negligible	Likely	1 – Negligible
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Reduction in ambient water quality from produced water and FLNG cooling water discharges and associated chemicals.	Nature: Negative Intensity: Moderate Spatial Extent: Immediate vicinity Duration: Long term	Minor	Likely	2 – Low
Solid Waste						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Changes in water quality from accidental loss of trash and debris.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Minor	Occasional	2 – Low
Chemicals and Hazardous Materials						
Addressed under FPSO produced water and FLNG cooling water discharges, above						

7.3.2.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-70) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the measures and controls already planned in the project design, but summarized here for reference.

Summary of existing measures inherent to design and operational controls:

- D01: Contractors will be expected to comply with the contract terms that have been established, including HSSE standards and performance requirements.
- D05: Compliance with applicable national and international regulations (MARPOL 73/78, Annex IV and V) for waste and waste water discharges from offshore project vessels.
- D06: A waste management plan will be developed and implemented to avoid unauthorized waste discharges and transfers, with written procedures for collection, segregation, storage, processing and disposal of waste, including use of equipment and record keeping.

- D07: Waste not permitted to be discharged at sea (such as waste chemicals, cooking oils or lubricating oils, biomedical waste) will be transported onshore for transfer to an approved disposal facility[109] (in-country or an international provider).
- D11: Completion and well workover fluids to be discharged overboard will be tested to confirm the fluids are suitable for discharge as required by applicable national and international regulations. Fluids that do not meet the specification would either be treated offshore or transported onshore for transfer to an approved disposal facility[110] (in-country or an international provider).
- D34: LNG and condensate carriers are expected to discharge ballast water according to the IMO International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM).
- D35: FPSO and FLNG vessel will be certified according to Class and Flag requirements before leaving the shipyard. The vessels will be double-hulled.
- D36: An inspection and maintenance program will be developed and implemented with the intent of maintaining mechanical integrity of equipment, piping, relief and vent systems and devices, emergency shutdown systems, controls, pumps and instrumentation, and prevent uncontrolled releases of hazardous or polluting materials from the project.
- D37: Chemicals used in the production process, flow assurance, maintenance, well intervention and management, desalination and fire management systems will be selected and managed with the intent to reduce the potential for environmental effects.
- D38: If dredging activities are required for maintenance during the Operations Phase, a dredging management plan will be developed and implemented that defines the maintenance dredging methodology, identifies and assesses dredged materials disposal options and sites, characterized the chemical and physical composition and behavior of the sediment to be dredged, and defines the area of influence and the potential mitigation and monitoring measures.

[109] In this document, a treatment center can mean either a center for waste treatment or for final disposal.
[110] In this document, a treatment center can mean either a center for waste treatment or for final disposal.

Table 7-70. Mitigation Measures to Avoid or Reduce Impacts to Water Quality from Routine Activities during the Operations Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Reduction in ambient water quality from produced water and FLNG cooling water discharges and associated chemicals.	2 – Low	M32, M33, M35, M36, M37, M38, M39	2 – Low
Changes in water quality from accidental loss of trash and debris.	2 – Low	M34	1 – Negligible

Notes:

M32 The seawater intake depth at the FLNG will be optimized to reduce the heated water plume. Cooling water effluent will not result in a temperature change of more than 3°C at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors, and assimilative capacity.

M33 Monitoring use of added chemicals to produced water stream (corrosion inhibitors, scale inhibitors, coagulants/flocculants).

M34: Verifying compliance with MARPOL Convention and implementation of a waste management plan, with the intent of reducing the likelihood of accidental loss.

M35: The seawater intake depth at the FPSO will be designed with the intent to reduce the need for use of antifoulant chemicals.

M36: Free chlorine in FLNG cooling water discharges to be sampled at point of discharge will be maintained below 0.2 parts per million (ppm).

M37: Produced water will be treated prior to discharge with sufficient treatment. Oil and grease content of the produced water effluent discharge at sea will be compliant with applicable regulation and not exceed 42 mg/L daily maximum; 29 mg/L monthly average.

M38: Produced water effluent quality will be monitored. The first 18 months of monitoring data will be used to assess the likely impacts of the effluent upon the receiving water body using an Environmental Risk Assessment approach, which is to be repeated following a material change in effluent composition or volume.

M39: The discharge of cooling water will be designed to reduce recirculation.

7.3.3 Coastal Erosion

High Level Summary

In this section on Coastal Erosion, the impact of one impact producing factor, this being Physical Presence, was evaluated. The residual impacts on Coastal Erosion during the Operations Phase for routine activities were assessed as of low significance when mitigation measures are applied.

7.3.3.1 Impact Producing Factors and Project Areas

The IPF identified for coastal erosion in Table 7-5 is distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence			•	

7.3.3.2 Impact Description

The Operations Phase will involve a multitude of specialized vessels specifically designed to complete various tasks, including berthing assistance and support operations. Operations in the Offshore and Pipeline Areas (e.g., at the FPSO) will not have an effect on erosional processes along the Mauritania and Senegal coast due to distance from shore.

The presence of the breakwater in the Nearshore Hub/Terminal Area has the potential to influence coastal processes, including waves and sediment transport. Physical presence of the breakwater structure is the only component of this IPF which has the potential to affect coastal erosion; noise associated with operation activities will have no effect on erosional processes.

The following subsections explain how this IPF will potentially produce impacts in the each of the project areas.

7.3.3.2.1 Nearshore Hub/Terminal Area

Physical Presence

Within the Nearshore Hub/Terminal Area, the Operations Phase will include utilization of the breakwater and installed infrastructure for gas processing and terminal operations. The duration of the Operations Phase is based on an anticipated 20-year contract duration of the FLNG vessel. The concept design for the breakwater is presented in Section 2.1.3. The Nearshore Hub/Terminal Area contains a constructed area of approximately 0.165 km² (excluding safety zone) containing a breakwater, associated berthing facilities for tugs, a single FLNG and berthing space for visiting LNG carriers (Figure 7-5).

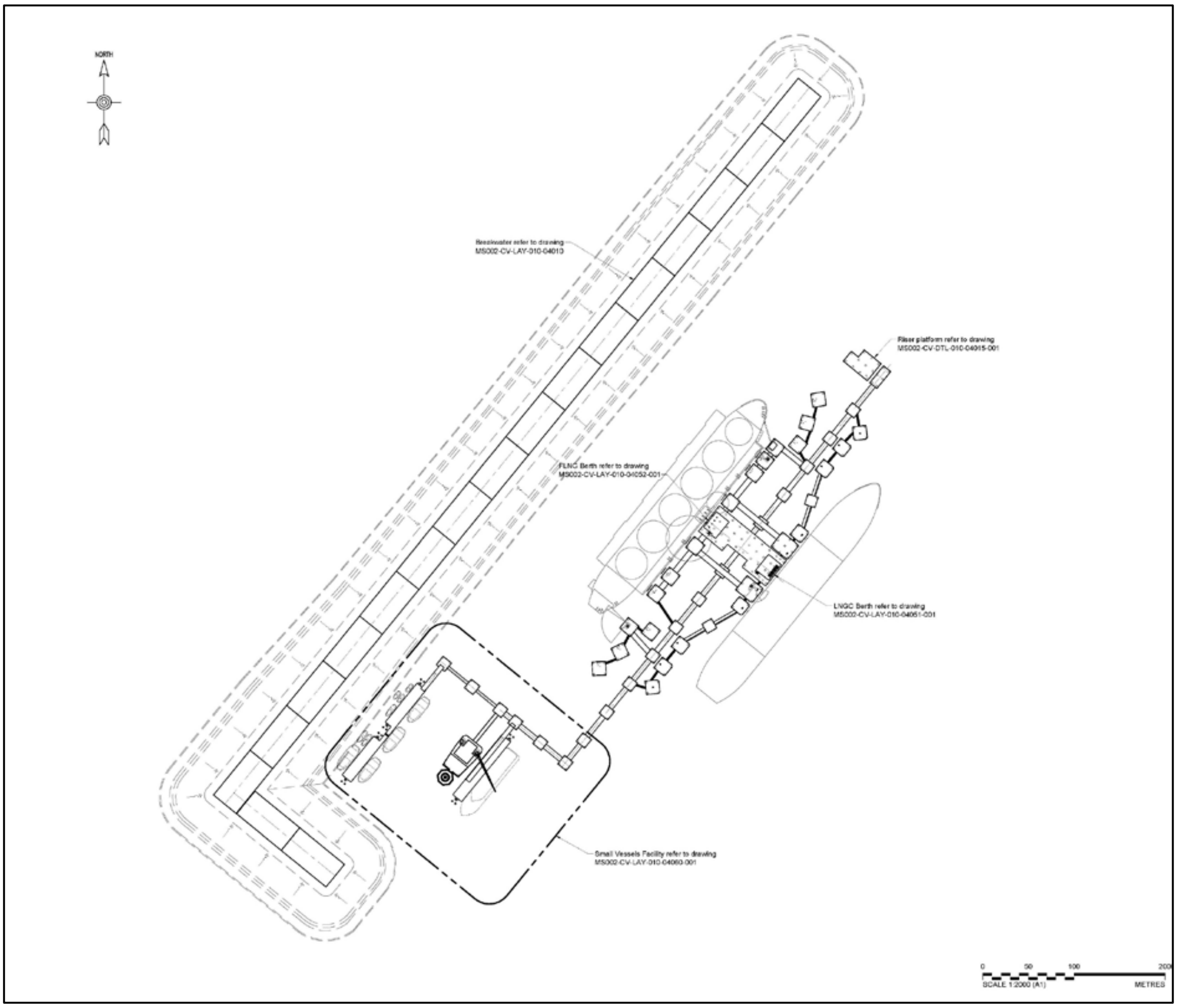
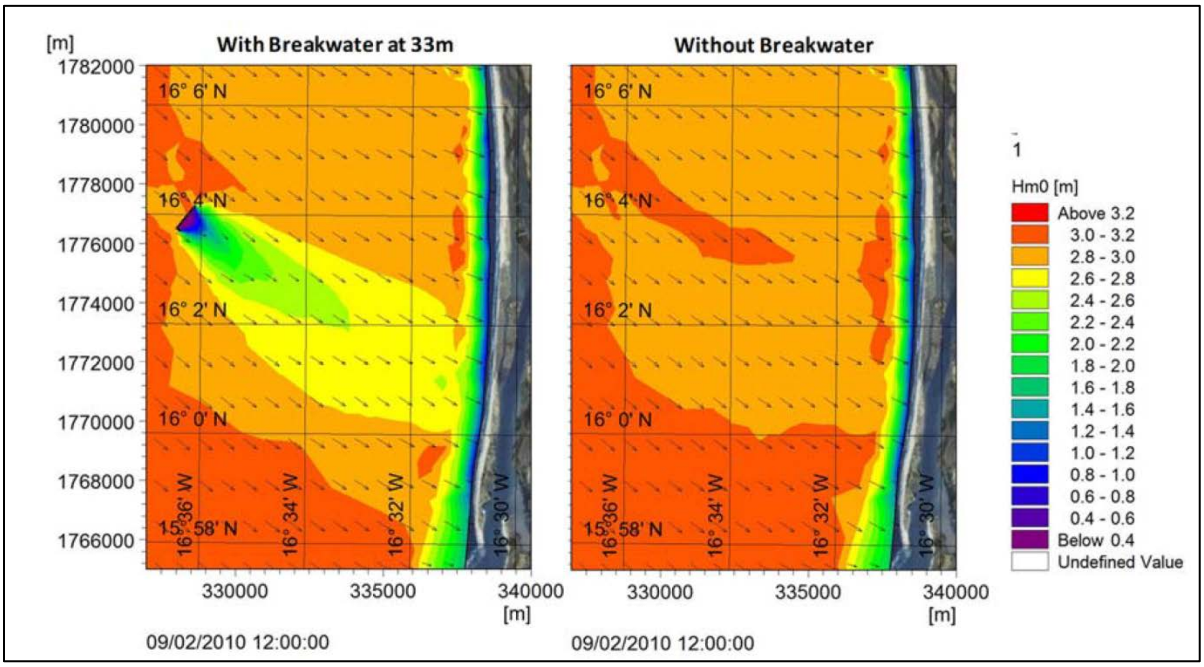


Figure 7-5. Layout of the Nearshore Hub/Terminal Area.

The Nearshore Hub/Terminal Area will be located about 10 to 11 km from the coast, in water depth of about 33 m. The breakwater orientation to the coastline and wave direction is reflected in Figure 7-6.



(From: Figure 4.3, Appendix I-3)

Figure 7-6. Breakwater Orientation Relative to the Coastline and Predominant Wave Direction.

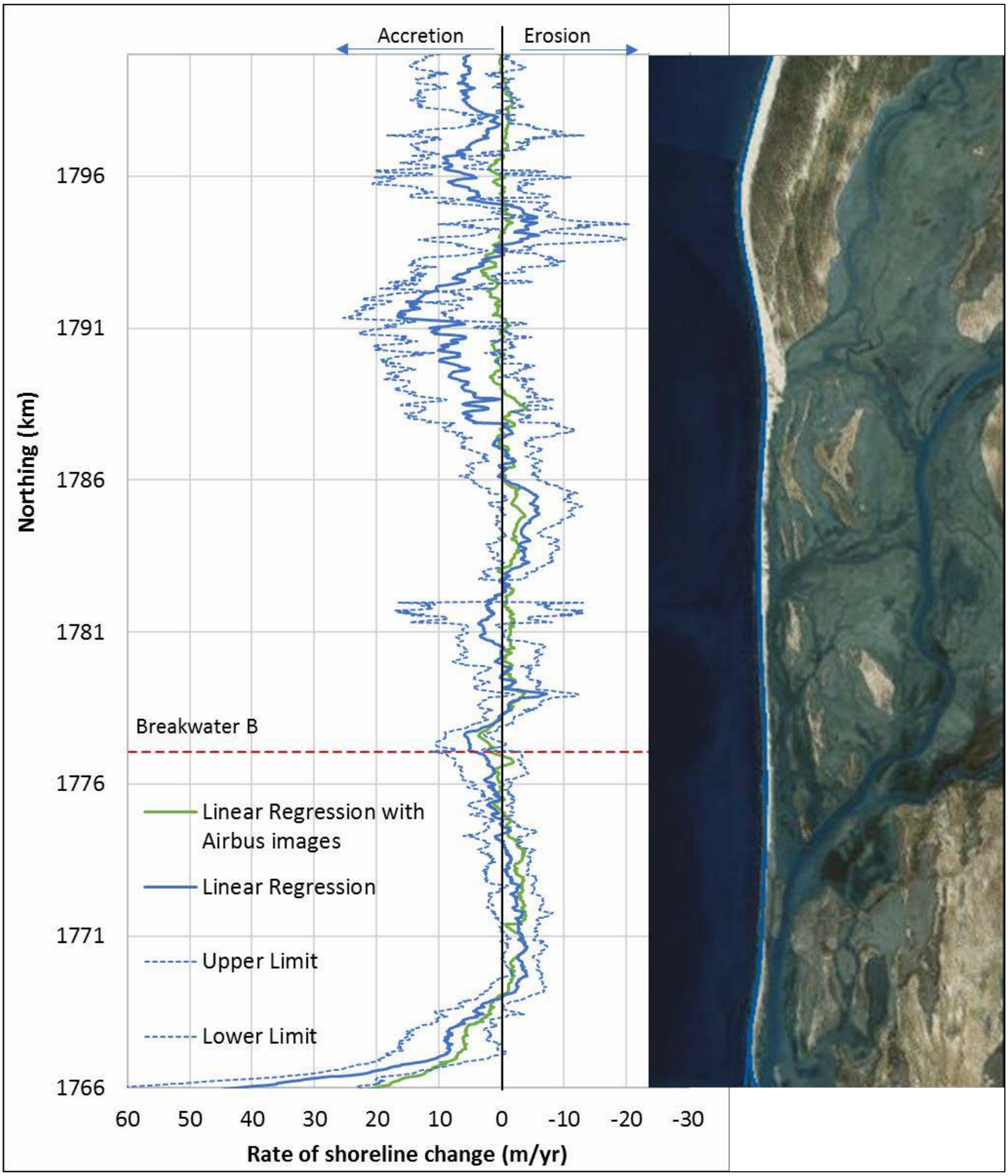
Images show the wave heights and the sheltering effect of the breakwater.

As discussed in Section 7.2.3, results of the coastal evolution model indicate that the presence of the breakwater will cause a reduction of the wave heights along part of the study area. It will also cause a modification to the wave directions (Figure 7-6). Model results showed that the presence of the breakwater will produce two effects: 1) accretion or reduction in natural erosion along approximately 8 km of coast southeast of the breakwater which is for the most part currently experiencing erosion, providing a positive impact to the coast along this coastal section; and 2) a maximum increase of 6 m over 10 years in coastal erosion rate relative to the case without breakwater along a total of approximately 2 km of coast further south, starting at the south end of the Hydrobase neighborhood in an area that is less densely populated and where the beach width currently ranges between approximately 100 and 250 m. The maximum positive shoreline change (accretion) is estimated to be 13 m over 10 years relative to the case without the breakwater. The maximum negative shoreline change (erosion) is estimated to be an additional 6 m over 10 years relative to the case without the breakwater.

7.3.3.3 Impact Rating

Physical Presence

The analysis of the historical coastline changes (2002-2016) shows accretion of up to 5 m/year north of the Mauritania-Senegal maritime boundary. The rates of accretion reduce southwards, switching to erosion around 1,774,500 m N (i.e., at Goxxu Mbacc). Historical erosion rates increase to a maximum of around 4 m/year between 1,769,500 and 1,770,000 m N (i.e., near Hydrobase); see Figure 7-7. Detailed discussions of these findings are presented in Appendix I-2.



(From: Figure 4.3, Appendix I-2)

Figure 7-7. Average Annual Coastline Change Rates 2002-2016.

The dotted red line represents the Mauritania-Senegal maritime boundary.

The potential impact of the proposed breakwater on coastal erosion has been evaluated using coastline evolution models. Detailed results are presented in Appendices I-2 and I-3. Initial modeling results conducted during site selection for the breakwater location (Appendix I-2) have been updated and the latest modeling results, which address some of the uncertainties identified in the previous study, including the use of more accurate wave data, are presented in Appendix I-3. Figure 7-8 below illustrates the differences in predicted changes in accretion and erosion associated with the breakwater presence relative to the case without the breakwater. A positive change means that the impact of the breakwater is a reduction in present day erosion or an increase in present day accretion, while a negative change means the impact of the breakwater is an increase in present day erosion or a reduction in present day accretion. Figure 7-8 shows that the modeling locates the maximum accretion zone relative to the case without the breakwater over an area of 8 km. This 8 km zone includes the neighborhoods of Goxxu Mbacc, Ndar Toute, Guet Ndar and Hydrobase (with the exception for its extreme south). The modeling locates the maximum erosion zone of 6 m over 10 years relative to the case without the breakwater over a 2 km area, starting at the extreme south of the Hydrobase. This figure also shows that the mouth of the river is much further south, more than 4 km further the illustrated erosion zone.

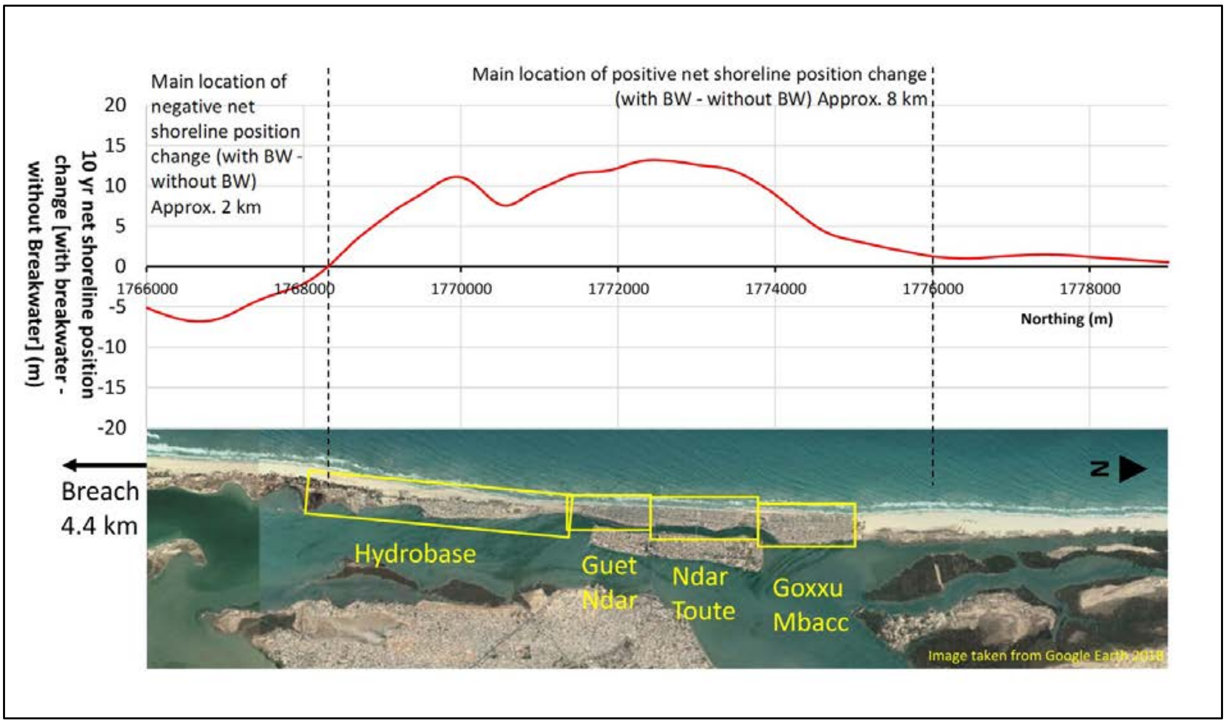


Figure 7-8. 10 Year Change in Shoreline Position with Breakwater Relative to the Case Without Breakwater.

As previously mentioned, the coastal evolution model results show that the presence of the breakwater will cause a reduction of the wave heights along part of the study area and a modification to the wave directions. This will then cause a reduction in the sediment transport rates along the section sheltered by the breakwater, inducing coastline changes. The model results show that the presence of the breakwater will produce two effects:

1) Accretion or reduction in natural erosion along part of the coastline southeast of the breakwater location in a densely populated area which is currently experiencing erosion. The presence of the breakwater will help protect this area from erosion, and accretion or reduction in natural erosion will be evident. This will provide a positive impact to the coast along an approximate 8 km stretch of the Langue de Barbarie, starting near the Mauritania-Senegal border and extending southward. The maximum positive shoreline change (accretion) is estimated to be 13 m over 10 years relative to the case without the breakwater; and

2) A maximum increase of 6 m over 10 years in coastal erosion rate relative to the case without breakwater south of approximately 1,768,000 m N, along about 2 km of coast, starting at the south end of the Hydrobase neighborhood, in an area that is less densely populated and where the beach width currently ranges between approximately 100 and 250 m. The

maximum negative shoreline change (erosion) is estimated to be an additional 6 m over 10 years relative to the case without the breakwater. The increased erosion is a consequence of the sediments accumulating over 8 km on the northern part of the Langue de Barbarie as mentioned above and, therefore, not being transported further south.

The duration of the Operations Phase is based on an anticipated 20 year contract duration of the FLNG vessel. During this period in which the breakwater will be operational, the consequence of its presence to coastal erosion is predicted to be variable, depending upon coastal location. Although there will be positive effects associated with sediment accretion or reduction in natural erosion, the overall impact has been rated negative in recognition of the erosion, with a low intensity. The adverse changes will occur in a less densely populated area. Further, the modelling results show that the increase in erosion rate is small compared to the observed natural variations in the coastline that can reach 4 m/year in this area. The extent of the impact will be local and its duration long term (i.e., for the whole life of the project and as long as the breakwater remains in place), producing a minor impact consequence. Overall impact significance to coastal erosion is 2 – Low (see Table 7-71 below for details on selected criteria). Modeling predictions do not account for climate change and potential sea level rise, both of which are discussed in Section 4.2.5.

Table 7-71. Impacts to Coastal Erosion during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Senegal	Nearshore Hub/ Terminal	Accretion or reduction in natural erosion of the Langue de Barbarie (relative to the case without the breakwater) of up to 13 m over 10 years near the Mauritania-Senegal border and extending southward approximately 8 km, accompanied by a maximum increase in coastal erosion rate (relative to the case without the breakwater) of approximately 6 m over 10 years further south, along approximately 2 km of coast, starting from the south end of the Hydrobase neighborhood.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Long term	Minor	Likely	2 – Low

7.3.3.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below along with mitigation measures (Table 7-72). These measures are in addition to the measures and controls already planned in the project design and summarized here for reference.

Summary of existing measures inherent to design and operational controls:

- D39: Given the principle of the need for parity either side of the border, the project has selected a location and design for the Nearshore/Hub terminal that has both the most beneficial and least potential adverse effect on the shoreline morphology of the options reviewed, while meeting the required conditions for safe approach of LNG carriers, subsequent mooring and operation of the facility (see Section 5.2.6).

Table 7-72. Mitigation Measures to Avoid or Reduce Impacts to Coastal Erosion from Routine Activities (Breakwater Presence) during the Operations Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Accretion or reduction in natural erosion of the Langue de Barbarie (relative to the case without the breakwater) of up to 13 m over 10 years near the Mauritania-Senegal border and extending southward approximately 8 km, accompanied by a maximum increase in coastal erosion rate (relative to the case without the breakwater) of approximately 6 m over 10 years further south, along approximately 2 km of coast, starting from the south end of the Hydrobase neighborhood.	2 – Low	M40, M41	2 – Low

Notes:

M40: a) To improve understanding of the long-term coastal dynamic equilibrium, the project will develop and implement a coastline monitoring plan during the project life cycle. Coastline monitoring will commence prior to breakwater construction, i.e. before 2020. This will include the collection of further bathymetric data along the Saint-Louis shore, including the Senegal River mouth. The project will aim to involve local academics in the implementation of the coastline monitoring plan. The relevant authorities and local communities will be informed of the monitoring results.

b) The data collected as part of the implementation of the coastline monitoring plan will be used to update the coastline modeling (in Appendix I-3) to be completed before the construction of the breakwater in 2020. Additional modeling updates will be conducted at key stages of the project life cycle when new information with the potential to have a significant impact on the modeling results will become available.

c) BP will seek the necessary authorizations to share relevant data for government led morphological studies initiatives and local academics.

d) a contingency plan for the coastline will be developed by the project in consultation with the relevant authorities if the results of the coastline monitoring and modeling clearly and systematically demonstrate, over the duration of the project, negative impacts related to the GTA Phase 1 project which exceeds those currently identified in the GTA Phase 1 project ESIA report (in particular Section 7.3.3).

M41: Provide specialist assistance to studies led by local or national authorities on Saint-Louis coastal management.

7.3.4 Sediment Quality

High Level Summary

In this section on Sediment Quality, the impact of three impact producing factors, these being Physical presence, Discharges and Solid waste, was evaluated. The residual impacts on Sediment Quality during the Operations Phase for routine activities were assessed as of negligible significance when mitigation measures are applied.

7.3.4.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	
Discharges	●	●	●	
Solid waste	●	●	●	

7.3.4.2 Impact Description

The Operations Phase will involve operation of the SPS, FPSO, and FLNG; use of various supply and support vessels; export of LNG and condensate via LNGC and condensate tankers, respectively; well maintenance; pipeline and flowlines pigging; and facility maintenance. Physical presence, discharges, and solid waste represent potential sources of impact to sediment quality in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area; no impacts to sediment quality in Support Operations Areas are expected as these areas are on shore.

Impacts to sediment quality from physical presence of structures and vessels will include potential leaching of chemicals, most notably associated with anti-fouling coatings, cathodic protection, and organic enrichment from epibiotal recruitment and subsequent sloughing. Operations Phase effluent sources include the FPSO, QU Platform, FLNG, and carrier/tankers. Effluents generated in the Pipeline Area by the FPSO or in the Nearshore Hub/Terminal Area by the FLNG and QU Platform are detailed in Section 7.3.2.2, and consist of treated produced water, cooling water, desalination brine, treated sewage, and deck drains. No drilling-related discharges are associated with the Operations Phase.

The following subsections explain how these IPFs will potentially produce impacts to sediment quality in each of the project areas.

7.3.4.2.1 Offshore Area

Physical Presence

The SPS infrastructure will be in position and stable during the Operations Phase and will provide hard substrate for recruitment and subsequent growth of epibenthos. Potential epibenthic colonists will depend on water depth but typically include ascidians, barnacles, bryozoans, hydroids, and sponges. Data from offshore platforms (Gallaway and Lewbel, 1982) and fouling plate studies (Danek and Lewbel, 1986) indicate that the biomass of these fouling biota decreases with increasing water depth. The amount of epibenthos is uncertain; due to the extended duration of the Operations Phase, it can be assumed that there will be a rather extensive continuous cycle of recruitment, epibiotal growth, and displacement (i.e., sloughing). The development of a mature, climax fouling community typically requires several years on newly exposed hard substrates (Marine Resources Research

Institute, 1984). Sporadic sloughing of biological material from the exposed subsea structures may produce organic enrichment of the underlying sediments (Wolfson et al., 1979).

Associated with the sloughing of the epibiota on the subsea structures, there is the potential for displacement of surficial materials (e.g. exposed metal oxides) from the structures. Exposed surfaces of the subsea structures may be susceptible to chemical leaching. This potential chemical leaching could cause very localized effects on the sediment quality.

Discharges

Routine effluent discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from the support vessels will have no impact on deepwater benthic communities due to water depth and rapid dilution of these discharges in surface waters.

Solid Waste

During operation activities, it is likely that debris (e.g., welding rods, buckets, pieces of pipe, plastic packaging materials) will accidentally fall overboard. The impact to sediment quality will be similar as described in Section 7.2.4.2.1.

7.3.4.2.2 Nearshore Hub/Terminal Area

Physical Presence

Within the Nearshore Hub/Terminal Area, the breakwater and other bottom-founded infrastructure will be in position and stable during the Operations Phase and will provide hard substrate for recruitment and subsequent growth of epibenthos. Effects to sediment quality from infrastructure physical presence will be similar to subsea structures as described in Section 7.3.4.2.1. However, the FLNG will have a long-term berth within the Nearshore Hub/Terminal Area; there is the potential for chemical leaching from the FLNG hull depending on the type of anti-fouling application (i.e., sloughing versus non-sloughing coatings) and the interaction between these coatings and the attached biota of the fouling community.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from the facilities and support vessels operating at the Nearshore Hub/Terminal will have no impact on local sediment quality due to rapid dilution of these discharge in surface waters; this rapid dilution and dispersion of these discharges will be facilitated by the shallow water oceanographic conditions.

Solid Waste

It is possible that debris may accidentally fall overboard during operations activities at the Nearshore Hub/Terminal. The impact to sediment quality will be similar as described in Section 7.2.4.2.1.

7.3.4.2.3 Pipeline Area

Physical Presence

Within the Pipeline Area, the pipeline, FPSO, and associated subsea structures will be in position and stable during the Operations Phase and will provide hard substrate for recruitment and subsequent growth of epibenthos. Effects to sediment quality from infrastructure physical presence will be similar as described in Section 7.2.4.2.1. With the long-term positioning of the FPSO within the Pipeline Area, there is the potential for chemical leaching from the FPSO hull similar to that noted previously for the FLNG (see Section 7.3.4.2.2).

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, and cooling water) from the FPSO and support vessels will have no impact on sediment quality within the Pipeline Area due to water depth and rapid dilution of these discharges in surface waters. However, long-term discharge of produced water from the FPSO may affect sediment quality, in particular concentrations of hydrocarbons and some metals. CSA Ocean Sciences Inc. (2016) conducted a monitoring study to assess the effects of development activities including FPSO discharge of produced water on the deepwater marine environment; findings of the study indicated elevated sediment mercury and hydrocarbon levels may be influenced by produced water discharges.

Solid Waste

It is possible that debris may accidentally fall overboard during operational activities within the Pipeline Area. The impact to sediment quality will be similar as described in Section 7.2.4.2.1.

7.3.4.2.4 Support Operations Areas

No impacts to sediment quality are expected in the Support Operations Areas from physical presence, discharges, or solid waste since these areas are on shore.

Summary

Impacts to sediment quality during the Operations Phase are primarily from organic enrichment from recruitment, growth, and sloughing of epibiota, discharge of produced water from the FPSO, and potential chemical leaching from exposed subsea structures. These effects to sediment quality are considered to be very localized and unquantifiable. With the exception of effects from produced water discharge, the level of intensity of these effects are not significant. Routine discharges and solid waste will have minimal effect on sediment quality during the Operations Phase.

7.3.4.3 Impact Rating

Physical Presence

The consequence of impacts to sediment quality in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area from physical presence include will include potential leaching of chemicals, most notably associated with anti-fouling coatings, and organic enrichment from epibiotal recruitment and subsequent sloughing. The overall impact significance is 1 – Negligible due to the intensity of the impact being low with changes unlikely to be noticed against background (see Table 7-73 below for details on selected criteria).

Discharges

Routine discharges including the produced water from operational activities in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area are expected to produce very localized impacts through the introduction of various components, predominantly organics and warm water (cooling water). The content of the produced water includes both natural and man-made chemicals. Chemicals to be added to the produced water discharge include corrosion inhibitors, scale inhibitors, and coagulants/flocculants. Naturally occurring substances in the produced water discharge include BTEX, phenols, and dispersed oil. Additional details regarding discharge volumes and composition are addressed in Section 7.3.2.2. Although the effects of these routine discharges will be generally restricted to surface waters, over the duration of the Operations Phase it is likely some level of discharge contaminants will reach the seafloor. The overall impact significance is 1 – Negligible (see Table 7-73 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during operational activities may occur in the Offshore Area, Nearshore Hub/Terminal Area, or within the Pipeline Area. These accidental losses are expected to produce localized impacts to the sediment quality due to potential chemical leaching and localized organic loading associated epibiota recruitment. The overall impact significance is 2 – Low (see Table 7-73 below for details on selected criteria).

Summary

A summary of impact to sediment quality from routine activities during the Operations Phase is presented in Table 7-73.

Table 7-73. Impacts to Sediment Quality during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Potential leaching of chemicals, most notably associated with anti-fouling coatings, and organic enrichment from epibiotal recruitment, growth and subsequent sloughing.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 – Negligible
Discharges						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Effects of routine discharges including produced water during operations.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 – Negligible
Solid Waste						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Potential chemical leaching of solid waste materials and localized organic loading from epibiota.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term to Long term	Minor	Likely	2 – Low

7.3.4.4 Mitigation Measures and Residual Impacts

For impacts to sediment quality from operations activities that are rated 1 – Negligible, no mitigation measures are required. Impacts with a significance rating over 1 are reported below (Table 7-74) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the measures and controls already planned in the project design.

Summary of existing measures inherent to design and operational controls:

- D01: Contractors will be expected to comply with the contract terms that have been established, including HSSE standards and performance requirements
- D05: Compliance with applicable national and international regulations (MARPOL 73/78, Annex IV and V) for waste and waste water discharges from offshore project vessels.
- D06: A waste management plan will be developed and implemented to avoid unauthorized waste discharges and transfers, with written procedures for collection, segregation, storage, processing and disposal of waste, including use of equipment and record keeping.
- D38: If dredging activities are required during the Operations Phase, a dredging management plan will be developed and implemented that defines the maintenance dredging methodology, identifies and assesses dredged materials disposal options and sites, characterized the chemical and physical composition and behavior of the sediment to be dredged, and defines the area of influence and the potential mitigation and monitoring measures.

Table 7-74. Mitigation Measures to Avoid or Reduce Impacts to Sediment Quality from Routine Activities during the Operations Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Potential chemical leaching of solid waste materials and localized organic loading from epibiota.	2 – Low	M34	1 – Negligible

Notes:

M34: Verifying compliance with MARPOL Convention and implementation of a waste management plan, with the intent of reducing the likelihood of accidental loss.

7.3.5 Benthic Communities

High Level Summary

In this section on Benthic Communities, the impact of three impact producing factors, these being Physical presence, Discharges and Solid waste, was evaluated. All impacts on Benthic Communities during the Operations Phase for routine activities were assessed as positive or as negative with a negligible significance. No mitigation measures were required.

7.3.5.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource (benthic communities) in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	
Discharges	●	●	●	
Solid waste	●	●	●	

As discussed in Section 7.2.5.1, Normandeau Associates, Inc. (2012) and Hawkins et al. (2014) identified various informational gaps concerning effects of noise on invertebrates that support a position that noise effects to benthic communities are undocumented based on current research status.

7.3.5.2 Impact Description

The Operations Phase will involve operation of the SPS, FPSO and FLNG; use of various supply and support vessels; export of LNG and condensate via LNGC and condensate tankers, respectively; well maintenance; pipeline and flowlines pigging; and facility maintenance. Physical presence, discharges, and solid waste represent potential sources of impact to benthic communities in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area; no impacts to benthic communities in Support Operations Areas are expected as these areas are on shore. Impacts to benthic communities from physical presence is very minimal during the Operations Phase due to seafloor-related phase activities being limited to possible anchoring from vessel support operations. Due to the extended duration of the Operations Phase, epibenthic recruitment, subsequent growth, and sloughing of organic materials from structures will affect benthic communities. Operations Phase effluent sources include the FPSO, QU Platform, FLNG, and carrier/tankers. Effluents generated by the FPSO is estimated to be approximately 96,146 m^3 per day, consisting of treated produced water, cooling water, desalination brine, treated sewage, and deck drains. No drilling-related discharges are associated with the Operations Phase.

The following subsections explain how these IPFs will potentially produce impacts to benthic communities in each of the project areas.

7.3.5.2.1 Offshore Area

Physical Presence

The SPS infrastructure will be in position and stable during the Operations Phase; support vessels operating in the Offshore Area will not utilize anchors. Therefore, the physical presence of the SPS and support vessels will have no effect on deepwater benthic communities from seafloor sediment disturbances within the Offshore Area. However, there will be recruitment and subsequent growth of epibenthos on the hard substrates as provide by the emplaced structures. The amount of epibenthos is uncertain; due to the extended duration of the Operations Phase, it can be assumed that there will be sloughing of organic materials from the fouling epibenthos. The effect of this sloughed material on benthic communities, depending on overall volume and distribution, may range from positive (i.e., organic input) to negligible negative (i.e., burial).

Discharges

Routine effluent discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from the support vessels will have no impact on deepwater benthic communities due to water depth and rapid dilution of these discharges in surface waters.

LNG and condensate carriers are expected to discharge ballast water according to IMO Ballast Water Management Regulations which should limit the introduction of planktonic larvae of potentially invasive benthic organisms.

Solid Waste

During operation activities, it is possible that debris (e.g., welding rods, buckets, pieces of pipe, plastic packaging materials) may accidentally fall overboard. Heavier, non-buoyant solid waste will sink and accumulate on the seafloor where it may eventually be colonized by epibiota. Seafloor debris may leach chemicals that could potentially cause localized changes in benthic communities. The addition of debris to the seafloor will add physical structure on the otherwise flat, soft bottom seafloor. This will provide hard substrate for epibiota similar to that provided by Offshore Area seafloor-founded infrastructure.

7.3.5.2.2 Nearshore Hub/Terminal Area

Physical Presence

Within the Nearshore Hub/Terminal Area, although not expected, there could be the potential for anchoring of various vessel types. This possible anchoring is the only activity where benthic communities will be affected by physical presence of the nearshore facility during the Operations Phase. Benthic communities present immediately below anchors will be crushed; emplacement and recovery of anchors will also disturb sediments in the immediate vicinity of the anchor footprint via sediment suspension and redistribution. Benthic community effect thresholds due to sediment deposition and post-depositional recovery are discussed in Section 7.2.5.2.1.

Over time, the breakwater, subsea structure, and semi-permanent berthing of the FLNG will acquire a biofouling community that will regularly slough off and provide organic material to adjacent benthic communities. The volume of organic input to the adjacent benthos from the fouling community and their effects will be mediated by ambient currents and near-shore oceanographic conditions. Effects on the benthic community from this periodic sloughing could range from beneficial (i.e., organic input as food source) to negligible negative (i.e., burial from accumulation).

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from support vessels operating at the Nearshore Hub/Terminal will have no impact on local benthic communities due to rapid dilution of these discharge in surface waters, similar to discharge-related impacts in offshore waters.

Cooling water discharges at the Nearshore Hub/Terminal will be released near the ocean surface. At these depths, and in spite of the large volumes of cooling water to be discharged, the thermal plume is not expected to reach the benthos due to rapid dilution and mixing. No thermal-related impacts to benthic communities are expected.

Solid Waste

It is possible that debris may accidentally fall overboard during operations activities at the Nearshore Hub/Terminal. The impact will be similar to that described in Section 7.3.5.2.1. However, shallow water oceanographic conditions and near-shore sediment transport processes may significantly reduce the potential for solid waste to add physical structure to the seafloor topography within the Nearshore Hub/Terminal Area. Floating debris will likely be transported away from the Nearshore Hub/Terminal Area via currents, to be deposited on the shoreline downcurrent from the site or transported offshore. Solid debris will sink in close proximity to its accidental release.

7.3.5.2.3 Pipeline Area

Physical Presence

The FPSO will be anchored and pipeline infrastructure will be positioned and stable during the Operations Phase; support vessels operating in the Pipeline Area will not utilize anchors. Therefore, the physical presence of the pipeline and support vessels will have no effect on deepwater benthic communities from seafloor sediment disturbances within the Pipeline Area. However, there will be recruitment and subsequent growth of epibenthos on the hard substrates as provided by the pipeline structure.

Over time, as the pipeline and other exposed subsea structures (including the FPSO hull) acquire a biofouling community that will regularly slough off due natural succession within this community. The sloughed material will provide an organic input and food source to benthic communities in the vicinity of these subsea structures. The volume of organic input to the adjacent benthos from the fouling community and their effects will be mediated by ambient currents and near bottom oceanographic conditions. Effects on the benthic community from this periodic sloughing will range from beneficial (i.e., organic food sources) to negligible negative (i.e., burial).

Discharges

Routine discharges (e.g., produced water, sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from the FPSO and support vessels will have no impact on benthic communities within the Pipeline Area due to water depth and rapid dilution of these discharges in surface waters. CSA Ocean Sciences Inc. (2016) conducted a monitoring study to assess the effects of development activities including FPSO discharge of produced water on the deepwater marine environment; findings of the study indicated elevated sediment mercury and hydrocarbon levels may be influenced by produced water discharges. These finding were not definitive concerning the source of elevated sediment mercury and hydrocarbons levels since there were multiple potential sources that included produced water and exploration and development drilling. However, the study did not detect any change in benthic community structure due to these elevated sediment sampling parameters (CSA Ocean Sciences Inc., 2016).

Neff et al., (2011) provides a review of produced water in the marine environment specific to composition, fate, and effects. General consensus concerning potential toxicity of produced water discharges are associated with aromatic hydrocarbons, some alkylphenols, and a few metals. Treated offshore produced water discharge points may range from above the sea surface to a water deep of 100 m. Primary factors affecting produced water dilution rates include rate and location of discharge, general oceanographic condition of the receiving environment, water depth, and density differential between the produced water and ambient seawater. Produced water dispersion modeling studies differ in specific details, but all predict a rapid initial dilution of discharges by 30- to 100-fold within the first few tens of meters of the outfall (Neff et al., 2011). Acute effects to the receiving environment from produced water discharges are not likely to occur beyond the immediate vicinity of the discharge pipe due to the effectiveness of natural dispersion (Neff et al., 2011) which supports the observation of no effects from produced water discharges to benthic communities during the CSA (2016) monitoring study.

Solid Waste

It is possible that debris may accidentally fall overboard during operational activities within the Pipeline Area. The impact will be similar as the one described in Section 7.3.5.2.1.

7.3.5.2.4 Support Operations Areas

No impacts to benthic communities are expected in the Support Operations Areas from physical presence, discharges or solid waste since these areas are on shore.

7.3.5.2.5 Summary

Impacts to benthic communities during the Operations Phase are minimal. No noise effects to benthic communities are expected due to the nature of the operation-related noise and general lack of documented effects from noise on benthic invertebrate. With the FPSO and all associated infrastructure in positioned and stable, there are few if any identifiable effects to benthic communities during the Operations Phase other than organic input from epibenthic community development, accidental loss of solid waste, and some anchoring of support vessels in the shallow-water areas. Exposed subsea structures will develop a biofouling community that will regularly slough off organic materials that could have an effect on benthic communities ranging from beneficial (i.e., organic food sources) to negligible negative (i.e., burial).

7.3.5.3 Impact Rating

Physical Presence

The consequence of impacts to benthic communities in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area from physical presence include crushing of benthos immediately below anchors of support vessels, and disturbance of benthic communities in close proximity to anchoring locations due to sediment resuspension and deposition. The presence of physical structure will also allow for production of organic material via epibiotal growth. The overall impact significance is 1 – Negligible (see Table 7-75 below for details on selected criteria).

Sloughed material from exposed subsea structures will provide an organic input and food source to benthic communities in the vicinity of these subsea structures; the addition of organic material will occur either by providing organic input in an organic limited zone (e.g., deep water), or by providing supplemental organic material in a productive ecosystem. Sloughed material will not be of sufficient quantity to produce hypoxic or anoxic conditions; consequently, this is considered a positive impact.

Discharges

Operational activities in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area will generate routine effluent discharges (produced water, sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from the FPSO, FLNG, and support vessels. These discharges are not expected to produce impacts to the benthic community since their influence, with the possible exception of the FPSO produced water, will be restricted to surface waters, with a very remote likelihood of reaching the seafloor. The overall impact significance is 1 – Negligible (see Table 7-75 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during operational activities may occur in the Offshore Area, Nearshore Hub/Terminal Area, or within the Pipeline Area. These accidental losses are expected to produce very localized impacts to the benthos via potential chemical leaching and possibly provide hard substrate for epibiota recruitment. The overall impact significance is 1 – Negligible (see Table 7-75 below for details on selected criteria).

Summary

A summary of impact to benthic communities from routine activities during the Operations Phase is presented in Table 7-75.

Table 7-75. Impacts to Benthic Communities during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Crushing of benthic communities below anchoring locations of support vessels; disturbance to benthic communities from resuspension and deposition of sediments.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 – Negligible
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Organic input and food source to benthic communities associated with sloughing associated with the exposed structures.	Not applicable	Not applicable	Not applicable	Positive
Discharges						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Effects of routine discharges from FPSO, FLNG, and support vessels; exposure of produced water discharge at FPSO.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term (exposure to produced water[111])	Negligible	Likely	1 – Negligible
Solid Waste						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Addition of hard substrate and potential leaching for accidental loss of solid waste from facilities and support vessels.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term to Long term	Negligible	Likely	1 – Negligible

7.3.5.4 Mitigation Measures and Residual Impacts

Impacts to benthic communities from Operations Phase activities are rated positive or negligible; no mitigation measures are required.

[111] Long term has been selected for the exposure of benthic communities to influences of produced water since it is a continuous process during the Operations Phase.

Summary of existing measures inherent to design and operational controls:

- D01: Contractors will be expected to comply with the contract terms that have been established, including HSSE standards and performance requirements
- D05: Compliance with applicable national and international regulations (MARPOL 73/78, Annex IV and V) for waste and waste water discharges from offshore project vessels.
- D06: A waste management plan will be developed and implemented to avoid unauthorized waste discharges and transfers, with written procedures for collection, segregation, storage, processing and disposal of waste, including use of equipment and record keeping.
- D34: LNG and condensate carriers are expected to discharge ballast water according to the IMO International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM).

7.3.6 Plankton & Fish and Other Fishery Resources

High Level Summary

In this section on Plankton & Fish and Other Fishery Resources, the impact of three impact producing factors, these being Physical presence, Discharges and Solid waste, was evaluated. The residual impacts on Plankton & Fish and Other Fishery Resources during the Operations Phase for routine activities were assessed as positive or as negative with a negligible significance when mitigation measures are applied.

7.3.6.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical Presence	•	•	•	
Discharges		•	•	
Solid Waste		•	•	

7.3.6.2 Impact Description

An overview of vessels and equipment used during the Operations Phase is provided in Section 2. Impact producing factors screened for plankton, fishes, and other fishery resources were physical presence, discharges, and solid waste. These impact-producing factors are discussed below for the Offshore Area, Nearshore Hub/Terminal, and the Pipeline Area.

7.3.6.2.1 Offshore Area

Physical Presence

During the Operations Phase, only the SPS will be physically present at the seafloor. Some demersal fishes will likely be attracted to these structures as has been observed on other deep-sea installations (e.g., Gates et al., 2017). Specifically, grenadiers, cusk-eels, cutthroat eels, and other deep-water fishes, some deep-water crabs, would be among the taxa attracted to the structures. None of these species would be of fishery importance as most of the deep trawling efforts occur in water depths of

700 m or less. There would be minimal effect on plankton in the near bottom environment of the offshore area. No lights, except for occasional Remotely Operated Vehicle operations, will be enhancing the attraction of plankton, fishes, or other fishery resources (squids).

Discharges

During operations, there will be only limited activity in the Offshore Area, primarily associated with well maintenance. Well maintenance may occur during normal drilling operations using the drillship; if well maintenance is required beyond the drilling windows, it will be conducted by a vessel similar to the drillship or by a dynamically positioned well service vessel. Support services would entail use of existing operational vessels and additional offshore vessels and helicopters, depending on the nature of the well work. Drilling operations which are scheduled to occur in the GTA Field after the Nearshore Hub/Terminal are commissioned have been addressed under assessment of the Construction Phase (see Section 7.2). Well maintenance vessels will discharge several different wastes, including sanitary and domestic wastes, food waste, and cooling water. Operations-related discharges in the Offshore Area will be diluted rapidly in the open ocean and are not likely to adversely affect plankton, fishes, and other fishery resources.

As stated above in Section 7.2.6.2.1, ballast water exchanges by support vessels entering the region from foreign waters will follow IMO (2004) guidelines to prevent introduction of invasive planktonic organisms.

Solid Waste

Operation of well maintenance vessels may result in the accidental loss of solid waste or debris. Buoyant materials will float and be transported by local currents; heavier items will sink to the seafloor. The occasional and unintentional loss of debris is not expected to affect plankton or fish and other fishery resources.

7.3.6.2.2 Nearshore Hub/Terminal

Physical Presence

The breakwater will act as an artificial reef, attracting pelagic and demersal fish species (e.g., Burt et al., 2013; Airoldi and Bulleri, 2011). Artificial reefs including oil and gas structures can cause fish to redistribute from natural habitats and provide novel habitat for invasive species (e.g., Airoldi and Bulleri, 2011), but can also contribute greatly to secondary production of fishes (Claisse et al., 2014). The breakwater will occupy 0.16 km^2 of the seafloor and extend vertically from the seafloor to the ocean surface. Because of the surface expression the FLNG and berthing area, the breakwater also will act as an FAD. As described in Section 7.2.6, artificial reefs attract demersal/reef species whereas FADs attract pelagic fishes and invertebrates. Pelagic species attracted to the breakwater structure will likely include sardines, anchovies, jack mackerels, skipjack tunas, dolphinfishes, jacks, sharks, and cephalopods. Demersal species attracted to the structure may include sea breams, croakers, drums, porgies, and some flatfishes. Adults and juveniles of demersal species may benefit from the presence of a three-dimensional habitat in an area otherwise devoid of such structure. This may be perceived as a benefit to structure-associated species where habitat is limiting or as an ecological trap where individuals are subjected to increased predation or competition within the breakwater structure. Because the entire structure will be excluded to fishermen, many of the associated fishes (and invertebrates) will be protected from harvest. This may be viewed as positive impact of the area; however, one of the benefits of protected areas is to protect spawning adults to ensure that adjacent areas are replenished to the level needed to maintain regional populations. As described below, spawning products will be at risk of entrainment into the cooling water intake system; thus, there may be a trade-off between the positive impact of protection versus the negative impact of entrainment. Lights on the breakwater and FLNG vessel will attract plankton as well as some fish and squid species (Hanlon et al., 1979; Keenan et al., 2007); some species may avoid lights altogether (Barker, 2016).

An FLNG running requires about 54,000 m^3 of seawater per hour for cooling under normal operations which results in a daily seawater intake of about 1,296,000 m^3. Impacts from cooling water intake on early life stages of fishes and invertebrates are usually described as impingement or entrainment (e.g., Barnthouse, 2013). Impingement is when organisms become forcibly trapped on the wire mesh screens (usually ~1 cm mesh) placed over intakes to prevent debris from entering the system. Impingement will injure or kill organisms trapped on the screens. Passively drifting plankton, including early life stages (eggs and larvae) of fishes and invertebrates are small enough (<1 cm) to pass through these screens become entrained into the cooling water system. Locally occurring zooplankton and ichthyoplankton (fish eggs and larvae) will be entrained with this cooling water and likely die within the water cooling system of the vessel. Appendix M provides calculations of proportional entrainment (plankton concentrations x intake volume) based on site-specific plankton samples.

To understand potential losses of fish eggs and larvae, samples were collected near the Nearshore Hub/Terminal Area in winter 2016 and summer 2017 (see Appendices D and M). Taxonomic composition and larval fish numbers varied between the two sampling years. Abundance of larvae in summer samples exceeded winter samples by more than tenfold. Mean numbers of larvae per 100 m^3 were 35.7 for winter and 564.5 for summer. Eggs per 100 m^3 averaged 33.3 in winter and 394.0 in summer. Proportional mortality was calculated by multiplying the density of fish larvae for various taxa in the samples by the daily cooling water intake volume (1,296,000 m^3). Winter entrainment estimates for *Sardinella aurita*, an important fishery species, was 16,935 individual larvae. Highest entrainment for winter samples, 263,047, was recorded for sciaenid (drum and croakers) larvae. Summertime daily entrainment of *Sardinella aurita* was 191,677 individual larvae and daily entrainment of *Sardinella* sp. (refers to larvae of the same genus which could not be identified to species) was estimated to be 440,010 individuals. The Atlantic Bumper (*Chloroscombrus chrysurus*) yielded the highest entrainment estimate from the summer samples at 2,807,382 larvae. One way to put these numbers into perspective is to realize the high fecundity of most marine fishes and invertebrates necessitates very high natural mortality of these young stages (Houde, 2008). Sources of natural mortality in early life stages are predation, starvation, and disease. Variable current patterns can greatly influence mortality (or survival) by transporting water masses into or out of areas with adequate prey or an overabundance of predators, or unfavorable environmental conditions (e.g., temperature, salinity, pH).

To estimate the effect of entrainment on fish eggs and larvae in the immediate project area, estimated numbers of eggs and larvae lost to entrainment were compared with the egg and larval “population” of a larger reference parcel of water (e.g., MacCall et al. 1983; Steinbeck et al., 2007). For this project, the reference parcel is a parcel of water likely to move by the intake during a 24-hour period given current speed and direction. The parcel was delineated using average current speed and direction for the general area based on regional oceanographic information (Appendix M). This resulted in a semi-circular area of 33.632×10^9 m^3. Proportion entrained was determined based on the following volumetric relationship:

1,296,000 m^3/33,632,241,641 m^3 = 0.0000385 or 0.004%.

This translates to the volume of water entrained in a single day divided by volume of water at risk of being drawn into the intake over a single day. In this case, the volumetric ratio actually serves as the estimate of entrainment loss because the estimates of plankton density in the source water and intake water were the same and cancel out of the equation relating the water volumes and larval concentrations. Undoubtedly, the parcel of water at risk will vary almost daily in this region and a more rigorous delineation of source water bodies could be developed for individual species and at different times of the year.

These analyses suggest that a very small percentage of the local plankton assemblage are at risk from entrainment. In addition, most ichthyoplankton, as well as the phyto- and zooplankton that larval fishes feed upon, are distributed widely, well beyond the calculated source water population from which the cooling water is drawn. For example, Arkhipov (2009) used ichthyoplankton data collected over Mauritania shelf waters from 1997 to 2008, to estimate standing stocks of eggs and larvae for several pelagic species between latitudes 16° and 21° N. Standing stock is an estimate of the total number of eggs or larvae (stocks) for a given area at a particular moment in time. The standing stock of *Sardinella aurita* eggs averaged 111.1×10^{10} eggs and ranged from 546.1×10^{10} eggs in June-July of 1998 to zero in December-January of 2005-2006. Standing stock of *S. aurita* larvae during the same period averaged 968.7×10^9 and ranged from 545.4×10^{10} in August 2001 to zero in June-July 1998. Standing stocks for other pelagic species including horse mackerels (*Trachurus* spp.) and flat sardine (*S. maderensis*) were of similar orders of magnitude. Egg and larval abundance, species composition, and richness will vary because of differences in spatial distribution, spawning times, larval durations, and multi-scale circulation patterns associated with the Canary Current Upwelling system (e.g., Zeeberg et al., 2008; Tiedemann et al., 2017; Thiaw et al., 2017). However, eggs and larvae from individual taxa with short planktonic durations or spawned very near the intake would be at much higher risk. Recent collections during summer of 2015 indicated that the area off Saint-Louis, near the Nearshore Hub/Terminal Area, can support high concentrations of sardine (*Sardinella*) eggs (Badji et al., 2017). Despite the highly dynamic nature of the regional circulation patterns, some areas along the coast predictably act to retain fish eggs and larvae most notably off Banc d'Arguin and south of Cape Vert (Mbaye et al., 2015; Tiedemann and Brehmer, 2017). Although not considered a retention zone, the area surrounding the Nearshore Hub/Terminal has been identified as one of several broad spawning areas for *Sardinella aurita* (Badji et al., 2017; Arkhipov, 2009).

Equipment noise could affect fishes and some invertebrates attracted to the breakwater by masking sounds related to mate recognition, feeding, or avoiding predators (Radford et al., 2014). Most fishes will habituate to such noise (Radford et al., 2016). Fishes residing at the breakwater would be more susceptible than transients to masking effects, but in either case population-level effects are not expected. Operational sounds are not expected to affect plankton.

Discharges

Discharges from the FLNG operations at the Nearshore Hub/Terminal will include cooling water, as well as ballast and bilge water, sewage and grey water, deck drainage, and desalination system discharge. Cooling water is discharged laterally and the temperature differential between effluent and ambient is reduced to within 3°C at the edge of the mixing zone as per IFC requirements. A mixing zone is an area where point discharges with elevated chemical and thermal components mix with ambient seawater. The portion nearest the discharge point is called the zone of initial dilution, its dimensions will depend on the physical and chemical properties of the discharge and receiving water. Generally outside the mixing zone, water quality parameters (including elevated temperature) must comply with regulatory standards (e.g., IFC). Although the effects increased temperature on planktonic organisms will ultimately be species-specific a change of 3º C is well within critical thermal maxima recorded for fish larvae (e.g., Moyano et al., 2017; Motani and Wainwright, 2015). The seawater cooling water discharge streams will contain a hypochlorite solution to control marine growth. Cooling water discharge concentrations from the FLNG will need to comply with the IFC discharge limits associated with chlorine of 0.2 ppm.

The FLNG desalination process will result in a discharge of seawater with an elevated salinity (depending on the desalination process used) and containing very low concentrations of hypochlorite. Brine and hypochlorite can be toxic to planktonic organisms in high concentrations but will dilute to ambient levels within the mixing zone. Fishes will likely avoid the discharges.

Solid Waste

Solid waste accidentally lost overboard at the Nearshore Hub/Terminal is not expected to affect plankton, fishes, and other fishery resources.

7.3.6.2.3 Pipeline Area

Physical Presence

Exposed portions of the pipeline and mounds of side cast material around the trench will attract demersal fishes, octopods, and some crabs. Individual species will vary with water depth. The FPSO will act as a large FAD attracting a variety of fishes and invertebrates. In water depths of the FPSO location, yellowfin tunas, skipjack tunas, billfishes, jacks, triggerfishes, chubs, sharks, and some squids will likely associate with the FPSO. These species may be diverted from normal migratory routes or feeding areas but the small area of habitat represented will not likely result in population level effects. Lights on the FPSO will attract plankton, larval fishes, and various invertebrates (crustaceans and squids). Spatial effects will be limited to the immediate area around the FPSO. An exclusionary zone around the FPSO may protect many of the fishes associated with surface and bottom-oriented structures from fishing pressure. This could reduce fishing mortality for some species, especially the small pelagics most of which are considered overfished (e.g., Ba et al., 2016). Some target species, particularly tunas and skipjack tunas, may stay as far as 9 km from a moored FAD and therefore may not be protected from fishing (USGS, 2002).

Cooling water intake by the operating FPSO will impinge and entrain early life stages of fishes and invertebrates as well as plankton as described above in Section 7.3.6.2.2. The amount of cooling water needed is in the order of 4.1 m^3 per hour, a mere fraction of the amount used by the FLNG. Impacts to fishes and other fishery resources are expected to be minimal when compared with other natural and fishing mortality (See Section 7.3.6.2.2 and Appendix M).

Operational noise will be generated by support vessels and the FPSO (see Section 2.12.5 for discussion of noise during the Operations Phase). Fishes will likely habituate to the operational noise.

Discharges

Effluents will be generated by the FPSO include treated produced water, cooling water, desalination brine, treated sewage, and deck drainages. For cooling water discharges, the temperature increase will be limited to 3°C at the edge of the mixing zone (see Section 7.3.6.2.2). Other effluent discharges will be regulated to conform to the listed parameters to meet applicable regulations and requirements. These discharges may temporarily affect plankton over a small area but are not expected to cause population level effects.

Per Neff et al. (2011), the causative agents of toxicity in produced water discharges are not well known. Toxic responses may be linked to the extremely high concentrations of total dissolved solids (salinity), altered ratios of major seawater ions, and elevated concentrations of ammonia in some produced waters (e.g., Gulf of Mexico – see Moffitt et al., 1992). Salinity and ion ratios quickly return to ambient levels following discharge to the open ocean; ammonia evaporates or degrades rapidly. These contaminants of concern within the produced water discharge stream rarely cause acute toxicity responses in the field. Projected levels of phenols in produced water discharges from the FPSO are 20 mg L^{-1}; the PNEC value for phenols is 7.7 µg L-1. To reach the PNEC threshold, a dilution factor of 2,600 would be required.

As stated above in Section 7.2.6.2.1, ballast water exchanges by support vessels entering the region from foreign waters will follow IMO (2004) guidelines to prevent introduction of invasive planktonic organisms.

Solid Waste

Solid waste may be lost from the FPSO or support vessels operating in the Pipeline Area. None of these are expected to result in impacts to fish and other fishery resources or plankton.

7.3.6.3 Impact Rating

Physical Presence

The consequence of impacts to plankton, fishes, and other fishery resources in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area from physical presence during the Operations Phase include attraction of fishes (artificial reef and FAD effect) to bottom-founded and surface structures provided by the SPS, FPSO, and the breakwater. Attraction of fishes to the structures would redistribute them from natural habitats or disrupt natural migratory routes for individuals of some species. Exclusionary zones around the Nearshore Hub/Terminal and FPSO would protect assemblages of several species from fishery exploitation. This would represent a positive impact when tempered against the entrainment impacts described below. The overall impact significance is 1 – Negligible (see Table 7-76 below for details on selected criteria).

The losses of fish eggs and larvae and adult fish associated with entrainment and impingement in the Nearshore Hub/Terminal and pipeline (FPSO) Areas during the Operations Phase are expected to affect only a very small percentage of plankton but the potential for concentrating spawning adults of some small pelagic and demersal taxa near the structure should be considered. The overall impact significance is 2 – Low.

Discharges

Routine discharges from operational activities in the Nearshore Hub/Terminal Area and Pipeline Area are expected to produce very localized impacts through the introduction of organics (sanitary and domestic wastes; food waste) and warm water (cooling water); these impacts will be restricted to surface waters and may affect plankton over a small area around the discharge. The overall impact significance is 1 – Negligible (see Table 7-76 below for details on selected criteria).

Cooling water discharges from during operations will be limited to the Pipeline/FPSO and Nearshore Hub/Terminal. Discharged water will reach a differential of 3°C near the edge of the mixing zone (see Section 7.3.6.2.2). The overall impact significance is 1 – Negligible (see Table 7-76 below for details on selected criteria).

Support vessels entering the project area from international waters (e.g., Indian or Pacific Oceans) could introduce non-native planktonic organisms when discharging ballast water. Support vessels arriving from foreign waters will comply with international guidelines (IMO, 2004) specifically to prevent introduction of invasive species. The overall impact significance is 1 – Negligible.

Solid Waste

The accidental loss of debris overboard may occur in the Nearshore Hub/Terminal Area or within the Pipeline Area. Due to the small size of these items, accidental losses are expected to cause minimal or no impacts to plankton, fishes or other fishery resources. The overall impact significance is 1 – Negligible (see Table 7-76 below for details on selected criteria).

A summary of impact to plankton, fish and other fisheries resources from routine activities during the Operations Phase is presented in Table 7-76.

Table 7-76. Impacts to Plankton & Fish and Other Fishery Resources during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Attraction of fishes to SPS, FPSO and Breakwater structures.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 – Negligible
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Entrainment and impingement of plankton and adult fish in FLNG cooling water at Nearshore Hub/Terminal. Entrainment and impingement of plankton and adult fish by FPSO.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Long term	Minor	Likely	2 – Low
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Protection from fishing pressure of some fishes and invertebrates species attracted to the project infrastructures where the exclusion safety zones will be applied.	Not applicable	Not applicable	Not applicable	Positive
Discharges						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Effects of routine vessel discharges (including ballast water) and cooling water discharges during operations.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Remote	1 – Negligible
Solid Waste						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Addition of hard substrate and potential leaching for accidental loss of solid waste from support vessels.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 – Negligible

7.3.6.4 Mitigation Measures and Residual Impacts

For negligible impacts to plankton and fish and other fishery resources, no mitigation measures are recommended. Summary of existing measures inherent to design and operational controls:

- D01: Contractors will be expected to comply with the contract terms that have been established, including HSSE standards and performance requirements.
- D05: Compliance with applicable national and international regulations (MARPOL 73/78, Annex IV and V) for waste and waste water discharges from offshore project vessels.
- D06: A waste management plan will be developed and implemented to avoid unauthorized waste discharges and transfers, with written procedures for collection, segregation, storage, processing and disposal of waste, including use of equipment and record keeping.
- D34: LNG and condensate carriers are expected to discharge ballast water according to the IMO International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM).

Impacts with a significance rating over 1 are reported below (Table 7-77) and potential applicable mitigation measures are identified. For impacts associated with high seawater demands at the FLNG and associated plankton losses via entrainment, some design modifications may help lessen the extent of entrainment at the Nearshore Hub/ Terminal Area. Although site-specific sampling found few significant differences in the total egg and larval abundances between 10 m depth strata, the seawater intake should be placed lower in the water column to lessen the entrainment of positively buoyant fish eggs. Modifications to the cooling water intake using velocity caps or wedgewire screens should be considered as a measure to reduce entrainment and impingement of larvae and adult fish (e.g., EPRI, 2007; Weisberg et al., 1987) These technologies are not new but have not been widely used in offshore settings. Impingement effects may be reduced by modifying mesh size on cooling water intake screens and maintaining the intake velocity below 1.0 m^{-sec}.

Table 7-77. Mitigation Measures to Avoid or Reduce Impacts to Plankton & Fish and Other Fishery Resources from Routine Activities during the Operations Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Entrainment and impingement of plankton and adult fish in FLNG cooling water at Nearshore Hub/Terminal. Entrainment and impingement of plankton and adult fish by FPSO	2 – Low	M42	1 – Negligible

Notes:

M42: The seawater intake of the cooling water systems will be positioned taking into account technical constraints and appropriate screens or velocity caps will be fitted, if safe and practical, with the intent of avoiding entrainment and impingement of marine flora and fauna. The intake velocity will be below 1.0 m/s.

7.3.7 Marine Flora

High Level Summary

In this section on Marine Flora, the impact of three impact producing factors, these being Physical presence, Discharges and Solid waste, was evaluated. All impacts on Marine Flora during the Operations Phase for routine activities were assessed as positive or as negative with a negligible significance. No mitigation measures were required.

7.3.7.1 Impact Producing Factors and Project Areas

The IPFs identified for marine flora resources during the Operations Phase in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Discharges		●	●	
Solid waste		●	●	

7.3.7.2 Impact Description

The following subsections explain how these IPFs will potentially produce impacts in each of the project areas.

7.3.7.2.1 Offshore Area

Due to local water depth of the Offshore Area (approximately 2,700 to 2,800 m) and the attenuation of ambient light with depth, the seafloor within the Offshore Area is aphotic and does not support marine flora. There are no project-related impacts to marine flora in this area.

7.3.7.2.2 Nearshore Hub/Terminal Area

Physical Presence

Macroalgal communities are expected to thrive on exposed hard substrate (e.g., breakwater, caissons, and pilings) associated with the Nearshore Hub/Terminal. Therefore, these structures will locally enhance marine flora populations. Invasive marine algal and plant species may be transferred to the Nearshore Hub/Terminal from project-related vessels. The two logical pathways for introduction of non-indigenous algae and plants include vessel ballast water and vessel hulls (biofouling).

Noise is not an impact producing factor for marine plants and, therefore, is not discussed in this analysis.

Discharges

Routine discharges from operations vessels within the Nearshore Hub / Terminal Area include sanitary and domestic wastes, food waste, deck drainage, cooling water, etc. Routine discharges from operations vessels operating at the Nearshore Hub/Terminal are not expected to negatively impact local marine flora due to rapid dilution of these discharge in surface waters, similar to discharge-related impacts in offshore waters.

Solid Waste

It is possible that debris may accidentally fall overboard during operations activities at the Nearshore Hub/Terminal. The impact to marine flora will be similar to that described in Section 7.2.7.2.3.

7.3.7.2.3 Pipeline Area

The production flowline will be trenched from nearshore to 800 m water depth; therefore, marine flora will not be present within the Pipeline Area. However, macroalgal communities are expected to thrive on areas of the FPSO and associate equipment within photic water depths. Therefore, these structures will locally enhance marine flora populations.

Noise is not an impact producing factor for marine plants and, therefore, is not discussed in this analysis.

Discharges

Routine discharges from the FPSO and support vessels within the Pipeline Area include sanitary and domestic wastes, food waste, deck drainage, cooling water, etc. Routine discharges from these vessels during operations are not expected to negatively impact local marine flora due to rapid dilution of these discharge in surface waters, similar to discharge-related impacts in offshore waters.

Solid Waste

It is possible that debris may accidentally fall overboard during FPSO operations. The impact to marine flora will be similar to that described in Section 7.2.7.2.3.

7.3.7.2.4 Support Operations Areas

Macroalgal communities are expected to thrive on exposed hard substrate (e.g., access trestle, quay/jetty, and breakwater) associated with the project related vessel operations near the Supply Base. Therefore, these structures will locally enhance marine flora populations. Invasive marine algal and plant species may be transferred to port and vessel operations facility near the shore base from project-related supply and service vessels. The two logical pathways for introduction of non-indigenous algae and plants include vessel ballast water and vessel hulls (biofouling).

Noise is not an impact producing factor for marine plants and, therefore, is not discussed in this analysis.

Discharges

Not Applicable.

Solid Waste

It is possible that debris may accidentally fall overboard during operations activities at docking facilities adjacent to the Supply Base. The impact to marine flora will be similar to that described in Section 7.2.7.2.3.

7.3.7.3 Impact Rating

Physical Presence

Marine flora are not present within the Offshore Area or the Pipeline Area. There are no impacts to marine flora expected within these areas. The consequence of impacts to marine flora at the FPSO, Nearshore Hub/Terminal Area, and new docking facilities associated with the Support Operations Areas from physical presence include habitat enhancement and community enrichment on infrastructure. Infrastructure will include the FPSO and associated equipment, Nearshore Hub/Terminal (i.e., breakwater, pilings) and shore side construction for dockage of vessels.

As discussed in Section 7.2.7.2.3, project vessels from other areas may introduce non-indigenous algae and plants to structures and seafloor within the photic zone of the project area. The likelihood of this potential impact is remote, but clearing of ballast tanks and biofouling from vessel hulls before bringing these vessels into the project area would greatly reduce any possibility for the introduction of non-indigenous marine flora.

The overall impact significance is Positive (see Table 7-78 below for details on selected criteria).

Discharges

Routine, non-drilling related discharges from operations at the FPSO, and within the Nearshore Hub/Terminal Area are expected to produce very localized impacts through the introduction of organics (sanitary and domestic wastes; food waste) and warm water (cooling water). These impacts will be restricted to surface waters, with a very remote likelihood of reaching the seafloor in shallow, photic zone areas and impact associated marine flora communities. The overall impact significance is 1 – Negligible (see Table 7-78 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during operations activities may occur in the Offshore Area, Pipeline Area, or Nearshore Hub/Terminal Area. These accidental losses are expected to be minimal but may produce very localized impacts to marine flora via potential chemical leaching. The overall impact significance is 1 – Negligible (see Table 7-78 below for details on selected criteria).

Table 7-78. Impacts to Marine Flora Communities during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline; Support Operations	Introduction of hard substrate in areas of unconsolidated sediments.	Not applicable	Not applicable	Not applicable	Positive
Discharges						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Effects of routine vessel discharges during operations reaching seafloor and infrastructure marine flora communities.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Remote	1 – Negligible
Solid Waste						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Addition of hard substrate and potential leaching for accidental loss of solid waste from operations vessels.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 – Negligible

7.3.7.4 Mitigation Measures and Residual Impacts

Impacts being rated positive or negligible, no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D01: Contractors will be expected to comply with the contract terms that have been established, including HSSE standards and performance requirements.
- D06: A waste management plan will be developed and implemented to avoid unauthorized waste discharges and transfers, with written procedures for collection, segregation, storage, processing and disposal of waste, including use of equipment and record keeping.
- D34: LNG and condensate carriers are expected to discharge ballast water according to the IMO International Convention for the Control and Management of Ships’ Ballast Water and Sediments (BWM).

7.3.8 Birds

High Level Summary

In this section on Birds, the impact of five impact producing factors, these being Physical presence, Vessel movements, Discharges, Solid waste and Helicopter traffic, was evaluated. The residual impacts on Birds during the Operations Phase for routine activities were assessed as of negligible or low significance when mitigation measures are applied.

7.3.8.1 Impact Producing Factors and Project Areas

The IPFs identified for bird resources in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	●
Vessel movements	●	●	●	●
Discharges	●	●	●	
Solid waste	●	●	●	●
Helicopter traffic		●		●

7.3.8.2 Impact Description

The Operations Phase of the project comprises the operation of the SPS, FPSO and FLNG; the use of supply and support vessels as well as tugboats to support operations; the export of LNG and condensate via LNGC and condensate tankers, respectively; well maintenance; pipeline and flowlines pigging; and maintenance operations for the vessels and facilities. The following subsections explain how these IPFs will potentially produce impacts in each of the project areas.

7.3.8.2.1 Offshore Area

The Operations Phase within the Offshore Area will include only activities associated with the wells and SPS, including possible well maintenance operations. These structures are near or on the seafloor and routine operations will not impact birds in the region.

The presence of well maintenance vessels on an infrequent basis will produce impacts similar to those noted below for support vessels operating in the Nearshore Hub/Terminal and Pipeline Areas – physical presence, vessel movements, discharges, and solid waste. No helicopter traffic is expected in the Offshore Area during operations.

7.3.8.2.2 Nearshore Hub/Terminal Area

Physical Presence

Physical disturbance of activities at the Nearshore Hub/Terminal may disturb marine birds. Birds are attracted to offshore structures (as well as support vessels) as roosting sites (Baird, 1990; Russell, 2005; Tasker et al., 1986), foraging opportunities (Burke et al., 2005; Ortego, 1978; Tasker et al., 1986), and due to disorientation by and attraction to light sources (Hope Jones, 1980; Montevecchi, 2006; Sage, 1979), as summarized by Ronconi et al. (2015). Physical disturbance and noise generated during LNG processing aboard the FLNG may also disturb birds on or near the Nearshore Hub/Terminal. Flaring from the FLNG is proposed only during non-routine conditions. It is possible that terrestrial migrant birds or seabirds may be incinerated following their attraction to and disorientation from an active gas flaring event. Information on mortality rates associated with collision and incineration of seabirds remains uncertain (Ronconi et al., 2015). Flaring at this location is only expected to occur during non-routine conditions; however, some mortality of birds associated with flaring cannot be ruled out.

While naturally occuring coastal erosion may affect the availability of nesting sites within coastal habitats, no impacts from breakwater presence are expected.

Vessel Movements

Vessel disturbances to birds from physical presence are discussed in Section 7.2.8. It is anticipated that movement of tugs and other support vessels, and LNGCs may result in behavioral disturbances of birds including marine birds, and coastal and terrestrial bird species that may transit to the Nearshore Hub/Terminal. It is expected that these disturbances will be short term. There are expected to be multiple vessel operations at the Nearshore Hub/Terminal, including, visiting LNGCs and other support vessels (e.g., tugs, support vessels). The transit of these vessels near the terminal may startle and temporarily displace coastal and marine birds, although it is anticipated that these disturbances are not significant to local bird populations.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from operations vessels within the Nearshore Hub/Terminal are similar to those discussed for construction activities in the Offshore Area (Section 7.2.8). Within the open ocean environment, discharged fluids will rapidly disperse and dilute in local currents. Solid material will likely descend through the water column and disperse in subsurface currents. Therefore, it is not likely that marine birds will encounter or be significantly affected by discharged materials from operations and Operations Phase vessels, either directly or indirectly through the effects to prey (local fish populations).

Operations at the Nearshore Hub/Terminal will also include the discharge of high volumes of cooling water. Cooling water is discharged laterally and the temperature differential between effluent and ambient is reduced to within 3°C at the edge of the mixing zone, per IFC requirements. The seawater cooling water discharge streams will contain a hypochlorite solution to control marine growth. Cooling water discharge concentrations from the FLNG will need to comply with the IFC discharge limits associated with chlorine of 0.2 ppm. It is not likely that marine birds will directly encounter or be significantly affected by the produced water discharge.

Solid Waste

Potential impacts to birds from solid debris in offshore waters are discussed Section 7.2.8. All vessels associated with Operations Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

7.3.8.2.3 Pipeline Area

Physical Presence

The physical presence of the FPSO and support vessels within the Pipeline Area that are associated with the Operations Phase of the project may result in vessel strikes with individual birds, or may disturb or attract individual birds or groups of birds. Flaring may occur at the FPSO during operations during abnormal conditions or emergencies. As discussed in Section 7.2.8.2.1, some seabird species are commonly attracted to offshore structures and vessels, and bird mortality has been documented as a result of light-induced attraction and subsequent collision with vessels or structures. Nonetheless, there is a very low potential for bird collision since the proposed vessels will be stationary (FPSO) or will move relatively slowly.

Birds may also be attracted to stationary vessels, structures, and moving vessels as a foraging strategy, and stationary vessels such as the FPSO may function as FADs and so may attract various pelagic fish and squid species, as well as provide a safe platform for resting or roosting birds that forage on these pelagic resources. Moving vessels (or stationary vessels using DP equipment) may injure or kill pelagic fish from contact with the moving hull or propellers. Therefore, ship-following by marine birds is a common behavior. Given the low potential for collision or gear entanglement, any impacts from attraction to stationary or moving vessels are not expected to result in mortality or serious injury to individual birds. Flaring from the FPSO is proposed only during abnormal conditions or emergencies. As discussed above, it is possible that terrestrial migrant birds or seabirds may be incinerated following their attraction to and disorientation from an active gas flaring event. It is also possible that start up flaring at the FPSO will occur but will be limited to a short time period. Other flaring at this location is only expected to occur during emergencies. Some mortality of birds associated with flaring cannot be ruled out.

Vessel Movements

Some project vessels may also disturb individual or groups of marine birds; however, it is anticipated that these disturbances would consist of short-term displacement of individuals away from the vessel or vessel aggregations. No significant impacts to these birds are expected.

As discussed in Section 7.2.8, vessels associated with operations within the Pipeline Area would generate sound that could disturb marine birds. Some marine birds (such as petrels, shearwaters, and gulls) either rest on the water surface, skim the water surface, or shallow-dive for only short durations and would be exposed to sound from vessel movement; contact would be for such a short time that it would result in little disruption of behavioral patterns or other non-injurious effects. Diving seabirds including some terns, pelicans, and gannets) may be more susceptible to underwater sound generated from operations vessels.

Discharges

Impacts from routine discharges from the FPSO and support vessels will be similar to those noted for construction activities within the Pipeline Area as discussed in Section 7.2.8. Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in subsurface currents. Therefore, it is not likely that marine birds will encounter discharged materials from vessels within the Pipeline Area during operations.

FPSO discharges will also include treated produced water, cooling water, and desalination brine. All effluent discharges will be regulated to conform to the listed parameters to meet applicable regulations and requirements. These FPSO discharges will be diluted in receiving waters and are will not affect marine birds.

Solid Waste

Potential impacts to birds from solid debris in offshore waters are discussed Section 7.2.8. All vessels associated with operations activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

Helicopter Traffic

Potential impacts to marine and coastal birds from aircraft traffic include disturbances from physical presence and collision. Sound generated by project-related helicopters that are directly relevant to birds are discussed above in Section 7.2.8. During the Operations Phase within the Pipeline Area, helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the FPSO).

7.3.8.2.4 Support Operations Areas

Physical Presence

Operations activities at the Support Operations Areas may disturb birds within both coastal and inshore (terrestrial) habitats in proximity to the supply base. The potential impacts to birds from supply base operations are difficult to assess, as many species or individuals of species may become more accustomed to the presence of the fixed base structures and activities. The supply base will support the arrival and departure of project support vessels and will support loading/offloading supplies and equipment being transported to and from the FPSO and the Nearshore Hub/Terminal. In addition, other activities at the supply base (i.e., equipment and material storage, and maintenance) may disturb birds but these effects are not expected to be significant for local bird populations.

Vessel Movements

There are expected to be two or three personnel transfers per week by crew boat for the FPSO and the Nearshore Hub/Terminal from the supply base and, the operation of the crew boat(s) may also occur on a nearly continuously basis. The transit of these vessels to and from the supply base may startle and temporarily displace coastal and marine birds, although it is anticipated that these disturbances are not significant to local bird populations.

In close proximity to Dakar and Nouakchott, the movements of support vessels will be coincident with other vessel traffic. As summarized in Sections 4.6.7.1 and 4.7.7.1, levels of maritime traffic at Dakar and Nouakchott are characterized as moderate and high, respectively. The addition of project vessel traffic should not present as novel; local bird populations are accustomed to significant levels of maritime traffic and only minor disturbances are expected.

Discharges

Routine discharges are not expected from facilities and vessels associated with supply bases. Therefore, no impacts from discharges to coastal and marine birds are expected.

Solid Waste

Potential impacts to birds from solid debris is discussed Section 7.2.8. All operations (supply base and crew boat) associated with operations activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage Therefore, the amount of trash and debris released in nearshore waters would be minimal and only accidental. In addition, the supply base and crew boats would implement a waste management plan that would include guidance for marine debris awareness. Impacts to coastal and marine birds from solid waste is not expected to be significant to local bird populations.

Helicopter Traffic

Helicopter traffic associated with the transfer of personnel to the FPSO and Nearshore Hub may affect local birds, including terrestrial species, and coastal and marine species. The potential effects of helicopters to birds are discussed in Section 7.2.8.1 and include physical presence (collisions and disturbances). Helicopter support will be based out of the airports in Dakar and/or Nouakchott. For the Operations Phase, helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the FPSO or QU Platform).

7.3.8.3 Impact Rating

Physical Presence

The consequence of impacts to birds in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, and the Support Operations Areas from physical presence include short-term behavioral alterations, short- and long-term displacement from (or attraction to) discrete operations areas disruptions in migrations and collisions with platforms (both potentially causing mortalities of individual birds), and foraging habitat loss or alteration immediately below nearshore infrastructure at the supply base. The impacts of offshore activities may affect marine bird species, whereas the impacts from operations at the supply base may also affect coastal and terrestrial bird species. The impact intensity is moderate and occurring within the immediate vicinity, but long term in duration, resulting in a minor consequence. Given the likely nature of this impact, overall impact significance is 2 – Low (see Table 7-79 below for details on selected criteria).

Some individual birds may be attracted to fixed structures and vessels in offshore waters. The overall impact significance in these cases is 1 – Negligible.

Flaring from the FPSO and FLNG is predicted only during abnormal conditions or in emergencies. Flaring from these sources may incinerate some terrestrial migrant birds or seabirds that are attracted to or disoriented by the flare. The numbers of mortalities are uncertain, but it is not expected to cause population level effects. Impact intensity is moderate and will occur in the immediate vicinity, and the effects are short term, resulting in a minor impact significance. The likelihood of this impact during the Operations Phase is occasional. Therefore, the overall impact significance is 2 – Low.

Vessel Movements

Vessel movements in any of the project areas during operations may result in vessel strikes with individual birds or may disturb or attract individual birds or groups of birds. Bird mortality has been documented as a result of light-induced attraction and subsequent collision with vessels or structures. Marine birds that occur within the project area and exhibit this behavior are typically petrels, with bird strikes typically occurring at night and occasionally resulting in mortality. Vessels are expected to have down-shielded lighting, where practical, to minimize the potential attraction of birds. Nonetheless, there is a rare likelihood for bird collision since the proposed vessels will be stationary or will move relatively slowly. Therefore, impacts from bird collisions on a vessel are not expected to be significant to either individual birds or their populations. The impact intensity is low and local, and the duration is long term. The impact consequence is therefore minor. The likelihood of this impact is likely; therefore the impact significance is 2 – Low (see Table 7-79 below for details on selected criteria).

Discharges

Routine discharges from operations activities in the Pipeline Area, Nearshore Hub/Terminal Area, and the Support Operations Areas are expected to produce very localized impacts through the introduction of organics (sanitary and domestic wastes; food waste) and warm water (cooling water); these impacts will be restricted to surface waters. High volume discharges (cooling water at the FLNG; produced water discharges at the FPSO) will be diluted to below regulatory limits within the mixing zone. The volumes and frequency of these discharges are not expected to significantly impact birds or their prey items, such as fishes and benthic organisms (in nearshore waters). The impact intensity is low and local, and the duration is long term. The impact consequence is therefore minor. The likelihood of this impact is likely; therefore the impact significance is 2 – Low (see Table 7-79 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during operations activities may occur in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, or within the Support Operations Areas. These accidental losses are expected to be minimal but may produce very localized impacts to marine and coastal birds via ingestion of small particles (plastic) or entanglement in debris. It may result in mortality of individual birds; impacts to local population is expected to be low and local. The likelihood of these events (release of solid debris and ingestion or entanglement) is rare; therefore, the overall impact significance to local bird communities is 1 – Negligible (see Table 7-79 below for details on selected criteria).

Helicopter Traffic

Potential impacts to marine and coastal birds from aircraft traffic include disturbances physical presence, and collision. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the FPSO or QU Platform). Based on this schedule and helicopter flight protocols, impact intensity to birds is expected to be low and local. The duration of the IPF is short term (infrequent), resulting in a negligible impact consequence. Given that the likelihood of this impact is occasional, the overall impact significance is 1 – Negligible (see Table 7-79 below for details on selected criteria).

Table 7-79. Impacts to Bird Communities during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Pipeline; Nearshore Hub/ Terminal; Support Operations	Avoidance or displacement from areas during routine operations for some species; Noise disturbances from operations at the FPSO, nearshore hub/terminal; and nearshore area adjacent to the supply base.	Nature: Negative Intensity: Moderate Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 – Negligible
	Pipeline; Nearshore Hub/ Terminal; Support Operations	Attraction to some individuals.	Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 – Negligible
	Pipeline; Nearshore Hub/ Terminal	Incineration of birds during flaring from the FPSO and FLNG during non-routine conditions.	Nature: Negative Intensity: Moderate Spatial Extent: Immediate vicinity Duration: Short term	Minor	Occasional	2 – Low
Vessel Movements						
Mauritania Senegal	Pipeline; Nearshore Hub/ Terminal; Support Operations	Potential vessel strike resulting in bird injury or mortality.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Long term	Minor	Likely	2 – Low
Discharges						
Mauritania Senegal	Pipeline; Nearshore Hub/ Terminal; Support Operations	Effects of routine vessel and facility discharges during operations impacting birds directly or indirectly.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Long term	Minor	Likely	2 – Low

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Solid Waste						
Mauritania Senegal	Pipeline; Nearshore Hub/ Terminal; Support Operations	Accidental release of solid waste from operations vessels resulting in impacts from ingestion by or entanglement of marine and coastal birds.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Rare	1 – Negligible
Helicopter Traffic						
Mauritania Senegal	Pipeline; Support Operations	Displacement and avoidance of helicopters near FPSO in offshore waters and when approaching heliports.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short-term (infrequent)	Negligible	Occasional	1 – Negligible

7.3.8.4 Mitigation Measures and Residual Impacts

For those impacts rated 1 - Negligible, no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D01: Contractors will be expected to comply with the contract terms that have been established, including HSSE standards and performance requirements.
- D05: Compliance with applicable national and international regulations (MARPOL 73/78, Annex IV and V) for waste and waste water discharges from offshore project vessels.
- D06: A waste management plan will be developed and implemented to avoid unauthorized waste discharges and transfers, with written procedures for collection, segregation, storage, processing and disposal of waste, including use of equipment and record keeping.
- D15: The FLNG and FPSO will be designed, constructed, and operated to avoid routine flaring[112].
- D16: Lighting will be reduced to the extent that worker safety and safe & secure operations is not compromised. Reduction of light may include avoiding use of unnecessary lighting, shading, and downward lighting where possible.
- D17: Development and implementation of a wildlife handling and rescue protocol for the FLNG and FPSO vessels and project patrol boats.
- D29: Develop and implement a flaring protocol with the intention to meet defined operational combustion performance.

[112] Routine flaring is defined in Section 7.3.1.

Impacts with a significance rating over 1 are reported below (Table 7-80) and potential applicable mitigation measures are identified.

Table 7-80. Mitigation Measures to Avoid or Reduce Impacts to Birds from Routine Activities during the Operations Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Incineration of birds during flaring from the FPSO and FLNG during non-routine conditions.	2 – Low	None	2 – Low
Potential vessel strike resulting in bird injury or mortality.	2 – Low	None	2 – Low
Effects of routine vessel and facility discharges during operations impacting birds directly or indirectly.	2 – Low	M33, M35, M36, M37, M38, M39	1 – Negligible

Notes:

M33: Monitoring use of added chemicals to produced water stream (corrosion inhibitors, scale inhibitors, coagulants/flocculants).

M35: The seawater intake depth at the FPSO will be designed with the intent to reduce the need for use of antifoulant chemicals.

M36: Free chlorine in FLNG cooling water discharges to be sampled at point of discharge will be maintained below 0.2 parts per million (ppm).

M37: Produced water will be treated prior to discharge with sufficient treatment. Oil and grease content of the produced water effluent discharge at sea will be compliant with applicable regulation and not exceed 42 mg/L daily maximum; 29 mg/L monthly average.

M38: Produced water effluent quality will be monitored. The first 18 months of monitoring data will be used to assess the likely impacts of the effluent upon the receiving water body using an Environmental Risk Assessment approach, which is to be repeated following a material change in effluent composition or volume.

M39: The discharge of cooling water will be designed to reduce recirculation.

7.3.9 Marine Mammals

High Level Summary

In this section on Marine Mammals, the impact of five impact producing factors, these being Physical presence, Vessel movements, Discharges, Solid waste and Helicopter traffic, was evaluated. The residual impacts on Marine Mammals during the Operations Phase for routine activities were assessed as of negligible or low significance when mitigation measures are applied.

7.3.9.1 Impact Producing Factors and Project Areas

The IPFs identified for marine mammal in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Vessel movements	●	●	●	●
Discharges	●	●	●	
Solid waste	●	●	●	●
Helicopter traffic		●	●	

7.3.9.2 Impact Description

The following subsections explain how these IPFs will potentially produce impacts in each of the project areas.

7.3.9.2.1 Offshore Area

Vessel Movements

Impacts to marine mammals from support (well maintenance) vessels include the potential for vessel strike with individual mammals. Potential impacts to marine mammals from vessel strike are discussed in Section 7.2.9.2.1. It is likely that a collision with a moving vessel would result in the mortality of the stricken whale or dolphin. However, most of the project-related vessel traffic is expected to travel at slow speeds.

Discharges

Routine discharges from well maintenance vessels within the Offshore Area include sanitary and domestic wastes, food waste, deck drainage, cooling water, etc. Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in subsurface currents. Therefore, it is not likely that marine mammals will encounter discharged materials from well maintenance vessels within the Offshore Area.

Solid Waste

Solid waste, also termed marine debris is discussed in Section 7.2.9.2.1. Marine debris poses two types of potentially negative impacts to marine biota, including marine mammals: 1) entanglement, and 2) ingestion. All vessels associated with Operations Phase activities will comply with MARPOL 73/78. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

7.3.9.2.2 Nearshore Hub/Terminal Area

Physical Presence

Potential physical disturbance and noise generated activities at the Nearshore Hub/Terminal Area may adversely affect marine mammals. At the FLNG during normal operations, underwater sound arising from the FLNG vessel is expected to be dominated by sound from onboard machinery (including power generation, compressors and pumps located within the hull) and topside process equipment (including compressors, turbines and motors). Sound from the FLNG can be expected to be continuous, at levels estimated to range between 140 and 190 dB (re 1 µPa @ 1 m) SPL, with most energy in the low frequency bands. As discussed in Section 7.2.9.2.1, marine mammal species, may be vulnerable to disturbance from noise.

Vessel Movements

Potential vessel collisions with vessel traffic operating within the Nearshore Hub/Terminal Area may adversely affect marine mammals. As discussed in Section 7.2.9.2.1, marine mammal species, particularly large whales and deep-diving species, may be vulnerable to collisions (ship strike) with moving vessels. Generally, it is assumed that the probability of this encounter, and thus impact, is very low. Certain cetacean species, including dolphin species (e.g., *Tursiops truncatus* and *Stenella* spp.), actively approach vessels moving at speed to swim within the pressure wave produced by the vessel's bow.

Most of the project-related vessel traffic (support vessels and LNGC) associated with Operations Phase activities at the Nearshore Terminal/Hub will travel at relatively slow speeds. However, crew boat traffic associated with the project is expected to operate at much higher speeds that construction and supply vessel traffic, and operations may occur during both day and night. Therefore, the chance for collisions between crew boats and marine mammals is higher than other vessels.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from operations vessels within the Nearshore Terminal/Hub are similar to those discussed for the pipeline area (Section 7.2.9.2.2). Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in subsurface currents. High volumes of cooling water will also be discharged. It is not likely that marine mammals will be affected by discharged materials from Operations Phase vessels or the Nearshore Hub/Terminal facilities.

Cooling water discharges from the FLNG will be discharged laterally and the temperature differential between effluent and ambient is reduced to within 3°C at the edge of the mixing zone. The seawater cooling water discharge streams will contain a hypochlorite solution to control marine growth. It is not likely that marine mammals will encounter or be affected by the thermal discharge.

Solid Waste

Potential impacts to marine mammals from solid debris in offshore waters is discussed Section 7.2.9.2.1. All vessels associated with Operations Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

Helicopter Traffic

Potential impacts to marine mammals from aircraft traffic include disturbances from noise and physical presence, and collision. Sound generated by project-related helicopters that are directly relevant to marine mammals are discussed above in Section 7.2.9.2.1. Helicopter personnel transfer is only expected at the QU Platform.

7.3.9.2.3 Pipeline Area

Physical Presence

The Operations Phase within the Pipeline Area will include the presence of the FPSO.

As discussed in Section 7.2.9.2.1, marine mammal species may be sensitive to noise from the FPSO. Operations activities would generate equipment sound that could disturb marine mammals. Broadband source levels for equipment will be within the audible range for all cetacean species and, near the source, exceed current NMFS threshold for non-injurious harassment by continuous sound sources (NMFS, 2016). Within the open ocean environment, it is assumed that marine mammals would avoid vessel noise at injurious levels. Therefore, it is conservative to assume that sound associated with operations vessels may, in some cases, elicit behavioral changes in individual marine mammals that are in close proximity.

Vessel Movements

The Operations Phase within the Pipeline Area will include the presence of the FPSO and support vessels. Impacts to marine mammals from these vessels include the potential for vessel strike with individual mammals. As discussed in Section 7.2.9.2.1, marine mammal species, particularly large whales and deep-diving species, may be vulnerable to collisions (ship strike) with moving vessels. Generally, it is assumed that the probability of this encounter, and thus impact, is very low. Certain cetacean species, including dolphin species (e.g., *Tursiops truncatus* and *Stenella* spp.), actively approach vessels moving at speed to swim within the pressure wave produced by the vessel's bow. Most of the project-related vessel traffic associated with Pipeline Area operations will travel at relatively slow speeds. However, crew boat traffic between the FPSO, FLNG, Nearshore Hub/Terminal, and the shore base facility is expected to operate at much higher speeds than supply vessel traffic, and operations may occur during both day and night. Therefore, the chance for collisions between crew boats and marine mammals is higher than other vessels.

Discharges

Routine discharges from operations vessels within the pipeline area are discussed in Section 7.2.9.2.1. Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in subsurface currents. Therefore, it is not likely that marine mammals will encounter discharged materials from vessels within the pipeline area during the Operations Phase.

Releases of produced water will contain naturally occurring substances and production chemicals (e.g., corrosion inhibitor; BTEX compounds; chemical flocculants, etc.; see Appendix K-2). The dispersion of the produced water plume is highly dependent upon ambient metocean conditions. Hydrocarbons within produced water discharges represent the organic compounds of greatest environmental concern (Neff, 2002); this concern is tempered by the results of degradation processes which effectively reduce produced water toxicity (Lee and Neff, 2011). Burns et al. (1999) indicate that dispersion and degradation processes are rapid. Marine mammals passing through the produced water plume are not expected to realize effects from chemical exposure.

Solid Waste

Potential impacts to marine mammals from solid debris in offshore waters are discussed Section 7.2.9.2.1. All vessels associated with Operations Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

Helicopter Traffic

Potential impacts to marine mammals from aircraft traffic include disturbances from physical presence. Sound generated by project-related helicopters that are directly relevant to marine mammals are discussed above in Section 7.2.9.2.1. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the FPSO).

7.3.9.2.4 Support Operations Areas

Vessel Movements

Impacts to marine mammals from vessels operating out of the Support Operations Areas include the potential for vessel strike with individual mammals. As discussed in Section 7.2.9.2.1, marine mammal species, particularly large whales and deep-diving species, may be vulnerable to collisions (ship strike) with moving vessels. Generally, it is assumed that the probability of this encounter, and thus impact, is very low. Certain cetacean species, including dolphin species (e.g., *Tursiops truncatus* and *Stenella* spp.), actively approach vessels moving at speed to swim within the pressure wave produced by the vessel's bow. Most of the project-related vessel traffic associated with operations in the Support Operations Areas will travel at relatively slow speeds. However, crew boat traffic associated with the project is expected to operate at much higher speeds than support vessel traffic, and operations may occur during both day and night. Therefore, the chance for collisions between crew boats and marine mammals is higher than other vessels.

Solid Waste

Potential impacts to marine mammals from solid debris is discussed Section 7.2.9.2.1. All operations (supply base and crew boat) associated with Operations Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage Therefore, the amount of trash and debris released in nearshore waters would be minimal and only accidental. In addition, the supply base and crew boats would implement a waste management plan that would include guidance for marine debris awareness. Impacts to marine mammals from solid waste is not expected to be significant to local populations.

7.3.9.3 Impact Rating

Physical Presence

The consequence of impacts to marine mammals in the Pipeline Area and Nearshore Hub/Terminal Area from physical presence of operations infrastructure include potential auditory injuries or impairment, short-term behavioral alterations, short- and long-term displacement from (or attraction to) discrete operations areas, and foraging habitat loss or alteration immediately below nearshore infrastructure at the supply base. Operations at the Nearshore Hub/Terminal will include noise from support vessels and the liquefaction of gas, and operations with the LNGC. These activities are expected to be limited to behavioral alterations; principally avoidance and displacement from the Nearshore Terminal/Hub Area. These impacts are expected to be local in nature, of low intensity, and long term; impact consequence is minor, given the likely nature of this impact, overall impact significance is 2 – Low (see Table 7-81 below for details on selected criteria).

Vessel Movements

Vessel collisions with marine mammals are possible but unlikely, based on normal operations vessel speeds. Exceptions may include the transiting of support vessels and crew boats out of the Support Operations Areas, where vessel speeds may be higher, or where night time transits may occur. In the event a marine mammal is stricken by a support vessel, impact intensity would be moderate, impact extent would be local, and impact duration would be long term. It is assumed that the likelihood of a vessel collision with a marine mammal within the project area is rare. Overall impact significance is 2 – Low (see Table 7-81 below for details on selected criteria).

Discharges

Routine, discharges from operation activities in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area are expected to produce very localized impacts through the introduction of organics (sanitary and domestic wastes; food waste) and warm water (cooling water); these impacts will be restricted to surface waters. Produced water discharges will also be limited to surface waters. The volumes and frequency of these discharges are not expected to impact marine mammal prey items, such as fishes. The overall impact significance is 1 – Negligible (see Table 7-81 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during operation activities may occur in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, or within the Support Operations Areas. These accidental losses are expected to be minimal but may produce impacts to marine mammals via ingestion of small particles (plastic) or entanglement in debris. The likelihood of these events (release of solid debris and ingestion or entanglement) is occasional; therefore, the overall impact significance to marine mammals is 1 – Negligible (see Table 7-81 below for details on selected criteria).

Helicopter Traffic

Potential impacts to marine mammals from aircraft traffic include disturbances from physical presence (overflights). Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the QU Platform). Based on this schedule and helicopter flight protocols, impacts to marine mammals are expected to be infrequent, short-term, and not severe to local populations. The overall impact significance is 1 – Negligible (see Table 7-81 below for details on selected criteria).

Table 7-81. Impacts to Marine Mammals during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Pipeline; Nearshore/ Hub Terminal;	Avoidance or displacement from FLNG or the FPSO; Noise disturbances from operations (liquefaction of LNG and transfer operations).	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Long term	Minor	Likely	2 – Low
Vessel Movements						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Potential vessel strike resulting in marine mammal injury or mortality.	Nature: Negative Intensity: Moderate Spatial Extent: Local Duration: Long term	Moderate	Rare	2 – Low
Discharges						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal	Direct and indirect effects of routine discharges during operations.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 – Negligible
Solid Waste						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Accidental release of solid waste from operations vessels resulting in impacts from ingestion by or entanglement of marine mammals.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Occasional	1 – Negligible
Helicopter Traffic						
Mauritania Senegal	Pipeline; Nearshore Hub/ Terminal	Displacement and avoidance of helicopters in offshore waters and when approaching heliports.	Nature: Negative Intensity: Low Spatial Extent: Immediate Vicinity Duration: Short-term (also infrequent)	Negligible	Likely	1 – Negligible

7.3.9.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-82) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the measures and controls already planned in the project design.

Table 7-82. Mitigation Measures to Avoid or Reduce Impacts to Marine Mammals from Routine Activities during the Operations Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Avoidance or displacement from vessel traffic or the FPSO; Noise disturbances from operations (liquefaction of LNG and transfer operations).	2 – Low	None	2 – Low
Potential vessel strike resulting in marine mammal injury or mortality.	2 – Low	M06	1 – Negligible

Notes:

M06: Vessel operators will implement vessel strike avoidance protocols to reduce the potential for vessel strike with marine mammals and sea turtles (including injured/dead protected species reporting).

7.3.10 Sea Turtles

High Level Summary

In this section on Sea Turtles, the impact of five impact producing factors, these being Physical presence, Vessel movements, Discharges, Solid waste and Helicopter traffic, was evaluated. The residual impacts on Sea Turtles during the Operations Phase for routine activities were assessed as of negligible or low significance when mitigation measures are applied.

7.3.10.1 Impact Producing Factors and Project Areas

The IPFs identified for sea turtles in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		•	•	
Vessel movements	•	•	•	•
Discharges	•	•	•	
Solid waste	•	•	•	•
Helicopter traffic		•		

7.3.10.2 Impact Description

The following subsections explain how these IPFs will potentially produce impacts in each of the project areas.

7.3.10.2.1 Offshore Area

Vessel Movements

The Operations Phase within the Offshore Area will be limited to well maintenance activities. Impacts to sea turtles from these vessels include the potential for vessel strike with individual turtles. As discussed in Section 7.2.10.2.1, sea turtle species may be vulnerable to collisions (ship strike) with moving vessels. Generally, it is assumed that the probability of this encounter, and thus impact, is possible but very low. Project-related vessel traffic associated with offshore area operations are expected to travel at relatively slow speeds.

Discharges

Routine discharges from well maintenance vessels within the Offshore Area include sanitary and domestic wastes, food waste, deck drainage, cooling water, etc. Within the open ocean environment, discharged fluids will rapidly disperse and dilute in local currents. Sea turtles are not expected to be attracted to maintenance vessels, and it is also likely that they will not approach a maintenance vessel's point of discharge. Therefore, assuming naturally rapid dispersion of discharged materials within the open ocean environment, it is not likely that sea turtles will come into contact with discharged materials from well maintenance vessels within the Offshore Area at concentrations and for a duration that poses a health risk.

Solid Waste

Solid waste, also termed marine debris, is discussed in Section 7.2.10.2.1. Marine debris poses two types of potentially negative impacts to marine biota, including sea turtles: 1) entanglement, and 2) ingestion. All vessels associated with Operations Phase activities will comply with MARPOL 73/78. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal; only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

7.3.10.2.2 Nearshore Hub/Terminal Area

Physical Presence

Physical disturbance by activities at the nearshore hub/terminal may impact sea turtles. While naturally occuring coastal erosion may affect the availability of suitable sea turtle nesting sites, no impacts from breakwater presence are expected.

Vessel Movements

The Operations Phase within the Nearshore Hub/Terminal Area will include the periodic visitation of the LNGC and support vessels by support vessels, including crew boats from the supply base. Impacts to sea turtles from these vessels include the potential for vessel strike with individual turtles. As discussed in Section 7.2.10.2.1, sea turtle species may be vulnerable to collisions (ship strike) with moving vessels. Generally, it is assumed that the probability of collisions with most operations vessels at the Nearshore Hub/Terminal Area is very low, based on their slow operational speeds. Crew boat traffic, however, is expected to operate at much greater speeds and may occur during the night; therefore, the possibility for collisions between crew boats and sea turtles are greater than other operations vessels.

Discharges

Routine discharges (e.g., treated sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from operations vessels within the Nearshore Terminal/Hub Area are similar to those discussed for the Offshore Area (Section 7.2.10.2.1). Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in subsurface currents. High volumes of cooling water will also be discharged from the FLNG. It is likely that sea turtles that are attracted to the Nearshore Hub/Terminal may occasionally encounter discharged waste. It is not assumed that these wastes will be concentrated on the seafloor or on the breakwater and other physical structures; rather, it is anticipated that most of the discharged fluids will be dispersed in the water column. Turtles may encounter elevated water temperature near the cooling water output at the FLNG, although it is expected that individual turtles will move away from areas of hot water. It is not likely that turtles will be affected by discharged materials from Operations Phase vessels or the Nearshore Hub/Terminal facilities, but, taking a conservative approach, it cannot be ruled out that exposure to these discharges may lead to some sublethal impacts.

Solid Waste

Potential impacts to sea turtles from solid debris in offshore waters are discussed Section 7.2.10.2.1. All vessels associated with Operations Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

Helicopter Traffic

Potential impacts to sea turtles from aircraft traffic include disturbances from physical presence. Noise generated by project-related helicopters that are directly relevant to marine mammals are discussed above in Section 7.2.9.2.1. Helicopter personnel transfer is only expected at the QU Platform.

7.3.10.2.3 Pipeline Area

Physical Presence

The Operations Phase within the Pipeline Area will include the presence of the FPSO and support vessels.

As discussed in Section 7.2.10.2.1, operations activities would generate sound that could disturb sea turtles. Within the open ocean environment, it is assumed that sea turtles would avoid sound levels from vessels at injurious levels. Therefore, it is conservative to assume that sound associated with operations vessels may, in some cases, elicit behavioral changes in individual turtles that are in close proximity to these vessels. These behavioral changes may include evasive maneuvers such as diving or changes in swimming direction and/or speed.

Vessel Movements

Impacts to sea turtles from these vessels include the potential for behavioral disturbance from the physical presence of these vessels, and sound generated by these vessels. As discussed in Section 7.2.10.2.1, sea turtle species may be vulnerable to physical disturbance from moving vessels.

The Operations Phase within the Pipeline Area will include the presence of the FPSO and support vessels. Impacts to sea turtles from these vessels include the potential for vessel strike with individual turtles. As discussed in Section 7.2.10.2.1, sea turtle species may be vulnerable to collisions (ship strike) with moving vessels. Generally, it is assumed that the probability of collisions with most operations vessels within the Pipeline Area is rare, based on their slow operational speeds. Crew boat traffic, however, is expected to operate at much greater speeds and may occur during the night; therefore, the possibility for collisions between crew boats and sea turtles are greater than other operations vessels.

Discharges

Impacts of routine discharges from the FPSO and operations vessels within the Pipeline Area will be similar to those previously noted (see Section 7.2.10.2.1). Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in sub-surface currents. Therefore, it is not likely that sea turtles will encounter discharged materials from vessels within the Pipeline Area during the Operations Phase.

Produced water discharges will undergo rapid dispersion and degradation in receiving waters. Sea turtles passing through the produced water plume are not expected to realize effects from chemical exposure.

Solid Waste

Potential impacts to sea turtles from solid debris in offshore waters are discussed Section 7.2.10.2.1. All vessels associated with Operations Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

Helicopter Traffic

Potential impacts to sea turtles from aircraft traffic include disturbances from physical presence. Noise generated by project-related helicopters that are directly relevant to sea turtles are discussed in Section 7.2.10.2.1. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the FPSO).

7.3.10.2.4 Support Operations Areas

Vessel Movements

Impacts to sea turtles from support vessel transits include the potential for vessel strike with individual turtles, behavioral disturbance from the physical presence of these vessels. Most of the project-related vessel traffic associated with the Support Operations Areas will be transiting to the FPSO and Nearshore Terminal/Hub, traveling at relatively fast speeds, and potentially operating at night. Vessel movement and noise generated by support vessels may also produce behavioral disturbance.

Solid Waste

Potential impacts to sea turtles from solid debris is discussed Section 7.2.10.2.1. All operations (supply base and crew boat) associated with Operations Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage Therefore, the amount of trash and debris released in nearshore waters would be minimal and only accidental. In addition, the supply base and crew boats would implement a waste management plan that would include guidance for marine debris awareness. Impacts to sea turtles from solid waste is not expected to be significant to local populations.

7.3.10.3 Impact Rating

Physical Presence

The consequence of physical presence of project facilities and support vessels to sea turtles in the Pipeline Area and Nearshore Hub/Terminal Area include potential auditory injuries or impairment, short-term behavioral alterations, short- and long-term displacement from (or attraction to) discrete operations areas, and foraging habitat loss or alteration immediately below nearshore infrastructure at the supply base. Operations at the Nearshore Hub/Terminal will include the liquefaction of gas, and operations with the LNG vessels; operations at the FPSO will include gas processing. Both facilities will generate sound as a result. Physical presence of the facilities and support vessel operations will result in behavioral alterations to turtles; principally avoidance and long-term displacement from the Nearshore Terminal/Hub Area and at the FPSO. These impacts are expected to be of low intensity, local and long term; impact consequence is expected to be minor. The overall impact significance is 2 - Low (see Table 7-83 below for details on selected criteria).

Vessel Movements

Generally, it is assumed that the probability of collisions with most operations vessels in all project areas is rare, based on their slow operational speeds. Crew boat traffic will operate at much greater speeds and may occur during the night; therefore, the possibility for collisions between crew boats and sea turtles are greater than other operations vessels. All turtles are listed as threatened species under the IUCN; as any collision is considered as fatal to the individual turtle, the intensity of the impact is rated as moderate.

In the rare event a sea turtle is stricken by a support vessel, impact intensity would be moderate, impact extent would be local, and impact duration would be long term. Overall impact significance is 2 – Low (see Table 7-83 below for details on selected criteria).

Discharges

Routine, discharges from operation activities in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area are expected to produce very localized impacts through the introduction of organics (sanitary and domestic wastes; food waste) and warm water (cooling water); these impacts will be restricted to surface waters. Produced water discharges will also be limited to surface waters, with the plume extending several hundred meters from the discharge. The volumes and frequency of these discharges are not expected to impact sea turtle prey items. The overall impact significance is 2 – Low (see Table 7-83 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during operation activities may occur in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, or within the Support Operations Areas. These accidental losses are expected to be minimal but may produce impacts to sea turtles via ingestion of small particles (plastic) or entanglement in debris. The likelihood of these events (release of solid debris and ingestion or entanglement) is occasional; therefore, the overall impact significance to sea turtles is 1 – Negligible (see Table 7-83 below for details on selected criteria).

Helicopter Traffic

Potential impacts to sea turtles from aircraft traffic include disturbances from noise and physical presence. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the QU Platform). Based on this schedule and helicopter flight protocols, impacts to sea turtles are expected to be infrequent, short-term, and of low impact intensity. Given the immediate vicinity and short-term duration of this impact, impact consequence is negligible. The overall impact significance is 1 – Negligible (see Table 7-83 below for details on selected criteria).

Table 7-83. Impacts to Sea Turtles during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Avoidance or displacement from vessel traffic or the FPSO; Noise disturbances from operations (liquefaction of LNG and transfer operations).	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Long term	Minor	Likely	2 – Low
Vessel Movements						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Potential vessel strike resulting in sea turtle injury or mortality.	Nature: Negative Intensity: Moderate Spatial Extent: Local Duration: Long term	Moderate	Rare	2 – Low
Discharges						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Direct and indirect effects of routine vessel discharges during operations.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Minor	Occasional	2 – Low
Solid Waste						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Accidental release of solid waste from operations vessels resulting in impacts from ingestion by or entanglement of sea turtles.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Helicopter Traffic						
Mauritania Senegal	Pipeline; Support Operations	Displacement and avoidance of helicopters in offshore waters and when approaching heliports.	Nature: Negative Intensity: Low Spatial Extent: Immediate Vicinity Duration: Short-term (also infrequent)	Negligible	Likely	1 – Negligible

7.3.10.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-84) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the measures and controls already planned in the project design.

Table 7-84. Mitigation Measures to Avoid or Reduce Impacts to Sea Turtles from Routine Activities during the Operations Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Avoidance or displacement from vessel traffic or the FPSO; Noise disturbances from operations (liquefaction of LNG and transfer operations).	2 – Low	None	2 – Low
Potential vessel strike resulting in sea turtle injury or mortality.	2 – Low	M06	1 – Negligible
Direct and indirect effects of routine vessel discharges during operations.	2 – Low	M33, M35, M36, M37, M38, M39	1 – Negligible

Notes:

M06: Vessel operators will implement vessel strike avoidance protocols to reduce the potential for vessel strike with marine mammals and sea turtles (including injured/dead protected species reporting).

M33: Monitoring use of added chemicals to produced water stream (corrosion inhibitors, scale inhibitors, coagulants/flocculants).

M35: The seawater intake depth at the FPSO will be designed with the intent to reduce the need for use of antifoulant chemicals.

M36: Free chlorine in FLNG cooling water discharges to be sampled at point of discharge will be maintained below 0.2 parts per million (ppm).

M37: Produced water will be treated prior to discharge with sufficient treatment. Oil and grease content of the produced water effluent discharge at sea will be compliant with applicable regulation and not exceed 42 mg/L daily maximum; 29 mg/L monthly average.

M38: Produced water effluent quality will be monitored. The first 18 months of monitoring data will be used to assess the likely impacts of the effluent upon the receiving water body using an Environmental Risk Assessment approach, which is to be repeated following a material change in effluent composition or volume.

M39: The discharge of cooling water will be designed to reduce recirculation.

7.3.11 Threatened Species and Protected Areas

High Level Summary

In this section on Threatened Species and Protected Areas, the impact of six impact producing factors, these being Physical presence, Vessel movements, Emissions, Discharges, Solid waste and Helicopter traffic, was evaluated. The residual impacts on Threatened Species and Protected Areas during the Operations Phase for routine activities were assessed as of negligible or low significance when mitigation measures are applied.

7.3.11.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence			●	
Vessel movements	●	●	●	
Emissions		●	●	●
Discharges	●	●	●	●
Solid waste	●	●	●	●
Helicopter traffic			●	

7.3.11.2 Impact Description

The Operations Phase will involve the ongoing operation and maintenance of the SPS, FPSO and FLNG vessels. Additionally, support vessels will be used for maintenance operations. These vessels and their activities are the source of several IPFs that may impact threatened species and/or protected areas during the Operations Phase.

7.3.11.2.1 Offshore Area

Vessel Movements

Support vessels transiting from the supply base to the Offshore Area to perform maintenance activities during the Operations Phase may pass through protected areas or other areas of conservation interest including the Convergence Zone of the Canary-Guinea Currents EBSA, the Cayar Canyon EBSA, and the Cayar Seamount Complex EBSA which are located between Dakar and the Offshore Area, or the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal EBSA or the Cold Water Reef areas which are located between Nouakchott and the Offshore Area.

Waves generated by vessels may erode unprotected shorelines, especially in areas that are already subject to natural erosion processes as is seen in the west African region (see Section 7.3.3). Vessel transits through the EBSAs could result in periodic disruption of individual marine mammals, sea turtles, or birds within the EBSAs. However, it is likely that individuals would experience, at most, a short term behavioral disruption.

Critically Endangered or Endangered species which may occur in the Offshore Area include sawback angel shark, smoothback angel shark, whale shark, scalloped hammerhead, great hammerhead, Atlantic Bluefin tuna, Balearctic shearwater, and green sea turtle. Vessel transits could result in periodic disruption of individual listed fishes, turtles, and birds. Support vessel operators are expected to follow all applicable maritime navigation rules and would normally follow the most direct route (weather conditions permitting) between the Offshore Area and the supply bases. Support vessels are expected to use existing routes into port including well-traveled shipping lanes. Vessel operators normally maintain a watch for obstructions during transit and will not deliberately approach a threatened marine mammal or sea turtle; birds may accidentally strike vessels. A full description of potential impacts from vessel movements on birds and marine mammals during the Operations Phase is presented in Sections 7.3.8 and 7.3.9; a discussion of potential impacts from vessel movements on sea turtles is presented in Section 7.3.10. It is likely that individuals would experience, at most, a short term behavioral disruption.

Discharges

Routine discharges from support vessels in the Offshore Area will produce localized areas of reduced water quality, including increases in total suspended solids, nutrients, and chlorine. All discharges are expected to be diluted rapidly due to the open ocean location of the Offshore Area. It is highly unlikely that any routine discharges support vessels in the Offshore Area will reach any protected area, IBA, EBSA, or other area of conservation interest. The nearest protected area to the Offshore Area is the Saint-Louis Marine Protected Area (approximately 50 km to the east), while the nearest EBSA is the Cayar Seamount Complex (approximately 20 km to the south). The greatest likelihood of any potential contact would be from transiting support vessels that will travel through EBSAs on their way to Dakar or Nouakchott.

Discharge of ballast water from support vessels could result in the introduction of non-native species in the project area. If any non-native species becomes established, it could result in disruptions to habitat or food availability which could impact threatened species and/or the ecological health of protected areas.

Routine discharges from support vessels are expected to produce similar impacts to threatened species as those noted for marine mammals, sea turtles, fishes, and birds – i.e., minimal effects. Any effects will be limited to a very small radius around the discharge that will vary with current and sea conditions.

Solid Waste

No solid waste will be intentionally discharged in the Offshore Area during the Operations Phase. However, accidental loss of debris from support vessels may occasionally occur and currents could transport debris through protected areas or onto coastal IBAs, EBSAs, or other areas of conservation interest. Floating debris may become hazardous to marine mammals, sea turtles, birds, or fish (including threatened species) that are present due to the risk of entanglement or ingestion. Marine debris that washes ashore may foul beaches, adversely affect the aesthetics of natural coastal areas, and provide an entanglement or ingestion hazard for coastal animals.

7.3.11.2.2 Nearshore Hub/Terminal Area

Physical Presence

Numerous vessels, including the FLNG and support vessels will be present in the Nearshore Hub/Terminal Area throughout the estimated 20 years of the Operations Phase. Portions of the Nearshore Hub/Terminal Area are in close proximity to several protected areas, including Diawling National Park and the Saint-Louis Marine Protected Area, and the Senegal River Delta Transboundary Biosphere Reserve. As described in Section 4.5.9, one EBSA, the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal, is located within the Nearshore Hub/Terminal Area. The Saint-Louis Marine Protected Area is located approximately 4 km south of the Nearshore Hub/Terminal Area and should not be affected by the presence or noise from the FLNG or supply vessels.

The portion of the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal that is within the Nearshore Hub/Terminal Area may experience disturbance due to the presence and noise from the FLNG vessel and support vessels during project operations. These disturbances, while likely minor, will be long-term due to the estimated 20-year duration of the Operations Phase.

Among threatened species, several may be expected to be present near the Nearshore Hub/Terminal Area, including nine fish species, two sea turtle species, and one marine mammal species (Table 7-33). Impacts to these threatened species from physical presence will be similar to those previously discussed for marine mammals, sea turtles, and fishes – short term behavioral disruptions.

Vessel Movements

As detailed in Section 2.1, substantial vessel activity is expected during the Operations Phase in the Nearshore Hub/Terminal Area, which includes a small portion of the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal EBSA and is near Diawling National Park and the Saint-Louis Marine Protected Area and the Senegal River Delta Transboundary Biosphere Reserve. While the FLNG vessel will be stationary, numerous support vessels will transit through the Nearshore Hub/Terminal Area to support the LNG process or maintenance operations. It is expected that fauna within nearby protected areas or other areas of conservation interest may be subject to behavioral disruptions.

The impact of vessel movements on threatened species will likely be limited to marine mammals, sea turtles, and birds. Impacts from physical disturbance are expected to include avoidance of, or displacement from, the operations area by individuals or groups of threatened marine mammals or sea turtles. Over the project life, some individuals may become accustomed to the presence of the FLNG, breakwater, and support vessels. There are several IBAs in the vicinity of the Nearshore Hub/Terminal Area (including Chatt Tboul Reserve and Diawling National Park) and substantial numbers of birds may be present during some portions of the year. Because these activities are either static or moving slowly, it is expected that disturbances will not significantly affect local populations.

Emissions

Emissions from the FLNG vessel and support vessels in the Nearshore Hub/Terminal Area during the Operations Phase will result in air contaminants typically associated with internal combustion engines including PM, SO_x, NO_x, VOCs, and CO. Depending on prevailing winds at the time of emissions, increased concentrations of these contaminants could occur any protected area or area of conservation interest that is downwind.

Air dispersion modeling completed for the Operations Phase (see Appendix J) estimated that emissions from the proposed operations, including operation of the FLNG do not exceed the WHO guidance levels for SO_2, PM_{10}, and $PM_{2.5}$, and the annual averaging period for NO_2. However, the maximum modeled concentration of 1-hour averaging for NO_2 exceeded WHO guidance levels. In the air modeling report, it was noted that the WHO air guidelines do not have a standard norm for the recommended NO_2 hourly value similar of the standard to the U.S. National Ambient Air Quality Standards (NAAQS) used by the U.S. EPA, which uses the three-year average of the 98th percentile of daily maximum NO_2-1h concentrations. Additional discussion regarding operations emissions is presented in Section 7.3.1.

The coastal area most likely to be maximally affected was estimated to be directly east of the FPSO along the Mauritania/Senegal border. Several protected areas are located in this area, including the offshore Saint-Louis Marine Protected Area, Langue de Barbarie National Park, Guembeul Natural Reserve, and the Senegal River Delta Transboundary Biosphere Reserve.

Any impacts to threatened species from project-related emissions would be limited. While reductions in local air quality associated with operations will be of local to regional extent, only limited impacts to threatened birds, sea turtles, and marine mammals may be expected from diminished air quality; no impacts to threatened fish are expected.

Discharges

Routine effluent discharges from the FLNG vessel and support vessels will result in localized areas of reduced water quality including increases in total suspended solids, nutrients, and chlorine. Results of the analysis of FLNG discharges are summarized in Section 7.3.2.2.2. The Saint-Louis Marine Protected Area is nearby (approximately 4 km to the south of the Nearshore Hub/Terminal Area), but it is expected that all discharges will be thoroughly dispersed and diluted and impacts on the protected area considered unlikely.

Among threatened species, the discharges resulting from the support of gas liquefaction operations are expected to affect threatened species in a similar fashion as other, non-listed species. Threatened fishes, birds, sea turtles, and marine mammals could be affected by discharges in the immediate vicinity of the discharge, but widespread impacts are not likely. Minimal effects to plankton and fishes are expected, while marine birds, sea turtles, and marine mammals are likely to come into contact with discharges in variable stages of dilution.

Solid Waste

No solid waste will be intentionally discharged during operations in the Nearshore Hub/Terminal Area. However, due to the long-term activities expected to occur during the Operations Phase, it is possible that occasional pieces of waste may fall overboard from support vessels or from the FLNG vessel. Currents could transport lost debris through protected areas or onto coastal IBAs, EBSAs, or other areas of conservation interest. Floating debris may become hazardous to marine mammals, sea turtles, birds, or fish that are present due to the risk of entanglement or ingestion. Marine debris that washes ashore may foul beaches, adversely affect the aesthetics of natural coastal areas, and provide an entanglement or ingestion hazard for coastal animals.

Operations at the Nearshore Hub/Terminal will generate trash comprising paper, plastic, wood, glass, and metal. The amount of trash and debris dumped nearshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. For threatened species present in the Nearshore Hub/Terminal Area, the accidental loss of solid waste and debris may result in entanglement or ingestion for marine mammals and sea turtles. The potential for impact to fishes and birds is considered to be limited.

Helicopter Traffic

It is not expected that helicopters will be utilized during the Operations Phase. However, in the event of an emergency, helicopters may transit to the Nearshore Hub/Terminal Area and land on the QU Platform to assist with an evacuation or other emergency response. If a helicopter was used in the event of an emergency, coastal and marine species found within protected areas, IBAs, or EBSAs may be impacted, either from noise or a visually based disturbance. Due to the transient nature of any helicopter trip, potential impacts to species within protected areas or other areas of conservation interest would be limited to short-term behavioral changes.

Helicopter traffic impacts on threatened species present at the Nearshore Hub/Terminal Area will be similar to those identified previously for birds, marine mammals, and sea turtles.

7.3.11.2.3 Pipeline Area

Physical Presence

The physical presence of the FPSO will produce no impact to protected areas due to distance. Impacts to threatened species from physical presence will be similar to those previously discussed for marine mammals, sea turtles, and fishes – behavioral disruptions.

Vessel Movements

As discussed in Section 7.3.11.2.1, vessels transiting from the supply base to the FPSO located within the Pipeline Area may pass through protected areas or other areas of conservation interest including the Convergence Zone of the Canary-Guinea Currents EBSA, the Cayar Canyon EBSA, and the Cayar Seamount Complex EBSA which are located between Dakar and the Offshore Area, or the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal EBSA or the Cold Water Reef areas which are located between Nouakchott and the Offshore Area. Impacts that could occur include coastal erosion due to wakes caused by transiting vessels or short term behavioral changes due to the presence transiting vessels.

The impact of vessel movements on threatened species will likely be limited to marine mammals, sea turtles, and birds. Impacts from physical disturbance are expected to include avoidance of or displacement from the operations by individuals or groups of threatened marine mammals, sea turtles, or birds.

Emissions

Emissions from the FPSO in the Pipeline Area will result in air contaminants typically associated with internal combustion engines including PM, SO_x, NO_x, VOCs, and CO. Depending on prevailing winds at the time of emissions, increased concentrations of these contaminants could occur any protected area or area of conservation interest that is downwind.

Air dispersion modeling completed for the Operations Phase (see Appendix J) estimated that emissions from the proposed operations, including operation of the FPSO do not exceed the WHO guidance levels for SO_2, PM_{10}, and $PM_{2.5}$, and the annual averaging period for NO_2. However, the maximum modeled concentration of 1-hour averaging for NO_2 exceeded WHO guidance levels. In the air modeling report, it was noted that the WHO air guidelines do not have standard norm for the recommended NO_2 hourly value similar of the standard to the U.S. National Ambient Air Quality Standards (NAAQS) used by the U.S. EPA, which uses the three-year average of the 98th percentile of daily maximum NO_2-1h concentrations. When comparing estimated NO_2 emissions using the equivalent NAAQS standard (98th percentile of the daily maximum concentration), the NO_2 emissions are less than the WHO guidance level.

The coastal area most likely to be maximally impacted was estimated to the directly east of the FPSO along the Mauritania/Senegal border. Several protected areas are located in this area, including the offshore Saint-Louis Marine Protected Area, Langue de Barbarie National Park, Guembeul Natural Reserve, and the Senegal River Delta Transboundary Biosphere Reserve.

Any impacts to threatened species from project-related emissions would be limited. Reductions in local air quality associated with operations activities will occur around the area of operations within the Pipeline Area and along emissions trajectories toward shore. As a result, limited impacts to threatened birds, sea turtles, and marine mammals may be expected from diminished air quality; no impacts to threatened fish are expected.

Discharges

Discharges from the FPSO during the Operations Phase will produce localized areas of reduced water quality, including increases in total suspended solids, nutrients, and chlorine. Slight, temporary increases in total suspended solids, nutrients, and chlorine will likely occur. However, rapid dispersion and dilution is expected and any residual remnants of diluted discharges that may enter a marine protected area, EBSA, IBA, or other area of conservation interest would, at most, cause localized and temporary reductions in water quality.

Among threatened species, the discharges resulting from the support of FPSO operations are expected to affect threatened species in a similar fashion as other, non-listed species. Threatened fishes, birds, sea turtles, and marine mammals could be affected by discharges in the immediate vicinity of the discharge, but widespread impacts are not likely. Minimal effects to fishes, sea turtles, and marine mammals are expected, primarily within the area where the produce water discharge occurs and where it is diluted, while marine birds are unlikely to encounter discharges.

Solid Waste

No solid waste will be intentionally discharged in the Pipeline Area during the Operations Phase. Accidental loss of debris from the FPSO or support vessels may occasionally occur and could result in an entanglement or ingestion hazard for marine fauna. If debris washed ashore, waste could result in the fouling of beaches, negative effects on the aesthetics of natural coastal areas, and result in an entanglement or ingestion hazard for coastal animals.

For threatened species present in the Pipeline Area, the accidental loss of solid waste and debris may result in entanglement or ingestion for marine mammals and sea turtles. The potential for impact to fishes and birds is considered to be limited.

7.3.11.2.4 Support Operations Areas

Emissions

Emissions from project support vessels in the Support Operations Areas in Dakar and Nouakchott will result in air contaminants typically associated with internal combustion engines including PM, SO_X, NO_X, VOCs, and carbon monoxide (CO). Depending on prevailing winds at the time of emissions, increased concentrations of these contaminants could occur in any protected area or area of conservation interest that is downwind. Any impacts to threatened species from project-related emissions would be limited. Reductions in local air quality associated with operations activities will be limited to vessel movements in support of operations activities in other project areas. As a result, only limited impacts to threatened birds, sea turtles, and marine mammals may be expected from diminished air quality; no impacts to threatened fish are expected.

Discharges

As discussed in Section 7.2.11.1.1, routine discharges from the project support vessels in the Support Operations Areas will produce localized areas of reduced water quality, including increases in total suspended solids, nutrients, and chlorine. Slight, temporary increases in total suspended solids, nutrients, and chlorine could occur in offshore protected areas near the Support Operations Areas such as the Coastal Habitats of the Neritic Zone of Mauritania and the extreme north of Senegal EBSA near Nouakchott or the Convergence Zone of the Canary-Guinea Currents EBA near Dakar.

Among threatened species, the discharges resulting from the support of operations are expected to affect threatened species in a similar fashion as other, non-listed species. Threatened fishes, birds, sea turtles, and marine mammals are not likely to be affected by discharges. Minimal effects to plankton and fishes are expected, while marine birds, sea turtles, and marine mammals are unlikely to encounter discharges.

Solid Waste

No solid waste will be intentionally discharged in the Support Operations Areas during the Operations Phase. As discussed in Section 7.2.11.1.1, accidental loss of debris from support vessels may occasionally occur as result in an entanglement or ingestion hazard for marine fauna. If debris washed ashore, waste could result in the fouling of beaches, negative effects on the aesthetics of natural coastal areas, and result in an entanglement or ingestion hazard for coastal animals.

Accidental loss of trash and debris is anticipated, some of which could float on the water surface. For threatened species present in the Support Operations Areas, the accidental loss of solid waste and debris may result in entanglement or ingestion for marine mammals and sea turtles. The potential for impact to fishes and birds is considered to be limited.

Helicopter Traffic

Helicopter take-offs and landings will occur during the Operations Phase from airports at Dakar and Nouakchott in the Support Operations Areas. Noise associated with helicopter flights may result in short-term behavioral changes to species within protected areas or other areas of conservation interest that are along the flight path between the airports and the Offshore Area. However, due to the altitude at which the helicopters are expected to fly and the intermittent nature of the helicopter trips, significant impacts are not expected.

Helicopter traffic impacts on threatened species will be similar to those noted for marine mammals, sea turtles, fishes, and birds. Noises generated by project-related aircraft that are directly relevant include both airborne sounds to individuals resting on the sea surface (e.g., marine mammals, sea turtles, birds) and underwater sounds from air-to-water transmission from passing aircraft.

7.3.11.3 Impact Rating

Physical Presence

Impacts to protected areas and other areas of conservation interest from the physical presence from the Operations Phase will potentially occur in the Nearshore/Hub Terminal Area where the FLNG vessel will operate. In this area, one EBSA (Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal) overlaps with the Nearshore Hub/Terminal Area and could be impacted by the long-term presence of the FLNG vessel and reoccurring presence of support vessels. However, consequences are expected to be limited to behavioral disturbances but could occur over the lifetime of the Operations Phase and could be moderate in intensity due to the persistent level of noise that the FLNG vessel will introduce. No impacts in the Pipeline Area are expected from physical presence of the FPSO because there are no protected areas or other areas of conservation interest in the vicinity. Therefore, the overall impact significance is 2 – Low (see Table 7-85 below for details on selected criteria).

Impacts to threatened species will be identical to those identified for marine mammals, sea turtles, birds and fish. Operational noise from the FPSO and FLNG may disturb marine mammals, sea turtles, and fish. These impacts are expected to be limited to behavioral alterations; specifically avoidance and displacement. The intensity of these impacts is moderate, as effects from noise may be expected to displace threatened species from the area surrounding the Nearshore Hub/Terminal. Based on activities discussed in Chapter 2, these impacts are likely to occur. The extent of these impacts to threatened species is expected to be limited within the immediate vicinity. The duration of operations–related impacts is long term. Therefore, the overall impact significance is 2 – Low (see Table 7-85 below for details on selected criteria).

Vessel Movements

Impacts to protected areas and other areas of conservation interest from vessel movements may occur due to operations in the Offshore, Nearshore/Hub Terminal, or Pipeline Area. The primary impact would be due to incremental coastal erosion caused by vessel wakes, or behavioral disturbances to marine fauna due to vessel noise. Due to the nature (i.e., duration, vessel routes) of support vessel operations, impact consequence to fauna in protected areas or other areas of conservation interest from noise disturbance is anticipated to be negligible. Although coastal erosion is possible, vessels will depart from established supply bases that are located in developed, industrial areas. Therefore, the overall impact significance is 1 – Negligible (see Table 7-85 below for details on selected criteria).

The consequence of impacts to threatened species (primarily marine mammals and turtles; to a lesser extent fish and birds) present in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, and the Support Operations Areas from vessel movement and noise include potential auditory injuries or impairment, short-term behavioral alterations, and short-term displacement from (or attraction to) the operations areas (FPSO, Nearshore Hub/Terminal). Vessel collisions with threatened marine mammals or sea turtles are possible but very unlikely, based on normal vessel speeds. The intensity of these impacts is low, as they are limited to behavioral alterations; specifically avoidance and temporary displacement. The extent of these impacts to threatened species is expected to be limited to the immediate vicinity of operations activities, with the duration long term. In the event a project vessel strikes a threatened marine mammal or sea turtle resulting in injury or mortality, the impact intensity would be moderate. The extent, in this case, would also be restricted to the immediate vicinity and the duration would be short term (impacts would not be felt by the local population during the life of the project). The consequence of the impact would be minor, but the likelihood would be remote. Therefore, in this case, the overall impact significance is 1 – Negligible (see Table 7-85 below for details on selected criteria).

Emissions

Emissions from project vessels may cause an increase in airborne contaminants in protected areas or other areas of conservation interest that are downwind of the location of emissions. Emission from the FLNG vessel and support vessels in the Nearshore/Hub Terminal Area, the FPSO in the Pipeline

Area and from vessel operations in the Support Operations Areas may cause impacts due to the proximity to shore and nearby protected areas. Air dispersion modeling completed for the Operations Phase (see Appendix J) estimated that emissions from the proposed operations, including operation of the FPSO do not exceed the WHO guidance levels for SO_2, PM_{10}, and $PM_{2.5}$, and the annual averaging period for NO_2. However, the maximum modeled concentration of 1-hour averaging for NO_2 exceeded WHO guidance levels.

Based on air modeling results (see Appendix J) and the modeled potential for elevated levels of NO_2 to reach shore where several protected areas are located along the Mauritania/Senegal border, the overall impact significance is rated 2 – Low (see Table 7-85 below for details on selected criteria).

The likelihood of emission-related impacts to threatened species is considered remote; impact intensity is low, local in extent, and of short-term duration, resulting in a negligible impact. Given the remote nature of this impact, overall impact significance is 1 – Negligible (see Table 7-85 below for details on selected criteria).

Discharges

Routine effluent discharges may produce localized areas of reduced water quality, including increases in total suspended solids, nutrients, and chlorine in the vicinity of the discharge points around the FLNG vessel in the Nearshore Hub/Terminal Area, near the FPSO in the Pipeline Area, and from transiting vessels. Due to the expected rapid dispersion of effluent discharges, the overall impact significance is 1 – Negligible (see Table 7-85 below for details on selected criteria).

Discharge of ballast water could result in the introduction of non-native species that could become established and invasive. If it occurred, a new invasive species could impact threatened species and/or protected areas by disrupting habitat or food availability for native species. The intensity of such impacts would be moderate. Based on the long-term and regional nature of such an impact, the overall impact significance to threatened species and protected areas would be 2 – Low.

Other impacts to threatened species from discharges are not expected. The extent of any potential impacts to threatened species is expected to be limited to the immediate vicinity of the discharges. The duration of operation-related impacts from discharges, however, is long term. The consequence of the impact would be negligible. Given the likely likelihood of impact, overall impact significance to threatened species from discharges is 1 – Negligible (see Table 7-85 below for details on selected criteria).

Solid Waste

The accidental discharge of solid waste from vessels operating in any of the project areas during the Operations Phase could potentially impact fauna in offshore protected areas or wash ashore and foul beaches and present an ingestion or entanglement hazard for terrestrial species within protected areas or other areas of conservation interest. Based on the occasional likelihood of debris loss, the overall impact significance is 1 – Negligible (see Table 7-85 below for details on selected criteria).

Accidental losses are expected to be limited but may produce very localized impacts to threatened species, particularly listed marine mammals, sea turtles, and birds, via ingestion of small particles (plastic) or entanglement in debris. The extent of these impacts to threatened species is expected to be limited to the immediate vicinity and of potential long duration; given a low impact intensity, impact consequence is negligible. Given an occasional likelihood, overall impact significance is 1 – Negligible (see Table 7-85 below for details on selected criteria).

Helicopter Traffic

Helicopters are not expected to be used during the Operations Phase unless there is an emergency or other unexpected situation which may require the use of a helicopter transiting to the Nearshore Hub/Terminal Area. If a helicopter needs to be used, the noise could result in temporary behavioral disruptions to marine mammals, turtles, or birds within protected areas or other areas of conservation interest between the heliport and the QU Platform. Because helicopters are not expected to be used under routine operations during the Operations Phase impact likelihood is rare and impact consequence to protected areas and other areas of conservation interest is considered negligible. The overall impact significance is 1 – Negligible (see Table 7-85 below for details on selected criteria).

For threatened species, intensity of impact from helicopter traffic is low, as it is limited to behavioral alterations (avoidance and temporary displacement). Impact extent to threatened species is limited to the immediate vicinity and is of short-term duration. The consequence of this impact would be negligible; given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-85 below for details on selected criteria).

Summary

A summary of impacts to protected areas or other areas of conservation interest and threatened species from routine activities during the Operations Phase is presented in Table 7-85.

Table 7-85. Impacts to Threatened Species and Protected Areas during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Nearshore Hub/ Terminal	Behavioral disturbances to fauna within protected areas or other areas of conservation interest.	Nature: Negative Intensity: Moderate Spatial Extent: Immediate vicinity Duration: Long term	Minor	Likely	2 – Low
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal	Behavioral disturbances to threatened species.	Nature: Negative Intensity: Moderate Spatial Extent: Immediate vicinity Duration: Long term	Minor	Likely	2 – Low
Vessel Movements						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Coastal erosion due to vessel wakes; behavioral disturbances to fauna within protected areas or other areas of conservation interest.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Occasional	1 – Negligible
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Disturbance, possible auditory injury, vessel strike to threatened species from vessels, operations.	Nature: Negative Intensity: Low to Moderate Spatial Extent: Immediate vicinity Duration: Long term	Negligible to Minor	Remote	2 – Low
Emissions						
Mauritania Senegal	Pipeline; Nearshore Hub/ Terminal; Support Operations	Increase in airborne contaminants in protected areas or other areas of conservation interest.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Long term	Minor	Occasional	2 – Low

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Emission-related impacts to threatened species.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Long term	Negligible	Remote	1 – Negligible
Discharges						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Temporarily decrease water quality in protected areas or other areas of conservation near the discharge location.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Remote	1 – Negligible
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Decreased water quality and effects on threatened species.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 – Negligible
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Introduction of non-native or invasive species.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Long term	Moderate	Remote	2 – Low
Solid Waste						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Potential entanglement or ingestion by fauna in protected areas; fouling of coastal areas in protected areas.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Rare	1 – Negligible
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Potential entanglement or ingestion by threatened species.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Long term	Negligible	Occasional	1 – Negligible

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Helicopter Traffic						
Mauritania Senegal	Nearshore Hub/ Terminal	Behavioral disturbances to fauna within protected areas or other areas of conservation interest.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Rare	1 – Negligible
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Behavioral disturbances to threatened species.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Long term	Negligible	Likely	1 – Negligible

7.3.11.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-86) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the measures and controls already planned in the project design but summarized here for reference.

Summary of existing measures inherent to design and operational controls:

- D01: Contractors will be expected to comply with the contract terms that have been established, including HSSE standards and performance requirements.
- D02: Compliance with applicable national and international regulations (MARPOL 73/78 Annex VI) and guidelines regarding emissions of nitrogen oxides (NOx) and Sulphur oxides (SOx) from main project vessels.
- D15: The FLNG and FPSO will be designed, constructed, and operated to avoid routine flaring[113].
- D29: Develop and implement a flaring protocol with the intention to meet defined operational combustion performance.
- D30: Implementation of leak detection and repair programs for fugitive emissions.
- D31: Implementation of technically feasible and cost-effective measures to optimize energy efficiency and air emissions on the FPSO and FLNG. This could include where feasible waste heat recovery, flare gas recovery, vapor recovery and selected method of export compression on the FPSO, and boil-off gas recovery and control of fugitive emissions through design of the FPSO and FLNG.
- D32: Use of project-produced gas as preferred fuel for FLNG, FPSO and QU processes instead of diesel or crude oil.

[113] Routine flaring is defined in Section 7.3.1.

- D33: Aggregate greenhouse gas emissions from all offshore project facilities will be quantified annually in accordance with internationally recognized methodologies. The FPSO and FLNG will have fuel flow or emissions metering systems installed for equipment rated at 10 MW thermal or above. A predictive emission monitoring system (PEMS) will be used on equipment rated 10 MW thermal or above for the calculation of emissions of GHG, SOx and NOx.

- D40: The location of project facilities at some distance offshore from the protected areas avoids most direct and indirect impacts from routine activities.

Table 7-86. Mitigation Measures to Avoid or Reduce Impacts to Threatened Species and Protected Areas from Routine Activities during the Operations Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Behavioral disturbances to fauna within protected areas or other areas of conservation interest.	2 – Low	M43	2 – Low
Behavioral disturbances to threatened species.	2 – Low	None	2 – Low
Disturbance, possible auditory injury, vessel strike to threatened species from vessels, operations.	2 – Low	M06	1 – Negligible
Increase in airborne contaminants in protected areas or other areas of conservation interest.	2 – Low	M01, M02	1 – Negligible
Introduction of non-native or invasive species.	2 – Low	See below	2 - Low

Notes:

M01: Maintaining routine maintenance procedures to help ensure that engines are operating at defined operational performance and specified emissions levels.

M02: Monitoring fuel consumption as a proxy for measuring performance and emissions. When practical or as required by applicable regulations, vessel operators will be expected to utilize low-sulfur fuels to limit SOx production.

M06: Vessel operators will implement vessel strike avoidance protocols to reduce the potential for vessel strike with marine mammals and sea turtles (including injured/dead protected species reporting).

In recognition of the importance of the conservation of protected areas and as part of its social investment, BP further proposes to:

- M43: Implement a program of support to local protected area management initiatives through mutually agreed capacity building.

Mitigation for the potential invasive species impacts associated with ballast water could be addressed under the IMO Ballast Water Management Convention with exchange of ballast water mid-ocean or installation of an on-board ballast water treatment system (D08).

7.3.12 Biodiversity

High Level Summary

In this section on Biodiversity, the impact of six impact producing factors, these being Physical presence, Vessel movements, Emissions, Discharges, Solid waste and Helicopter traffic, was evaluated. The residual impacts on Biodiversity during the Operations Phase for routine activities were assessed as of negligible or low significance when mitigation measures are applied.

7.3.12.1 Impact Producing Factors and Project Areas

As discussed in Chapter 4, the characteristics for biodiversity represent a suite of previously identified resources – i.e., fish and other fishery resources, marine mammals, sea turtles, birds, threatened species, and protected areas and areas of conservation interest. Biodiversity IPFs consequently represent a combination of IPFs identified for those resources that contribute to biodiversity. Refer to Sections 7.3.6 and 7.3.8 through 7.3.11 for detailed discussion of impact determinations for these resources.

7.3.12.2 Impact Description

The Operations Phase of the project comprises the operation of the SPS, FPSO and FLNG; the use of supply and support vessels as well as tugboats to support operations; the export of LNG and condensate via LNGC and condensate tankers, respectively; well maintenance; pipeline and flowlines pigging; and maintenance operations for the vessels and facilities. With exception of well maintenance activities, impacts from other project vessels during the Operations Phase are not expected to occur within the Offshore Area.

Physical presence, vessel movements, emissions, discharges, solid waste, and helicopter traffic represent potential sources of impact to biodiversity resources in the project areas. Table 7-87 summarizes the impact determinations for each of these biodiversity resources before the implementation of mitigation measures.

An important aspect of biodiversity is the potential impact associated with alien invasive species (AIS).

Table 7-87. Summary of Impact Determinations for Various Components of Biodiversity for the Operations Phase

IPF	Plankton and Fish and Other Fishery Resources	Marine Mammals	Sea Turtles	Birds	Threatened Species	Protected Areas
Physical presence	Positive and 1 – Negligible to 2 – Low	2 – Low	2 – Low	1 – Negligible to 2 – Low	2 – Low	2 – Low
Vessel movements	-	2 – Low	2 – Low	2 – Low	1 – Negligible to 2 – Low	1 – Negligible
Emissions	-	-	-	-	1 – Negligible	2 – Low
Discharges	1 – Negligible	1 – Negligible	2 – Low	2 – Low	1 – Negligible	1 – Negligible to 2 – Low
Solid waste	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible
Helicopter traffic	-	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible

7.3.12.3 Mitigation Measures and Residual Impacts

Impacts to biodiversity resources resulting from operations activities were rated negligible to low. Low impacts arise from physical presence, vessel movements and emissions, variably applicable to resources. Summary information on these mitigation measures is presented in Table 7-88.

Table 7-88. Mitigation Measures to Avoid or Reduce Impacts to Biodiversity from Routine Activities during the Operations Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Plankton and Fish and Other Fishery Resources			
Entrainment and impingement of plankton and adult fish in FLNG cooling water at Nearshore Hub/Terminal. Entrainment and impingement of plankton and adult fish by FPSO.	2 – Low	M42	1 – Negligible
Marine Mammals			
Avoidance or displacement from vessel traffic or the FPSO; Noise disturbances from operations (liquefaction of LNG and transfer operations).	2 – Low	None	2 – Low
Potential vessel strike resulting in marine mammal injury or mortality.	2 – Low	M06	1 – Negligible
Sea Turtles			
Avoidance or displacement from vessel traffic or the FPSO; Noise disturbances from operations (liquefaction of LNG and transfer operations).	2 – Low	None	2 – Low
Potential vessel strike resulting in sea turtle injury or mortality.	2 – Low	M06	1 – Negligible
Direct and indirect effects of routine vessel discharges during operations.	2 – Low	M33, M35, M36, M37, M38, M39	1 – Negligible
Birds			
Incineration of birds during flaring from the FPSO and FLNG during non-routine conditions.	2 – Low	None	2 – Low
Potential vessel strike resulting in bird injury or mortality.	2 – Low	None	2 – Low
Effects of routine vessel and facility discharges during operations impacting birds directly or indirectly.	2 – Low	M33, M35, M36, M37, M38, M39	1 – Negligible
Threatened Species and Protected Areas			
Behavioral disturbances to fauna within protected areas or other areas of conservation interest.	2 – Low	M43	2 – Low
Behavioral disturbances to threatened species.	2 – Low	None	2 – Low
Disturbance, possible auditory injury, vessel strike to threatened species from vessels, operations.	2 – Low	M06	1 – Negligible
Increase in airborne contaminants in protected areas or other areas of conservation interest.	2 – Low	M01, M02	1 – Negligible

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Introduction of non-native or invasive species.	2 – Low	See below	2 – Low

Notes:

M01: Maintaining routine maintenance procedures to help ensure that engines are operating at defined operational performance and specified emissions levels.

M02: Monitoring fuel consumption as a proxy for measuring performance and emissions. When practical, or as required by applicable regulations, vessel operators will be expected to utilize low-sulfur fuels to limit SOx production.

M06: Vessel operators will implement vessel strike avoidance protocols to avoid or minimize the potential for vessel strike with marine mammals and sea turtles (including injured/dead protected species reporting).

M33: Monitoring use of added chemicals to produced water stream (corrosion inhibitors, scale inhibitors, coagulants/flocculants).

M35: The seawater intake depth at the FPSO will be designed with the intent to reduce the need for use of antifoulant chemicals.

M36: Free chlorine in FLNG cooling water discharges to be sampled at point of discharge will be maintained below 0.2 parts per million (ppm).

M37: Produced water will be treated prior to discharge with sufficient treatment. Oil and grease content of the produced water effluent discharge at sea will be compliant with applicable regulation and not exceed 42 mg/L daily maximum; 29 mg/L monthly average.

M38: Produced water effluent quality will be monitored. The first 18 months of monitoring data will be used to assess the likely impacts of the effluent upon the receiving water body using an Environmental Risk Assessment approach, which is to be repeated following a material change in effluent composition or volume.

M39: The discharge of cooling water will be designed to reduce recirculation.

M42: The seawater intake of the cooling water systems will be positioned taking into account technical constraints and appropriate screens or velocity caps will be fitted, if safe and practical, with the intent of avoiding entrainment and impingement of marine flora and fauna. The intake velocity will be below 1.0 m/s.

M43: Implement a program of support to local protected area management initiatives through mutually agreed capacity building.

As summarized in Section 7.2.5.2.1, project vessels could be a source for potential invasive species via several mechanisms, including ballast water and hull-established fouling community. This potential impact would be of concern if a project vessel was coming from another international location outside of the tropical/subtropical North Atlantic Ocean. Mitigation for the potential invasive species impacts associated with ballast water could be addressed under the IMO Ballast Water Management Convention with exchange of ballast water mid-ocean or installation of an on-board ballast water treatment system.

7.3.13 Land & Seabed Occupation and Use

High Level Summary

In this section on Land & Seabed Occupation and Use, the impact of one impact producing factor, this being Physical presence, was evaluated. All impacts on Land & Seabed Occupation and Use during the Operations Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

7.3.13.1 Impact Producing Factors and Project Areas

The IPF identified for this resource in Table 7-5 is distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	●

7.3.13.2 Impact Description

As indicated in Section 7.2.13, the physical presence of infrastructures will start during the Construction Phase and it will last during the whole life of the project and beyond since most of the structures laying on the seabed will remain there even after decommissioning. Therefore, its duration was considered permanent. Noise associated with the operations activities will not affect seabed occupation and use.

The project does not include any onshore facilities except for the Support Operations Areas, i.e. supply base facilities. These will be located inside existing port and airport facilities in Dakar and/or Nouakchott. Therefore, the physical presence of the supply base facilities will have no effect on the land occupation in the Support Operations Areas. In addition, the expected noise levels associated with the supply base facilities will be similar to existing noise levels inside the ports and thus will not affect the land occupation and use. Therefore, the impact of physical presence in the Support Operations Areas is not discussed further.

No additional land and sea bed occupation and use will be required during the Operations Phase. Therefore, the impacts identified for the Construction Phase will remain the same throughout the Operations Phase. To avoid redundancy, the impact description is not repeated here.

7.3.13.2.1 Summary

Table 7-89 provides a summary of the total seafloor area occupied during the Operations Phase as a result of the physical presence of infrastructures installed during the Construction Phase.

Table 7-89. Area of Seabed Used by Project Area for the Operations Phase.

Project Area	Seabed Occupied in km^2
Offshore Area	<0.01
Nearshore Hub/Terminal Area	0.16
Pipeline Area	0.13
Total	<0.30

7.3.13.3 Impact Rating

Physical Presence

As indicated in Section 7.2.13, the impacts of the physical presence of project infrastructures to seabed occupation and use in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area include a modification in current seabed occupation on a very small area: <0.3 km^2. This modification will have no interference with other users since no anthropogenic activities have been identified in the concerned seabed area.

The intensity of the impact is low. The small adverse changes on the seabed are unlikely to be noticed. The extent of the impact will be limited to the infrastructure footprint. Its duration is considered here for the whole life of the project and beyond as the impact is permanent. Based on the combination of these criteria, the consequence of the impact will be negligible. Even if this impact is likely to happen, its overall significance is rated 1 – Negligible (details are provided in Table 7-90).

Table 7-90. Impacts to Land & Seabed Occupation and Use during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Nearshore/ Hub Terminal; Pipeline	Modifications in current seabed occupation on an area <0.3 km^2 due to presence of project infrastructures.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term (permanent)	Negligible	Likely	1 – Negligible

7.3.13.4 Mitigation Measures and Residual Impacts

The impact being rated 1 – Negligible, no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D19: The relevant maritime, port or shipping authorities will be notified of all permanent offshore facilities, as well as safety zones and routine shipping routes to be used by project-related vessels. Permanent facility locations will be demarcated on nautical charts.

7.3.14 Maritime Navigation

High Level Summary

In this section on Maritime Navigation, the impact of three impact producing factors, these being Physical presence, Exclusion safety zones and Vessel movements, was evaluated. The residual impacts on Maritime Navigation during the Operations Phase for routine activities were assessed as of negligible or low significance when mitigation measures are applied.

7.3.14.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	
Exclusion safety zones	●	●	●	
Vessel movements	●	●	●	●

While two IPFs include noise, only the physical presence of the infrastructures and the vessel movements can impact maritime navigation. Therefore, noise is not discussed here. Additionally, the exclusion safety zones around the infrastructures are addressed together with the physical presence of those infrastructures since they combine to potentially interfere with maritime navigation.

7.3.14.2 Impact Description

The following subsections explain how the IPFs will potentially produce impacts in each of the project areas.

7.3.14.2.1 Offshore Area

Physical Presence, Exclusion Safety Zones and Vessel Movements

No exclusion safety zone is associated with the wells after their drilling which have been addressed under the Construction Phase. Additionally, no exclusion safety zone is associated with the SPS once installed during the Construction Phase. Finally, no project vessels movements are expected in the Offshore Area after the Construction Phase except for well maintenance when needed. During these punctual maintenance operations, a 500-m exclusion safety zone will be established around the ship from which the maintenance operations will be conducted. Standard international and national maritime communication procedures will enable offshore maritime traffic and shipping to go around the exclusion safety zone without significantly modifying their usual maritime route. Therefore, the punctual maintenance activities in the Offshore Area during the Operations Phase will have no significant interference with maritime navigation and it is not discussed further.

7.3.14.2.2 Nearshore Hub/Terminal Area

Physical Presence and Exclusion Safety Zones

As previously mentioned, the Nearshore Hub/Terminal Area is located in an artisanal fishing area with a concentration of pirogues as shown on Figures 4-35 and 4-36 in Chapter 4. As indicated in Section 7.2.14, it is expected that the physical presence of the breakwater (approximately 10 km from the coast) and its exclusion safety zone will interfere with maritime navigation of pirogues.

Interference will start during the Construction Phase and it will continue throughout the whole life of the project and beyond (permanent impact). The impacts identified during the Construction Phase will remain the same throughout the Operations Phase. To avoid redundancy, their description is not repeated here.

Vessel Movements

During operations, vessel movements will occur in and out the exclusion safety zone around the breakwater on a regular basis. Typical vessel usage during operations is provided in Table 2-6 in Chapter 2. This information is reported in Table 7-91 with indication on assumed use in the Nearshore/Hub Terminal Area and the FPSO location.

Table 7-91. Typical Vessel Usage During Operations at the Nearshore Hub/Terminal Area and at the FPSO.

Vessel	Number Used	Days Used	Assumed Use at Nearshore Hub/Terminal Area and FPSO Location
Tug boat	4	Every 2 days	2 at hub, 2 at FPSO
Supply vessel	2	Every 2 -3 days	1 each at hub and FPSO
Crew boat	3	Every 2-3 days	2 at hub, 1 at FPSO
LNGC	1	Every 10-11 days	Hub only
Condensate carrier	1	Every 65-70 days	FPSO only
Mooring Line vessel	3	Every 2 days	2 at hub, 1 at FPSO
Project Patrol Boats	2	365	1 each at hub and FPSO
Total	16		9 at hub and 7 at FPSO

As indicated in Table 7-91, it is expected that 9 vessels will be operating in the Nearshore/Hub Terminal Area. Seven of them will be used every 2-3 days, while the LNGC will be used every 10-11 days (3 times/month) and the project patrol boat will be operating 7/7.

The vessels that will be used every 2-3 days will travel to/from the Ports of Dakar and/or Nouakchott. It is assumed that the LNGC carrier will travel directly to/from its international destination.

These vessel movements will last during the 20-year Operations Phase.

7.3.14.2.3 Pipeline Area

Physical Presence and Exclusion Safety Zones

As indicated in Section 7.2.14, the physical presence of the FPSO and its 500-m exclusion safety zone, might interfere with maritime navigation. However, the location of the FPSO is out of the maritime navigation and shipping corridor offshore Mauritanian and Senegalese coasts. Being located in a 120-m water depth, the FPSO could potentially interfere with the navigation of pirogues since artisanal fishing is generally conducted in water depths up to 200 m. This interference will start during the Construction Phase and it will continue throughout the whole life of the project. The impacts identified during the Construction Phase will remain the same throughout the Operations Phase. To avoid redundancy, their description is not repeated here.

Vessel Movements

As indicated on Table 7-91, it is estimated that 7 vessels will be coming in/out of the FPSO location on a regular basis during the Operations Phase. Five of them will be used every 2-3 days, while the condensate carrier will be used every 65-70 days (5-6 times/year) and the guard vessel will be operating 7/7.

These vessel movements will last during the 20-year Operations Phase.

7.3.14.2.4 Support Operations Areas

Vessel Movements

As indicated on Table 7-91, about 9 vessels (the tug boats, the supply vessels and the crew boats) will be moving in and out of the Ports of Dakar and Nouakchott during the Operations Phase. These movements will not be noticeable against background traffic in these ports.

7.3.14.2.5 Summary

Table 7-92 provides a summary of exclusion safety zones as a result of physical infrastructure emplacement and Table 7-93 provides a summary of the estimated number of project vessels by project area.

Table 7-92. Area of Exclusion Safety Zones by Project Area for the Operations Phase.

Project Area	Estimated Exclusion Safety Zones Sizes in km^2
Offshore Area	None
Nearshore Hub/Terminal Area	<3.25 km^2, i.e. about 1.6 km^2 in each country
Pipeline Area	<1 km^2, i.e. <500m^2 in each country
Total	<4.25 km^2, i.e. about 2.1 km^2 in each country

Table 7-93. Project Vessels by Project Area for the Operations Phase.

Project Area	Estimated Number of Project Vessels
Offshore Area	None
Nearshore Hub/Terminal Area	9
Pipeline Area	7
Total	16

7.3.14.3 Impact Rating

Physical Presence and Exclusion Safety Zones

As planned by the project, proper information on the exact project vessels location and operation calendar will be provided to mariners through standard international and national communication channels. In Mauritania, information will be provided through the Department of Merchant Marine Activities and in Senegal, it will be provided through the National Agency on Maritime Affairs.

In the Pipeline Area and in the Nearshore Hub/Terminal Area, the physical presence of project infrastructures and their exclusion safety zones will interfere with the navigation of artisanal fishing boats. The pirogues will need to adjust their navigation routes to avoid two exclusion safety zones: a <1 km^2 zone around the FPSO and a <3.25 km^2 zone around the breakwater. However, these exclusion safety zones being located on the maritime border, the size of the exclusion safety zones for the fishermen operating in each country will be divided by two: <0.5 km^2 around the FPSO and about 1.6 km^2 around the breakwater.

As planned by the project, information will be provided to the local fishing communities to communicate and record the exclusion safety zones and applicable navigational charts. This communication procedure will enable pirogues to avoid the exclusion safety zones. The pirogues navigate in a very large area in Mauritanian and Senegalese waters. The need to avoid one <500 m^2 area located about 40 km from the coast and one 1.6 km^2 area located 10 km from the coast, will not significantly modify their multiple navigation routes. The intensity of the impact will be low and its extent will be limited to the immediate vicinity of the project infrastructures. The impact will last during the whole life of the project. Based on the combination of these criteria, the consequence of the impact will be negligible. Even if this impact is likely to happen, its overall significance is rated 1 – Negligible (details are provided in Table 7-94).

Vessel Movements

Vessel movements in the Nearshore Hub/Terminal Area and the Pipeline Area could potentially entail risks of collision notably with non-project vessels. This subject is also discussed in Chapter 8.

To comply with international regulation, it is assumed that all project vessels will follow the Convention on International Regulations for Preventing Collisions at Sea (COLREGs) adopted by the IMO. These rules cover things such as steering/sailing, lights and shapes, light and sound signals, international distress signals, and signals with other vessels in close proximity, including fishing boats.

To reduce the risks of collision with non-project vessels, the project design includes exclusion safety zones. As previously mentioned, the exclusion safety zones established around all project facilities and the navigation rules for project vessels will minimize collision potential during all project phases. Designated travel and approach plans will be used to manage project vessels and the designated exclusion safety zones will be enforced with project patrol boats.

In addition, the boundaries of the exclusion safety zone around the breakwater will be demarcated through the use of:

- Marker buoys equipped with audio and visual warnings effective by both day and night in the prevailing sea conditions;
- Long life (LED or similar) bulbs;
- Anchored at pre-set intervals;
- Positioned to demarcate shipping lanes used for entry/exit and safety areas around fixed assets; and
- Tamper-proof design, anti-climb and not suitable for small vessels to use as a mooring.

To deter incursion to the exclusion safety zone around the Nearshore Hub/Terminal Area, a minimum of one project patrol boat will be used to control this area.

However, a risk of collision could happen between non-project vessels and project vessels transiting out of the exclusion safety zones. The total number of project vessels moving in and out the exclusion safety zones during the Operations Phase is estimated at 16: 9 in the Nearshore Hub/Terminal Area and 7 at the FPSO location.

As indicated in Section 7.2.14, the Nearshore Hub/Terminal Area and the FPSO are located out of the main maritime traffic corridor offshore the Mauritanian and Senegalese coasts. While the risk of collision with larger boats is not excluded, the main concern revolves around risks of collisions with pirogues. Pirogues could be present at the FPSO location, about 40 km from the coast, and they are likely to be present in the Nearshore Hub/Terminal Area, located about 10 km from the coast.

As indicated in Section 7.2.14, pirogues are particularly sensitive to a collision incident. The movements of the project vessels moving in/out of the Nearshore Hub/Terminal Area will be noticeable since the current background traffic in this area is limited to pirogues. However, the movement of the project vessels will be less important during the Operations Phase than during the Construction Phase. It will go from about 29 project vessels in the Nearshore Hub/Terminal during the Construction Phase to 9 project vessels during the Operations Phase. Similarly, it will go from about 25 vessels in the Pipeline Area during the Construction Phase to 7 project vessels during the Operations Phase.

Additionally, any risk of collision with pirogues in the two areas should decrease during the Operations Phase due to the mitigation measures implemented during the 3-year Construction Phase.

However, the intensity of the impact is still considered high since collisions resulting in fatalities could still happen. Its extent is limited to the areas where the project activities are conducted. The duration of the impact is considered long term: in case of a fatality, the impact would be irreversible. Based on the combination of these criteria, the consequence of the impact will be moderate. While the likelihood of a collision would decrease during the Operations Phase, it is still considered occasional as a collision could happen more than one time during the 20-year operation. As a result, the overall significance of the impact is still rated 3 – Medium (details are provided in Table 7-94).

Table 7-94. Impacts to Maritime Navigation during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence and Exclusion Safety Zones						
Mauritania Senegal	Pipeline; Nearshore/ Hub Terminal	Roundabout for pirogues to avoid in each country one <500 m² exclusion safety zone located 40 km from the coast and one <1.6 km² exclusion safety zone located 10 km from the coast due to project infrastructures and their exclusion safety zones.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term (permanent)	Negligible	Likely	1 – Negligible
Vessel Movements						
Mauritania Senegal	Pipeline; Nearshore/ Hub Terminal	Risk of collision between project vessels and pirogues due to project vessels movements.	Nature: Negative Intensity: High Spatial Extent: Immediate vicinity Duration: Long term (potentially irreversible)	Moderate	Occasional	3 – Medium

7.3.14.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-95) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the measures and controls already planned in the project design, summarized as follows:

- D19: The relevant maritime, port or shipping authorities will be notified of all permanent offshore facilities, as well as safety zones and routine shipping routes to be used by project-related vessels. Permanent facility locations will be demarcated on nautical charts.
- D20: Project vessels will follow the Convention on International Regulations for Preventing Collisions at Sea (COLREGs) adopted by the IMO.
- D21: Main project vessels will be equipped with Universal Shipborne Automatic Identification System (AIS), a system of transponders installed on vessels which transmit over two dedicated digital marine VHF channels.

- D22: Standard communication procedures will be used in international maritime traffic and shipping, aided by project patrol boats or standby vessels near the drilling, pipelay and Nearshore Hub/Terminal Area to prevent collision with larger vessels.
- D23: Information will be provided to the national industrial fishing fleet of both Mauritania and Senegal to communicate and record the exclusion safety zones and applicable navigational charts.

The measures proposed to reduce the risk of collision during the Operations Phase are identical to the measures identified for the Construction Phase. If needed, the measures in Table 7-95 should be adjusted before the Operations Phase starts to reflect the results of their implementation during the Construction Phase.

Table 7-95. Mitigation Measures to Avoid or Reduce Impacts to Maritime Navigation from Routine Activities during the Operations Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Risk of collision between project vessels and pirogues due to project vessels movements.	3 – Medium	M08, M09, M10, M11, M12, M13, M14, M15, M16, M17, M18, M19	2 – Low

Notes:

M08: Develop and implement a training and awareness program targeting local fishing communities on the specific maritime safety rules associated with the project.

M09: Provide regular notices to mariners in the appropriate form and language to artisanal fishermen on project infrastructure, associated exclusion safety zones, travel and approach plans and the approximate timing of project activities.

M10: Equip the support vessels and other project vessels that regularly move outside the construction or operational exclusion safety zones with radar or infrared systems that can detect small fishing vessels during poor visibility/night time.

M11: Provide adequate lighting aboard the support vessels and other project vessels that regularly move outside the construction or operational exclusion safety zones with the intent of maintaining high visibility during poor visibility/night time. These vessels will also feature searchlights that can be used to shine on or signal approaching pirogues and foghorns for audible signaling.

M12: Having a project patrol boat to monitor the exclusion safety zones, including patrolling ahead of the approach or exiting of larger project vessels into or out of the exclusion safety zones.

M13: Using the services of local fishermen liaison officers (FLOs) aboard the project patrol boats in the areas of artisanal fishing.

M14: Equipping the support vessels and the project patrol boat with lifesaving appliances approved by the Convention for Safety of Life at Sea (SOLAS) and IMO, which can be used to assist in rescuing fishermen in the water in line with international maritime protocols or in the event of an accident involving a pirogue with a project vessel. Assist with the rescue of any fishermen involved in a collision with a project vessel or following the capsizing of their vessel due to ship wake.

M15: In case of a collision, BP will inform as soon as possible the relevant national authorities: the Mauritanian Coast Guard (Garde Côte Mauritanienne) in Mauritania and HASSMAR in Senegal.

M16: Ensuring that each project vessel keeps records of maritime safety incidents with pirogues and other vessels, including near misses, and that these are subsequently shared with the project. BP will monitor maritime safety incidents and adjust, if required, project specific maritime safety rules, security and search & rescue arrangements in place.

M17: Establishing a grievance mechanism easily accessible to fishing communities members that includes monitoring of claims and the resolution thereof.

M18: Maintaining a community liaison officer (CLO) for N'Diago and Saint-Louis to provide a direct link with the fishing communities.

M19: Collaboration with a community council of formally nominated representatives of local key stakeholders from N'Diago and Saint-Louis set up to review local fishing communities' concerns and grievances related to the project.

7.3.15 Industrial Fisheries

High Level Summary

In this section on Industrial Fisheries, the impact of three impact producing factors, these being Physical presence, Exclusion safety zones and Vessel movements, was evaluated. All residual impacts on Industrial Fisheries during the Operations Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

7.3.15.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●		
Exclusion safety zones	●	●		
Vessel movements	●	●		

While two IPFs include noise, only the physical presence of the infrastructures and the vessel movements can impact the industrial fisheries. Therefore, noise is not discussed here. Additionally, the exclusion safety zones around the infrastructures are addressed together with the physical presence of those infrastructures since they combine to potentially interfere with industrial fisheries.

7.3.15.2 Impact Description

The following subsections explain how the IPFs will potentially produce impacts in each of the project areas.

7.3.15.2.1 Offshore Area

Physical Presence, Exclusion Safety Zones and Vessel Movements

No exclusion safety zone is associated with the wells after their drilling which have been addressed under the Construction Phase. Additionally, no exclusion safety zone is associated with the SPS once installed during the Construction Phase. Finally, no project vessel movements are expected in the Offshore Area after the Construction Phase except for well maintenance when needed. Therefore, the activities in the Offshore Area during the Operations Phase will have no interference with industrial fisheries.

7.3.15.2.2 Nearshore Hub/Terminal Area

Physical Presence, Exclusion Safety Zones and Vessel Movements

The physical presence of the breakwater, the exclusion safety zone around it and the vessel movements in the Nearshore Hub/Terminal Area will have no impacts on the industrial fisheries since none is conducted in this area.

7.3.15.2.3 Pipeline Area

Physical Presence and Exclusion Safety Zones

The FPSO will be located at a distance of approximately 40 km from the coast on the Mauritania and Senegal maritime border in 120 m water depth. Industrial fishing could potentially be conducted in that area. With a radius of 500 m, the exclusion safety zone around the FPSO will be <1 km^2. While this exclusion safety zone will start during the Construction Phase, it will last during all phases of the project.

Any long-term loss of an area <1 km^2 located along the Mauritania and Senegal maritime border is unlikely to be noticed or measurable against background industrial fishing grounds in Mauritania and Senegal.

Vessel Movements

As indicated on Table 7-91, it is expected that 7 project vessels will be moving in and out the FPSO exclusion safety zone during the 20-year Operations Phase.

The presence of those 7 vessels is unlikely to be noticed or measurable against background maritime traffic around the FPSO location where industrial fishing could potentially occur. Therefore, no interference is expected with industrial fishing boats in the Pipeline Area.

7.3.15.2.4 Support Operations Areas

The Support Operation Areas being on shore, the activities conducted in those areas will have no impact on the industrial fisheries.

7.3.15.2.5 Summary

Table 7-96 provides a summary of exclusion safety zones as a result of physical infrastructure emplacement which will preclude any industrial fishing activities.

Table 7-96. Potential Industrial Fishing Grounds Losses by Project Area for the Operations Phase.

Project Area	Estimated Potential Industrial Fishing Ground Losses in km^2
Offshore Area	None
Nearshore Hub/Terminal Area	Not applicable
Pipeline Area	<1 km^2
Total	<1 km^2

7.3.15.3 Impact Rating

Physical Presence and Exclusion Safety Zones

The impacts of the physical presence of project infrastructures and their exclusion safety zones in the Pipeline Area include interference with existing potential industrial fishing grounds in the Mauritanian and the Senegalese waters. In both countries, the industrial fleet consists mainly in foreign boats. Therefore, any impact on the industrial fishing activity is considered for the industry as a whole, with no country specific considerations.

Around the FPSO, the loss of <1 km^2 of potential industrial fishing grounds will last during the whole life of the project.

Standard international and national communication procedures will enable industrial fishing boats to avoid the exclusion safety zone around the FPSO without significantly modifying their potential fishing grounds. The intensity of the impact will be low and its extent will be limited to the exclusion safety zone. The loss of potential fishing grounds around the FPSO will last during the whole life of the project. Based on the combination of these criteria, the consequence of the impact will be negligible. Even if the impact is likely to happen and it is rated 1 – Negligible (details are provided in Table 7-97).

Table 7-97. Impacts to Industrial Fisheries during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence and Exclusion Safety Zones						
Mauritania Senegal	Pipeline	Loss of potential industrial fishing grounds of <1 km^2 due to presence of FPSO and its exclusion safety zone.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 – Negligible

7.3.15.4 Mitigation Measures and Residual Impacts

Impacts being rated 1 – Negligible, no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D19: The relevant maritime, port or shipping authorities will be notified of all permanent offshore facilities, as well as safety zones and routine shipping routes to be used by project-related vessels. Permanent facility locations will be demarcated on nautical charts.
- D20: Project vessels will follow the Convention on International Regulations for Preventing Collisions at Sea (COLREGs) adopted by the IMO.
- D21: Main project vessels will be equipped with Universal Shipborne Automatic Identification System (AIS), a system of transponders installed on vessels which transmit over two dedicated digital marine VHF channels.
- D22: Standard communication procedures will be used in international maritime traffic and shipping, aided by project patrol boats or standby vessels near the drilling, pipelay and Nearshore Hub/Terminal Area to prevent collision with larger vessels.
- D23: Information will be provided to the national industrial fishing fleet of both Mauritania and Senegal to communicate and record the exclusion safety zones and applicable navigational charts.

7.3.16 Artisanal Fisheries and Related Activities

High Level Summary

In this section on Artisanal Fisheries and Related Activities, the impact of three impact producing factors, these being Physical presence, Exclusion safety zones and Vessel movements, was evaluated. The residual impacts on Artisanal Fisheries and Related Activities during the Operations Phase for routine activities were assessed as of negligible or low significance when mitigation measures are applied.

7.3.16.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Exclusion safety zones		●	●	
Vessel movements		●	●	

The exclusion safety zones are addressed together with the physical presence of the infrastructures since they combine to potentially interfere with the artisanal fisheries and related activities. While two IPFs include noise, only the physical presence of the infrastructures and the vessel movements can impact the artisanal fisheries and related activities. As indicated in Section 2.12.2, the primary sources of airborne sound from vessels and facilities are uses of machinery, such as engines, generators, pumps, cranes, etc. Airborne sound generated by any activities associated with the facilities will be managed by the project. The airborne sound levels at all facilities are required to meet the applicable occupational health working limits which in turn is unlikely to result in unacceptable sound level for other sea users, especially since they will be kept out of a 500 m exclusion safety zone.

7.3.16.2 Impact Description

The following subsections explain how the IPFs will potentially produce impacts in each of the project areas.

7.3.16.2.1 Offshore Area

As indicated in Section 7.2.16.2.1, the physical presence of project infrastructures, their exclusion safety zones and the vessel movements in the Offshore Area will have no impacts on the artisanal fisheries and related activities since none is conducted in this area located in approximately 2,700 to 2,800 m water depth, about 125 km from the coast.

7.3.16.2.2 Nearshore Hub/Terminal Area

Physical Presence and Exclusion Safety Zones

The physical presence of the breakwater and the exclusion safety zone around it in the Nearshore Hub/Terminal Area during the Operations Phase could affect artisanal fishing grounds and obstruct access to fishing grounds.

As detailed in Section 7.2.16, the physical presence of the breakwater and its exclusion safety zone will entail the loss of about 3.24 km^2 of potential fishing ground, i.e. about 1.6 km^2 in Mauritanian and 1.6 km^2 in Senegal. This potential loss will start during the Construction Phase and will stay the same throughout the 20-year Operations Phase.

As previously mentioned, there are no traditional systems that define ownership, access to and use of fishing resources or fishing grounds in the maritime waters of Mauritania or Senegal. Few Mauritanian fishermen operate in proximity of the Mauritania-Senegal maritime border. Indeed, the waters there are less rich than they are farther north. In general, the southern fishing zone is of little interest for Mauritanian artisanal fishermen. Productivity indicators for artisanal fishing per zone in Mauritania indicate that the southern fishing zone, in which the breakwater is located, only accounts for 2% of national catches.

However, the fishermen of Senegal do fish at the maritime border. In Senegal, Saint-Louis is by far the main locality in terms of number of fishermen. Saint-Louis fishermen operate offshore Saint-Louis, especially on the Mauritania-Senegal maritime border, but they also fish all along the coast and in neighboring countries. Similarly, fishermen from other coastal villages of the Grand Côte also travel and their fishing grounds could potentially include locations offshore Saint-Louis. Fishermen do not limit themselves to waters close to the locality where they live. The important geographical mobility of the Senegalese fishermen makes the analysis of their fishing grounds complex.

While it is reasonable to assume that most fishermen fishing offshore Saint-Louis probably live in this city, they are not the only Senegalese fishermen in that area. Therefore, no fishing ground losses can be linked to one specific coastal community. The fishing ground losses analysis needs to consider the larger area of the coastal waters.

Vessel Movements

As indicated in Table 7-91, it is planned that 9 project vessels will be used in the Nearshore Hub/Terminal Area during the 20-years of operation.

Impact of project vessels movements on the navigation of artisanal fishing boats includes risks of collision in the Nearshore Hub/Terminal Area during the Operations Phase. This has been assessed in Section 7.3.14.

Additionally, project vessel movements could interact with artisanal fishermen gears. All 9 project vessels coming in/out of the exclusion safety zone around the breakwater could interfere with artisanal fishermen gears. Due to the large number of fishing nets deployed in the coastal waters offshore Saint-Louis and the length of the nets (up to 500 m), the fishing nets could be difficult to avoid for project vessels. There is a risk for project vessels to cross over fishing nets and buoys and, in some cases, damaging them. This would entail fishing gear losses for artisanal fishermen.

7.3.16.2.3 Pipeline Area

Physical Presence and Exclusion Safety Zones

The FPSO will be installed in the Pipeline Area, at a distance of approximately 40 km from the coast on the Mauritania and Senegal maritime border in 120 m water depth. With a radius of 500 m, the exclusion safety zone around the FPSO will be <1 km^2. Any fishing ground losses for artisanal fisheries around the FPSO would be less than 0.5 km^2 in each country.

Vessel Movements

Impact of vessel movements on the navigation of artisanal fishing boats and risks of collision in the Pipeline Area have been assessed in Section 7.3.14. There is a risk for project vessels to cross over fishing nets and buoys and in some cases, damaging them. This would entail fishing gear losses for artisanal fishermen. All 7 project vessels coming in/out of the FPSO exclusion safety zone could interfere with artisanal fishermen gears.

7.3.16.2.4 Support Operations Areas

The Support Operation Areas being on shore in existing ports and airports, the activities conducted in those areas will have no impact on artisanal fisheries and related activities.

7.3.16.2.5 Summary

Table 7-98 provides a summary of exclusion safety zones as a result of physical infrastructure emplacement which will preclude any artisanal fishing activities. Table 7-99 summarizes the number of project vessels that could potentially interfere with fishing gears.

Table 7-98. Potential Artisanal Fishing Grounds Losses by Project Area for the Operations Phase.

Project Area	Estimated Potential Artisanal Fishing Ground Losses in km^2 – Two Countries	Estimated Potential Artisanal Fishing Ground Losses in km^2 – Per Country
Offshore Area	Not applicable	Not applicable
Nearshore Hub/Terminal Area	<3.25 km^2	About 1.6 km^2
Pipeline Area	<1 km^2	<0.5 km^2
Total	<4.25 km^2	About 2.1 km^2

Table 7-99. Project Vessels Potentially Interfering with Artisanal Fishing Gears by Project Area for the Operations Phase.

Project Area	Estimated Number of Project Vessels	Estimated Maximum Duration
Offshore Area	Not applicable	Not applicable
Nearshore Hub/Terminal Area	9 vessels	20 years
Pipeline Area	7 vessels	20 years
Total	16 vessels	20 years

7.3.16.3 Impact Rating

Physical Presence and Exclusion Safety Zones

The impacts of the physical presence of project infrastructures and their exclusion safety zones in the Nearshore Hub/Terminal Area and in Pipeline Area include interference with existing potential artisanal fishing grounds in Mauritania and Senegal.

The loss of potential fishing grounds around the FPSO and the breakwater will start during the Construction Phase and it will last during all phases of the project and beyond (permanent impact).

The loss of <1 km^2 of potential fishing grounds around the FPSO is of little concern since the FPSO is located about 40 km from the shore. While there might be some artisanal fishing activities going on in the area, they would be marginal. Therefore, the loss in each country of <0.5 km^2 of potential artisanal fishing grounds around the FPSO is unlikely to be noticeable.

At the breakwater location, the loss of access to <3.25 km^2 of potential artisanal fishing grounds will be split each side of the border. As a result, access to about 1.6 km^2 of potential fishing grounds will be lost in each country.

In Mauritania, the consequence of losing an access to about 1.6 km^2 of potential artisanal fishing grounds on the maritime border is not significant since very few Mauritanian fishermen fish in this area.

In Senegal, the maritime border area is currently under more fishing pressure than usual, due to the fact that the prohibition of Senegalese fishing boats in Mauritanian waters has accentuated the fishing efforts on Senegal's side of the border. Although the loss of access to about 1.6 km^2 of potential artisanal fishing grounds is not significant in itself, it may slightly increase the fishing pressure caused by the Mauritanian fishing ban in the area. Indeed, this ban would be much more determinant on any fishing pressure off Saint-Louis than the 1.6 km^2 exclusion safety area.

As a result, the intensity of the impact of the project on artisanal fishing grounds will be low. The extent will be limited to the infrastructures and their exclusion safety zones. It will last during the whole life of the project. Based on the combination of these criteria, the consequence of the impact will be negligible. While the impact is likely to happen, its overall significance is rated 1 – Negligible (details are provided in Table 7-100).

The loss of about 1.6 km^2 of potential artisanal fishing grounds in each country should not entail any increased competition on existing fishing grounds. In a similar manner, it should not entail any loss of catches. Therefore, it should not affect fishing-related economic activities either, for instance the processing of fish catches by women.

Section 7.3.6 shows that the impacts of the project on plankton, fishes and other fishery resources during the Operations Phase will be negligible except for one that will be low. The attraction of fishes to SPS, FPSO and Breakwater structures, and the entrainment of plankton in FLNG cooling water at the Nearshore Hub/Terminal will have a negative impact rated low. After implementation of the proposed mitigation measure, this impact will be negligible. As a result, no indirect impacts are expected on artisanal fisheries.

As indicated previously, the perception of an impact might be very different from the impact itself. Perceived loss of fishing grounds and fishing catches during the Operations Phase is discussed in Section 7.3.26 (Social Climate).

Vessel Movements

In addition to the risk of collision that has been addressed in Section 7.3.14.2, the impact of project vessel movements includes risks of artisanal fishing gear losses in the Nearshore Hub/Terminal Area and around the FPSO in the Pipeline Area. The risks are associated with the 16 project vessels that will be in these two areas during the Operations Phase. The impact is similar to the one noted during the Construction Phase. The intensity of the impact is considered moderate as it could cause adverse changes that will be noticeable and could potentially affect several people. The extent is limited to the areas where project activities will be conducted. The duration will last throughout the Operations Phase. Based on the combination of these criteria, the consequence of the impact will be minor. Because the impact is likely to happen, its overall significance is rated 2 – Low (details are provided in Table 7-100).

Table 7-100. Impacts to Artisanal Fisheries and Related Activities during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence and Exclusion Safety Zones						
Mauritania Senegal	Nearshore/ Hub Terminal	Loss of potential artisanal fishing grounds of up to <3.25 km^2, i.e. about 1.6 km^2 in each country, due to project infrastructures and their exclusion safety zones.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 – Negligible
Vessel Movements						
Mauritania Senegal	Nearshore/ Hub Terminal; Pipeline	Potential loss of artisanal fishing gears (nets and buoys) due to project vessel movements in artisanal fishing areas.	Nature: Negative Intensity: Moderate Spatial Extent: Immediate vicinity Duration: Long term	Minor	Likely	2 – Low

7.3.16.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-101) and potential applicable mitigation measures are identified.

These measures are in addition to the existing measures inherent to design and operational controls:

- D19: The relevant maritime, port or shipping authorities will be notified of all permanent offshore facilities, as well as safety zones and routine shipping routes to be used by project-related vessels. Permanent facility locations will be demarcated on nautical charts.
- D24: Exclusion safety zones will be demarcated on applicable navigational charts, and a communication procedure will be developed to communicate the location of the exclusion safety zones to the local fishing communities. This is intended to allow pirogues to avoid the exclusion safety zones.

The mitigation measures proposed to reduce the loss of artisanal fishing gears during the Operations Phase are identical to the measures identified for the Construction Phase. If needed, the measures in Table 7-101 should be adjusted before the Operations Phase starts to reflect the results of their implementation during the Construction Phase. The proposed mitigation measures could reduce the likelihood of losses of artisanal fishing gear from likely to occasional. However, the residual impact would remain low since the overall impact significance of an impact with a minor consequence and an occasional likelihood is rated low (see overall impact significance matrix in Table 7-9)

Table 7-101. Mitigation Measures to Avoid or Reduce Impacts to Artisanal Fisheries and Related Activities from Routine Activities during the Operations Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Potential loss of artisanal fishing gears (nets and buoys) due to project vessel movements in artisanal fishing areas.	2 – Low	M09, M12, M13, M17, M18, M19, M20, M21, M22, M23, M24, M27	2 – Low

Notes:

M09: Provide regular notices to mariners in the appropriate form and language to artisanal fishermen on project infrastructure, associated exclusion safety zones, travel and approach plans and the approximate timing of project activities.

M12: Having a project patrol boat to monitor the exclusion safety zones, including patrolling ahead of the approach or exiting of larger project vessels into or out of the exclusion safety zones.

M13: Using the services of local fishermen liaison officers (FLOs) aboard the project patrol boats in the areas of artisanal fishing.

M17: Establishing a grievance mechanism easily accessible to fishing communities members that includes monitoring of claims and the resolution thereof.

M18: Maintaining a community liaison officer (CLO) for N'Diago and Saint-Louis to provide a direct link with the fishing communities.

M19: Collaboration with a community council of formally nominated representatives of local key stakeholders from N'Diago and Saint-Louis set up to review local fishing communities' concerns and grievances related to the project.

M20: Develop and implement a framework for interaction with artisanal fisheries, with provisions covering engagement with local communities on access to fishing grounds, grievance and recourse mechanism for damage to fishing gear, environmental awareness building, livelihood enhancement and the role of community liaison officers.

M21 Project vessels to record incidents with fishing gears and report them to the project.

M22 To the extent feasible, establish a maritime corridor or speed restrictions for project vessels within artisanal fishing areas.

M23: Implement an environmental awareness building program in association with local schools and community groups.

Although impacts on artisanal fisheries are low, the following additional measures are also planned in the context of the need for awareness building of the actual environmental impacts associated with the project and the need to address perceived impacts:

- M24: Provide technical assistance to mutually agreed marine resource research programs notably the national oceanographic research centers of both countries (CRODT and IMROP).
- M27: Developing a social investment program to enhance project benefits for the directly affected N'Diago and Saint-Louis communities, including livelihood enhancement activities.

7.3.17 Other Coastal & Sea Based Activities

High Level Summary

In this section on Other Coastal & Sea-Based Activities, the impact of three impact producing factors, these being Physical presence, Exclusion safety zones and Vessel movements, was evaluated. All impacts on Other Coastal & Sea-Based Activities during the Operations Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

7.3.17.1 Impact Producing Factors and Project Areas

In addition to potentially impacting maritime navigation and fisheries, the project could potentially impact other coastal and sea-based activities (or features): tourism and recreation and other oil and gas activities.

The IPFs identified for these resources in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Exclusion safety zones		●	●	
Vessel movements		●	●	

As indicated in Section 7.2.17, the assessment of Tourism and Recreation in Mauritania and in Senegal shows that no tourism or recreational activities, including deep-sea sport fishing, are currently conducted in the project's Offshore Area, Pipeline Area or Nearshore Hub/Terminal Area. For the purpose of this assessment, it is assumed that this will not change. Therefore, no project interference is expected with tourism and recreation during the Operations Phase. Additionally, Section 7.2.17 has indicated that no project interference is expected with any shipwreck during the Construction Phase since none is identified in the project areas. Therefore, no interference with shipwrecks is expected neither during the Operations Phase.

The only coastal and sea-based activity potentially impacted during the Operations Phase is oil and gas activities. It is discussed below.

7.3.17.2 Impact Description

The following subsections explain how the IPFs will potentially produce impacts in each of the project areas.

7.3.17.2.1 Offshore Area

As indicated in Section 7.2.17., the Offshore Area is located within the limits of Block C8 in Mauritania and within Block Saint-Louis Offshore Profond in Senegal, which are under BP's licenses. Therefore, activities conducted in the Offshore Area during the Operations Phase will have no impacts on oil and gas activities of other oil and gas operators.

7.3.17.2.2 Nearshore Hub/Terminal Area

Physical Presence and Exclusion Safety Zones

As indicated in Section 7.2.17, the Nearshore Hub/Terminal Area covers an area split each side of the Mauritania and Senegal maritime border. Appendix H provides a map with the licensed blocks off the Mauritanian coast and a similar map for the licensed blocks off the Senegalese coast.

On the Mauritania side, the Nearshore Hub/Terminal Area is located in Block C32, which is not currently under license. However, the license could be given to an oil and gas operator in the future. On the Senegalese side, the Nearshore Hub/Terminal Area is located in Block Saint-Louis Offshore. Oranto Petroleum Ltd (Oranto) currently holds a license for this block.

The physical presence of the breakwater and its exclusion safety zone would prevent any oil and gas exploration activities in a <3.5 km^2 area, i.e. about 1.6 km^2 in Block C32 in Mauritania and 1.6 km^2 in Block Saint-Louis Offshore in Senegal.

Vessel Movements

The project vessel movements in the Nearshore Hub/Terminal Area could potentially disturb other oil and gas exploration activities. Disturbance would come from the 9 project vessels coming in and out of the exclusion safety zone.

7.3.17.2.3 Pipeline Area

Physical Presence and Exclusion Safety Zones

As indicated in Section 7.2.17, the Pipeline Area crosses three blocks in Mauritania: C8, under a BP license, and C1 and C-32, which are not currently under license. In Senegal, the Pipeline Area crosses Block Saint-Louis Offshore Profond, under a BP license, and Block Saint-Louis Offshore, currently under Oranto license.

Any potential impact of the physical presence of infrastructures, noise and exclusion safety zones in the Pipeline Area would be similar to the potential impact identified in the Nearshore Hub/Terminal Area.

The physical presence of the FPSO and its exclusion safety zone would prevent any oil and gas exploration activities in a <1 km^2 area, i.e. <0.5 km^2 in Block C1 in Mauritania and <0.5 km^2 in Block Saint-Louis Offshore in Senegal.

Additionally, exploratory drilling activities would be precluded over the installed pipeline of 30-inch (about 76 cm) diameter that will extend from the FPSO to the breakwater. It is assumed that exclusion of exploratory drilling inside this very narrow corridor would not be significant for other oil and gas exploration activities.

Vessel Movements

Any potential impact of the vessel movements in the Pipeline Area would be identical to the potential impact identified in the Nearshore Hub/Terminal Area. The 7 vessel movements in the Pipeline Area could potentially disturb other oil and gas exploration activities.

7.3.17.2.4 Support Operations Areas

Activities planned in the Support Operations Areas will have no interference with any potential offshore oil and gas activities.

7.3.17.2.5 Summary

Table 7-102 provides a summary of the total area precluded from any other potential oil and gas exploration activities during the Operations Phase as a result of the physical presence of infrastructures and their exclusion safety zones. About 2.1 km^2 would be precluded from other oil and gas exploration activities in each country: a <0.5 km^2 area located about 40 km from the shore and about 1.6 km^2 located 10 km from the shore. This preclusion, started during the Construction Phase, will last during the whole life of the project.

Table 7-102. Area Precluded from Potential Other Oil and Gas Exploration Activities by Project Area for the Operations Phase.

Project Area	Total Estimated Area in km^2 Precluded from Potential Other Oil and Gas Exploration Activities	Estimated Area in km^2 Precluded from Potential Other Oil and Gas Exploration Activities – per Country
Offshore Area	Non applicable	Non applicable
Nearshore Hub/Terminal Area	<3.25 km^2	About 1.6 km^2
Pipeline Area	<1 km^2	<0.5 km^2
Total	<4.25 km^2	About 2.1 km^2

While the 16 project vessel movements in the Nearshore Hub/Terminal Area and the Pipeline Area could potentially disturb other oil and gas exploration activities, the project vessels movements would unlikely be noticed by other oil and gas exploration vessels against background maritime traffic.

7.3.17.3 Impact Rating

Any future oil and gas exploration activity in the blocks where the breakwater and the FPSO are located would need to avoid two small areas (<0.5 km^2 and about 1.6 km^2) in each country where exploration will be precluded.

It is assumed that these exclusion safety zones would not prevent the potential identification of areas in Mauritania and Senegal where hydrocarbons could be trapped in oil or gas-filled geological large structures. Therefore, the intensity of the impact is considered low. The extent is limited to about 2.1 km^2 in each country. The duration would be long term. Based on the combination of these criteria, the consequence of the impact would be negligible. Even if this impact is likely to happen, its overall significance is rated 1 – Negligible (details are provided in Table 7-103).

Table 7-103. Impacts to Other Coastal & Sea-Based Activities during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence and Exclusion Safety Zones						
Mauritania Senegal	Nearshore/ Hub Terminal; Pipeline	Preclusion of potential future oil and gas exploration activities in two small areas in each country (<0.5 km^2 and about 1.6 km^2) due to project infrastructures and their exclusion safety zones.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 – Negligible

7.3.17.4 Mitigation Measures and Residual Impacts

Impacts being rated 1 – Negligible, no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D19: The relevant maritime, port or shipping authorities will be notified of all permanent offshore facilities, as well as safety zones and routine shipping routes to be used by project-related vessels. Permanent facility locations will be demarcated on nautical charts.

7.3.18 Employment & Business Opportunities

High Level Summary

In this section on Employment & Business Opportunities, the impact of two impact producing factors, these being Vessel movements and Onshore logistic activities, was evaluated. All impacts on Employment & Business Opportunities during the Operations Phase for routine activities were assessed as positive.

7.3.18.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Vessel movements		●	●	
Onshore logistic activities				●

Since the project is being conducted at sea, much of the employment will be offshore. Employment at sea opportunities are considered under the IPF "Vessel movements". However, noise is irrelevant here and it is not discussed in the impact description. While employment opportunities offshore cover activities in the Pipeline Area and the Nearshore Hub/Terminal Area, they are discussed together under the Nearshore Hub/Terminal Area. Since no project activities will be conducted in the Offshore Area during the Operations Phase except for maintenance, no employment opportunities are associated with the Offshore Area.

7.3.18.2 Impact Description

The following subsections explain how the IPFs will potentially produce impacts in each of the project areas.

7.3.18.2.1 Offshore Area

Not applicable (See Section 7.3.18.1).

7.3.18.2.2 Nearshore Hub/Terminal Area

Vessel Movements

The number of personnel required for the Operations Phase is smaller than for the Construction Phase. As indicated in Section 2.13.1, the total number of employees required to work offshore during the Operations Phase is estimated at approximately 400 people maximum versus 1,500 during the Construction Phase. Out of these 400 people, about 130 would be working on project vessels and about 270 would be working at the breakwater location or on the FPSO.

It is not known at this time how many project vessels could be contracted in Mauritania and/or Senegal and how many people could be hired directly in these countries.

As indicated in Section 2.13.3, the project proponent will put in place an in-country employment and procurement policy. Recruitment will follow BP diversity and inclusion principles to target diverse candidates for example female, and personnel from different background. Recruitment will be open at National level, however, where possible will target local community talent. Application will be opened through different channels to increase awareness and accessibility to job offers.

It is assumed that the people required for the positions on the project vessels rented in Mauritania and/or Senegal will be filled in at a National level. Since the project vessels will be operating out of the Ports of Dakar and/or Nouakchott, it is also reasonable to assume that most of the positions will be filled in by people living in these two cities.

The 270 people working aboard the FPSO or at breakwater location will require very specialized skills. It is assumed that at the beginning of the Operations Phase, they will be hired internationally.

However, it is also reasonable to assume that the expatriate workers aboard the FPSO, at the breakwater location and on the project vessels could progressively be replaced by National workers during the course of the 20-year Operations Phase when Mauritanian and/or Senegalese are trained to fit the required professional profile. Expatriates will be required to commit to train a National worker to fill their role in the future. This principle will be included in BP expatriates annual performance plan.

It is also reasonable to assume that the 16 vessels required during the 20-year Operations Phase could progressively be contracted to National service providers.

7.3.18.2.3 Pipeline Area

The employment and business opportunities in the Pipeline Area are discussed together with the Nearshore Hub/Terminal Area in the above Section 7.3.18.2.2.

7.3.18.2.4 Support Operations Areas

Onshore Logistic Activities

The project will require manpower for onshore logistics in Dakar and/or Nouakchott. Based on the project proponent experience in other countries, the manpower needs for onshore logistics during the Operations Phase is estimated between 20 to 40 people. It is assumed that these needs will last during the whole Operations Phase. These 20 to 40 people will be direct employees as well as third-party contractors. It is not known at this time how many of these employees will be international. It is assumed that during the course of the 20-year Operations Phase, most of the 20-40 positions will be filled in by National workers.

As indicated in Section 7.3.18.2.2, the project proponent will put in place an in-country employment and procurement policy. Recruitment will follow BP diversity and inclusion principles to target diverse candidates for example female, and personnel from different background. Recruitment will be open at National level, however, where possible will also target local community talent. Application will be opened through different channels to increase awareness and accessibility to job offers.

It is assumed that the 20-40 people required for onshore logistics in Mauritania and/or Senegal will be filled in at a National level. Since the onshore logistics will be conducted out of Dakar and/or Nouakchott, it is assumed that most of the positions will be filled in by people living in these two cities.

The onshore logistics will create business opportunities for the National companies who will provide services as third-party contractors. While the number of potential National third-party contractors is not known yet, the manpower required (20 to 40) suggests that 2-3 National companies will be contracted in total.

Additionally, BP's local procurement management policy will focus on developing opportunities in Mauritania and Senegal to support the supply chain for the project. As indicated in Section 7.2.18, a preliminary list of target services that could potentially be sourced in Mauritania and/or Senegal has been identified. At this stage of the project planning, it is difficult to quantify the business opportunities and indirect employment that could be created to support the supply chain during the Operations Phase. However, this procurement approach could ultimately create a multiplier effect within the communities and promote retained value in Mauritania and/or Senegal.

As indicated previously, quantitative evidence show that local content has positive effects on local economies that can be measured by calculating the direct, indirect and induced effects of operations. While the project budget dedicated to local procurement is not known at this stage, quantitative evidence shows that the local procurement approach will have a positive multiplier effect on the economy of Mauritania and Senegal and their human capital development.

7.3.18.2.5 Summary

Table 7-104 provides a summary of employment opportunities in the Operations Phase and Table 7-105 provides a summary of business opportunities during this phase. Since the project onshore logistics and support vessels will be located in Dakar and/or Nouakchott, the employment and business opportunities are likely to be concentrated in these two cities.

Table 7-104. Potential National Employment Opportunities by Project Area for the Operations Phase.

<table>
<tr><th>Project Area</th><th>Estimated Number of Positions and Duration</th></tr>
<tr><td>Offshore Area</td><td rowspan="3">About 400 people including a number of Mauritanian and Senegalese workers increasing progressively over 20 years</td></tr>
<tr><td>Nearshore Hub/Terminal Area</td></tr>
<tr><td>Pipeline Area</td></tr>
<tr><td>Support Operations Areas</td><td>20 to 40 people during 20 years</td></tr>
</table>

Table 7-105. Potential National Business Opportunities by Project Area for the Operations Phase.

<table>
<tr><th>Project Area</th><th>Estimated Number of Business Opportunities and Duration</th></tr>
<tr><td>Offshore Area</td><td rowspan="3">Vessel providers for about 16 vessels including Mauritanian and Senegalese providers increasing progressively over 20 years</td></tr>
<tr><td>Nearshore Hub/Terminal Area</td></tr>
<tr><td>Pipeline Area</td></tr>
<tr><td>Support Operations Areas</td><td><2-3 service providers during about 20 years</td></tr>
</table>

7.3.18.3 Impact Rating

The project could provide onshore employment opportunities for 20-40 National workers during 20 years. These employment opportunities will be split between Mauritania and Senegal, and they will likely be concentrated in two cities: Dakar and Nouakchott.

Additionally, the project could provide offshore employment opportunities for up to 400 National workers that would fill in expatriate positions progressively over 20 years. It is expected that people from the two countries will progressively be trained to fill positions initially filled by expatriates. Similarly, some national companies would be expected to progressively develop and over time provide services initially provided by international companies.

The population of working age is about 2 million people in Dakar and over 580 000 people in Nouakchott. The employment opportunities created by the project will not have a significant impact on the cities employment figures. However, they will be beneficial for up to 20-40 National workers during 20 years and, progressively, an additional up to 400 workers. In addition, local Fisheries Liaison Officers or Community Liaison Officers will also be required in N'Diago and Saint-Louis during the Operations Phase. These employment opportunities, split between the two countries, will result in a positive impact (Table 7-106).

There are a lot of uncertainties on the profile that will be required for the employment opportunities onshore and offshore. As a result, it is not possible to determine if these opportunities will create equal employment opportunities for women and for men. However, there is usually an under-representation of women in the oil and gas industry. It could also be the case at the beginning of the 20-year Operations Phase of the project but it could also change over the course of the project. Due to the limited number of employment opportunities that will be created in each country, any gender imbalance would have limited consequence on the overall employment situation of women.

Business opportunities could concern 2 or 3 National services providers for onshore logistics in Dakar and/or Nouakchott during the 20-years Operations Phase. Additionally, services providers in Dakar and/or Nouakchott could provide up to 16 project vessels if available in country. Due to the small number of business opportunities and the limited scope of services that will be provided, the potential contracts will not have a significant impact on business opportunities in Dakar and Nouakchott. However, they will be beneficial to the concerned third-party contractors, resulting in a positive impact (Table 7-106).

Additionally, the local procurement policy that will be implemented to support the supply chain for the project will create additional business and indirect employment opportunities. Ultimately, this could create a multiplier effect within the communities and promote retained value in Mauritania and/or Senegal. While this cannot be quantified at this stage of the project, the result will be beneficial and it will result in a positive impact (Table 7-106).

Table 7-106. Impacts to Local Employment & Business Opportunities during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Vessel Movements and Onshore Logistic Activities						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline; Support Operations	Employment opportunities for 20-40 people in Dakar and/or Nouakchott during 20 years, as well as progressively for 400 nationals people on offshore facilities for 20 years, and local Fisheries Liaison Officers or Community Liaison Officers will also be required in N'Diago and Saint-Louis.	Not applicable	Not applicable	Not applicable	Positive
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline; Support Operations	Business opportunities for 2-3 National services providers in Dakar and/or Nouakchott for onshore logistics services during 20 years and progressive additional service providers for potentially up to 16 vessels during the course of 20 years.	Not applicable	Not applicable	Not applicable	Positive
Mauritania Senegal	Support Operations	Business opportunities, indirect employment and multiplier effects that could be created through local procurement policy to support the supply chain for the project.	Not applicable	Not applicable	Not applicable	Positive

7.3.18.4 Mitigation Measures and Residual Impacts

No mitigation measures are required.

7.3.19 Population and Demography

High Level Summary

In this section on Population and Demography, the impact of one impact producing factor, this being Onshore logistic activities, was evaluated. No impacts are anticipated on Population and Demography during the Operations Phase for routine activities.

7.3.19.1 Impact Producing Factors and Project Areas

The IPF identified for this resource in Table 7-5 is distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Onshore logistic activities				●

Activities conducted in the Offshore Area, the Pipeline Area and the Nearshore Hub/Terminal Area do not have the potential to affect National and local demography of Mauritania and Senegal. Therefore, they are not discussed further in this section.

7.3.19.2 Impact Description

The following subsections explain how this IPF will potentially produce impacts in each of the project areas.

7.3.19.2.1 Offshore Area

Not applicable (see Section 7.3.19.1).

7.3.19.2.2 Nearshore Hub/Terminal Area

Not applicable (see Section 7.3.19.1).

7.3.19.2.3 Pipeline Area

Not applicable (see Section 7.3.19.1).

7.3.19.2.4 Support Operations Areas

Onshore Logistic Activities

As explained in Section 7.2.19, large projects have the potential to change the demography of local communities with an influx of population: an influx of workers in the project area and an influx of jobseekers.

However, Section 7.2.19 has shown that population influx will not be a concern for the current project during the Construction Phase. It will not be either for the Operations Phase.

As indicated previously, the total amount of manpower required on vessels, at the FPSO and at the breakwater for the Operations Phase is estimated to 400. The personnel will be living aboard the vessels, on the FPSO and on the QU at the breakwater. It is assumed that they will be working back-to-back on monthly assignments. National workers will be brought back to Dakar or Nouakchott after their assignments and international workers will be flying in/out of Dakar and/or Nouakchott from/to their home countries. These population movements will not entail an influx of workers or job seekers in Dakar and/or Nouakchott. In some cases, flight schedules to home countries might require a one-night stayover in a hotel in Dakar or Nouakchott. As a result, there will be a very limited presence of project offshore workers in Dakar and/or Nouakchott.

On shore, the project could hire up 20-40 people in Dakar and/or Nouakchott during 20-year Operations Phase. This small number of employment opportunities in Dakar and/or Nouakchott is unlikely to entail any population influx and changes in local demography in the two cities that count respectively over 3 million and around 1 million inhabitants.

Finally, no impact is anticipated on the population and local demography of N'Diago and Saint-Louis. No transit through those locations are planned for the offshore workers. Additionally, no project support operations areas are planned in N'Diago and Saint-Louis, and limited employment or business opportunities will be created in these locations. Consequently, no population influx and changes in local demography are expected in N'Diago and Saint-Louis.

7.3.19.2.5 Summary

No impacts are anticipated on population and demography.

7.3.19.3 Impact Rating

Not applicable (see Section 7.3.19.2.5).

7.3.19.4 Mitigation Measures and Residual Impacts

Not applicable (see Section 7.3.19.5).

7.3.20 Community Livelihoods

High Level Summary

In this section on Community Livelihoods, the impact of three impact producing factors, these being Physical presence, Exclusion safety zones and Onshore logistic activities, was evaluated. No impacts are anticipated on Community Livelihoods during the Operations Phase for routine activities.

7.3.20.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Exclusion safety zones		●	●	
Onshore logistic activities				●

The three IPFs identified above could impact community livelihoods indirectly. The two first ones (physical presence and exclusion safety zones) could impact negatively artisanal fisheries and related activities on which the coastal communities' livelihood is largely based. Since the impacts on the communities' livelihood are indirect, the distinction between Pipeline Area and Nearshore Hub/Terminal Area is irrelevant. Therefore, impacts of these two IPFs on community livelihoods are considered globally in the impact description under the Nearshore Hub/Terminal Area.

The third IPF (onshore logistic activities) has the potential to positively impact employment and business opportunities in the Support Operations Areas. Therefore, it has the indirect potential to impact community livelihoods positively. Additionally, the onshore logistic activities have the potential to entail an influx of workers in the project area which in turn could result in an increase of living costs for local communities. An influx of workers, notably expatriates, has been associated in other projects with increases in prices of land, housing, food and services. This price inflation has the potential to impact community livelihoods negatively.

7.3.20.2 Impact Description

The following subsections explain how the projects impacts on artisanal fisheries and on employment and business opportunities could potentially produce indirect impacts on community livelihoods.

7.3.20.2.1 Offshore Area

Not applicable (see Section 7.3.20.1).

7.3.20.2.2 Nearshore Hub/Terminal Area

Sections 4.6.5.2 and 4.6.6.4 provide a detailed description of the economic activities and the means of subsistence of the coastal communities in Mauritania, notably N'Diago. Sections 4.7.5.2 and 4.7.6.3 provide a similar description for the coastal communities of Senegal, notably Saint-Louis.

As previously indicated, the economy of the coastal villages and camps south of Nouakchott is almost exclusively linked to artisanal fisheries. With 1,240 inhabitants, N'Diago is the most important of those locations and the closest to the Nearshore Hub/Terminal Area (16 km). N'Diago counts 136 fishermen. The majority of them operate off the coast of Nouadhibou or Nouakchott where the fishery resources are much more plentiful. They live in Nouadhibou or Nouakchott and come back on a regular basis to N'Diago where they have their families. However, some fishermen living in N'Diago operate in the waters north of N'Diago and they land their catches in this location. In N'Diago, several dozen women are involved in the fresh fish trade. They sell their products in the border city of Saint-Louis, whereas other women are engaged in artisanal fish processing.

In Senegal, the economy of Saint-Louis (230,801 inhabitants) is heavily based on artisanal fishing and tourism. The fishing communities of Saint-Louis, located on the Langue de Barbarie and close to the Nearshore Hub/Terminal Area (13 km), count 70,532 inhabitants. Most of them make their living out of artisanal fisheries and related activities. These communities count approximately 22,000 fishermen, 1,000 women involved in artisanal fish processing and at least a similar number involved in fresh fish trade, and 150 fish mongers. Any loss of means of subsistence for these community members would affect the livelihood of their families and the communities as a whole. Since fishermen from other coastal communities of the Grande Côte also fish in the waters offshore Saint-Louis, any loss of fishery resources catches due to project activities during the Operations Phase could also have ramifications on these communities' livelihoods.

The number of people engaged in artisanal fishing, trade and processing in Mauritania and Senegal presented above reflect the current situation. Of course, these numbers will not remain static over the 20-year Operations Phase. The numbers will change over the lifetime of the project as a result of population increase and market forces.

The importance of artisanal fisheries in the livelihood of the communities of N'Diago and Saint-Louis over the 20-year Operations Phase could be as it is in 2018 or it could be different. In the absence of any data allowing future projection of the weight of fisheries in the community livelihoods in the future, the current situation is used to assess the potential impacts of the project on community livelihoods during the Operations Phase.

The assessment of the impacts of the project on artisanal fisheries and related activities during the Operations Phase has been made in Section 7.3.16. The assessment demonstrates that the project should not entail any loss in fishery resources catches in Mauritania and Senegal. As a result, no impacts are expected on the means of subsistence of the fishermen and the other community members involved in activities related to artisanal fisheries.

While no impacts are anticipated on community livelihoods, the perception of the impact by local communities might be very different. Perceived loss of fishing grounds and catches by community members whose means of subsistence are based on artisanal fisheries is discussed in Section 7.3.26 (Social Climate).

7.3.20.2.3 Pipeline Area

Not applicable (see Section 7.3.20.1).

7.3.20.2.4 Support Operations Areas

Significant employment and business opportunities have the potential to improve community livelihoods. The assessment of the impacts of the project on employment and business opportunities during the Operations Phase has been made in Section 7.3.18. The results show that since the project onshore logistic activities will be located in Dakar and/or Nouakchott, the project will have limited impacts on local employment in N'Diago or Saint-Louis. Similarly, limited impacts are anticipated on business opportunities in these two locations. As a result, employment and business opportunities will have limited impacts on the livelihood of local communities of N'Diago or Saint-Louis. While the employment and business opportunities in Dakar and/or Nouakchott identified in Section 7.3.18 will be beneficial, their number will not be important enough to change the livelihood of the communities in these two big cities.

The assessment of the impacts of the project on population and demography during the Operations Phase has been made in Section 7.3.19. The results show that the project will have no impact on the population and demography of Dakar and Nouakchott. Additionally, it will entail no population influx in N'Diago or Saint-Louis. Therefore, no changes in local demography and no price inflation are expected in these locations. No further impacts are anticipated on the communities' livelihoods.

7.3.20.2.5 Summary

No impacts are anticipated on community livelihoods.

7.3.20.3 Impact Rating

Not applicable (See section 7.3.20.2.5).

7.3.20.4 Mitigation Measures and Residual Impacts

Although no impacts are anticipated on community livelihoods, the project recognizes the need for awareness building of the actual environmental impacts associated with the perceived impacts. As such, some of the mitigation measures identified for the artisanal fisheries and related activities that will also have a ripple effect on the community livelihoods have been identified:

- M20: Develop and implement a framework for interaction with artisanal fisheries, with provisions covering engagement with local communities on access to fishing grounds, grievance and recourse mechanism for damage to fishing gear, environmental awareness building, livelihood enhancement and the role of community liaison officers.
- M23: Implement an environmental awareness building program in association with local schools and community groups.
- M24: Provide technical assistance to mutually agreed marine resource research programs notably the national oceanographic research centers of both countries (CRODT and IMROP).

7.3.21 Community Health, Safety and Security

High Level Summary

In this section on Community Health, Safety and Security, the impact of five impact producing factors, these being Physical presence, Exclusion safety zones, Vessel movements, Onshore logistic activities and Presence of foreign workers, was evaluated. The residual impacts on Community Health, Safety and Security during the Operations Phase for routine activities were assessed as of low significance when mitigation measures are applied.

7.3.21.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Exclusion safety zone		●	●	
Vessel movements		●	●	
Onshore logistic activities				●
Presence of foreign workers				●

The activities conducted in the Offshore Area do not have the potential to affect community health, safety and security since there are no community sea users in the Offshore Area.

The physical presence of the infrastructures and the vessels movements during the Operations Phase have the potential to impact the safety of communities' sea users. The only communities' sea users in the Pipeline Area and the Nearshore Hub/Terminal Area are the artisanal fishermen and the impacts of these IPFs have been addressed in Section 7.3.14 (Maritime Navigation).

The noise from the infrastructures and from the vessels during the Operations Phase does not have the potential to impact the health of communities. The Nearshore Hub/Terminal Area is the closest area from the coast. It is located about 10 km from the coast. The airborne sound levels at all facilities being required to meet the applicable occupational health working limits, the noise at these facilities will not be heard from the shore. The only community members in the vicinity of the Pipeline Area and the Nearshore Hub/Terminal Area are the artisanal fishermen. The potential impact of noise on artisanal fishermen has been addressed in Section 7.3.16 (Artisanal Fisheries and Related Activities). Therefore, no further impacts from infrastructures and vessels noise are expected on community health.

7.3.21.2 Impact Description

The following subsections explain how the IPFs could potentially produce impacts in each of the project areas.

7.3.21.2.1 Offshore Area

Not applicable (see Section 7.3.21.1).

7.3.21.2.2 Nearshore Hub/Terminal Area

Physical Presence Exclusion Safety Zones

For the purpose of vessel and operation safety, an exclusion safety zone will be established around the breakwater. This exclusion safety zone will ensure maritime safety for project vessels and non-project vessels.

As indicated in Section 7.3.14, the boundaries of the exclusion safety zone around the breakwater will be demarcated through several communication measures.

With all these measures already included in the project design, it is unlikely that artisanal fishermen could enter the exclusion safety zone inadvertently. Based on similar projects, it is however possible that some could try to make their way through the exclusion safety zone to fish in the area.

In such case, it is assumed that security protocols will be followed, which may include informing or involving the authorities of Mauritania and/or Senegal.

In addition to the risk that some artisanal fishermen might try to break into the exclusion safety zone, there is a risk that other sea users try to make their way through this zone. As indicated by some stakeholders during the consultation process for the current project, the physical presence of the infrastructures has the potential to attract terrorists. Some of them might try to enter the exclusion safety zone around to breakwater to conduct terrorism acts. While there are no records of such incidents offshore Mauritania or Senegal, offshore oil production projects have entailed important security issues in other countries. Therefore, the physical presence of the project infrastructures in the Nearshore Hub/Terminal Area during the Operations Phase could raise the level of risk of terrorism and entail national security issues in Mauritania and/or Senegal.

In the case of a terrorist threat or attack in the Nearshore Hub/Terminal Area, it is assumed that the project management will inform the authorities of Mauritania and/or Senegal and ask for their support to handle the situation.

7.3.21.2.3 Pipeline Area

Physical Presence and Exclusion Safety Zones

For the purpose of vessel and operation safety, an exclusion safety zone will be established around the FPSO. While maritime communication procedures indicated in Section 7.3.14. should deter incursion in the exclusion safety zone, it is however possible that some artisanal fishermen could try to make their way through to fish in the area.

Additionally, the physical presence of the FPSO in the Pipeline Area could attract terrorists during the Operations Phase. This will raise the level of risk of terrorism and entail national security issues for Mauritania and/or Senegal.

In case of an intrusion of an artisanal fisherman or a terrorist threat/attack around the FPSO location in the Pipeline Area, it is assumed that the project personnel will follow security protocols, which may include informing or involving the authorities of Mauritania and/or Senegal.

7.3.21.2.4 Support Operations Areas

Onshore Logistic Activities

Onshore logistic activities including hazardous materials have the potential to affect community health. All the material used by the project, notably the chemicals used for drilling activities will be stored in dedicated storage areas inside the supply bases located inside the Port of Dakar and/or the Port of Nouakchott.

Chemicals (and equipment) will be shipped by boat directly to the port areas. It is assumed that the sites will be fenced and monitored by security services 24/7. In addition, the port areas themselves are guarded and non-accessible to the public. Therefore, onshore logistic activities are not anticipated to present any risks to community health in Dakar and/or Nouakchott.

Onshore logistic activities including the use of security personnel to safeguard personnel and property also have the potential to affect community security. In Dakar and/or Nouakchott, it is expected that the project will contract third parties to ensure the security of its premises and its personnel inside the port areas. The unarmed security guards will be working under the security rules of the ports. Therefore, these security arrangements are not anticipated to present any risks to community security in Dakar and/or Nouakchott.

Presence of Foreign Workers

The presence of foreign workers has the potential to affect community health. Based on previous experience with large projects, there is a risk that the presence of single foreigners might contribute to prostitution in the local population and sexually transmitted diseases such as HIV/AIDS. However, this is not an important concern for the current project, as there will be a limited presence of foreign personnel onshore.

Therefore, no impacts on community health are anticipated from the presence of foreign workers during the Operations Phase of the project.

7.3.21.2.5 Summary

The risk of collisions for artisanal fishing boats due to the physical presence of infrastructures and vessels has been assessed in Section 7.3.14. The other IPFs that have the potential to impact the community health, safety and security have been assessed in the current section. All potential impacts have been dismissed except for one: the enforcement of the exclusion safety zone could present a risk for local community members.

7.3.21.3 Impact Rating

Enforcement of the exclusion safety zones will be conducted in similar ways during the Construction and the Operations Phases of the project. Therefore, the potential risk of the enforcement of the exclusion safety zones for local community members are the same during construction and Operations Phase.

The project personnel will be unarmed and there is no plan to use any force in case an artisanal fisherman refuses to respect the exclusion safety zone. Enforcement of the exclusion safety zones around the FPSO in the Pipeline Area and in the Nearshore Hub/Terminal Area will be based on communication procedures. It is possible that some artisanal fishermen will willingly enter the exclusion safety zones to fish in these areas. In such case, no force will be used by project personnel to stop the fishermen from entering the area. It is assumed that the project personnel will follow security protocols, which may include informing or involving the authorities of Mauritania and/or Senegal. Therefore, the project personnel will not present any direct threat to the security of community members.

If some fishermen refuse to get out of the exclusion safety zone, this may lead to a situation where the National authorities become involved and send the public security forces to escort the fishermen out of the area. In this process, there is a risk that the public security forces might use force and harm some artisanal fishermen.

Public security forces are responsible in both countries for patrolling the national maritime waters and to ensure that no illegal activities are conducted including illegal fishing activities. As such, they are armed. The project exclusion safety zones are located in an area where there are frequent incidents between fishermen and public security forces, in regard to areas where these fishermen are excluded. Therefore, the enforcement of the project exclusion safety zone could be challenging. The support of public security forces to escort the artisanal fishermen out of the exclusion safety zones could be conflictual and present a risk for local community members.

An incident between the artisanal fishermen and the public security forces could include fatalities. Therefore, the intensity of the impact is considered high. The extent of the impact could be limited to the exclusion safety zones. However, public outrage is likely where a fatality is concerned. As a result, the impact could be felt beyond N'Diago and/or Saint-Louis, and considered regional. The impact would be irreversible in case of a fatality. Based on the combination of these criteria, the consequence of the impact would be moderate. Considering that incidents between artisanal fishermen and public security forces are often in the area, such an incident is likely to happen during the Operations Phase. As a result, the overall impact significance is rated 3 – Medium to 4-High (Table 7-107).

In addition to this security risk at a local community level, there is a security risk at a National level during the Operations Phase resulting from the presence of the project infrastructures in the Nearshore/Hub Terminal Area and at the FPSO location. The gas production activities conducted at those two offshore locations could attract terrorists, which in turn will raise the level of a terrorism risk in Mauritania and/or Senegal. The support of National security authorities would be required to handle any terrorist threat or attack in the Nearshore/Hub Terminal Area and at the FPSO location.

A terrorist attack could include fatalities. Therefore, the intensity of the impact is considered high. The extent of the impact would be regional (and beyond). The impact would be irreversible in case of a fatality. Based on the combination of these criteria, the consequence of the impact would be severe. There are some uncertainties around the likelihood of the impact. While threats might be occasional, an attack could be rare. As a result, the overall impact significance is rated 4 – High (Table 7-107).

Table 7-107. Impacts to Community Health, Safety and Security during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Exclusion Safety Zones						
Mauritania Senegal	Nearshore/ Hub Terminal; Pipeline	Risk of conflicts between artisanal fishermen and public security forces if some fishermen need to be escorted out of the exclusion safety zones.	Nature: Negative Intensity: High Spatial Extent: Immediate vicinity to regional Duration: Short to Long term	Moderate to Severe	Likely	3 – Medium to 4 – High
Mauritania Senegal	Nearshore/ Hub Terminal; Pipeline	Risk of terrorism act targeting the gas production facilities which in turn will raise the level of terrorism risk at a national level.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Long term	Severe	Rare to Occasional	4 – High

7.3.21.4 Mitigation Measures and Residual Impacts

Impacts are reported below (Table 7-108) and potential applicable mitigation measures are identified. The measures proposed to reduce the risks of conflicts with artisanal fishermen during the Operations Phase are identical to the measures identified for the Construction Phase. With the proposed mitigation measures, it is assumed that fatalities could be avoided. As a result, the intensity of the residual impact would be moderate and its extent would be the immediate vicinity of the exclusion safety zones. Its duration would be limited to the time of the incident, and therefore it would be short term. The consequence of the impact would be minor. Such incidents would still be likely to happen. As a result, the overall residual impact significance is rated 2 – Low.

If needed, the measures in Table 7-108 should be adjusted before the Operations Phase starts to reflect the results of their implementation during the Construction Phase.

These mitigation measures are in addition to the measures and controls already planned in the project design, summarized as follows:

- D24: Exclusion safety zones will be demarcated on applicable navigational charts, and a communication procedure will be developed to communicate the location of the exclusion safety zones to the local fishing communities. This is intended to allow pirogues to avoid the exclusion safety zones.
- D26: A site security plan will be developed that considers the security arrangements for each of the facilities including the modalities of support provided by government.

Moreover, the Inter-state Cooperation Agreement (ICA) requires that the “two states (Mauritania and Senegal) are to consult with a view to jointly setting appropriate security and safety measures for each of the facilities and surrounding areas”.

Table 7-108. Mitigation Measures to Avoid or Reduce Impacts to Community Health, Safety and Security during the Operations Phase from Routine Activities.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Risk of conflicts between artisanal fishermen and public security forces if some fishermen need to be escorted out of the exclusion safety zones.	3 – Medium to 4 – High	M08, M17, M19, M25, M26	2 – Low
Risk of terrorism act targeting the gas production facilities which in turn will raise the level of terrorism risk at a national level.	4 – High	M25, M26	2 – Low

Notes:

M08: Develop and implement a training and awareness program targeting local fishing communities on the specific maritime safety rules associated with the project.

M17: Establishing a grievance mechanism easily accessible to fishing communities members that includes monitoring of claims and the resolution thereof.

M19: Collaboration with a community council of formally nominated representatives of local key stakeholders from N’Diago and Saint-Louis set up to review local fishing communities’ concerns and grievances related to the project.

M25: The project will seek to work with the public security forces to establish an appropriate response and security framework which may include resource, equipment, training and response protocols.

M26 Include in the project security plan, provisions around response, management and interface with Public security forces for security incidents scenario such as act of terrorism and unlawful entry in the exclusion safety zones.

7.3.22 Public Infrastructure and Services

High Level Summary

In this section on Public Infrastructure and Services, the impact of four impact producing factors, these being Exclusion safety zones, Vessel movements, Onshore logistic activities and Presence of foreign workers, was evaluated. The residual impacts on Public Infrastructure and Services during the Operations Phase for routine activities were assessed as of low significance when mitigation measures are applied.

7.3.22.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Exclusion safety zones	●	●	●	
Vessel movements	●	●	●	
Onshore logistic activities				●
Presence of foreign workers				●

All IPFs identified above could impact public infrastructures and services indirectly. The exclusion safety zones could indirectly impact the National authorities called in to enforce the exclusion safety zones. The risk of collision associated with vessel movements could indirectly impact the National authorities in charge of search and rescue operations.

Additionally, the onshore logistic activities and the presence of foreign workers have the potential to indirectly impact existing port and airport infrastructures, accommodation and health services.

The following sections explain how the projects impacts have the potential to produce indirect impacts on public infrastructure and services.

7.3.22.2 Impact Description

7.3.22.2.1 Offshore Area

No exclusion safety zone is associated with the wells after their drilling which have been addressed under the Construction Phase. Additionally, no exclusion safety zone is associated with the SPS once installed during the Construction Phase. Finally, no project vessels movements are expected in the Offshore Area after the Construction Phase except for well maintenance when needed. Therefore, there will be no need from public services for activities in the Offshore Area during the Operations Phase.

7.3.22.2.2 Nearshore Hub/Terminal Area

Exclusion Safety Zones and Vessel Movements

The project proponent will take care of all operations planned in the Nearshore Hub/Terminal Area during the Operations Phase of the project. However, direct support from public services could be required to handle an incident with other sea users entering the exclusion safety zones.

As indicated in Section 7.3.21, the project proponent will manage the enforcement of the exclusion safety zone through communication procedures with other sea users notably the artisanal fishermen. If an artisanal fisherman enters the exclusion safety zone, this may lead to a situation where the National authorities become involved and would likely send the public security forces to escort the fishermen out of the area. The frequency of such incidents is difficult to estimate, but they are likely to happen. The public security forces will need to be ready to handle such an incident 24/7.

The public security forces will also need to be available to handle search and rescue operations if a collision happens in the Nearshore Hub/Terminal Area.

In addition to being involved in handling incidents with artisanal fishermen and search and rescue operations, the National authorities of Mauritania and/or Senegal will need to be available and ready to handle a National security threat or incident at the Nearshore Hub/Terminal Area.

7.3.22.2.3 Pipeline Area

Exclusion Safety Zones and Vessel Movements

The support potentially required from the National authorities for the enforcement of the exclusion safety zones around the FPSO will be the same as in the Nearshore Hub/Terminal Area. However, the FPSO being located about 40 km from the coast, the public security forces would need to cover a longer distance than in the Nearshore Hub/Terminal Area to provide support to handle an incident with artisanal fishermen. They would also be called in to handle search and rescue operations.

Additionally, the National authorities of Mauritania and/or Senegal will need to be available and ready to handle a National security threat or incident around the FPSO in the Pipeline Area.

7.3.22.2.4 Support Operations Areas

Onshore Logistic Activities

The onshore logistic activities will be conducted out of the ports and airports of Dakar and/or Nouakchott. In the ports and airports, space will be rented by the project proponent inside existing infrastructures according to availabilities. The services required for project purposes will be similar to those required from other operators in the ports and airports of the two cities. The project will not put significant additional demands on the ports and airports.

Presence of Foreign Workers

The presence of foreign workers has the potential to put additional demands on accommodation and health care services. However, it is not expected to be the case for the current project.

It is expected that the project expatriate personnel in Dakar and/or Nouakchott will account for less than 30 people at a time in each location. The project will require onshore accommodations in Dakar and/or Nouakchott for these people during the Operations Phase. The project will rent apartments or hotel rooms for these people. Additionally, some of the offshore international workers who will be living on the project vessels, the FPSO and the QU at the breakwater location might need to spend one night in a hotel on their way to/from their home country. Dakar and Nouakchott are large cities with a large number of apartments and hotels. The limited presence of foreign workers will not overburden the existing accommodation facilities of the cities.

Some incidents or accidents requiring medical support may occur offshore, and onshore personnel might also require medical attention. Routine medical needs on the project vessels, the FPSO and the QU at the breakwater location will be managed by trained paramedics onboard the vessels. Should additional medical attention be needed for a limited number of personnel, arrangements will be made with pre-screened health providers in Dakar and/or Nouakchott. More serious cases will be managed by international medical providers, who will work to source medical care and repatriation of personnel.

With regard to the project proponent HSSE practices, medical support from local providers is not expected to be significant. Therefore, these incidents or accidents will not overburden local health infrastructures and services.

7.3.22.2.5 Summary

Several potential impacts on public infrastructure and services have been assessed, but only two could be significant.

A direct support from the public security forces could be required for handling incidents with artisanal fishermen entering the exclusion safety zones in the Nearshore Hub/Terminal Area and the Pipeline Area. Their direct support would also be required for search and rescue operations. This will involve having the public security forces available 24/7 during the Operations Phase of the project and this could place additional demands on their resources if those are not increased.

Additionally, the project may place additional demands on the National security services of Mauritania and Senegal who will need to prevent and be prepared to handle terrorist incidents that could happen in the breakwater and the FPSO areas.

7.3.22.3 Impact Rating

As indicated in Sections 4.6.10.4 and 4.7.10.4, the public security forces of Mauritania and Senegal operate with a small number of vessels. They have limited means with regards to the length of the coast under their responsibility. The availability required from the public security forces to handle project specific incidents could place additional demands on their limited resources if those are not increased and/or decrease their availability for other public services under their responsibility.

The intensity of the impact is moderate; the adverse change would be noticeable and the adverse change could affect several people. The extent of the impact would be local since it could comprise services provided by public security forces beyond the project zone. The impact will be long term as it will last during the 20-year Operations Phase. Based on the combination of these criteria, the consequence of the impact would be moderate. Considering that the impact is incident is likely to happen during the Operations Phase, its overall significance is rated 3 – Medium (details are provided in Table 7-109).

In addition to being involved in handling incidents with artisanal fishermen and search and rescue operations, the National authorities of Mauritania and/or Senegal will need to be available and ready to prevent and handle a National security threat or incident at the Nearshore Hub/Terminal Area. Mauritania and Senegal have limited means with regards to National security in general, and offshore threats or incidents in particular. The availability required from the National security services to handle National threats or incidents resulting from the presence of gas production infrastructures could place additional demands on their limited resources if those are not increased and/or decrease their availability for other public services under their responsibility.

The intensity of the impact is moderate; the adverse change would be noticeable and the adverse change could affect several people. The extent of the impact would be regional since it could comprise services provided by National authorities beyond the project zone. The impact will be long term as it will last during the 20-year Operations Phase. Based on the combination of these criteria, the consequence of the impact would be moderate. Considering that the impact is incident is likely to happen during the Operations Phase, its overall significance is rated 3 – Medium (details are provided in Table 7-109).

Table 7-109. Impacts to Public Infrastructure and Services during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Exclusion Safety Zones and Vessel Movements						
Mauritania Senegal	Nearshore/ Hub Terminal; Pipeline	Placing additional demands on the public security forces limited resources since they will be required to be available 24/7 to handle a safety incident with artisanal fishermen or a search and rescue operation if needed.	Nature: Negative Intensity: Moderate Spatial Extent: Local Duration: Long term	Moderate	Likely	3 – Medium
Mauritania Senegal	Nearshore/ Hub Terminal; Pipeline	Placing additional demands on National security authorities who will need to prevent and be available 24/7 to handle a national security incident at sea resulting from the presence of offshore gas production infrastructures.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Long term	Moderate	Likely	3 – Medium

7.3.22.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-110) and potential applicable mitigation measures are identified. The measures proposed to reduce the risk of placing additional demands on public security forces during the Operations Phase are similar to the measures identified for the Construction Phase. If needed, these measures should be adjusted before the Operations Phase starts to reflect the results of their implementation during the Construction Phase.

These mitigation measures are in addition to the measures and controls already planned in the project design, summarized as follows:

- D24: Exclusion safety zones will be demarcated on applicable navigational charts, and a communication procedure will be developed to communicate the location of the exclusion safety zones to the local fishing communities. This is intended to allow pirogues to avoid the exclusion safety zones.
- D26: A site security plan will be developed that considers the security arrangements for each of the facilities including the modalities of support provided by government.
- D27: Expat workers and national workers will undergo a briefing to raise awareness on health risks, prevention and available treatment and their responsibilities. There will be an active screening and medical treatment program for workers.

Moreover, the Inter-state Cooperation Agreement (ICA) requires that the “two states (Mauritania and Senegal) are to consult with a view to jointly setting appropriate security and safety measures for each of the facilities and surrounding areas”.

Table 7-110. Mitigation Measures to Avoid or Reduce Impacts to Public Infrastructure and Services during the Operations Phase from Routine Activities.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Placing additional demands on the public security forces limited resources since they will be required to be available 24/7 to handle a safety incident with artisanal fishermen or a search and rescue operation if needed.	3 – Medium	M08, M09, M10, M11, M12, M13, M14, M16, M25, M26	2 – Low
Placing additional demands on National security authorities who will need to prevent and be available 24/7 to handle a national security incident at sea resulting from the presence of offshore gas production infrastructures.	3 – Medium	M25, M26	2 – Low

Notes:

M08: Develop and implement a training and awareness program targeting local fishing communities on the specific maritime safety rules associated with the project.

M09: Provide regular notices to mariners in the appropriate form and language to artisanal fishermen on project infrastructure, associated exclusion safety zones, travel and approach plans and the approximate timing of project activities.

M10: Equip the support vessels and other project vessels that regularly move outside the construction or operational exclusion safety zones with radar or infrared systems that can detect small fishing vessels during poor visibility/night time.

M11: Provide adequate lighting aboard the support vessels and other project vessels that regularly move outside the construction or operational exclusion safety zones with the intent of maintaining high visibility during poor visibility/night time. These vessels will also feature searchlights that can be used to shine on or signal approaching pirogues and foghorns for audible signaling.

M12: Having a project patrol boat to monitor the exclusion safety zones, including patrolling ahead of the approach or exiting of larger project vessels into or out of the exclusion safety zones.

M13: Using the services of local fishermen liaison officers (FLOs) aboard the project patrol boats in the areas of artisanal fishing.

M14: Equipping the support vessels and the project patrol boat with lifesaving appliances approved by the Convention for Safety of Life at Sea (SOLAS) and IMO, which can be used to assist in rescuing fishermen in the water in line with international maritime protocols or in the event of an accident involving a pirogue with a project vessel. Assist with the rescue of any fishermen involved in a collision with a project vessel or following the capsizing of their vessel due to ship wake.

M16: Ensuring that each project vessel keeps records of maritime safety incidents with pirogues and other vessels, including near misses, and that these are subsequently shared with the project. BP will monitor maritime safety incidents and adjust, if required, project specific maritime safety rules, security and search & rescue arrangements in place.

M25: The project will seek to work with the public security forces to establish an appropriate response and security framework which may include resource, equipment, training and response protocols.

M26: Include in the security stakeholder engagement plan, provisions around response, management and interface with Public security forces for security incidents scenario such as act of terrorism and unlawful entry in the exclusion safety zones.

7.3.23 Women and Vulnerable Groups

High Level Summary

In this section on Women and Vulnerable Groups, the impact of one impact producing factor, this being Presence of foreign workers, was evaluated. No impacts are anticipated on Women and Vulnerable Groups during the Operations Phase for routine activities.

7.3.23.1 Impact Producing Factors and Project Areas

The IPF identified for this resource in Table 7-5 is distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Presence of foreign workers				●

There is no potential interaction between offshore activities and local communities' women and vulnerable groups. Only Support Operations Areas located onshore have been retained for a potential impact on women and vulnerable groups.

7.3.23.2 Impact Description

The following subsections explain how this IPF could potentially produce impacts in the Support Operations Areas.

7.3.23.2.1 Offshore Area

Not applicable (see Section 7.3.23.1).

7.3.23.2.2 Nearshore Hub/Terminal Area

Not applicable (see Section 7.3.23.1).

7.3.23.2.3 Pipeline Area

Not applicable (see Section 7.3.23.1).

7.3.23.2.4 Support Operations Areas

The only IPF considered for this discussion is the presence of foreign workers. This discussion is limited to direct impacts to women and vulnerable groups. Indirect impacts to these receptors may ensue from impacts on community livelihoods, community health and safety, and employment and business opportunities, public infrastructure and services. These indirect impacts have been discussed under the respective headings, if required.

Presence of Foreign Workers

Sections 4.6.11 and 4.7.11 have provided a description of the situation of women and vulnerable groups in Mauritania and Senegal with more specific information on those living in the coastal fishing communities. The following groups have been identified as vulnerable in the two countries: women, youth, the disabled, HIV positive people/households. Specific vulnerable groups included for Mauritania, descendants of former slaves and refugees who returned from Senegal in 1989, and for Senegal, the communities living on the Langue de Barbarie due to the erosion process that threatens the physical integrity of the dwellings on this narrow strip of land. Women and vulnerable groups generally rely on their families which provide the only significant social net in these communities.

In large onshore projects, the presence of foreign workers has the potential to contribute to prostitution in the local population and sexually transmitted diseases such as HIV/AIDS. This is the case, for instance, with some mining projects. Generally speaking, some women and other vulnerable groups are more at risk of prostitution than other members of the population because of their precarious financial situation. However, the current assessment did not need to examine if it was also the case in Mauritania and Senegal because Section 7.2.24 has assessed that contribution to prostitution is not a significant concern for the current project due to the limited presence of project foreign workers. Therefore, no impacts from the presence of foreign workers are expected on women and other vulnerable groups.

7.3.23.2.5 Summary

No impacts are anticipated on women and other vulnerable groups.

7.3.23.3 Impact Rating

Not applicable (see Section 7.3.23.2.5).

7.3.23.4 Mitigation Measures and Residual Impacts

Although no impacts are anticipated on women and other vulnerable groups, the project recognizes that women and vulnerable groups are at risk of changes to local economy and well-being. As such, some mitigation measures identified for artisanal fisheries and related activities that can have a ripple effect on women and vulnerable groups have been identified:

- M19: Collaboration with a community council of formally nominated representatives of local key stakeholders from N'Diago and Saint-Louis set up to review local fishing communities' concerns and grievances related to the project.
- M20: Develop and implement a framework for interaction with artisanal fisheries, with provisions covering engagement with local communities on access to fishing grounds, grievance and recourse mechanism for damage to fishing gear, environmental awareness building, livelihood enhancement and the role of community liaison officers.
- M23: Implement an environmental awareness building program in association with local schools and community groups.
- M27: Developing a social investment program to enhance project benefits for the directly affected N'Diago and Saint-Louis communities, including livelihood enhancement activities.

7.3.24 Cultural and Archaeological Heritage

High Level Summary

In this section on Cultural and Archaeological Heritage, the impact of one impact producing factor, this being Physical presence, was evaluated. No impacts are anticipated on Cultural and Archaeological Heritage during the Operations Phase for routine activities.

7.3.24.1 Impact Producing Factors and Project Areas

The IPF identified for this resource in Table 7-5 is distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	

Support Operations Areas have not been retained since the supply bases will be located in existing ports and airports locations.

7.3.24.2 Impact Description

The physical presence of infrastructures offshore has a potential to impact cultural and archaeological heritage in the Offshore Area, the Pipeline Area and the Nearshore Hub/Terminal Area. Therefore, the potential impacts are considered globally in the impact description under one of these areas, the Nearshore Hub/Terminal Area.

7.3.24.2.1 Offshore Area

See Section 7.3.24.2.2.

7.3.24.2.2 Nearshore Hub/Terminal Area

Physical Presence

If there are any archaeological marine artifacts in the vicinity of the planned infrastructures, their installation or construction could impact them through seafloor disturbance. Any loss of marine archaeological artifacts would occur at the Construction Phase. Since no additional construction or installation of equipment on the seabed is planned during the Operations Phase, no impacts on archaeological heritage are expected during the Operations Phase of the project.

As previously mentioned, one of the important aspects of Saint-Louis intangible cultural heritage is the protective goddess of the city, Mame Coumba Bang, whose abode is believed to lie near the mouth of the Senegal River. The intangible cultural heritage also includes mystical rituals practiced from an uninhabited location on the Langue de Barbarie, Sal Sal, located in front of the location for the Nearshore Hub/Terminal Area. The project infrastructures planned about 10 km offshore, their physical presence should not interfere with the intangible cultural heritage of local populations of Saint-Louis and N'Diago.

Finally, the physical presence of the project infrastructures will not interfere with the historical and cultural heritage of the island of Saint-Louis which is a UNESCO world heritage site. The island of Saint-Louis is located on the Senegal River. No project activities will be conducted on the river. Therefore, there is no potential interference between the project infrastructures and the island of Saint-Louis during the Operations Phase.

7.3.24.2.3 Pipeline Area

See Section 7.3.24.2.2.

7.3.24.2.4 Support Operations Areas

Not applicable (see Section 7.3.24.1).

7.3.24.2.5 Summary

No impacts are anticipated on cultural and archaeological heritage.

7.3.24.3 Impact Rating

Not applicable (see Section 7.3.24.2.5).

7.3.24.4 Mitigation Measures and Residual Impacts

No mitigation measures are required as no impacts are anticipated on cultural and archaeological heritage. It should be noted that existing measures inherent to design and operational controls include:

- D25: The seabed has been mapped as part of an extensive geophysical and geotechnical survey carried out by the project. The survey has not identified any shipwrecks or other maritime heritage on the seabed. Further seabed surveys are foreseen prior to dredging taking place.

7.3.25 Landscape and Seascape

High Level Summary

In this section on Landscape and Seascape, the impact of two impact producing factors, these being Physical presence and Vessel movements, was evaluated. No impacts are anticipated on Landscape and Seascape during the Operations Phase for routine activities.

7.3.25.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence			●	
Vessel movements			●	

While this section addresses landscape and seascape, the project will not impact the landscape. The only onshore operations will be support operations conducted inside the ports and airports of Dakar and/or Nouakchott. They will have no effect on the landscape. The only potential impacts considered in this section are those on the seascape. The Offshore Area and Pipeline Area are too far from the coast for the operations activities to be seen.

While the two above IPFs include noise, only the physical presence of the infrastructures and the vessel movements can impact the seascape.

7.3.25.2 Impact Description

7.3.25.2.1 Offshore Area

Not applicable (see Section 7.3.25.1).

7.3.25.2.2 Nearshore Hub/Terminal Area

Physical Presence and Vessel Movements

The physical presence of infrastructures and vessel movements in the Nearshore Hub/Terminal Area could potentially impact the seascape. However, they will be located about 10 km from the coast. The closest locations, N'Diago and Saint-Louis, are located respectively at 16 and 13 km from the breakwater. The physical presence of infrastructures and vessel movements at these distances are unlikely to be noticed. Therefore, no impact is anticipated on the seascape for the onshore viewers.

The physical presence of infrastructures and vessel movements in the Nearshore Hub/Terminal Area (and also in the Pipeline Area) will be observable by other sea users. However, the observations by people navigating or fishing in the surrounding areas will be very localized. It will be limited to their time being in a specific area from which they will have a view on the infrastructures and vessel movements. Consequently, no significant impact on the seascape is anticipated for offshore viewers.

7.3.25.2.3 Pipeline Area

Not applicable (See Section 7.3.25.1).

7.3.25.2.4 Support Operations Areas

Not applicable (See Section 7.3.25.1).

7.3.25.2.5 Summary

No impacts on landscape or seascape are anticipated from routine operations during the Operations Phase of the project.

7.3.25.3 Impact Rating

Not applicable (See Section 7.3.25.5).

7.3.25.4 Mitigations Measures and Residual Impacts

Not applicable (see Section 7.3.25.5).

7.3.26 Social Climate

High Level Summary

In this section on Social Climate, the impact of four impact producing factors, these being Physical presence, Exclusion safety zones, Onshore logistic activities and Presence of foreign workers, was evaluated. The residual impacts on Social Climate during the Operations Phase for routine activities were assessed as of low significance when mitigation measures are applied.

7.3.26.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-5 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Exclusion safety zones		●	●	
Onshore logistic activities				●
Presence of foreign workers				●

The IPFs identified above could impact the social climate indirectly. These IPFs are the same as those identified for the Construction Phase.

The impact assessment made in Section 7.3.16 shows the physical presence of infrastructures and their exclusion safety zones in the Nearshore Hub/Terminal Area and in the Pipeline Area will have a negligible impact on artisanal fisheries. No losses of catches are expected and no impacts on activities related to artisanal fisheries, such as fish transformation by women, are expected neither.

However, based on other similar projects, there could be a perception of loss of fishing grounds and catches by fishermen and other community members whose revenues are based on artisanal fisheries. This perception could lead to social discontent. Since the impacts of the physical presence of infrastructures and their exclusion safety zones on social climate are indirect, the distinction between Pipeline Area and Nearshore Hub/Terminal Area is irrelevant. Therefore, they are considered globally in the impact description under the Nearshore Hub/Terminal Area.

The onshore logistic activities have been identified as an IPF that could impact the social climate. Again, the impact is indirect. The impact assessment made in Section 7.3.18 shows that the project will create a few employment and business opportunities in Dakar and/or Nouakchott which is a positive impact. However, the limited employment and business opportunities in N'Diago and Saint-Louis could lead to social discontent in these communities. Therefore, the onshore logistics is considered as an indirect IPF in the impact description under the Support Operations Areas.

The presence of foreign workers has also been identified as an IPF that could lead to social discontent and could impact the social climate. However, the impact assessment made in Section 7.3.19 shows that the presence of foreign workers will not be significant. Therefore, this IPF does not need to be furtherly discussed in the present section.

In any country, the social climate can change anytime due to non-project related events. Therefore, assessing the impacts of a project on the social climate includes some uncertainties. Additionally, these uncertainties increase the further the projections are made in the future. The assessment of the potential impacts of the project during the Construction Phase, presented in Section 7.2.26, was based on the current social climate in Mauritania and Senegal in general, and in N'Diago and Saint-Louis in particular. Given that the Construction Phase should start in 2018, the level of uncertainty revolving around the potential impacts on social climate is relatively small. However, assessing the potential impacts of the project during the Operations Phase which is planned to start in 2022 includes a much greater level of uncertainty. The population growth over the course of the 20-year Operations Phase adds to this uncertainty.

The social climate in N'Diago and in Saint-Louis in 2022 includes a lot of uncertainties. Some of the uncertainties are non-project related. For instance, the social climate in Saint-Louis fishermen communities could be tenser in three years from now if the coastal erosion of the Langue de Barbarie continues to progress or if no inter-country fishing agreement is in place. However, some of the uncertainties are project related. For instance, any important discontent of fishing communities around project benefits during the Construction Phase could entail a tense climate in N'Diago and Saint-Louis when the Operations Phase will start. Conversely, satisfaction around projects benefits could result in a calm social climate at the beginning of the Operations Phase.

The impact assessment of the project on the social climate during Operations Phase is based on the current situation in N'Diago and Saint-Louis. The assessment should be updated before the Operations Phase starts to ensure that the results are still accurate and the proposed mitigation measures are still appropriate.

7.3.26.2 Impact Description

7.3.26.2.1 Offshore Area

Not applicable (see Section 7.3.26.1).

7.3.26.2.2 Nearshore Hub/Terminal Area

As detailed in Section 7.2.26, the current social climate in N'Diago and Saint-Louis is very different. The social climate in N'Diago, a village of about 1,240 people, is calm. With regard to the perceptions of oil and gas activities, community members are hopeful to be able to take advantage of the present project in terms of employment opportunities and social investments.

In Saint-Louis (230,801 inhabitants), the social climate is generally calm. However, the social climate in the fishing communities of the Langue de Barbarie, which count 70,532 people has been tense since the beginning of 2017. Three main factors contribute to this tension:

- The termination of the fishing agreement between Mauritania and Senegal and the significant loss of access to fishery resources and associated revenues for the Saint-Louis fishing communities;
- The unresolved problem of the breach in the Langue de Barbarie and associated marine safety issues; and
- The unresolved problem of coastal erosion on the Langue de Barbarie and the associated hazards and risks that homes might be lost.

The absence of solution to the three problems above contributes to social discontent and, in certain cases, a certain degree of despair. The severity of the problems affecting the fishing communities of Saint-Louis has increased in January 2018 and this raises the prospect of a volatile social climate. In this context, the fishing community members may show discontent with any project involving operations in waters where they currently fish.

While the loss of fishing grounds in the breakwater area and the FPSO area will be negligible and the project will not entail loss in fishing catches, the fishermen are likely to have a different perception of the losses. This perception is likely to be shared by all community members whose revenues are linked to artisanal fisheries, for instance the women fish processors and vendors. Perceived inadequate resolution of grievances may compound the matter. This could lead to discontent and social unrest in the fishing communities of Saint-Louis. Discontent could be expressed in several ways, including fishermen forcing the exclusion safety zone in the Nearshore Hub/Terminal Area. This has the potential to escalate in conflicts between fishermen, and the project proponent and the National authorities called in to enforce the exclusion safety zones.

7.3.26.2.3 Pipeline Area

See Section 7.3.26.2.

7.3.26.2.4 Support Operations Areas

As indicated in Section 7.2.26, expectations for employment opportunities are high in N'Diago and Saint-Louis. While the project will include employment opportunities in the Support Operations Areas, these opportunities will be located in Dakar and/or Nouakchott. Therefore, the project will provide limited employment opportunities in N'Diago and Saint-Louis during the Operations Phase.

In Saint-Louis, the perceived loss of fishing revenues combined to the limited employment opportunities could fuel social discontent in fishing communities and lead to potential social discontent.

Additionally, the perception that the project is not providing satisfactory resolution of grievances and/or compensation claims (e.g. for lost gear) or is causing elevated risk of injury/death of fishermen at sea due to presence of project vessels could also lead to social discontent.

This could lead to fishermen making a point entering the Nearshore Hub/Terminal Area exclusion safety zone. On shore, the social discontent could be expressed through the vandalization of public buildings or private properties. It should not be excluded that discontent could be expressed towards breaking in Mauritanian properties or harming Mauritanian nationals that would serve as scapegoats.

7.3.26.2.5 Summary

The perception of loss of fishing grounds and fishing catches combined with the limited employment opportunities could lead to social discontent in N'Diago and Saint-Louis. In Saint-Louis, this has the potential to lead to social unrest.

The perception that the project is not providing satisfactory resolution of grievances and/or compensation claims or is causing elevated risk of injury/death of fishermen at sea due to presence of project vessels could also lead to social discontent.

However, there are a lot of uncertainties around the social climate in N'Diago and Saint-Louis over the course of the Operations Phase. The population growth during the 20-year Operations Phase adds to this uncertainty.

7.3.26.3 Impact Rating

The social discontent could lead to conflicts and potentially involve fatalities. As a result, its intensity is high. With a risk for social unrest and violent conflicts in the city of Saint-Louis and beyond, the extent of the impact would be local or regional. The duration of the impact is considered short to long term in recognition that potential fatalities would be irreversible and because the impact could occur during the 20-year long Operations Phase. Based on the combination of these criteria, the consequence of the impact is severe. Based on the current situation of social discontent in Saint-Louis fishing communities, it is likely that the impact could happen during the course of the Operations Phase of the project. As a result, this impact is rated 4 – High (details are provided in Table 7-111).

Table 7-111. Impacts to Social Climate during the Operations Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence, Exclusion Safety Zones, Onshore Logistic Activities, and Presence of Foreign Workers						
Mauritania Senegal	Nearshore/ Hub Terminal; Pipeline; Support Operations	Social discontent in N'Diago and Saint-Louis due to the potential perception of loss of fishing grounds and fishing catches combined with the limited employment opportunities, the perception of unsatisfied grievances and/or compensation claims (e.g. for lost gear), and elevated safety risk for fishermen at sea due to presence of project vessels.	Nature: Negative Intensity: High Spatial Extent: Local to Regional Duration: Short to long term	Severe	Likely	4 – High

7.3.26.4 Mitigation Measures and Residual Impacts

The impact is reported below (Table 7-112) and potential applicable mitigation measures are identified. The proposed measures to reduce the risk of social discontent during the Operations Phase are similar to the measures identified for the Construction Phase. However, as indicated in Section 7.3.26.1, the impact assessment of the project on the social climate during Operations Phase is based on the current situation in Saint-Louis and N'Diago. The assessment should be updated before the Operations Phase starts to ensure that the results are still accurate and the proposed mitigation measures are still appropriate.

These measures are in addition to the existing measures inherent to design and operational controls:

- D19: The relevant maritime, port or shipping authorities will be notified of all permanent offshore facilities, as well as safety zones and routine shipping routes to be used by project-related vessels. Permanent facility locations will be demarcated on nautical charts.
- D24: Exclusion safety zones will be demarcated on applicable navigational charts, and a communication procedure will be developed to communicate the location of the exclusion safety zones to the local fishing communities. This is intended to allow pirogues to avoid the exclusion safety zones.

Table 7-112. Mitigation Measures to Avoid or Reduce Social Discontent during the Operations Phase from Routine Activities.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Social discontent in N'Diago and Saint-Louis due to the potential perception of loss of fishing grounds and fishing catches combined with the limited employment opportunities, the perception of unsatisfied grievances and/or compensation claims (e.g. for lost gear), and elevated safety risk for fishermen at sea due to presence of project vessels.	4 – High	M09, M17, M18, M19, M20, M23, M24, M27, M28, M44	2 – Low

Notes:

M09: Provide regular notices to mariners in the appropriate form and language to artisanal fishermen on project infrastructure, associated exclusion safety zones, travel and approach plans and the approximate timing of project activities.

M17: Establishing a grievance mechanism easily accessible to fishing communities members that includes monitoring of claims and the resolution thereof.

M18: Maintaining a community liaison officer (CLO) for N'Diago and Saint-Louis to provide a direct link with the fishing communities.

M19: Collaboration with a community council of formally nominated representatives of local key stakeholders from N'Diago and Saint-Louis set up to review local fishing communities' concerns and grievances related to the project.

M20: Develop and implement a framework for interaction with artisanal fisheries, with provisions covering engagement with local communities on access to fishing grounds, grievance and recourse mechanism for damage to fishing gear, environmental awareness building and livelihood enhancement and the role of community liaison officers.

M23: Implement an environmental awareness building program in association with local schools and community groups.

M24 Provide technical assistance to mutually agreed marine resource research programs notably the national oceanographic research centers of both countries (CRODT and IMROP).

M27: Developing a social investment program to enhance project benefits for the directly affected N'Diago and Saint-Louis communities, including livelihood enhancement activities.

M28: Engaging in an on-going dialogue with national, regional and local authorities to monitor the social climate in the local communities in order to help identify and support, if needed, ad hoc measures to prevent social discontent linked to project activities and its escalation into conflicts.

M44: Review the social climate in N'Diago and in Saint-Louis prior to the Operations Phase to adjust as needed the mitigation measures identified to avoid or reduce social discontent.

7.4 Impacts during the Decommissioning Phase for Routine Activities

7.4.1 Air Quality and Greenhouse Gases

High Level Summary

In this section on Air Quality and GHG, the impact of one impact producing factor, this being Emissions, was evaluated. All impacts on Air Quality and GHG during the Decommissioning Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

7.4.1.1 Impact Producing Factors and Project Areas

The IPF identified for this resource in Table 7-6 is distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Emissions	•	•	•	

7.4.1.2 Impact Description

7.4.1.2.1 Offshore Area

Emissions

Decommissioning activity expected in the Offshore Area will include well plugging and abandonment at each development well, removal of SPS infrastructure, and flushing and abandonment of flowlines and pipelines (Section 2.9.4). Air emissions from the drillship required for well decommissioning and support vessels will increase ambient levels of contaminants near the area of operations.

Estimates of decommissioning operations in the Offshore Area are summarized in Table 7-113.

Table 7-113. Summary of Decommissioning-Related Emissions, Offshore Area.

Activity	NOx t	CO t	PM t	VOC t	SOx t	GHG tCO_2eq
Well Abandonment, SPS removal	286.15	101.85	18.65	14.00	62.45	17,561
BOEM Threshold	2,584	61,857	-	2,584	2,584*	-

From: Developed from Chapter 2

Abbreviations: CO – Carbon Monoxide; GHG – Greenhouse Gas; NO_x – Oxides of Nitrogen; PM – particulate matter; SO_x – Oxides of Sulphur; t – Tonnes; tCO_2eq – tonnes CO_2 equivalent; VOC – Volatile Organic Compound.

Table 7-113 also provides an annual BOEM threshold value (see Section 7.2.1.2.1), above which air dispersion modeling would be required to assess whether its emissions would have a significant effect on onshore air quality.

The decommissioning of wells in the Offshore Area will not exceed the BOEM threshold for any of the contaminants identified in Table 7-113. Emissions from these operations will not have a significant effect on onshore air quality.

No air quality standards are currently in place in Mauritania. In Senegal, the Senegal Air Pollution Discharge Standards (Document NS 05-062) applies to existing and new stationary installations and vehicles capable of generating gaseous emissions (see Section 7.2.1.2.1). The thresholds contained within NS 05-062 are in units of mg/m^3 which are much more lenient than the µg/m^3 thresholds from the World Health Organization (WHO) and the U.S. EPA, the latter of which provide the basis for the BOEM thresholds noted above. Further discussion of the WHO thresholds is presented in Section 7.3.1 and Appendix J.

Air emissions thresholds established by the International Finance Corporation (IFC; EHS Guidelines, 2007) and the World Bank Group make reference to current WHO thresholds; these thresholds are not directly applicable in the current context as decommissioning-related emissions modeling was not conducted due to the short duration of decommissioning activities in the Offshore Area, limited number of decommissioning vessels (i.e., limited emission sources), and distance from shore. IFC standards also note that all vessels, platforms and drilling rigs should be compliant with the Regulations for the Prevention of Air Pollution from Ships set forth in MARPOL Annex VI, where applicable.

7.4.1.2.2 Nearshore Hub/Terminal Area

Emissions

During decommissioning operations in the Nearshore Hub/Terminal Area, air emissions from vessel engines will increase ambient levels of contaminants near the area of operations. Decommissioning-related emissions calculations are outlined in Chapter 2 and Appendix B.

Decommissioning at the Nearshore Hub/Terminal will include multiple vessels, including one MSV and two crane vessels (for 64 days), two anchor handling tug vessels (64 days), two standby vessels (24 days), and three tugs to tow the FLNG to port (80 days). For the Nearshore Hub/Terminal Area, decommissioning of the FLNG, terminal, and associated infrastructure will produce the following emissions (Table 7-114).

Table 7-114. Summary of Decommissioning-Related Emissions, Nearshore Hub/Terminal Area.

Activity	NO_x t	CO t	PM10 t	PM2.5 t	VOC t	HAPs t	SO_2 t	GHG tCO_2eq
Hub	202.52	16.91	10.55	10.06	7.62	1.32	45.76	10,488.19
BOEM Threshold	228	-	228		228	-	226*	-

From: Chapter 2

Abbreviations: CO – Carbon Monoxide; GHG – Greenhouse Gas; HAPs – hazardous air pollutants; NO_x – Oxides of Nitrogen; PM10 – particulate matter, >10 microns; PM2.5 – particulate matter, >2.5 microns; SO_2 – Sulphur Dioxide; t – Tonnes; tCO_2eq – tonnes CO_2 equivalent; VOC – Volatile Organic Compound.
Footnotes: * - calculation of SO_x provided; data on the composition of SO_x from combustion and other man-made sources indicate that about 98% of emitted SO_x is sulfur dioxide (SO_2).

Decommissioning-related emissions in the Nearshore Hub/Terminal Area are sufficiently low that onshore air quality impacts are not expected.

7.4.1.2.3 Pipeline Area

Emissions

During decommissioning operations within the Pipeline Area, air emissions from vessel engines will increase ambient levels of contaminants near the area of operations. Maximum decommissioning-related emissions calculations are outlined in Chapter 2 and Appendix B.

For the Pipeline Area, the purging of pipelines and removal of the SPS and select infrastructure (e.g., umbilicals; flowlines, etc.), as well as removal of the FPSO, will produce the following emissions (Table 7-115).

Table 7-115. Summary of Decommissioning-Related Emissions, Pipeline Area.

Activity	CO_2 t	CH_4 t	N_2O t	NO_x t	CO t	VOC t	SO_2 t	GHG tCO_2eq
Subsea	8,703	0.54	0.26	171.36	45.64	4.41	54	8,793
FPSO	2,867	0.18	0.08	56.42	15.05	1.45	18	2,897
Total	11,570	0.72	0.34	227.78	60.69	5.86	72	11,690
BOEM Threshold @ 125 km	-	-	-	2,584	61,857	2,584	2,584*	-
BOEM Threshold @ 40 km	-	-	-	826	28,914	826	826*	-

From: MS002-EV-REP-010-01002, Rev B02

Abbreviations: CH_4 – Methane; CO – Carbon Monoxide; CO_2 – Carbon Dioxide; GHG – Greenhouse Gas; N_2O – Nitrous Oxide; NO_x – Oxides of Nitrogen; SO_2 – Sulphur Dioxide; t – Tonnes; tCO_2eq – tonnes CO_2 equivalent; VOC – Volatile Organic Compound.
Footnotes: * - calculation of SOx provided; data on the composition of SOx from combustion and other man-made sources indicate that about 98% of emitted SOx is sulfur dioxide (SO_2).

Decommissioning-related emissions in the Pipeline Area are sufficiently low that onshore air quality impacts are not expected.

7.4.1.2.4 Support Operations Areas

Emissions

Operations of support vessels through the Ports of Dakar and Nouakchott and will occur intermittently throughout the Decommissioning Phase. Emissions from support vessels have been accounted for in each of the prior discussions, covering operations in the Nearshore Hub/Terminal Area and Pipeline Area. No significant impacts are likely to be realized at the Support Operations Areas due to the amount of time that support vessels will remain in or near port.

7.4.1.2.5 Summary

Emissions associated with decommissioning activities in the Offshore Area, Nearshore Hub/Terminal Area, Pipeline Area, and Support Operations Areas are expected to produce localized impacts through the introduction of atmospheric contaminants. For decommissioning operations at the Offshore Area, Nearshore Hub/Terminal Area or within the Pipeline Area, these emissions will be below BOEM threshold levels.

GHGs for all decommissioning activities are estimated to be 39,739 tonnes. By comparison, Mauritania and Senegal GHG emissions in 2014 amounted to 52.96 and 136.75 MT (Mega-Tonnes), respectively (CAIT Climate Data Explorer, 2017).

7.4.1.3 Impact Rating

Emissions

Impact intensity for criteria contaminants where no exceedances were noted is expected to be low, occurring on a local level, and of short-term duration, resulting in a negligible impact consequence. Given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-116 below for details on selected criteria).

Summary

A summary of impact to air quality associated with emissions from routine activities during the Decommissioning Phase is presented in Table 7-116.

Table 7-116. Impacts to Ambient Air Quality and GHG during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Emissions						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Reduction in ambient air quality.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Likely	1 – Negligible

7.4.1.4 Mitigation Measures and Residual Impacts

Impacts being rated 1 - Negligible, no mitigation measures are required. Summary of existing measures inherent to design and operational controls:

- D41: Contractors will be expected to comply with the applicable legal requirements and standards at the time of decommissioning, including HSSE standards and performance requirements.
- D42: A preliminary decommissioning plan will be developed for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[114] for equipment and materials.
- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[115] for equipment and materials.

7.4.2 Water Quality

High Level Summary

In this section on Water Quality, the impact of three impact producing factors, these being Discharges, Solid waste and Chemicals and hazardous materials, was evaluated. All impacts on Water Quality during the Decommissioning Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

[114] In this case, disposal includes treatment, reuse, recycling and final disposal practices.
[115] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

7.4.2.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Discharges	•	•	•	•
Solid waste	•	•	•	•
Chemicals and hazardous materials		•	•	

7.4.2.2 Impact Description

7.4.2.2.1 Offshore Area

Discharges

During decommissioning operations in the Offshore Area, discharges from vessels will affect local water quality near the area of operations, including discharges of sanitary and domestic wastes, food waste, and miscellaneous discharges. Decommissioning-related discharges are outlined in Appendix K-1.

Plugging and abandonment will be conducted to fully isolate each well. A drillship, ROV vessel, and support vessel will be utilized for decommissioning. Vessels operating in the Offshore Area during decommissioning activities will generate various discharges, as outlined in Table 7-117 and detailed in Appendix K-1.

Table 7-117. Summary of Projected Discharges during Decommissioning Activities, Offshore Area.

Source	Volume Discharged (m^3)	
	Black Water	Grey Water
Drillship	861	1,239
Supply vessel	216	312
ROV survey vessel	154	221
Total	1,231	1,772

From: Chapter 2 and Appendix K-1

During abandonment operations small discharges of cement, condensate, MEG and brine may escape from one or more well heads. Although there will be discharges associated with this activity, they will be short-term and have only a localized effect at the seafloor.

Solid Waste

Accidental loss of debris from the drillship or support vessels during the Decommissioning Phase may occasionally occur. Should accidental loss occur, local water quality may be affected by the presence of cardboard, plastics, or other drilling-related items (e.g., tools, gear, hardhats, containers, etc.). Buoyant materials will float and be transported by local currents; heavier items will sink to the seafloor. The occasional and unintentional loss of debris may produce localized effects to water quality, depending upon the source (e.g., floating trash, buckets containing paints or other chemicals). Floating or sinking debris may leach residual chemicals, with effects to local water quality.

7.4.2.2.2 Nearshore Hub/Terminal Area

Discharges

During decommissioning operations in the Nearshore Hub/Terminal Area, vessels will discharge several different wastes, including sanitary and domestic wastes. Sanitary and domestic waste from the decommissioning vessels may affect concentrations of suspended solids, nutrients, and chlorine in the water column as well as generate BOD. However, these discharges are expected to be diluted rapidly in the open ocean (USEPA, 2017; MMS, 2007). Impacts would likely be undetectable beyond tens of meters from the source.

Removal of any bottom founded infrastructure will mobilize sediments, creating a turbidity plume and resuspending local sediments. Although turbidity will diminish water quality within the area of the plume, no chemically-related impacts to water quality are expected.

Solid Waste

Accidental loss of debris from support vessels during the Decommissioning Phase may occasionally occur. Local water quality may be affected by the loss of cardboard, plastics, or other items (e.g., tools, gear, hardhats, containers, etc.). Buoyant materials will float and be transported by local currents; heavier items will sink to the seafloor. The occasional and unintentional loss of debris may produce localized effects to water quality, depending upon the source (e.g., floating trash, buckets containing paints or other chemicals). Floating or sinking debris may leach residual chemicals, with effects to local water quality.

Chemicals and Hazardous Materials

Key decommissioning processes which will include chemicals are pigging of pipelines and flushing of equipment and systems on the QU platform and FLNG. Pigging and flushing may result in the release of small amounts of chemicals.

7.4.2.2.3 Pipeline Area

Discharges

During decommissioning operations within the Pipeline Area, routine discharges (including sanitary and domestic wastes) from vessels may affect local water quality. Sanitary and domestic waste from the decommissioning vessels may affect concentrations of suspended solids, nutrients, and chlorine in the water column as well as generate BOD. However, these discharges are expected to be diluted rapidly in the open ocean (USEPA, 2017; MMS, 2007). Impacts would likely be undetectable beyond tens of meters from the source.

At the FPSO site, the FPSO will be disconnected and towed from the location. It is expected that FPSO anchors will be left in place, while the FPSO umbilicals will be removed, with the potential for disturbance of local sediments.

The pipelines will be pigged, flushed, and filled with seawater prior to abandonment in place. Pigging and flushing may result in the release of small amounts of chemicals.

Solid Waste

Accidental loss of debris from support vessels during the Decommissioning Phase may occasionally occur. Local water quality may be affected by the loss of cardboard, plastics, or other items (e.g., tools, gear, hardhats, containers, etc.). Buoyant materials will float and be transported by local currents; heavier items will sink to the seafloor. The occasional and unintentional loss of debris may produce localized effects to water quality, depending upon the source (e.g., floating trash, buckets containing paints or other chemicals). Floating or sinking debris may leach residual chemicals, with effects to local water quality.

Chemicals and Hazardous Materials

Key decommissioning processes which will include chemicals are pigging of pipelines and flushing of equipment and systems on the FPSO. Pigging and flushing may result in the release of small amounts of chemicals.

7.4.2.2.4 Support Operations Areas

Discharges

Sanitary and domestic wastes discharged from support vessels operating in Support Operations Areas, if discharging, may affect concentrations of suspended solids, nutrients, and chlorine in the water column as well as generate BOD. These discharges are expected to be diluted rapidly. Impacts would likely be undetectable beyond tens of meters from the source.

Solid Waste

The intentional release of solid waste into the marine environment is prohibited under MARPOL. Should accidental loss occur, local water quality may be affected by the presence of cardboard, plastics, or other items (e.g., tools, gear, hardhats, containers, etc.). Buoyant materials will float and be transported by local currents; heavier items will sink to the seafloor. The occasional and unintentional loss of debris may produce localized effects to water quality, depending upon the source (e.g., floating trash, buckets containing paints or other chemicals). Floating or sinking debris may leach residual chemicals, with effects to local water quality.

7.4.2.2.5 Summary

Discharges associated with decommissioning activities in the Offshore Area, Nearshore Hub/Terminal Area, Pipeline Area, and Support Operations Areas are expected to produce localized water quality impacts via the discharge of treated sanitary wastes, domestic wastes, and miscellaneous discharges. A total of approximately 911 m^3 of effluents will be discharged during the decommissioning of the FPSO and approximately 3,410 m^3 from the FLNG, QU Platform, Hub and General Support Vessels during the Decommissioning Phase. The accidental loss of solid waste may produce effects on local water quality. Release of any chemicals associated with decommissioning will have limited effects to water quality.

7.4.2.3 Impact Rating

Discharges

Impact intensity for discharges and other sources of turbidity and sediment resuspension is expected to be low, occurring in the immediate vicinity and of short-term duration, resulting in a negligible impact consequence. Given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-118 below for details on selected criteria).

Solid Waste

The occasional and unintentional loss of debris may produce effects of low intensity to ambient water quality, occurring in the immediate vicinity and of short-term duration, resulting in a negligible impact consequence. Given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-118 below for details on selected criteria).

Chemicals and Hazardous Materials

Impact intensity for infrequent releases of chemicals and hazardous wastes is expected to be low, occurring in the immediate vicinity and of short-term duration, resulting in a negligible impact consequence. Given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-118 below for details on selected criteria).

Summary

A summary of impact to water quality from routine activities during the Decommissioning Phase is presented in Table 7-118.

Table 7-118. Impacts to Ambient Water Quality during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Discharges						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Reduction in ambient water quality from discharges and possible sediment disturbance.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Solid Waste						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Changes in water quality from accidental loss of trash and debris.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible
Chemicals and Hazardous Materials						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Changes in water quality from release of treatment chemicals.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible

7.4.2.4 Mitigation Measures and Residual Impacts

Impacts being rated 1 - Negligible, no mitigation measures are required. Summary of existing measures inherent to design and operational controls:

- D41: Contractors will be expected to comply with the applicable legal requirements and standards at the time of decommissioning, including HSSE standards and performance requirements.
- D42: A preliminary decommissioning plan will be developed for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[116] for equipment and materials.

[116] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[117] for equipment and materials.

7.4.3 Coastal Erosion

High Level Summary

In this section on Coastal Erosion, the impact of one impact producing factor, this being Physical presence, was evaluated. The residual impacts on Coastal Erosion during the Decommissioning Phase for routine activities were assessed as of low significance when mitigation measures are applied.

7.4.3.1 Impact Producing Factors and Project Areas

The IPF identified for coastal erosion in Table 7-6 is distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence			●	

Physical presence of the breakwater structure is the only component of this IPF which has the potential to affect coastal erosion; noise associated with decommissioning activities will have no effect on erosional processes.

Decommissioning activities in the Offshore Area and Pipeline Area will not have an effect on erosional processes along the Mauritanian and Senegalese coasts because of their distance. Support Operations Areas are located on-shore. Only the transit of vessels to and from the Support Operations Areas has the potential to affect local erosion, although such effects are highly unlikely.

7.4.3.2 Impact Description

The Decommissioning Phase will involve a variety of specialized vessels specifically designed to complete various tasks, including removal of infrastructure, towing, and support operations. The decommissioning plan will describe decommissioning activities in detail including infrastructure to be removed. It is envisaged that the breakwater will be left in place.

The following subsections explain how this IPF will produce impacts in the project areas.

7.4.3.2.1 Offshore Area

Not applicable (see Section 7.4.3.1).

[117] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

7.4.3.2.2 Nearshore Hub/Terminal Area

Physical Presence

Within the Nearshore Hub/Terminal Area, decommissioning activities will include removal and towing of the FLNG and removal of related infrastructure. The breakwater will remain in place and will continue to affect local erosional processes (see Section 7.3.3).

7.4.3.2.3 Pipeline Area

Not applicable (see Section 7.4.3.1).

7.4.3.2.4 Support Operations Areas

Not applicable (see Section 7.4.3.1).

7.4.3.2.5 Summary

As summarized in Section 7.3.3.2.1, the potential impact of the breakwater on coastline stability (i.e., whether the breakwater will have an effect on coastal erosion) has been evaluated using coastline evolution models (detailed results of which are presented in Appendices I-2 and I-3).

The coastal evolution model results show that the breakwater causes a reduction of the wave heights along part of the studied area (see Figure 6.5 in Appendix I-3). This causes a reduction in the sediment transport rates along the section sheltered by the breakwater, inducing coastline changes. The coastal evolution model results showed that the presence of the breakwater will produce two effects over the initial 10-year period: 1) accretion or reduction in natural erosion along part of the coastline southeast of the breakwater location (i.e., an area which is currently experiencing erosion), providing a positive impact to the coast along an approximate 8 km stretch of the Langue de Barbarie, starting near the Mauritania-Senegal border and extending southward; and 2) a maximum increase of 6 m over 10 years in coastal erosion rate relative to the case without breakwater south of approximately 1,768,000 m N, along about 2 km of coast, starting at the south end of the Hydrobase neighborhood. The increased erosion is a consequence of the sediments accumulating over 8 km on the northern part of the Langue de Barbarie and, therefore, not being transported further south.

The maximum positive shoreline change (accretion) is estimated to be 13 m over 10 years relative to the case without the breakwater. The maximum negative shoreline change (erosion) is estimated by the modelling to be an additional 6 m over 10 years relative to the case without the breakwater. No projections are available for the long-term presence of the breakwater (e.g., beyond 10 years) however similar rate of changes are expected over a longer period provided that no new infrastructure or changes to the physical environment conditions affecting the shoreline occurs.

7.4.3.3 Impact Rating

Physical Presence

Based on the data currently available, it is anticipated that the presence of the breakwater during the Decommissioning Phase and after will have the same effects as during the Operations Phase as long as the breakwater remains into place. Uncertainties lie with the extrapolation of the 10-year modeling exercise to 30 years and beyond. The impacts of the breakwater will be alterations of current erosional processes along the coast, including predicted accretion or reduction in natural erosion along one segment of coastline, and predicted increase in coastal erosion rate along another. The likelihood of any effect during the Decommissioning Phase, is likely based on modeling comparisons. Although there will be positive impacts associated with the accretion or reduction in natural erosion, the overall impact has been rated negative in recognition of the increase of coastal erosion rate, with a low intensity. The extent of the impact will be local and its duration is considered for the whole life of the project as long as the breakwater remains in place. Overall impact significance to coastal erosion is 2 – Low (see Table 7-119 below for details on selected criteria).

Table 7-119. Impacts to Coastal Erosion during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Senegal	Nearshore Hub/ Terminal	Accretion or reduction in natural erosion of the Langue de Barbarie (relative to the case without the breakwater) of up to 13 m over 10 years near the Mauritania-Senegal border and extending southward approximately 8 km, accompanied by a maximum increase in coastal erosion rate (relative to the case without the breakwater) of approximately 6 m over 10 years further south, along approximately 2 km of coast, starting from the south end of the Hydrobase neighborhood.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Long term	Moderate	Likely	2 – Low

7.4.3.4 Mitigation Measures and Residual Impacts

Negative impacts with a significance rating over 1 are reported below (Table 7-120) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the measures and controls already planned in the project design.

Summary of existing measures inherent to design and operational controls:

- D42: A preliminary decommissioning plan will be developed for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[118] for equipment and materials.

[118] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

Table 7-120. Mitigation Measures to Avoid or Reduce Impacts to Coastal Erosion from Routine Activities (Breakwater Presence) during the Decommissioning Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Accretion or reduction in natural erosion of the Langue de Barbarie (relative to the case without the breakwater) of up to 13 m over 10 years near the Mauritania-Senegal border and extending southward approximately 8 km, accompanied by a maximum increase in coastal erosion rate (relative to the case without the breakwater) of approximately 6 m over 10 years further south, along approximately 2 km of coast, starting from the south end of the Hydrobase neighborhood.	2 – Low	M40, M41, M45	2 – Low

Notes:

M40: a) To improve understanding of the long-term coastal dynamic equilibrium, the project will develop and implement a coastline monitoring plan during the project life cycle. Coastline monitoring will commence prior to breakwater construction, i.e., before 2020. This will include the collection of further bathymetric data along the Saint-Louis shore, including the Senegal River mouth. The project will aim to involve local academics in the implementation of the coastline monitoring plan. The relevant authorities and local communities will be informed of the monitoring results.

b) The data collected as part of the implementation of the coastline monitoring plan will be used to update the coastline modeling (in Appendix I-3) to be completed before the construction of the breakwater in 2020. Additional modeling updates will be conducted at key stages of the project life cycle when new information with the potential to have a significant impact on the modeling results will become available.

c) BP will seek the necessary authorizations to share relevant data for government led morphological studies initiatives and local academics.

d) a contingency plan for the coastline will be developed by the project in consultation with the relevant authorities if the results of the coastline monitoring and modeling clearly and systematically demonstrate, over the duration of the project, negative impacts related to the GTA Phase 1 project which exceeds those currently identified in the GTA Phase 1 project ESIA report (in particular Section 7.3.3).

M41: Provide specialist assistance to studies led by local or national authorities on Saint-Louis coastal management.

M45: A final decommissioning plan will be developed for approval by the authorities near the end of the operational lifetime, which takes into consideration further morphological studies and data collection as applicable.

7.4.4 Sediment Quality

High Level Summary

In this section on Sediment Quality, the impact of three impact producing factors, these being Physical presence, Discharges and Solid waste, was evaluated. All impacts on Sediment Quality during the Decommissioning Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

7.4.4.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-4 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	
Discharges	●	●	●	
Solid waste	●	●	●	

7.4.4.2 Impact Description

The Decommissioning Phase activities that may affect sediment quality include well plug/abandonment; flushing and abandonment of flowlines and burial of flowline ends; pigging and flushing of production flowlines and export pipeline; and removal of the FLNG and FPSO. Physical presence, discharges, and solid waste represent potential sources of impact to sediment quality in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area; no impacts to sediment quality in Support Operations Areas are expected as these areas are on shore.

Most of the seafloor in the project area consists of soft-bottom benthic habitat. Seafloor-disturbing activities during decommissioning should not have any effect on sediment quality but could help mitigate effects on sediment quality resulting from the Construction and Operations Phases from resuspension of bottom sediments and dispersion of surficial sediments. During abandonment operations small discharges of cement, condensate, MEG, and brine may escape from the wellhead which will have a localized effect on sediment quality. Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from decommissioning-related vessels are expected to have no impact on sediment quality due primarily to rapid dilution of these discharges in surface waters. Solid waste accidentally lost overboard could potentially affect sediment quality from chemical leaching and organic enrichment.

The following subsections explain how these IPFs will produce impacts to sediment quality in each of the project areas.

7.4.4.2.1 Offshore Area

Physical Presence

The drillship will not be utilizing anchors to maintain position over wellsites; support vessels operating in the Offshore Area will not utilize anchors. Therefore, the physical presence of the drillship and support vessels will have no effect on deepwater sediment quality within the Offshore Area.

The decommissioning with handling of SPS-related structures (e.g., wellheads and flowlines) will disturb local sediments causing turbidity and potential exposure and transport sediment-associated contaminants. The effect of sediment disturbance during removal of seabed infrastructure and well heads, which could resuspend and further disperse sediment quality effects primarily from the Construction Phases associated with drilling activities (e.g. cuttings with residual oil). There are limited effects to Offshore Area sediment quality during the Operations Phase that would provide for an extended natural recovery from sediment contaminants introduced during the Construction Phase. Although there will have been significant development activities in the Offshore Area, it is presumed that there have not been any area-wide negative effects to the sediment and in conjunction with an extended recovery period there should be a continued maintenance of good surficial sediment quality (see Appendix D).

It is assumed that any SPS structures to be removed during the Decommissioning Phase will have some amount of attached epifauna. The epifauna attached to these structures will be lost upon removal during the decommissioning process. These epifauna are an artifact of the Construction and Operations Phases; removal of these resources is considered inconsequential to sediment quality.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from the drillship and support vessels should have no impact on deepwater sediment quality due to water depth and rapid dilution of these discharges in surface waters.

During the plugging and abandonment of each well, there is the potential for small discharges of cement, condensate, MEG, and brine to escape from the wellhead and be distributed onto the seafloor. These discharges, heavier than seawater, may affect sediment quality in relatively close proximity to the wellhead. Deposition of these materials may result in localized changes in the texture and physical/chemical properties of the sediments. The effects to sediment quality due to these possible discharges are not readily quantifiable due to the uncertainty concerning discharge material composition, volumes and depositional patterns.

Solid Waste

During decommissioning activities, it is likely that debris (e.g., welding rods, buckets, pieces of pipe, plastic packaging materials) will accidentally fall overboard. The impact to sediment quality will be similar as described in Section 7.2.4.2.1.

7.4.4.2.2 Nearshore Hub/Terminal Area

Physical Presence

Within the Nearshore Hub/Terminal Area, effects to sediment quality from physical presence will be minimal during the Decommissioning Phase since the infrastructure (i.e., breakwater, pilings, etc.) will remain in place. The presence of these structure will continue to have an effect on sediment quality similar to subsea structures as previously described above and in Section 7.3.4.2.2.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from support vessels operating at the Nearshore Hub/Terminal will have no impact on local sediment quality due to rapid dilution of these discharge in surface waters; this rapid dilution and dispersion of these discharges will be facilitated by the shallow water oceanographic conditions.

Solid Waste

It is possible that debris may accidentally fall overboard during decommissioning activities at the Nearshore Hub/Terminal. Heavier, non-buoyant solid waste will sink to the seafloor where the material, depending on size and weight, may it will be subject to on-bottom mobilization due to shallow water oceanographic conditions and near-shore sediment transport processes. Mobilization will limit the potential for colonization by epibiota. Seafloor debris could potentially leach chemicals that may cause localized changes in sediment quality.

7.4.4.2.3 Pipeline Area

Physical Presence

Effects to sediment quality from physical presence within the Pipeline Area will be similar to the Offshore Area as described in Section 7.4.4.2.1. Sediment disturbing activities will include recovery of the FPSO umbilicals and selected subsea structures. FPSO anchors will not be removed.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from the support vessels will have no impact on sediment quality within the Pipeline Area due to dispersion and rapid dilution of these discharges in surface waters. Pigging and cleaning of abandoned pipeline will result in discharges that may affect sediment quality in immediate vicinity of discharge point (e.g. scale, wax deposits, sand, etc.).

Solid Waste

It is possible that debris may accidentally fall overboard during decommissioning activities within the Pipeline Area. Abandonment of subsea infrastructure will metallic, primarily steel, structure that will eventually degrade and deteriorate creating localized impacts on sediment quality. The impact to sediment quality will be similar as described in Section 7.2.4.2.1.

7.4.4.2.4 Support Operations Areas

No impacts to sediment quality are expected in the Support Operations Areas from physical presence, discharges or solid waste since these areas are on shore.

7.4.4.2.5 Summary

Impacts to sediment quality during the Decommissioning Phase will result from physical presence, discharges and solid waste. For infrastructure left in place, impacts to sediment quality will be similar to those resulting from operations; for infrastructure to be removed, sediment disturbance is expected. Discharges from surface vessels are unlikely to affect sediment quality, however, releases of small amounts of chemicals at each of the wellhead may affect the quality of sediments around each wellhead. The accidental loss of solid waste may result in chemical leaching and effects to sediment quality.

7.4.4.3 Impact Rating

Physical Presence

The consequence of impacts to sediment quality in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area from physical presence include potential exposure and transport of sediment-associated contaminants during recovery of FPSO umbilicals and subsea structures. Impact intensity is expected to be low, with spatial extent being in the immediate vicinity, and impact of short duration; impact consequence is considered to be negligible. Given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-121 below for details on selected criteria).

Discharges

Routine discharges from decommissioning activities in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area are expected to produce very localized impacts through the introduction of various components, predominantly organics and warm water (cooling water). The effects of these routine discharges will be restricted to surface waters, with a very remote likelihood of reaching the seafloor. Impact intensity is expected to be low, with spatial extent being in the immediate vicinity, and impact of short duration; impact consequence is considered to be negligible. Given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-121 below for details on selected criteria).

Releases of small amounts of chemicals (cement, condensate, MEG, brine) at each of the wellheads may affect sediment quality. These discharges, heavier than seawater, may affect sediment quality in relatively close proximity to the wellhead. Deposition of these materials may result in localized changes in the texture and physical/chemical properties of the sediments. Impact intensity is expected to be low, with spatial extent being in the immediate vicinity, and impact of short duration; impact consequence is considered to be negligible. Given the occasional nature of this impact, overall impact significance is 1 – Negligible (see Table 7-121 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during decommissioning activities may occur in the Offshore Area, Nearshore Hub/Terminal Area, or within the Pipeline Area. These accidental losses are expected to produce very localized impacts to the sediment quality due to potential chemical leaching and organic loading associated with epibiota recruitment. Impact intensity is expected to be low, with spatial extent being in the immediate vicinity, and impact of short duration; impact consequence is considered to be negligible. Given the occasional nature of this impact, overall impact significance is 1 – Negligible (see Table 7-121 below for details on selected criteria).

Summary

A summary of impact to sediment quality from routine activities during the Decommissioning Phase is presented in Table 7-121.

Table 7-121. Impacts to Sediment Quality during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Nearshore/ Hub Terminal; Pipeline	Exposure and transport of sediment-associated contaminants during recovery of subsea structure and FPSO umbilicals.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Discharges						
Mauritania Senegal	Offshore; Nearshore/ Hub Terminal; Pipeline	Effects of routine vessel discharges during decommissioning.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Mauritania Senegal	Offshore	Effects of the loss of chemicals from wellheads during decommissioning.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Solid Waste						
Mauritania Senegal	Offshore; Nearshore/ Hub Terminal; Pipeline	Potential chemical leaching of solid waste materials and localized organic loading from epibiota.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible

7.4.4.4 Mitigation Measures and Residual Impacts

Impacts to sediment quality from Decommissioning Phase activities are rated 1 - Negligible; no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D41: Contractors will be expected to comply with the applicable legal requirements and standards at the time of decommissioning, including HSSE standards and performance requirements.
- D42: A preliminary decommissioning plan will be developed for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[119] for equipment and materials.
- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[120] for equipment and materials.
- D44: Well abandonment will be carried out in line with applicable BP practices and applicable legislation. A seabed survey will be conducted at the end of the well abandonment program to survey the seabed for debris.

7.4.5 Benthic Communities

High Level Summary

In this section on Benthic Communities, the impact of three impact producing factors, these being Physical presence, Discharges and Solid waste, was evaluated. All impacts on Benthic Communities during the Decommissioning Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

7.4.5.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	
Discharges	●	●	●	
Solid waste	●	●	●	

As discussed for other project phases, one of the IPFs for benthic communities includes both physical presence and noise. Noise generated during decommissioning, primarily from the vessels and well plug/abandonment, is similar to noise levels and characteristics of the Construction Phase, exclusive of the pile driving. Similarly to the Construction Phase, no noise effects to benthic communities are expected during the Decommissioning Phase.

7.4.5.2 Impact Description

The Decommissioning Phase activities most germane to assessing impacts to benthic community include well plug/abandonment; flushing and abandonment of flowlines and burial of flowline ends; pigging and flushing of production flowlines and export pipeline; and removal of the FLNG and FPSO.

[119] In this case, disposal includes treatment, reuse, recycling and final disposal practices.
[120] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

Physical presence, discharges, and solid waste represent potential sources of impact to benthic communities in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area; no impacts to benthic communities in Support Operations Areas are expected as these areas are on shore.

The project proponent will evaluate technically feasible options for facilities and pipeline decommissioning and will undertake decommissioning activities in compliance with regulatory requirements in force, and GIIP, at the time of decommissioning; the amount of SPS structures to be removed and left in place are uncertain. The process for plugging and abandonment of wells will need to be carefully assessed to select the type of barrier material and the placement technique utilizing a drillship, ROV, and support vessel operations. During abandonment operations, small discharges of cement, condensate, MEG, and brine may escape from the wellhead. Key decommissioning processes which will include chemicals are pigging of pipelines and flushing of equipment and systems on FPSO, QU platform and FLNG; there is no expected effluent release to the sea as part of this process.

As a result of the decommissioning, there is the possibility that vessel ballast water and vessel hull established fouling communities could become a source for invasive species. The establishment pelagic and epibenthic biota within and on project vessels could remain viable during transport to another international and subsequently be introduced as potential invasive species.

The following subsections explain how these IPFs will produce impacts to benthic communities in each of the project areas.

7.4.5.2.1 Offshore Area

Physical Presence

The drillship will not be utilizing anchors to maintain position over wellsites; support vessels operating in the Offshore Area will not utilize anchors. Therefore, the physical presence of the drillship and support vessels will have no effect on deepwater benthic communities present within the Offshore Area.

The decommissioning of SPS-related structures (e.g., wellheads and flowlines) will disturb local sediments and indigenous benthic communities. Benthic communities present in the immediate vicinity of these decommissioning activities will be disturbed by sediment suspension and redeposition as components of the SPS are removed. Effects to benthic communities will be variable within the area of sediment disturbance based on the amount of sediment displacement and depositional thickness. There will most likely be a gradient of decreasing sediment deposition with increasing distance from the seafloor decommissioning activity. Benthic community effect thresholds due to sediment deposition and post-depositional recovery are discussed in Section 7.2.5.2.1. The effects to benthic communities due to physical presence is not quantifiable due to uncertainty concerning sediment deposition patterns and area of seafloor decommissioning activities.

It is assumed that any SPS structures to be removed during the Decommissioning Phase will have some amount of attached epifauna. The epifauna attached to these structures will be lost upon removal during the decommissioning process. These epifauna are an artifact of the Construction and Operations Phases; installation and removal of these resources are not considered an effect on the benthic community.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from the drillship and support vessels will have no impact on deepwater benthic communities due to water depth and rapid dilution of these discharges in surface waters.

During the plug and abandonment of each well, there is the potential for small discharges of cement, condensate, MEG, and brine may escape from the wellhead and be distributed onto the seafloor. These discharges, heavier than seawater, will affect benthic communities in relatively close proximity to the wellhead. Biological effects of these well discharges may include smothering of benthic communities and changes in the texture and physical/chemical properties of the sediments.

Deposition of these materials may result in a localized decrease in the infaunal and megafaunal community. The duration of benthic community effects from these discharges are uncertain since the severity of the impact is likely correlated with the thickness and organic load of discharge deposited on the seabed, local environmental conditions, and reproductive cycle of the benthic fauna. The effects to benthic communities due to these possible discharges are not quantifiable due to uncertainty concerning discharge material volumes and depositional patterns.

Solid Waste

During decommissioning activities and similar to other project phases, it is possible that debris (e.g., welding rods, buckets, pieces of pipe, plastic packaging materials) may accidentally fall overboard. Materials reaching the seafloor may eventually be colonized by epibiota. This seafloor debris, depending on its composition, may leach chemicals, causing localized changes in benthic communities. The addition of debris to the seafloor will provide physical structure and hard substrate to facilitate epifauna recruitment.

7.4.5.2.2 Nearshore Hub/Terminal Area

Physical Presence

Within the Nearshore Hub/Terminal Area, effects to benthic communities from physical presence will be minimal during the Decommissioning Phase since the infrastructure (i.e., breakwater, pilings, etc.) will remain in place. There is likely going to be anchoring of various vessel types during this phase to facilitate transportation of materials onshore for reuse, recycling or disposal. This potential anchoring is the only activity where benthic communities will be affected by physical presence of the near-shore facility during the Decommissioning Phase. Benthic communities present immediately below anchors will be crushed; emplacement and recovery of anchors will also disturb sediments in the immediate vicinity of the anchor footprint via sediment suspension and redeposition. The effects to benthic communities due to physical presence is not quantifiable due to uncertainty concerning anchoring frequency and consequentially the areas of anchoring-related footprint and sediment disturbances.

Benthic community effect thresholds due to sediment deposition and post-depositional recovery are discussed in Section 7.2.5.2.1. Shallow water oceanographic conditions and near-shore sediment transport processes may reduce the overall effects of localized sediment disturbances and facilitate a more expeditious recovery of the benthic community following sediment disturbances from anchoring.

The FLNG could be a source for potential invasive species via ballast water and hull established fouling community. This potential impact would be of concern if the FLNG was moving to another international location outside of the tropical/subtropical North Atlantic Ocean. Mitigation for the potential invasive species impacts associated with ballast water could be addressed under the International Maritime Organization Ballast Water Management Convention. The Convention would require all ships in international traffic to manage their ballast water and sediments with exchange of ballast water mid-ocean or installation of an on-board ballast water treatment system.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from support vessels operating at the Nearshore Hub/Terminal will have no impact on local benthic communities due to rapid dilution and dispersion of these discharge in near-shore surface waters.

Solid Waste

It is possible that debris may accidentally fall overboard during decommissioning activities at the Nearshore Hub/Terminal. The impact will be similar to that described in Section 7.4.5.2.1. However, shallow water oceanographic conditions and near-shore sediment transport processes may significantly reduce the potential for solid waste to add physical structure to the seafloor topography within the Nearshore Hub/Terminal Area.

7.4.5.2.3 Pipeline Area

Physical Presence

At the FPSO location, benthic communities will be affected by the recovery of the anchors. Benthic communities present in the immediate vicinity of this decommissioning activity will be disturbed by sediment suspension and redeposition. Effects to benthic communities will be variable within the area of sediment disturbance based on the amount of sediment displacement and depositional thickness. There will most likely be a gradient of decreasing sediment deposition with increasing distance from the anchor footprint. Benthic community effect thresholds due to sediment deposition and post-depositional recovery are discussed in Section 7.2.5.2.1. The effects to benthic communities due to physical presence is not quantifiable due to uncertainty concerning sediment deposition patterns and area of seafloor decommissioning activities.

Similar to the Offshore Area and SPS structures, it is assumed that the FPSO anchor lines to be removed during the Decommissioning Phase will have some amount of attached epifauna. The epifauna attached to these structures will be lost upon removal during the decommissioning process. These epifauna are an artifact of the Construction and Operations Phases; installation and removal of these resources are not considered an effect on the benthic community.

The impacts from the FPSO associated with potential invasive species is as described for the FLNG.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from the FPSO and support vessels will have no impact on benthic communities within the Pipeline Area due to water depth and rapid dilution of these discharges in surface waters.

Solid Waste

It is possible that debris may accidentally fall overboard during decommissioning activities within the Pipeline Area. The impact will be similar as the one described in Section 7.2.5.2.1.

7.4.5.2.4 Support Operations Areas

No impacts to benthic communities are expected in the Support Operations Areas from physical presence, discharges or solid waste since these areas are on shore.

7.4.5.2.5 Summary

Impacts to benthic communities during the Decommissioning Phase are minimal and unquantifiable. No noise effects to benthic communities are expected due to the nature of the activity-related noise and general lack of documented effects from noise on benthic invertebrate. The primary source of impacts is recovery of FPSO anchors, support vessel anchoring, and removal of selected SPS structures. Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from all areas will have no impact on benthic communities due to water depth and rapid dilution of these discharges in surface waters.

A possible impact from decommissioning activities is the introduction of invasive species to another international location due to transport of established fouling communities on project equipment and structure.

7.4.5.3 Impact Rating

Physical Presence

The consequence of impacts to benthic communities in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area from physical presence include crushing of benthos associated with anchoring and disturbance of benthic communities in close proximity FPSO anchor and SPS structure removal locations due to sediment resuspension and deposition. Impact intensity is expected to be low, with spatial extent being in the immediate vicinity, and impact of short duration; impact consequence is considered to be negligible. Given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-122 below for details on selected criteria).

Discharges

Routine discharges from decommissioning activities in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area are expected to produce localized impacts restricted to surface waters, with a very remote likelihood of reaching the seafloor and associated benthic communities. Impact intensity is expected to be low, with spatial extent being in the immediate vicinity, and impact of short duration; impact consequence is considered to be negligible. Given the remote nature of this impact, overall impact significance is 1 – Negligible (see Table 7-122 below for details on selected criteria).

Releases of small amounts of chemicals (cement, condensate, MEG, brine) at each of the wellheads may occur. Deposition of these materials may result in localized changes in the texture and physical/chemical properties of the sediments, affecting sediment quality and possibly benthic communities. Impact intensity is expected to be low, with spatial extent being in the immediate vicinity, and impact of short duration; impact consequence is considered to be negligible. Given the occasional nature of this impact, overall impact significance is 1 – Negligible (see Table 7-122 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during decommissioning activities may occur in the Offshore Area, Nearshore Hub/Terminal Area, or within the Pipeline Area. These accidental losses are expected to produce localized impacts to the benthos via potential chemical leaching and possibly provide hard substrate for epibiota recruitment. The overall impact significance is 1 – Negligible (see Table 7-122 below for details on selected criteria).

Summary

A summary of impact to benthic communities from routine activities during the Decommissioning Phase is presented in Table 7-122.

Table 7-122. Impacts to Benthic Communities during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Crushing of benthic communities below support vessel anchors; disturbance to benthic communities from resuspension and deposition of sediments in proximity to FPSO anchors and SPS structures selected for removal.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Discharges						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Effects of routine vessel discharges during decommissioning.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Remote	1 – Negligible
Mauritania Senegal	Offshore	Effects of the loss of chemicals from wellheads during decommissioning.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Solid Waste						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Addition of hard substrate and potential leaching for accidental loss of solid waste from decommissioning vessels.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible

7.4.5.4 Mitigation Measures and Residual Impacts

Impacts to benthic communities from Decommissioning Phase activities are rated 1 – Negligible; no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D41: Contractors will be expected to comply with the applicable legal requirements and standards at the time of decommissioning, including HSSE standards and performance requirements.
- D42: A preliminary decommissioning plan will be developed for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[121] for equipment and materials.
- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[122] for equipment and materials.
- D44: Well abandonment will be carried out in line with applicable BP practices and applicable legislation. A seabed survey will be conducted at the end of the well abandonment program to survey the seabed for debris.

7.4.6 Plankton & Fish and Other Fishery Resources

High Level Summary

In this section on Plankton & Fish and Other Fishery Resources, the impact of three impact producing factors, these being Physical presence, Discharges and Solid waste, was evaluated. All impacts on Plankton & Fish and Other Fishery Resources during the Decommissioning Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

7.4.6.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	•	•	•	
Discharges	•	•	•	
Solid Waste	•	•	•	

7.4.6.2 Impact Description

The details of equipment and procedures associated with the Decommissioning Phase are discussed in Chapter 2. A screening of different IPFs associated with these activities indicated that for plankton, fish, and other fishery resources, the following should be considered: physical presence, discharges,

[121] In this case, disposal includes treatment, reuse, recycling and final disposal practices.
[122] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

and solid waste. It is expected that some members of the regional plankton and fish assemblages as described in Chapter 4 and Appendix M could be affected by decommissioning activities.

7.4.6.2.1 Offshore Area

Physical Presence

For decommissioning the wells, a dynamically positioned drillship will plug and permanently abandon each subsea well. A multipurpose subsea construction vessel with a ROV will be used to decommission the subsea production flowline. Fishes will likely leave the area during some of these activities (Gates et al., 2017). Some seafloor disturbance and turbidity may temporarily displace fishes in the immediate area of the decommissioning activity.

Discharges

During decommissioning operations in the Offshore Area, discharges from vessels will affect local water quality near the area of operations. Specifically, discharges of sanitary and domestic wastes, food waste, and miscellaneous discharges will occur. These discharges have no toxic components and will rapidly dilute; additional discussion of discharge volumes is presented in Table 7-115 of Section 7.4.2 and in Chapter 2. Minimal effects to plankton and fishes from these discharges are expected.

Releases of small amounts of chemicals (cement, condensate, MEG, brine) at each of the wellheads may affect sediment quality, with limited potential for effects to plankton and fish and other fishery resources. These discharges, heavier than seawater, may affect sediment quality in relatively close proximity to the wellhead. Only demersal fish species present near the wellhead have the potential for realizing effects.

Solid Waste

Only accidentally lost solid waste is expected during the Decommissioning Phase. Impacts from solid waste loss occurring during decommissioning are similar to those noted for construction (see Section 7.2.6), and would include colonization of debris reaching the seafloor by epibiota and small fishes. Seafloor debris could leach chemicals into the surrounding water potentially affecting local benthic organisms. Effects on demersal fishes are expected to be negligible.

7.4.6.2.2 Nearshore Hub/Terminal Area

Physical Presence

Removal of the FLNG piles will disturb the seafloor and elevate turbidity in the vicinity of the activity. Noise will be generated during decommissioning from the vessels used to remove the equipment from the Nearshore Hub/Terminal, and from the activities associated with removal of other infrastructure. The noise levels and characteristics will be similar to those described for the Construction Phase (Section 7.2.6). Most fishes will likely vacate the area during the decommissioning activities. Once the FLNG facility ceases gas liquefaction, cooling water intake will cease eliminating entrainment as an effect on the local plankton assemblage.

Discharges

Discharges expected during decommissioning at the Nearshore Hub/Terminal Area will be similar to those described for the Construction Phase (see Section 7.2.6), including vessel discharges (e.g., sanitary waste, domestic waste, etc.). Decommissioning activities may include the removal of large quantities of sand, some of which may be barged to shore (see Section 2.2.3). If the rock mound around the breakwater is left in place it will continue to attract fishes and serve as a de facto artificial reef.

Solid Waste

Only accidentally lost solid waste items are expected during decommissioning at the Nearshore Hub/Terminal Area. Impacts associated with lost debris would be similar to those described in Section 7.2.6.

7.4.6.2.3 Pipeline Area

Physical Presence

The pipeline will be cleaned (pigged) to remove condensate, gas, water, and wax, by routing back to the processing facility at the FPSO. The pipeline will then be flooded with seawater and left in situ. This process will generate noise, along with vessel noise associated with FPSO removal. Noise will prompt fishes to abandon the area. Fishes will likely continue to associate with the pipeline structure. Vessel and equipment noise associated with the decommissioning will be similar to noise discussed for the Construction Phase (exclusive of pile driving) as discussed in Section 7.2.6.

Discharges

A relatively small amount of waste may be generated during the decommissioning of the FPSO, and subsea infrastructure (see Chapter 2). These discharges will not affect local fishes or plankton assemblages.

Solid Waste

Only accidentally lost solid waste items are expected during the decommissioning at the Pipeline Area. Impacts would be similar to those noted for construction (see Section 7.2.6).

7.4.6.2.4 Summary

Impacts to plankton and fish and other fishery resources during the Decommissioning Phase will result from physical presence, discharges and solid waste. For infrastructure left in place, impacts to fish and other fishery resources will be similar to those resulting from operations; for infrastructure to be removed, sediment disturbance is expected. Discharges from surface vessels are unlikely to affect plankton and fish and other fishery resources, however, releases of small amounts of chemicals at each of the wellhead may affect sediment quality around each wellhead, with potential effects on demersal fishes in the immediate vicinity of each wellhead. The accidental loss of solid waste may result in chemical leaching.

7.4.6.3 Impact Rating

Physical Presence

The consequence of impacts to plankton, fishes, and other fishery resources in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area from physical presence include temporary preclusion from seafloor feeding areas immediately adjacent to infrastructure and anchors (FPSO area only), excess turbidity, and removal of some structured habitat. Routine vessel noise may cause fishes to move from or avoid those sources. The cessation of cooling water intake will be a positive effect of decommissioning at the Nearshore Hub/Terminal Area. Impact intensity is deemed low, while spatial extent and duration are considered to be the immediate vicinity and short duration, respectively. Given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-123 below for details on selected criteria).

Discharges

Routine discharges from decommissioning activities in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area are expected to produce very localized impacts through the introduction of organics (sanitary and domestic wastes; food waste); these impacts will be restricted to surface waters and may affect plankton and fish over a small area around the discharge. Impact intensity is deemed low, while spatial extent and duration are considered to be the immediate vicinity and short duration, respectively. Given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-123 below for details on selected criteria).

Releases of small amounts of chemicals (cement, condensate, MEG, brine) at each of the wellheads may occur. Deposition of these materials may result in localized changes in the texture and physical/chemical properties of the sediments, affecting sediment quality and possibly affecting demersal fish species found in close proximity to the wellheads. Impact intensity is expected to be low, with spatial extent being in the immediate vicinity, and impact of short duration; impact consequence is considered to be negligible. Given the occasional nature of this impact, overall impact significance is 1 – Negligible (see Table 7-123 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard may occur during decommissioning activities in the Offshore Area, Nearshore Hub/Terminal Area, or within the Pipeline Area. These accidental losses are expected to present localized impacts to some fishes via potential chemical leaching and providing habitat similar to that provided by the infrastructure being removed. Impact intensity is deemed low, while spatial extent and duration are considered to be the immediate vicinity and short duration, respectively. Given the occasional nature of this impact. overall impact significance is 1 – Negligible (see Table 7-123 below for details on selected criteria).

Table 7-123. Impacts to Plankton & Fish and Other Fishery Resources during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Displacement of benthic-feeding fishes from infrastructure footprint, avoidance of vessel noise, repulsion of fishes from abandonment sites.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Discharges						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Effects of routine vessel discharges during decommissioning.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Mauritania Senegal	Offshore	Effects of the loss of chemicals from wellheads during decommissioning.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Solid Waste						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Addition of hard substrate and potential leaching for accidental loss of solid waste from project vessels.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible

7.4.6.4 Mitigation Measures and Residual Impacts

Impacts to plankton and fish and other fishery resources from decommissioning activities are rated 1 - Negligible; no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D41: Contractors will be expected to comply with the applicable legal requirements and standards at the time of decommissioning, including HSSE standards and performance requirements.

- D42: A preliminary decommissioning plan will be developed for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[123] for equipment and materials.
- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[124] for equipment and materials.
- D44: Well abandonment will be carried out in line with applicable BP practices and applicable legislation. A seabed survey will be conducted at the end of the well abandonment program to survey the seabed for debris.

7.4.7 Marine Flora

High Level Summary

In this section on Marine Flora, the impact of three impact producing factors, these being Physical presence, Discharges and Solid waste, was evaluated. All impacts on Marine Flora during the Decommissioning Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

7.4.7.1 Impact Producing Factors and Project Areas

The IPFs identified for marine flora resources in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Discharges		●	●	
Solid waste		●	●	

7.4.7.2 Impact Description

The following subsections explain how these IPFs will produce impacts in each of the project areas. The project proponent will evaluate technically feasible options for facilities and pipeline decommissioning and will undertake decommissioning activities in compliance with regulatory requirements in force, and GIIP, at the time of decommissioning; the amount of SPS structures to be removed and left in place are uncertain. The process for plugging and abandonment of wells will need to be carefully assessed to select the type of barrier material and the placement technique utilizing a drillship, ROV, and support vessel operations. During abandonment operations, small discharges of cement, condensate, MEG, and brine may escape from the wellhead. Key decommissioning processes which will include chemicals are pigging of pipelines and flushing of equipment and systems on FPSO, QU platform and FLNG; there is no expected effluent release to the sea as part of this process.

[123] In this case, disposal includes treatment, reuse, recycling and final disposal practices.
[124] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

7.4.7.2.1 Offshore Area

Due to local water depth of the Offshore Area (approximately 2,700 to 2,800 m) and the attenuation of ambient light with depth, the seafloor within the Offshore Area is aphotic and does not support marine flora. There are no project-related impacts to marine flora in this area.

7.4.7.2.2 Nearshore Hub/Terminal Area

Physical Presence

The Nearshore Hub/Terminal Area, where LNG processing and export has occurred over the life of the project, is located in 33 m of water on the Mauritania and Senegal maritime border. The natural seafloor in this area is composed of unconsolidated sediments, with interspersed macroalgae found only on areas of exposed rock or on exposed shell fragments. The presence of the breakwater, pilings, and other infrastructure is expected to provide suitable substrate for the development of marine flora over the course of the project lifetime. As outlined in Section 7.3.7.2, these structures will locally enhance marine flora populations. In the Nearshore Hub/Terminal Area (as well as along the Pipeline Area), the flushing and abandonment of flowlines and the pigging and flushing of production flowlines and export pipeline will occur. These lines will be abandoned in place and will continue to provide substrate for macroalgal communities. Flushing and abandonment of the flowlines and burial of flowline ends during decommissioning is not expected to significantly impact marine flora in surrounding areas and those that may have colonized the flowlines themselves. The physical disturbance of seafloor during decommissioning operations within the pipeline area may impact algal communities only at the shallowest depths of the export pipeline route. Removal of the FLNG, QU platform, and other infrastructure will remove the artificial hard substrate.

Vessel noise is not an impact producing factor for marine plants and so is not discussed here.

Discharges

Routine discharges from decommissioning vessels within the Nearshore Hub/Terminal Area include sanitary and domestic wastes, food waste, deck drainage, cooling water, etc. A variety of chemicals, including both non-hazardous and hazardous chemicals, may also be employed during the decommissioning of the project. Key decommissioning processes which will include chemicals are pigging of pipelines and flushing of equipment and systems on the QU platform and FLNG. It is possible that sparse algal communities may occur only at the shallowest depths of the pipeline route, and only on areas of exposed rock or on exposed shell fragments. It is not likely that discharges from decommissioning vessels and the FPSO would reach the seafloor and so would not affect marine flora.

Solid Waste

Decommissioning Phase activities will generate trash comprising paper, plastic, wood, glass, and metal. Discarded material could reach the seafloor and smother marine flora. All vessels performing work are expected to implement and comply with MARPOL 73/78., Annex V, which is designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, it is unlikely that discarded solid waste would reach sparse marine macroalgal communities within the project area and impacts are not expected to be significant.

7.4.7.2.3 Pipeline Area

A dual production flowline extends from the Offshore Area to the FPSO. From the FPSO, a separate 30” (OD) export pipeline extends to the Nearshore Hub/Terminal Area. A fiber optic cable will be present parallel to the gas export pipeline. The decommissioning of the flowlines and pipelines will include the flushing and abandonment of flowlines and the pigging and flushing of production flowlines and export pipelines.

Physical Presence

Flushing and abandonment of the flowlines and burial of flowline ends during decommissioning is not expected to significantly impact marine flora in surrounding areas and those that may have colonized the flowlines themselves. The physical disturbance of seafloor during decommissioning operations within the pipeline area may affect algal communities only at the shallowest depths of the export pipeline route.

Vessel noise is not an impact producing factor for marine plants and so is not evaluated in this analysis.

Discharges

Routine discharges from decommissioning vessels within the Pipeline Area include sanitary and domestic wastes, food waste, deck drainage, cooling water, etc. A variety of chemicals, including both non-hazardous and hazardous chemicals, may also be employed during the decommissioning of the project. Key decommissioning processes which will include chemicals are pigging of pipelines and flushing of equipment and systems on the FPSO. It is possible that sparse algal communities may occur only at the shallowest depths of the pipeline route, and only on areas of exposed rock or on exposed shell fragments. It is not likely that discharges from decommissioning vessels and the FPSO would reach the seafloor and so would not affect marine flora.

Solid Waste

Decommissioning Phase activities will generate trash comprising paper, plastic, wood, glass, and metal. Discarded material could reach the seafloor and smother marine flora. All vessels performing work are expected to implement and comply with MARPOL 73/78, Annex V, which is designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, it is unlikely that discarded solid waste would reach sparse marine macroalgal communities within the project area and impacts are not expected to be significant.

7.4.7.2.4 Support Operations Area

No impacts to marine flora are expected in the Support Operations Areas from physical presence, discharges or solid waste since these areas are on shore.

7.4.7.2.5 Summary

Marine flora are not present within the Offshore Area and the section of the Pipeline Area between the wells and the FPSO. There are no impacts to marine flora within these areas. The impacts to marine flora in the inner reaches of the Pipeline Area and Nearshore Hub/Terminal Area include impacts associated with physical presence, discharges, and solid waste. Decommissioning operations within the Pipeline Area and at the Nearshore Hub/Terminal Area may impact algal communities only at the shallowest depths of the export pipeline route.

7.4.7.3 Impact Rating

Physical Presence

The consequence of impacts to marine flora in the inner reaches of the Pipeline Area and Nearshore Hub/Terminal Area from decommissioning vessel physical presence include habitat loss or alteration due to vessel or infrastructure removal and related disturbance of marine flora in close proximity due to sediment resuspension and deposition. The intensity of these impacts is low, with spatial extent and duration being the immediate vicinity and short term, respectively. These factors result in a negligible impact consequence. Given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-124 below for details on selected criteria).

Discharges

Routine, non-drilling related discharges from decommissioning activities in the inner reaches of the Pipeline Area and Nearshore Hub/Terminal Area are expected to produce very localized impacts through the introduction of organics (sanitary and domestic wastes; food waste; these impacts will be restricted to surface waters, with a very remote likelihood of reaching the seafloor and associated marine flora communities. The intensity of these impacts is low, with spatial extent and duration being the immediate vicinity and short term, respectively. These factors result in a negligible impact consequence. Given the remote nature of this impact, overall impact significance is 1 – Negligible (see Table 7-124 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during decommissioning activities may occur in the Pipeline Area and Nearshore Hub/Terminal Area. These accidental losses are expected to be minimal but may produce very localized impacts to marine flora via potential chemical leaching and providing hard substrate for epibiota similar to that provided by the infrastructure being installed. The intensity of these impacts is low, with spatial extent and duration being the immediate vicinity and short term, respectively. These factors result in a negligible impact consequence. Given the occasional nature of this impact, overall impact significance is 1 – Negligible (see Table 7-124 below for details on selected criteria).

Table 7-124. Impacts to Marine Flora Communities during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Crushing of marine flora below infrastructure during pipeline decommissioning; disturbance to marine flora communities from resuspension and deposition of sediments; removal of marine flora on sections of pipe removed during decommissioning.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Discharges						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Effects of routine vessel discharges during decommissioning reaching seafloor marine flora communities.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Remote	1 – Negligible
Solid Waste						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline	Addition of hard substrate and potential leaching for accidental loss of solid waste from project vessels.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible

7.4.7.4 Mitigation Measures and Residual Impacts

Impacts being rated 1 - Negligible, no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D41: Contractors will be expected to comply with the applicable legal requirements and standards at the time of decommissioning, including HSSE standards and performance requirements.

- D42: A preliminary decommissioning plan will be developed for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[125] for equipment and materials.
- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[126] for equipment and materials.

7.4.8 Birds

High Level Summary

In this section on Birds, the impact of four impact producing factors, these being Physical presence, Discharges, Solid waste and Helicopter traffic, was evaluated. All impacts on Birds during the Decommissioning Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

7.4.8.1 Impact Producing Factors and Project Areas

The IPFs identified for bird resources in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	●
Discharges	●	●	●	
Solid waste	●	●	●	●
Helicopter traffic	●	●	●	●

7.4.8.2 Impact Description

The Decommissioning Phase will involve plugging and abandonment of wells, flushing and abandonment of flowlines and burial of flowline ends; pigging and flushing of production flowlines and export pipeline, shut-down of all systems, cleaning and making safe topsides, jackets, pipelines and all other materials; purging of topsides to remove hydrocarbons and removal of topsides, transportation to an onshore site(s) for reuse, recycling or disposal; and removal of the FLNG and FPSO vessels.

The following subsections explain how these IPFs may impact birds in each of the project areas.

7.4.8.2.1 Offshore Area

Physical Presence

As discussed in Section 7.2.8.2.1, the physical presence of vessels within the Offshore Area during decommissioning activities may result in vessel strikes with individual birds, or may disturb or even attract individual birds or groups of birds. Some project vessels may also disturb individual or groups

[125] In this case, disposal includes treatment, reuse, recycling and final disposal practices.
[126] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

of marine birds; however, it is anticipated that these disturbances would consist of short-term displacement of individuals away from the vessel or vessel aggregation. No significant impacts to these birds are expected.

Vessels associated with the Decommissioning Phase within the Offshore Area would generate vessel and equipment noise that could disturb marine birds. It is likely that airborne noise may result in little disruption of behavioral patterns or other non-injurious effects.

Discharges

Routine discharges from decommissioning vessels within the Offshore Area include sanitary and domestic wastes, food waste, deck drainage, cooling water, etc. Within the open ocean environment, discharged fluids will rapidly disperse and dilute in local currents. Solid material will likely descend through the water column and disperse in subsurface currents. Therefore, it is not likely that marine birds will encounter discharged materials from decommissioning vessels.

Solid Waste

Solid waste and its effects on birds are discussed in Section 7.2.8.2. All vessels associated with decommissioning activities will comply with MARPOL 73/78. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface.

7.4.8.2.2 Nearshore Hub/Terminal Area

Physical Presence

Within the Nearshore Hub/Terminal Area, marine birds may be disturbed during the decommissioning of infrastructure. Impacts from physical disturbance are expected to include avoidance of, or displacement, from the Nearshore Hub/Terminal Area by individuals or groups of birds. When considering the length of time estimated for the project (20 years), it is expected that some birds may become accustomed to the presence of these vessels and routine operational activities. Because these activities are either static or moving slowly, it is expected that disturbances will not significantly affect local populations.

Decommissioning activities will generate both in-air and underwater noise that may impact marine birds.

This, in addition to effects from physical presence, may result in short term displacement of birds from the Nearshore Hub/Terminal Area during decommissioning.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from decommissioning vessels operating at the Nearshore Hub/Terminal are the same as those discussed for the Construction Phase (Section 7.2.8.2.3). Within the open ocean environment, discharged fluids will rapidly disperse and dilute in local currents. Solid material will likely descend through the water column and disperse in subsurface currents. Therefore, it is not likely that marine birds will encounter discharged materials from decommissioning vessels.

Solid Waste

Potential impacts to birds from solid debris in offshore waters are discussed Section 7.2.8.2.1. All vessels associated with decommissioning activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface.

7.4.8.2.3 Pipeline Area

Physical Presence

The physical presence of vessels within the Pipeline Area that are associated with the Decommissioning Phase of the project may result in vessel strikes with individual birds, or may disturb or attract individual birds or groups of birds. As discussed in Section 7.2.8.2.1, some seabird species are commonly attracted to offshore structures and vessels, and bird mortality has been documented as a result of light-induced attraction and subsequent collision with vessels or structures. Nonetheless, there is a very low potential for bird collision since the proposed vessels will be stationary or will move relatively slowly.

Birds may also be attracted to stationary vessels, structures, and moving vessels as a foraging strategy. Given the low potential for collision, any impacts from attraction to stationary or moving vessels are not expected to result in mortality or serious injury to individual birds.

Some project vessels may also disturb individual or groups of marine birds; however, it is anticipated that these disturbances would consist of short-term displacement of individuals away from the vessel or vessel aggregation. No significant impacts to these birds are expected.

As discussed in Section 7.2.8.2.1, vessels associated with the Decommissioning Phase within the Pipeline Area would generate vessel and equipment noise (both in air and underwater) that could disturb marine birds. Exposure to vessel and equipment noise is expected to result in little disruption of behavioral patterns or other non-injurious effects.

Discharges

Routine discharges from decommissioning vessels within the pipeline area are discussed in Section 7.2.8.2.2. Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in subsurface currents. Therefore, it is not likely that marine birds will encounter discharged materials from decommissioning vessels.

Solid Waste

Potential impacts to birds from solid debris in pipeline area waters are discussed Section 7.2.8.2.2. All vessels associated with Decommissioning Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

Helicopter Traffic

Potential impacts to marine and coastal birds from aircraft traffic include disturbances from noise and physical presence, and collision. Noise generated by project-related helicopters that are directly relevant to birds are discussed above in Section 7.2.8.2.2. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the FPSO). Based on this schedule and helicopter flight protocols discussed in Section 7.2.8.2.1, impacts to birds are expected to be infrequent, short-term, and not severe to local populations.

7.4.8.2.4 Support Operations Areas

Physical Presence

The decommissioning of support operations infrastructure may disturb birds within both coastal and inshore (terrestrial) habitats. These activities at the supply base (removal of equipment and material storage) may disturb birds but these effects are not expected to be significant for local bird populations.

Discharges

Routine discharges are not expected from facilities and vessels associated with supply bases. Therefore, no impacts from discharges to coastal and marine birds are expected.

Solid Waste

Potential impacts to birds from solid debris is discussed Section 7.2.8.2.1. All operations (shore base and crew boat) associated with Decommissioning Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage Therefore, the amount of trash and debris released in nearshore waters would be minimal and only accidental. In addition, the shore base and crew boats would implement a waste management plan that would include guidance for marine debris awareness. Impacts to coastal and marine birds from solid waste is not expected to be significant to local bird populations.

7.4.8.2.5 Summary

Operation of decommissioning-related vessels, and removal of select infrastructure may result in negative impacts to birds present in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area, and to a lesser extent at the Support Operations Areas. Physical presence may disturb birds, while the presence of vessels may attract birds. Discharges and the accidental loss of solid waste has the potential to adversely affect birds in proximity to these sources.

7.4.8.3 Impact Rating

Physical Presence

The consequence of impacts during the Decommissioning Phase to birds in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, and the Support Operations Areas from physical presence include short-term behavioral alterations, short- and long-term displacement from (or attraction to) discrete project areas, and foraging habitat loss or alteration immediately below nearshore infrastructure. The impacts of offshore activities may affect marine bird species, whereas the impacts from decommissioning of the supply base may also affect coastal and terrestrial bird species. The intensity of these impacts is low, with spatial extent and duration being the immediate vicinity and short term, respectively. These factors result in a negligible impact consequence. Given the likely nature of this impact, the overall impact significance is 1 – Negligible (see Table 7-125 below for details on selected criteria).

Discharges

Routine, non-drilling related discharges from Decommissioning Phase activities in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, and the nearshore areas of the Support Operations Areas' supply base are expected to produce very localized impacts through the introduction of organics (sanitary and domestic wastes; food waste); these impacts will be restricted to surface waters, with a very remote likelihood of directly or indirectly affecting birds in the project area. The volumes and frequency of these discharges are not expected to impact bird prey items, such as fishes and benthic organisms (in nearshore waters). The intensity of these impacts is low, with spatial extent and duration being the immediate vicinity and short term, respectively. These factors result in a negligible impact consequence. Given the remote nature of this impact, overall impact significance is 1 – Negligible (see Table 7-125 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during decommissioning activities may occur in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, or within the Support Operations Areas. These accidental losses are expected to be minimal but may produce very localized impacts to marine and coastal birds via ingestion of small particles (plastic) or entanglement in debris. The likelihood of these events (release of solid debris and ingestion or entanglement) is very low. The intensity of these impacts is low, with spatial extent and duration being the immediate vicinity and short term, respectively. These factors result in a negligible impact consequence. Given the occasional nature of this impact, overall impact significance to local bird communities is 1 – Negligible (see Table 7-125 below for details on selected criteria).

Helicopter Traffic

Potential impacts to marine and coastal birds from aircraft traffic include disturbances from noise and physical presence, and collision. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the FPSO or QU Platform). Based on this schedule and helicopter flight protocols, impacts to birds are expected to be infrequent, short-term, and not severe to local populations. The intensity of these impacts is low, with spatial extent and duration being the immediate vicinity and short term, respectively. These factors result in a negligible impact consequence. Given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-125 below for details on selected criteria).

Table 7-125. Impacts to Bird Communities during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Avoidance or displacement from areas under decommissioning for some species; attraction to other species as a foraging strategy and noise disturbances from decommissioning activities.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Discharges						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline; Support Operations	Effects of routine vessel discharges during decommissioning.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Remote	1 – Negligible
Solid Waste						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline; Support Operations	Accidental release of solid waste from decommissioning vessels resulting in impacts from ingestion by or entanglement of marine and coastal birds.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible
Helicopter Traffic						
Mauritania Senegal	Offshore; Pipeline	Displacement and avoidance of helicopters in offshore waters and when approaching heliports.	Nature: Negative Intensity: Low Spatial Extent: Localized Duration: Short-term (infrequent)	Negligible	Likely	1 – Negligible

7.4.8.4 Mitigation Measures and Residual Impacts

Impacts being rated 1 – Negligible, no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D41: Contractors will be expected to comply with the applicable legal requirements and standards at the time of decommissioning, including HSSE standards and performance requirements.
- D42: A preliminary decommissioning plan will be developed for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[127] for equipment and materials.
- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[128] for equipment and materials.

7.4.9 Marine Mammals

High Level Summary

In this section on Marine Mammals, the impact of five impact producing factors, these being Physical presence, Vessel movements, Discharges, Solid waste and Helicopter traffic, was evaluated. The residual impacts on Marine Mammals during the Decommissioning Phase for routine activities were assessed as of negligible significance when mitigation measures are applied.

7.4.9.1 Impact Producing Factors and Project Areas

The IPFs identified for marine mammals in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	●
Vessel movements	●	●	●	●
Discharges	●	●	●	●
Solid waste	●	●	●	●
Helicopter traffic		●	●	●

7.4.9.2 Impact Description

The following subsections explain how these IPFs will produce impacts in each of the project areas.

[127] In this case, disposal includes treatment, reuse, recycling and final disposal practices.
[128] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

7.4.9.2.1 Offshore Area

Physical Presence

Impacts to marine mammals from decommissioning vessels include the potential for behavioral disturbance from the physical presence of these vessels, and noise generated by these vessels. Potential impacts to marine mammals from disturbance, and noise from the physical presence of offshore vessels are discussed in Section 7.2.9.2. Physical disturbance is expected to result in avoidance and/or short-term displacement of individuals or groups of marine mammals. Vessel noise is audible to all marine mammals and sound levels are relatively high near the sources. It is expected that marine mammals will avoid or move away from vessel noise; therefore, it is expected that impacts will include only behavior alterations, including avoidance and short-term displacement.

Vessel Movements

Vessel strike and disturbances from the movement and noise resulting from offshore vessels to marine mammals is discussed in Section 7.2.9.2. Marine mammal species of concern for possible ship strike with all vessels operating at speed include primarily slow-moving species (e.g., North Atlantic right whales) and deep-diving species while on the surface (e.g., sperm whales, pygmy/dwarf sperm whales, and beaked whales). Generally, it is assumed that the probability of this encounter, and thus impact, is very low. Conversely, certain cetacean species, including dolphin species (e.g., *Tursiops truncatus* and *Stenella* spp.), actively approach vessels moving at speed to swim within the pressure wave produced by the vessel's bow.

Discharges

As presented in Section 7.2.9.2, routine discharges from project vessels within the Offshore Area include sanitary and domestic wastes, food waste, deck drainage, cooling water, etc. Within the open ocean environment, discharged fluids will rapidly dilute in local currents. Solid material will likely descend through the water column and disperse in sub-surface currents. Therefore, it is not likely that marine mammals will encounter discharged materials from Decommissioning Phase vessels.

Solid Waste

Solid waste and impacts to marine mammals are discussed in Section 7.2.9.2. Marine debris poses two types of potentially negative impacts to marine biota, including marine mammals: 1) entanglement, and 2) ingestion. Records suggest that entanglement is a far more likely cause of mortality to marine mammals than ingestion-related interactions.

All vessels associated with Decommissioning Phase activities will comply with MARPOL 73/78. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

7.4.9.2.2 Nearshore Hub/Terminal Area

Physical Presence

Within the Nearshore Hub/Terminal Area, marine mammals may be impacted by decommissioning activities of infrastructure, such as the removal of the FLNG and QU platform, and removal of piping, lighting, and other materials from the location. It is currently expected that caissons will be removed and the rubble mound foundation be left in place.

Disturbances are expected to include avoidance of or displacement from the Nearshore Hub/Terminal Area by individuals or groups of mammals. Because these activities are either static or moving slowly, it is expected that disturbances will not significantly affect local populations of marine mammals.

Vessel Movements

As discussed in Section 7.2.9.2.1, marine mammal species, particularly large whales and deep-diving species, may be vulnerable to physical disturbance from or collisions (ship strike) with moving vessels. Generally, it is assumed that the probability of this encounter, and thus impact, is very low. Conversely, certain dolphin species actively approach vessels moving at speed to swim within the pressure wave produced by the vessel's bow.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from decommissioning vessels operating at the Nearshore Hub/Terminal are the same as those discussed for the Offshore Area (Section 7.4.9.2.1). Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in sub-surface currents. Therefore, it is not likely that marine mammals will encounter discharged materials from Decommissioning Phase vessels.

Solid Waste

Potential impacts to marine mammals from solid debris in offshore waters are discussed Section 7.2.9.2.1. All vessels associated with Decommissioning Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

7.4.9.2.3 Pipeline Area

Physical Presence

Impacts to marine mammals decommissioning vessels within the Pipeline Area includes the potential for behavioral disturbance from the physical presence of these vessels, and noise generated by these vessels.

As discussed in Section 7.2.9.2, decommissioning activities would generate vessel and equipment noise that could disturb marine mammals. Broadband source levels for most vessels are anticipated to be within the audible range for all cetacean and pinniped species and, near the source, exceed current NMFS threshold for non-injurious harassment by continuous sound sources (NMFS, 2016). It is conservative to assume that noise associated with decommissioning may, in some cases, elicit behavioral changes in individual marine mammals that are in close proximity to these vessels. These behavioral changes may include evasive maneuvers such as diving or changes in swimming direction and/or speed. Vessel and equipment noise is transitory and generally does not propagate at great distances from the vessel.

Vessel Movements

As discussed in Section 7.2.9.2.1, marine mammal species, particularly large whales and deep-diving species, may be vulnerable to physical disturbance from or collisions (ship strike) with moving vessels. Generally, it is assumed that the probability of this encounter, and thus impact, is very low. Conversely, certain dolphin species actively approach vessels moving at speed to swim within the pressure wave produced by the vessel's bow.

Discharges

Routine discharges from decommissioning vessels within the Pipeline Area are discussed in Section 7.2.8.2.1. Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in subsurface currents. Therefore, it is not likely that marine mammals will encounter discharged materials from these vessels.

Solid Waste

Potential impacts to marine mammals from solid debris in offshore waters are discussed Section 7.2.9.2.1. All vessels associated with Decommissioning Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface. In addition, these vessels would implement a waste management plan that would include guidance for marine debris awareness.

Helicopter Traffic

Potential impacts to marine mammals from aircraft traffic include disturbances from noise and physical presence. Noise generated by project-related helicopters that are directly relevant to marine mammals are discussed above in Section 7.2.9.2.1. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the FPSO). Based on this schedule and helicopter flight protocols discussed in Section 7.2.9.2.1, impacts to marine mammals are expected to be infrequent, short-term, and not severe to local populations.

7.4.9.2.4 Support Operations Areas

Decommissioning activities associated with the supply base may impact marine mammals by vessel strike and disturbances. Vessel strike in marine mammals is discussed above (e.g., in Section 7.4.9.2.1) and in Section 7.3.9.2.1. Crew boats traveling to and from the supply base travel at relatively high speeds and may operate at night. In addition, noise from these vessels may disturb marine mammals, although it is likely that their underwater noise may alert mammals of the vessels' presence and relative distance, speed, and direction.

Vessel Movements

Impacts to marine mammals from vessels operating out of the Support Operations Areas include the potential for vessel strike with individual mammals. As discussed in Section 7.2.9.2.1, marine mammal species, particularly large whales and deep-diving species, may be vulnerable to collisions (ship strike) with moving vessels. Generally, it is assumed that the probability of this encounter, and thus impact, is very low. Certain cetacean species, including dolphin species (e.g., *Tursiops truncatus* and *Stenella* spp.), actively approach vessels moving at speed to swim within the pressure wave produced by the vessel's bow. Most of the vessel traffic associated with decommissioning activities operating out of the Support Operations Areas will travel at relatively slow speeds, although high speed vessel traffic at night may also occur, increasing the potential for vessel strike.

Discharges

Routine discharges are not expected from facilities and vessels associated with supply bases. Therefore, no impacts from discharges to marine mammals are expected.

Solid Waste

Potential impacts to marine mammals from solid debris is discussed Section 7.2.9.2.1. All operations (supply base and crew boat) associated with Decommissioning Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage Therefore, the amount of trash and debris released in nearshore waters would be minimal and only accidental. In addition, the shore base and crew boats would implement a waste management plan that would include guidance for marine debris awareness. Impacts to marine mammals from solid waste is not expected to be significant to local populations of marine mammals.

7.4.9.2.5 Summary

Operation of decommissioning-related vessels, and removal of select infrastructure may result in negative impacts to marine mammals in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area, and to a lesser extent at the Support Operations Areas. Physical presence and noise may disturb marine mammals through low intensity sound exposure (e.g., vessel operations. Vessel movements and noise in all areas may result in auditory injuries or impairment, short-term behavioral alterations, and short-term displacement from (or attraction to) discrete decommissioning areas. Vessel collisions with marine mammals are possible but very unlikely. Discharges and the accidental loss of solid waste has the potential to adversely affect marine mammals.

7.4.9.3 Impact Rating

Physical Presence

The consequence of impacts to marine mammals in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area during decommissioning activities from physical presence include potential behavioral effects from vessel presence and noise. Decommissioning vessel noise is expected to result in negligible impacts to marine mammals. These impacts are expected to be limited to behavioral alterations; specifically avoidance and temporary displacement. The overall impact significance is 1 – Negligible (see Table 7-126 below for details on selected criteria).

Vessel Movements

Vessel collisions with marine mammals are possible but very unlikely, based on normal operations vessel speeds. Exceptions may include the transiting of support vessels out of the Support Operations Areas, where vessel speeds may be higher, or where night time transits may occur. In the event a marine mammal is stricken by a support vessel, impact intensity would be moderate, impact extent would be local, and impact duration would be long term. Overall impact significance is 2 – Low (see Table 7-126 below for details on selected criteria).

Discharges

Routine, non-drilling related discharges from decommissioning activities in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area are expected to produce very localized impacts through the introduction of organics (sanitary and domestic wastes; food waste); these impacts will be restricted to surface waters, with a very remote likelihood of reaching the seafloor and associated benthic communities. The volumes and frequency of these discharges are not expected to impact marine mammal prey items, such as fishes. The overall impact significance is 1 – Negligible (see Table 7-126 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during decommissioning activities may occur in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, or within the Support Operations Area. These accidental losses are expected to be minimal but may produce very localized impacts to marine mammals via ingestion of small particles (plastic) or entanglement in debris. The likelihood of these events (release of solid debris and ingestion or entanglement) is occasional; therefore, the overall impact significance to marine mammals is 1 – Negligible (see Table 7-126 below for details on selected criteria).

Helicopter Traffic

Potential impacts to marine mammals from helicopter traffic include disturbances from noise and physical presence. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the FPSO or QU Platform). Based on this schedule and helicopter flight protocols, impacts to marine mammals are expected to be infrequent, short-term, and not severe to local populations. The overall impact significance is 1 – Negligible (see Table 7-126 below for details on selected criteria).

A summary of impacts to marine mammals from routine activities during the Decommissioning Phase is presented in Table 7-126.

Table 7-126. Impacts to Marine Mammal Communities during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Avoidance or displacement from decommissioning vessels and noise disturbances from decommissioning activities.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Likely	1 – Negligible
Vessel Movements						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Avoidance or displacement from decommissioning vessels and noise disturbances from decommissioning activities.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Likely	1 – Negligible
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Potential vessel strike resulting in marine mammal injury or mortality.	Nature: Negative Intensity: Moderate Spatial Extent: Immediate vicinity Duration: Short term	Minor	Rare	2 – Low
Discharges						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal	Direct and indirect effects of routine vessel discharges during decommissioning.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Remote	1 – Negligible

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Solid Waste						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Accidental release of solid waste from decommissioning vessels and infrastructure resulting in impacts from ingestion by or entanglement of marine mammals.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible
Helicopter Traffic						
Mauritania Senegal	Pipeline	Displacement and avoidance of helicopters in offshore waters and when approaching heliports.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short-term (also infrequent)	Negligible	Likely	1 – Negligible

7.4.9.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-127) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the measures and controls already planned in the project design.

Summary of existing measures inherent to design and operational controls:

- D41: Contractors will be expected to comply with the applicable legal requirements and standards at the time of decommissioning, including HSSE standards and performance requirements.
- D42: A preliminary decommissioning plan will be developed for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[129] for equipment and materials.
- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[130] for equipment and materials.

[129] In this case, disposal includes treatment, reuse, recycling and final disposal practices.
[130] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

Table 7-127. Mitigation Measures to Avoid or Reduce Impacts to Marine Mammals from Routine Activities during the Decommissioning Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Potential vessel strike resulting in marine mammal injury or mortality.	2 – Low	M06	1 – Negligible

Notes:

M06: Vessel operators will implement vessel strike avoidance protocols to reduce the potential for vessel strike with marine mammals and sea turtles (including injured/dead protected species reporting).

7.4.10 Sea Turtles

High Level Summary

In this section on Sea Turtles, the impact of five impact producing factors, these being Physical presence, Vessel movements, Discharges, Solid waste and Helicopter traffic, was evaluated. The residual impacts on Sea Turtles during the Decommissioning Phase for routine activities were assessed as of negligible significance when mitigation measures are applied.

7.4.10.1 Impact Producing Factors and Project Areas

The IPFs identified for sea turtles in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	●
Vessel movements	●	●	●	●
Discharges	●	●	●	●
Solid waste	●	●	●	●
Helicopter traffic		●		●

7.4.10.2 Impact Description

The following subsections explain how these IPFs will produce impacts in each of the project areas.

7.4.10.2.1 Offshore Area

Physical Presence

Impacts to sea turtles from decommissioning vessels include the potential for behavioral disturbance from the physical presence of vessels and noise generated by these vessels. Vessels associated with decommissioning operations include a drillship, standby vessels, supply vessels, ROV survey vessel, anchor vessels, crane vessels, tug boats, crew boat, and multi-service vessels.

The effects of noise on sea turtles, including vessel noise and drilling noise are discussed in Section 7.2.10.2. Vessel noise is audible to sea turtles and sound levels are relatively high near the sources. It is expected that sea turtles will avoid or move away from vessel noise generated during decommissioning operations; therefore, it is expected that impacts will include only behavior alterations, including avoidance and short-term displacement.

Vessel Movements

Vessel strike and disturbances to sea turtles from the transiting of offshore vessels are discussed in Section 7.2.10.2. There have been no documented sea turtle collisions with drilling and service vessels, although it is possible that such collisions with small or submerged sea turtles may go undetected, particularly during periods of poor weather and during the night.

Discharges

Routine discharges and their potential impacts to sea turtles are discussed in Sections 2.10.4 and 7.2.10.2, respectively. Routine discharges from decommissioning vessels within the offshore area include sanitary and domestic wastes, food waste, deck drainage, cooling water, etc. Within the open ocean environment, discharges will rapidly disperse and dilute in local currents. Solid material will likely descend through the water column and disperse in subsurface currents. Therefore, it is not likely that sea turtles will encounter discharges from decommissioning vessels in sufficiently high concentrations to cause injury.

Solid Waste

Solid waste and impacts to sea turtles are discussed in Section 7.2.10.2. Marine debris poses two types of potentially negative impacts to marine biota, including sea turtles: 1) entanglement, and 2) ingestion. All vessels associated with Decommissioning Phase activities will comply with MARPOL 73/78. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface.

7.4.10.2.2 Nearshore Hub/Terminal Area

Physical Presence

Within the Nearshore Hub/Terminal Area, sea turtles may be impacted by decommissioning activities of infrastructure removal, such as the removal of pipeline, the removal of the FLNG, and removal of piping, lighting, and other materials from the location. It is currently expected that caissons will be removed and the rubble mound foundation be left in place. The physical presence of decommissioning vessels may impact sea turtles from physical disturbance and noise. As discussed in Section 7.2.10.2.1, sea turtle species may be vulnerable to physical disturbance from vessels, exhibiting diving or avoidance behaviors. Generally, it is assumed that the probability of this encounter, and thus impact, is very low. Impacts from physical disturbance are expected to include avoidance of or displacement from areas of activity adjacent to the Nearshore Hub/Terminal Area. Because these activities are either static or moving slowly, it is expected that disturbances will not significantly affect local populations.

The potential effects of noise to sea turtles are discussed in Section 7.2.10.2.1. Decommissioning activities will generate both in-air and underwater noise that may impact sea turtles. Other than support vessels that are in transit to and from the Nearshore Hub/Terminal Area it is expected that decommissioning activities will occur at fixed locations or movements will be made slowly. Therefore, it is expected that turtles will avoid decommissioning sounds at injurious levels; potential impacts are expected to be restricted to behavioral effects (disturbances), including avoidance of or displacement from the Nearshore Hub/Terminal Area by individual turtles.

Vessel Movements

The Decommissioning Phase within the Nearshore Hub/Terminal Area will include the removal of the FLNG and QU platform and removal of other infrastructure by specialized vessels and support vessels. Impacts to sea turtles from these vessels include the potential for vessel strike with individual turtles. As discussed in Section 7.2.10.2.1, sea turtle species may be vulnerable to collisions (ship strike) with moving vessels. Generally, it is assumed that the probability of collisions with most operations vessels at the Nearshore Hub/Terminal Area is very low, based on their slow operational speeds. Vessel traffic operating at greater speeds or at night increases the possibility for collisions with sea turtles. All turtles are listed as threatened species under the IUCN; any collision is considered as fatal to the individual turtle, and the impact would be significant.

Discharges

Routine discharges (e.g., sanitary and domestic wastes, food waste, deck drainage, cooling water, etc.) from decommissioning vessels operating at the Nearshore Hub/Terminal are discussed in Section 2.10.4. Within the open ocean environment, discharges will rapidly disperse and dilute in local currents. Solid material will likely descend through the water column and disperse in subsurface currents. Therefore, it is not likely that sea turtles will encounter discharged materials from Decommissioning Phase vessels.

Solid Waste

Potential impacts to sea turtles from solid debris in offshore waters are discussed Section 7.2.10.2.1. All vessels associated with Decommissioning Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface.

7.4.10.2.3 Pipeline Area

Physical Presence

Impacts to sea turtles from decommissioning vessels within the Pipeline Area include the potential for behavioral disturbance from the physical presence of these vessels and noise generated by these vessels. As discussed in Section 7.2.10.2.1, sea turtles may be vulnerable to physical disturbance from vessels involved in decommissioning operations at the FPSO.

Vessel Movements

There have been no documented sea turtle collisions with drilling and service vessels, although it is possible that such collisions with small or submerged sea turtles may go undetected, particularly during periods of poor weather and during the night.

The effects of noise on sea turtles, including vessel noise is discussed in Section 7.2.10.2. Vessel noise is audible to sea turtles and sound levels are relatively high near their source. It is expected that sea turtles will avoid or move away from vessel noise generated during decommissioning operations; therefore, it is expected that impacts will include only behavior alterations, including avoidance and short-term displacement.

Discharges

Routine discharges from decommissioning vessels within the pipeline area and their potential impacts to sea turtles are discussed in Sections 2.10.4 and 7.2.10.2, respectively. Within the open ocean environment, discharged fluids will rapidly disperse dilute in local currents. Solid material will likely descend through the water column and disperse in subsurface currents. Therefore, it is not likely that sea turtles will encounter discharged materials from these vessels.

Solid Waste

Potential impacts to sea turtles from solid debris in offshore waters are discussed Section 7.2.10.2.1. All vessels associated with Decommissioning Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage generated on board vessels. Therefore, the amount of trash and debris dumped offshore would be expected to be minimal, as only accidental loss of trash and debris is anticipated, some of which could float on the water surface.

Helicopter Traffic

Potential impacts to sea turtles from project-related helicopter traffic include disturbances from noise and physical presence. Noise generated by project-related helicopters that are directly relevant to sea turtles are discussed in Section 7.2.10.2.1. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the FPSO). Based on this schedule and helicopter flight protocols discussed in Section 7.2.9.2.1, impacts to sea turtles are expected to be infrequent, short-term, and not severe to local populations.

7.4.10.2.4 Support Operations Areas

Physical Presence

Decommissioning activities associated with the Support Operations Areas may affect sea turtles by vessel strike and disturbances. Vessel strike in sea turtles is discussed in Section 7.2.10.2.1. Most vessels engaged in decommissioning activities are expected to move relatively slowly; however, vessels traveling to and from the supply base operate at relatively high speeds and may operate at night. Both factors add additional risk for potential collisions with sea turtles.

The effects of noise and sea turtles are discussed in Section 7.2.10.2.1. Noise from support vessels during decommissioning activities may disturb sea turtles, although it is possible that their underwater noise may alert turtles of vessel presence.

Discharges

Routine discharges are not expected from facilities and vessels associated with supply bases. Therefore, no impacts from discharges to sea turtles are expected.

Solid Waste

Potential impacts to sea turtles from solid debris is discussed Section 7.2.10.2.1. All operations (supply base and crew boat) associated with Decommissioning Phase activities will comply with MARPOL 73/78, which comprises regulations designed to protect the marine environment from various types of garbage Therefore, the amount of trash and debris released in nearshore waters would be minimal and only accidental. In addition, the shore base and crew boats would implement a waste management plan that would include guidance for marine debris awareness. Impacts to sea turtles from solid waste is not expected to be significant to local populations.

Helicopter Traffic

Helicopter traffic associated with the transfer of personnel to the FPSO and Nearshore hub/Terminal Area during decommissioning may affect local sea turtles. The potential effects of helicopters to sea turtles are discussed in Section 7.2.10.2.1 and include physical presence (disturbances) and noise. Helicopter support will be based out of the Dakar and/or Nouakchott airports. Helicopter personnel transfer is only expected for crew changeout or during emergencies (e.g., landing aboard the FPSO or QU Platform). Based on this schedule, impacts to sea turtles are expected to be infrequent, short-term, and not severe to local populations.

7.4.10.2.5 Summary

Operation of decommissioning-related vessels and helicopters, and removal of select infrastructure may result in negative impacts to sea turtles in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area, and to a lesser extent at the Support Operations Areas. Physical presence and noise may disturb sea turtles through low intensity sound exposure (e.g., vessel operations). Vessel movements and noise in all areas may result in auditory injuries or impairment, short-term behavioral alterations, and short-term displacement from (or attraction to) discrete decommissioning areas. Vessel collisions with sea turtles are possible but very unlikely. Discharges and the accidental loss of solid waste has the potential to adversely affect sea turtles, while helicopter traffic and associated noise may be sources for disturbance.

7.4.10.3 Impact Rating

Physical Presence

The consequence of impacts to sea turtles in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, and the Support Operations Areas during decommissioning activities from physical presence include potential vessel strikes, and behavioral effects from vessel presence and noise, Vessel collisions with sea turtles are possible, particularly with crew boat traffic operating from the supply base, but generally potential collisions are very unlikely, based on normal decommissioning vessel speeds. Decommissioning vessel traffic noise is expected to result in negligible impacts to sea turtles. These impacts are expected to be limited to behavioral alterations; specifically avoidance and temporary displacement. The intensity of these impacts is low, with spatial extent and duration being local and short term, respectively. These factors result in a negligible impact consequence. Given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-128 below for details on selected criteria).

Vessel Movements

Vessel movement and noise generated by support vessels may also produce behavioral disturbance, specifically avoidance and temporary displacement. The intensity of these impacts is low, with spatial extent and duration being local and short term, respectively. These factors result in a negligible impact consequence. Given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-128 below for details on selected criteria).

Generally, it is assumed that the probability of collisions with most decommissioning vessels in all project areas is very low, based on their slow operational speeds. Some support vessels may operate at much greater speeds or operate at night, increasing the possibility for collisions between vessels and sea turtles. All sea turtles species are listed as threatened species under the IUCN; as any collision is considered as fatal to the individual turtle, the intensity of the impact is rated as moderate. The spatial extent and duration are local and long term, respectively. These factors result in a moderate impact consequence. Given the rare nature of this impact, overall impact significance is 2 – Low (see Table 7-128 below for details on selected criteria).

Discharges

Routine, non-drilling related discharges from decommissioning activities in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, and the nearshore areas of the Support Operations Areas supply base are expected to produce very localized impacts to the water column through the introduction of organics (sanitary and domestic wastes; food waste); these impacts will be restricted to surface waters, with a very remote likelihood of reaching the seafloor and associated benthic communities. The volumes and frequency of these discharges are not expected to impact sea turtles or their prey items, such as fishes and benthic invertebrates, and seagrasses and macroalgae. The intensity of these impacts is low, with spatial extent and duration being the immediate vicinity and short term, respectively. These factors result in a negligible impact consequence. Given the occasional nature of this impact, overall impact significance is 1 – Negligible (see Table 7-128 below for details on selected criteria).

Solid Waste

The accidental loss of debris overboard during decommissioning activities may occur in the Offshore Area, Pipeline Area, Nearshore Hub/Terminal Area, or within the Support Operations Areas. These accidental losses are expected to be minimal but may produce very localized impacts to sea turtles via ingestion of small particles (plastic) or entanglement in debris. The intensity of these impacts is low, with spatial extent and duration being the immediate vicinity and short term, respectively. These factors result in a negligible impact consequence. Given the occasional nature of this impact, therefore, the overall impact significance to turtles is 1 – Negligible (see Table 7-128 below for details on selected criteria).

Helicopter Traffic

Potential impacts to sea turtles from helicopter traffic include disturbances from noise and physical presence. Helicopter personnel transfer is only expected during emergencies (e.g., landing aboard the FPSO or QU Platform). Based on this schedule and helicopter flight protocols, impacts to sea turtles are expected to be infrequent, short-term, and not severe to local populations. The intensity of these impacts is low, with spatial extent and duration being the immediate vicinity and short term, respectively. These factors result in a negligible impact consequence. Given the occasional nature of this impact, overall impact significance is 1 – Negligible (see Table 7-128 below for details on selected criteria).

Table 7-128. Impacts to Sea Turtles during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Avoidance or displacement from decommissioning vessels and noise disturbances from decommissioning activities.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Likely	1 – Negligible
Vessel Movements						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Short-term behavioral alterations, and short-term displacement from vessel noise.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Likely	1 – Negligible
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Potential vessel strike resulting in sea turtle injury or mortality.	Nature: Negative Intensity: Moderate Spatial Extent: Local Duration: Long term	Moderate	Rare	2 – Low
Discharges						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Direct and indirect effects on sea turtles of routine vessel discharges during decommissioning.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Solid Waste						
Mauritania Senegal	Offshore; Pipeline; Nearshore Hub/ Terminal; Support Operations	Accidental release of solid waste from decommissioning vessels and infrastructure resulting in impacts from ingestion by or entanglement of sea turtles.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible
Helicopter Traffic						
Mauritania Senegal	Pipeline; Support Operations	Displacement and avoidance of helicopters in offshore waters and when approaching heliports.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short-term (infrequent)	Negligible	Occasional	1 – Negligible

7.4.10.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-129) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the measures and controls already planned in the project design.

Summary of existing measures inherent to design and operational controls:

- D41: Contractors will be expected to comply with the applicable legal requirements and standards at the time of decommissioning, including HSSE standards and performance requirements.
- D42: A preliminary decommissioning plan will be developed for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[131] for equipment and materials.
- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[132] for equipment and materials.

[131] In this case, disposal includes treatment, reuse, recycling and final disposal practices.
[132] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

Table 7-129. Mitigation Measures to Avoid or Reduce Impacts to Sea Turtles from Routine Activities during the Decommissioning Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Potential vessel strike resulting in sea turtle injury or mortality.	2 – Low	M06	1 – Negligible

Notes:

M06: Vessel operators will implement vessel strike avoidance protocols to reduce the potential for vessel strike with marine mammals and sea turtles (including injured/dead protected species reporting).

7.4.11 Threatened Species and Protected Areas

High Level Summary

In this section on Threatened Species and Protected Areas, the impact of five impact producing factors, these being Physical presence, Vessel movements, Emissions, Discharges and Solid waste, was evaluated. The residual impacts on Threatened Species and Protected Areas during the Decommissioning Phase for routine activities were assessed as of negligible or low significance when mitigation measures are applied.

7.4.11.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence			•	
Vessel movements	•	•	•	
Emissions			•	•
Discharges	•	•	•	•
Solid waste	•	•	•	•

7.4.11.2 Impact Description

The Decommissioning Phase will involve the plugging and abandonment of all wells, flushing of flowlines, and removal of the FLNG and FPSO vessels, among other operations. These operations will utilize support vessels which are the source of several IPFs that may impact threatened species, protected areas or other areas of conservation interest during the Decommissioning Phase.

As noted in Section 7.2.11.2, there are a total of 10 Critically Endangered species identified on the IUCN Red List which may be present in the coastal zone or nearshore and offshore waters of the core and extended study areas. Critically Endangered species include two marine and coastal bird species, two sea turtle species, and six demersal soft bottom and hard bottom fish species. No Critically Endangered marine mammals occur in the core or extended study areas. The presence of one Critically Endangered species (Atlantic Goliath Grouper) within the core or extended study areas is considered likely, whereas the presence of several other Critically Endangered species (three fish species, one bird species, and one turtle species in the core or extended study areas) is considered possible.

There are 18 Endangered species identified on the IUCN Red List which may be present in the coastal zone or nearshore and offshore waters of the core and extended study areas. Endangered species include four marine mammal species, one sea turtle species, nine demersal soft and hard bottom fish species, and four pelagic fish species. No endangered marine and coastal bird species are present in the core or extended study areas. Five endangered demersal fish and three pelagic fish species are considered likely to occur in the core or extended study areas. The endangered Mediterranean monk seal is likely to occur within the core or extended study areas.

7.4.11.2.1 Offshore Area

Vessel Movements

Support vessels working the Offshore Area during the Decommissioning Phase may transit through protected areas, IBAs, EBSAs, or other areas of conservation interest on their way to or from Dakar or Nouakchott. Waves generated by vessels may erode unprotected shorelines, especially in areas that are already subject to natural erosion processes as is seen in the west African region. Vessel transits through the EBSAs could result in periodic disruption of individual marine mammals, sea turtles, or birds within the EBSAs. However, it is likely that individuals would experience, at most, a short term behavioral disruption.

Support vessel operators are expected to follow all applicable maritime navigation rules and would normally follow the most direct route (weather conditions permitting) between the Offshore Area and the Support Operations Areas on shore. Support vessels are expected to use existing routes into port including well-traveled shipping lanes. Vessel operators normally maintain a watch for obstructions during transit and will not deliberately approach a marine mammal or turtle. A full description of potential impacts from vessel movements and noise on marine mammals and sea turtles during the Decommissioning Phase is presented in Section 7.4.9 and Section 7.4.10, respectively.

Vessel movements and noise are expected to affect threatened species in the same manner as other, non-listed species within each respective resource group. Among threatened birds, some project vessels may disturb individual or groups of marine birds; however, it is anticipated that these disturbances would consist of short-term displacement of individuals away from the vessel or vessel aggregation. No significant impacts to these birds are expected. Among threatened marine mammals, physical disturbance is expected to result in avoidance and/or short-term displacement of individuals or groups of marine mammals, while noise will include only behavior alterations, including avoidance and short term displacement. For threatened fishes, seafloor disturbance and turbidity may temporarily displace fishes in the immediate area of the decommissioning activity.

Discharges

Routine discharges from support vessels in the Offshore Area will produce localized areas of reduced water quality, including increases in total suspended solids, nutrients, and chlorine. All discharges are expected to be diluted rapidly due to the open ocean location of the Offshore Area. It is highly unlikely that any routine discharges from support vessels in the Offshore Area will reach any protected area, IBA, EBSA, or other area of conservation interest. The nearest protected area to the Offshore Area is the Saint-Louis Marine Protected Area (approximately 50 km to the east), while the nearest EBSA is the Cayar Seamount Complex (approximately 20 km to the south). The greatest likelihood of any potential contact would be from transiting support vessels that will travel through EBSAs on their way to Dakar or Nouakchott.

Discharges are expected to affect threatened species in a similar fashion as other, non-listed species. Threatened fishes, birds, sea turtles, and marine mammals could be affected by discharges in the immediate vicinity of the discharge, but widespread impacts are not likely. Minimal effects to plankton and fishes are expected, while marine birds, sea turtles, and marine mammals are unlikely to encounter discharged materials from Decommissioning Phase vessels.

Solid Waste

No solid waste will be intentionally discharged in the Offshore Area. However, accidental loss of debris from support vessels during decommissioning activities may occasionally occur, and currents could transport debris through protected areas or onto coastal IBAs, EBSAs, or other areas of conservation interest. Floating debris may become hazardous to marine mammals, sea turtles, birds, or fish that are present due to the risk of entanglement or ingestion. Marine debris that washes ashore may foul beaches, adversely affect the aesthetics of natural coastal areas, and provide an entanglement or ingestion hazard for coastal animals.

For threatened species, the accidental loss of solid waste and debris poses two types of potentially negative impacts to marine biota, including marine mammals and sea turtles: 1) entanglement, and 2) ingestion. Records suggest that entanglement is a far more likely cause of mortality to these groups than ingestion-related interactions. The potential for impact to fishes and birds is considered to be limited.

7.4.11.2.2 Nearshore Hub/Terminal Area

Physical Presence

Decommissioning activities in the Nearshore Hub/Terminal Area to remove the FLNG vessel and other infrastructure will necessitate the presence of numerous support vessels. Portions of the Nearshore Hub/Terminal Area are in close proximity to several protected areas, including Diawling National Park and the Saint-Louis Marine Protected Area in Senegal, and the Senegal River Delta Transboundary Biosphere Reserve. As described in Section 4.5.9, one EBSA, the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal, is located within the Nearshore Hub/Terminal Area. The Saint-Louis Marine Protected Area is located approximately 4 km south of the Nearshore Hub/Terminal Area and should not be affected by the presence or noise of supply vessels.

The portion of the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal that is within the Nearshore Hub/Terminal Area may experience disturbance due to the presence and noise from decommissioning activities. However, fauna located within any impacted protected area or other area of conservation interest should experience, at most, short term behavioral changes as a result of vessel presence and noise.

For threatened species, physical presence is expected to result in avoidance of the decommissioning activity, displacement from the area, or disturbance. These impacts are expected for all threatened species, including birds, fish, sea turtles, and marine mammals.

Vessel Movements

Substantial vessel activity is likely during the Decommissioning Phase in the Nearshore Hub/Terminal Area, which includes a small portion of the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal EBSA and is near Diawling National Park and the Saint-Louis Marine Protected Area in Senegal and the Senegal River Delta Transboundary Biosphere Reserve. Numerous support vessels will transit through the Nearshore Hub/Terminal Area to facilitate the removal of the FLNG vessel and other project equipment. It is expected that fauna within nearby protected areas or other areas of conservation interest may be subject to short-term behavioral changes.

Among threatened species, the potential for vessel strike is acute for marine mammals and sea turtles. Fish will avoid moving vessels and associated noise sources, while bird exposure to vessel and equipment noise is expected to result in little disruption of behavioral patterns or other non-injurious effects.

Emissions

The presence of support vessels assisting in decommissioning operations in the Nearshore Hub/Terminal Area will result in the increase of airborne contaminants in nearby areas of conservation interest, including the Saint-Louis Marine Protected Area, Langue-de-Barbarie National Park, Guembeul Natural Reserve, and the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal EBSA. Depending on prevailing winds at the time of emissions, increased concentrations of these contaminants could occur any protected area or area of conservation interest that is downwind.

Among threatened species, reductions in local air quality associated with decommissioning activities will be limited to the area around the Nearshore Hub/Terminal Area. As air breathers, only limited impacts to threatened birds, sea turtles, and marine mammals may be expected; no impacts to threatened fish are expected.

Discharges

Routine effluent discharges from support vessels assisting in decommissioning operations in the Nearshore Hub/Terminal Area will result in localized areas of reduced water quality including increases in total suspended solids, nutrients, and chlorine. Slight increases in total suspended solids, nutrients, and chlorine could occur in areas near the discharge points. The Saint-Louis Marine Protected Area is nearby (approximately 4 km to the south of the Nearshore Hub/Terminal Area), but it is expected that all discharges will be thoroughly dispersed and diluted and impacts on the protected area considered unlikely.

Discharges from decommissioning operations in the Nearshore Hub/Terminal Area are expected to affect threatened species in a similar fashion as other, non-listed species. Threatened fishes, birds, sea turtles, and marine mammals could be affected by discharges in the immediate vicinity of the discharge, but widespread impacts are not likely. Minimal effects to plankton and fishes are expected, while marine birds, sea turtles, and marine mammals are unlikely to encounter discharged materials from Decommissioning Phase vessels.

Solid Waste

No solid waste will be intentionally discharged during the Decommissioning Phase in the Nearshore Hub/Terminal Area. However occasional pieces of waste may fall overboard from support vessels or from the FLNG vessel. Currents could transport lost debris through protected areas or onto coastal IBAs, EBSAs, or other areas of conservation interest. Floating debris may become hazardous to marine mammals, sea turtles, birds, or fish that are present due to the risk of entanglement or ingestion. Marine debris that washes ashore may foul beaches, adversely affect the aesthetics of natural coastal areas, and provide an entanglement or ingestion hazard for coastal animals.

For threatened species present in the Nearshore Hub/Terminal Area, the accidental loss of solid waste and debris may result in entanglement or ingestion for marine mammals and sea turtles. The potential for impact to fishes and birds is considered to be limited.

7.4.11.2.3 Pipeline Area

Vessel Movements

As discussed in Section 7.3.11.2.1, vessels transiting from the supply bases to the Pipeline Area to assist with decommissioning activities may pass through protected areas or other areas of conservation interest including the Convergence Zone of the Canary-Guinea Currents EBSA, the Cayar Canyon EBSA, and the Cayar Seamount Complex EBSA which are located between Dakar and the Offshore Area, or the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal EBSA or the Cold Water Reef areas which are located between Nouakchott and the Offshore Area. Impacts that could occur include coastal erosion due to wakes caused by transiting vessels or short-term behavioral changes of marine fauna due to the presence and noise of transiting vessels.

Vessel movements and noise are expected to affect threatened species in the same manner as other, non-listed species within each respective resource group. Among threatened birds, some project vessels may disturb individual or groups of marine birds; however, it is anticipated that these disturbances would consist of short-term displacement of individuals away from the vessel or vessel aggregation. No significant impacts to these birds are expected. Among threatened marine mammals, physical disturbance is expected to result in avoidance and/or short-term displacement of individuals or groups of marine mammals, while noise will include only behavior alterations, including avoidance and short-term displacement. For threatened fishes, seafloor disturbance and turbidity may temporarily displace fishes in the immediate area of the decommissioning activity.

Emissions

Emissions from support vessels in the Pipeline Area during decommissioning activities will result in air contaminants typically associated with internal combustion engines including PM, SO_x, NO_x, VOCs, and CO. Depending on prevailing winds at the time of emissions, increased concentrations of these contaminants could occur any protected area or area of conservation interest that is downwind.

Among threatened species, reductions in local air quality associated with decommissioning activities will be limited to the area around the FPSO, within the Pipeline Area. As a result, only limited impacts to threatened birds, sea turtles, and marine mammals may be expected; no impacts to threatened fish are expected.

Discharges

Discharges from support vessels operating in the Pipeline Area during the Decommissioning Phase will produce localized areas of reduced water quality, including increases in total suspended solids, nutrients, and chlorine. Slight, temporary increases in total suspended solids, nutrients, and chlorine will likely occur. However, rapid dispersion and dilution is expected and any residual remnants of discharges that may enter a marine protected area, EBSA, IBA, or other area of conservation interest would, at most, cause localized and temporary reductions in water quality.

Among threatened species, the discharges resulting from decommissioning operations in the Pipeline Area are expected to affect threatened species in a similar fashion as other, non-listed species. Threatened fishes, birds, sea turtles, and marine mammals could be affected by discharges in the immediate vicinity of the discharge, but widespread impacts are not likely. Minimal effects to plankton and fishes are expected, while marine birds, sea turtles, and marine mammals are unlikely to encounter discharged materials from Decommissioning Phase vessels.

Solid Waste

No solid waste will be intentionally discharged in the Pipeline Area during the Decommissioning Phase. As discussed in Section 7.2.11.1.1, accidental loss of debris from the support vessels may occasionally occur as result in an entanglement or ingestion hazard for marine fauna. If debris washed ashore, waste could result in the fouling of beaches, negative effects on the aesthetics of natural coastal areas, and result in an entanglement or ingestion hazard for coastal animals.

For threatened species present in the Pipeline Area, the accidental loss of solid waste and debris may result in entanglement or ingestion for marine mammals and sea turtles. The potential for impact to fishes and birds is considered to be limited.

7.4.11.2.4 Support Operations Areas

Emissions

Emissions from project support vessels in the Support Operations Areas in Dakar and Nouakchott during decommissioning will result in an increase in concentrations of air contaminants typically associated with internal combustion engines including PM, SO_x, NO_x, VOCs, and CO. Depending on prevailing winds at the time of emissions, increased concentrations of these contaminants could occur within any protected area or area of conservation interest that is downwind.

Among threatened species, reductions in local air quality associated with decommissioning activities will be limited to the area around the Support Operations Areas, or along transit corridors to other project areas. As a result, only limited impacts to threatened birds, sea turtles, and marine mammals may be expected; no impacts to threatened fish are expected.

Discharges

Routine discharges from support vessels assisting in decommissioning activities in the Support Operations Areas will produce localized areas of reduced water quality, including increases in total suspended solids, nutrients, and chlorine. Slight, temporary increases in total suspended solids, nutrients, and chlorine could occur in offshore protected areas near the Support Operations Areas such as the Coastal Habitats of the Neritic Zone of Mauritania and the extreme north of Senegal EBSA near Nouakchott or the Convergence Zone of the Canary-Guinea Currents EBA near Dakar.

Among threatened species, the discharges resulting from the support of decommissioning operations are expected to affect threatened species in a similar fashion as other, non-listed species. Threatened fishes, birds, sea turtles, and marine mammals could be affected by discharges in the immediate vicinity of the discharge, but widespread impacts are not likely. Minimal effects to plankton and fishes are expected, while marine birds, sea turtles, and marine mammals are unlikely to encounter discharged materials from Decommissioning Phase vessels.

Solid Waste

No solid waste will be intentionally discharged in the Support Operations Areas during the Decommissioning Phase. As discussed in Section 7.2.11.1.1, accidental loss of debris from support vessels may occasionally occur as result in an entanglement or ingestion hazard for marine fauna. If debris washed ashore, waste could result in the fouling of beaches, negative effects on the aesthetics of natural coastal areas, and result in an entanglement or ingestion hazard for coastal animals.

For threatened species present in the Support Operations Areas, or more likely along transit corridors to other project areas, the accidental loss of solid waste and debris may result in entanglement or ingestion for marine mammals and sea turtles. The potential for impact to fishes and birds is considered to be limited.

7.4.11.2.5 Summary

Operation of decommissioning-related vessels and helicopters, and removal of select infrastructure may result in negative impacts to threatened species in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area, and to a lesser extent at the Support Operations Areas. Potential impacts to protected areas are mediated by distance; vessels transiting to and from the Offshore Area and Pipeline Area, both of which are well removed from the majority of protected areas, may be sources of limited impact. At the Nearshore Hub/Terminal Area, decommissioning operations are much closer to shore and coastal protected areas. Physical presence may disturb threatened species through low intensity sound exposure (e.g., vessel operations). For threatened species, vessel movements in all areas may result in auditory injuries or impairment, short-term behavioral alterations, and short-term displacement from (or attraction to) discrete decommissioning areas. Vessel collisions with threatened species (e.g., marine mammals, sea turtles) are possible but very unlikely. Discharges and the accidental loss of solid waste has the potential to adversely affect threatened species and protected areas, while helicopter traffic and associated noise may be sources for disturbance.

7.4.11.3 Impact Rating

Physical Presence

Impacts to protected areas and other areas of conservation interest from the physical presence from the support vessels in the Decommissioning Phase will potentially occur from support vessels in the Nearshore/Hub Terminal Area. In this area, one EBSA (Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal) overlaps with the Nearshore Hub/Terminal Area and could be impacted by the reoccurring presence of support vessels. However, consequences are expected to be limited to behavioral disturbances and should be short term given the expected duration of the Decommissioning Phase. No impacts from physical presence in the Offshore Area or Pipeline Area are expected during decommissioning because there are no protected areas or other areas of conservation interest in the vicinity.

Impacts to threatened species from physical presence impacts are expected to be limited to behavioral alterations, specifically avoidance and temporary displacement.

The intensity of these impacts is moderate, with spatial extent and duration being local and short term, respectively. These factors result in a minor impact consequence. Given the likely nature of this impact, overall impact significance is 2 – Low (see Table 7-130 below for details on selected criteria).

Vessel Movements

Impacts to protected areas and other areas of conservation interest from vessel movements may occur due to decommissioning operations in the Offshore Area, Nearshore/Hub Terminal Area, or Pipeline Area. The primary impact would be due to incremental coastal erosion caused by vessel wakes, or behavioral disturbances to marine fauna due to vessel noise. Due to the nature (i.e., duration, vessel routes) of support vessel operations, impact consequence to fauna in protected areas or other areas of conservation interest from noise disturbance is anticipated to be negligible. Although coastal erosion is possible, vessels will depart from established supply bases that are located in developed, industrial areas. Therefore, the overall impact significance is 1 – Negligible (see Table 7-130 below for details on selected criteria).

For threatened species, impacts associated with vessel movement are only applicable to marine mammals and sea turtles; vessel movement will have no effect on birds and fishes. In the event a threatened marine mammal or sea turtle is stricken by a support vessel, impact intensity would be moderate, impact extent would be local, and impact duration would be long term. Overall impact significance is 2 – Low (see Table 7-130 below for details on selected criteria).

Emissions

Emissions from project vessels may cause an increase in airborne contaminants in protected areas or other areas of conservation interest that are downwind of the location of emissions. Emission from the FLNG vessel and support vessels assisting in decommissioning operations in the Nearshore/Hub Terminal Area, the Pipeline Area and from vessel operations in the Support Operations Areas may cause reduced air quality in downwind protected areas. There are no protected areas in the vicinity of the Offshore Area and impacts from emissions in that area are not expected. Due to expected rapid dispersion of emitted contaminants and the relatively brief period that decommissioning activities will occur, the overall impact significance is rated 1 – Negligible (see Table 7-130 below for details on selected criteria).

For threatened species, reductions in local air quality associated with decommissioning activities will be limited to the area around each of the project areas, or along transit corridors to each project area. As a result, only limited impacts to threatened birds, sea turtles, and marine mammals may be expected; no impacts to threatened fish are expected. The intensity of these impacts is low, with spatial extent and duration being local and short term, respectively. These factors result in a negligible impact consequence. Given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-130 below for details on selected criteria).

Discharges

Routine effluent discharges may produce localized areas of reduced water quality, including increases in total suspended solids, nutrients, and chlorine in the vicinity of the discharge points around the FLNG vessel in the Nearshore Hub/Terminal Area, near the FPSO in the Pipeline Area, and from transiting vessels. Due to the expected rapid dispersion of effluent discharges, impact intensity is low, spatial extent is local, and duration is short term, resulting in a negligible impact consequence. Given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-130 below for details on selected criteria).

Discharge of ballast water could result in the introduction of non-native species that could become established and invasive. If it occurred, a new invasive species could impact threatened species and/or protected areas by disrupting habitat or food availability for native species. The intensity of such impacts would be moderate. Based on the long-term and regional nature of such an impact, the overall impact significance to threatened species and protected areas would be 2 – Low (see Table 7-130 below for details on selected criteria).

For threatened species, reductions in local water quality associated with decommissioning-related discharges will be limited to the area around each of the project areas, or along transit corridors to each project area. As a result, only limited impacts to threatened birds, fishes, sea turtles, and marine mammals may be expected. The intensity of these impacts is low, with spatial extent and duration being local and short term, respectively. These factors result in a negligible impact consequence. Given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-130 below for details on selected criteria).

Solid Waste

The accidental discharge of solid waste from vessels operating in any of the project areas during the Decommissioning Phase could potentially impact fauna in offshore protected areas or wash ashore and foul beaches and present an ingestion or entanglement hazard for terrestrial species within protected areas or other areas of conservation interest. Based on the mitigation measures implemented to reduce the likelihood of lost debris and the resulting rare likelihood, the overall impact significance is 1 – Negligible (see Table 7-130 below for details on selected criteria).

For threatened species, no impacts to fishes or birds are expected from the accidental loss of solid waste and debris associated with decommissioning activities. For threatened marine mammals and sea turtles, solid waste represents an entanglement or ingestion hazard. The intensity of these impacts is low, with spatial extent and duration being local and short term, respectively. These factors result in a negligible impact consequence. Given the likely nature of this impact, overall impact significance is 1 – Negligible (see Table 7-130 below for details on selected criteria).

Summary

A summary of impacts to threatened species, protected areas or other areas of conservation interest from routine activities during the Decommissioning Phase is presented in Table 7-130.

Table 7-130. Impacts to Threatened Species and Protected Areas or Other Areas of Conservation Interest during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Nearshore Hub/ Terminal	Behavioral disturbances to fauna within protected areas or other areas of conservation interest.	Nature: Negative Intensity: Moderate Spatial Extent: Local Duration: Short term	Minor	Likely	2 – Low
Mauritania Senegal	Nearshore Hub/ Terminal; Offshore	Behavioral disturbances to threatened species.	Nature: Negative Intensity: Moderate Spatial Extent: Local Duration: Short term	Minor	Likely	2 – Low
Vessel Movements						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Coastal erosion due to vessel wakes; behavioral disturbances to fauna within protected areas or other areas of conservation interest.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Occasional	1 – Negligible
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline	Disturbance, possible auditory injury, vessel strike to threatened species from vessels, operations.	Nature: Negative Intensity: Moderate Spatial Extent: Local Duration: Long term	Moderate	Rare	2 – Low
Emissions						
Mauritania Senegal	Nearshore Hub/ Terminal; Support Operations	Increase in airborne contaminants in protected areas or other areas of conservation interest.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Likely	1 – Negligible

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Mauritania Senegal	Nearshore Hub/ Terminal; Support Operations	Increase in airborne contaminants and subsequent exposure for threatened species (birds, sea turtles, marine mammals only).	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Likely	1 – Negligible
Discharges						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Temporarily decrease water quality in protected areas or other areas of conservation discharge near the discharge location.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Likely	1 – Negligible
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Introduction of non-native or invasive species.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Long term	Moderate	Remote	2 – Low
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Reductions in local water quality from routine discharges and effects on threatened species.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Likely	1 – Negligible
Solid Waste						
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Potential entanglement or ingestion by fauna in protected areas; fouling of coastal areas in protected areas.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Occasional	1 – Negligible
Mauritania Senegal	Offshore; Nearshore Hub/ Terminal; Pipeline; Support Operations	Potential entanglement or ingestion by threatened species (sea turtles, marine mammals only).	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Occasional	1 – Negligible

7.4.11.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-131) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the measures and controls already planned in the project design.

Summary of existing measures inherent to design and operational controls:

- D41: Contractors will be expected to comply with the applicable legal requirements and standards at the time of decommissioning, including HSSE standards and performance requirements.
- D42: A preliminary decommissioning plan will be developed for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[133] for equipment and materials.
- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[134] for equipment and materials.

Table 7-131. Mitigation Measures to Avoid or Reduce Impacts to Threatened Species and Protected Areas from Routine Activities during the Decommissioning Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Behavioral disturbances to fauna within protected areas or other areas of conservation interest.	2 – Low	None	2 – Low
Behavioral disturbances to threatened species.	2 – Low	None	2 – Low
Disturbance, possible auditory injury, vessel strike to threatened species from vessels, operations.	2 – Low	M06	1 – Negligible
Introduction of non-native or invasive species.	2 – Low	see below	2 – Low

Notes:

M06: Vessel operators will implement vessel strike avoidance protocols to reduce the potential for vessel strike with marine mammals and sea turtles (including injured/dead protected species reporting).

Mitigation for the potential invasive species impacts associated with ballast water could be addressed under the IMO Ballast Water Management Convention with exchange of ballast water mid-ocean or installation of an on-board ballast water treatment system (D08).

[133] In this case, disposal includes treatment, reuse, recycling and final disposal practices.
[134] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

7.4.12 Biodiversity

High Level Summary

In this section on Biodiversity, the impact of six impact producing factors, these being Physical presence, Vessel movements, Emissions, Discharges, Solid waste and Helicopter traffic, was evaluated. The residual impacts on Biodiversity during the Decommissioning Phase for routine activities were assessed as of negligible or low significance when mitigation measures are applied.

7.4.12.1 Impact Producing Factors and Project Areas

As discussed in Chapter 4, the characteristics for biodiversity represent a suite of previously identified resources – i.e., fish and other fishery resources, marine mammals, sea turtles, birds, threatened species, and protected areas and areas of conservation interest. Biodiversity IPFs consequently represent a combination of IPFs identified for those resources that contribute to biodiversity. Refer to Sections 7.4.6 and 7.4.8 through 7.4.11 for detailed discussion of impact determinations for these resources.

7.4.12.2 Impact Description

The Decommissioning Phase will involve a multitude of specialized vessels specifically designed to complete various tasks, including the plugging and abandonment of all wells, flushing of flowlines, and removal of the FLNG and FPSO vessels, among other operations. These vessels and the associated infrastructure which they will remove or decommission/abandon in place are the source of several IPFs. Physical presence, vessel movements, emissions, discharges, solid waste, and helicopter traffic represent potential sources of impact to biodiversity resources in the project areas. Table 7-132 summarizes the impact determinations for each of these biodiversity resources.

The introduction of invasive non-indigenous specious could have an impact on biodiversity.

Table 7-132. Summary of Impact Determinations for Various Components of Biodiversity during the Decommissioning Phase.

IPF	Fish and Other Fishery Resources	Marine Mammals	Sea Turtles	Birds	Threatened Species	Protected Areas and Areas of Conservation Interest
Physical presence	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible	2 – Low	2 – Low
Vessel movements	-	1 – Negligible to 2 – Low	1 – Negligible to 2 – Low	-	2 – Low	1 – Negligible
Emissions	-	-	-	-	1 – Negligible	1 – Negligible
Discharges	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible to 2 – Low	1 – Negligible
Solid waste	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible	1 – Negligible
Helicopter traffic	-	1 – Negligible	1 – Negligible	1 – Negligible	-	-

7.4.12.3 Mitigation Measures and Residual Impacts

The majority of impacts to biodiversity resources resulting from decommissioning activities were rated negligible and therefore no mitigation measures were required. Table 7-133 summarizes the proposed mitigation measures for non negligible impacts to marine mammals or sea turtles resulting from decommissioning activities. Summary of existing measures inherent to design and operational controls:

- D41: Contractors will be expected to comply with the applicable legal requirements and standards at the time of decommissioning, including HSSE standards and performance requirements.
- D42: A preliminary decommissioning plan will be developed for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[135] for equipment and materials.
- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[136] for equipment and materials.

Table 7-133. Mitigation Measures to Avoid or Reduce Impacts to Biodiversity (i.e., Marine Mammals, Sea Turtles) from Routine Activities during the Decommissioning Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Behavioral disturbances to fauna within protected areas or other areas of conservation interest.	2 – Low	None	2 – Low
Behavioral disturbances to threatened species.	2 – Low	None	2 – Low
Potential vessel strike resulting in marine mammal or sea turtle injury or mortality (including impacts to threatened marine mammal and sea turtle species).	2 – Low	M06	1 – Negligible
Introduction of non-native or invasive species.	2 – Low	see below	2 – Low

Notes:

M06: Vessel operators will implement vessel strike avoidance protocols to reduce the potential for vessel strike with marine mammals and sea turtles (including injured/dead protected species reporting).

As summarized in Section 7.2.5.2.1, project vessels could be a source for potential invasive species via several mechanisms, including ballast water and hull-established fouling community. This potential impact would be of concern if a project vessel was coming from another international location outside of the tropical/subtropical North Atlantic Ocean. Mitigation for the potential invasive species impacts associated with ballast water could be addressed under the IMO Ballast Water Management Convention with exchange of ballast water mid-ocean or installation of an on-board ballast water treatment system (D08).

[135] In this case, disposal includes treatment, reuse, recycling and final disposal practices.
[136] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

7.4.13 Land & Seabed Occupation and Use

High Level Summary

In this section on Land & Seabed Occupation and Use, the impact of one impact producing factor, this being Physical presence, was evaluated. All impacts on Land & Seabed Occupation and Use during the Decommissioning Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

7.4.13.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	

7.4.13.2 Impact Description

For the purpose of the assessment of the impacts of the project on the land and seabed occupation and use, it is assumed that the infrastructures installed or constructed on the seabed will remain there.

As indicated in Sections 7.2.13 and 7.3.13, the physical presence of infrastructures will start during the Construction Phase and it will last during the whole life of the project and beyond since most of the structures laying on the seabed will remain there even after decommissioning. Therefore, the duration of their impact was considered permanent.

No additional land and seabed occupation and use will be required during the Decommissioning Phase. Therefore, the impacts identified for the Construction and Operations Phases will remain the same throughout the Decommissioning Phase. To avoid redundancy, the impact description is not repeated here.

7.4.13.2.1 Summary

Table 7-134 provides a summary of the total seabed area occupied during the Decommissioning Phase as a result of the physical presence of infrastructures installed during the Construction Phase.

Table 7-134. Area of Seabed Used by Project Area for the Decommissioning Phase.

Project Area	Seabed Occupied in km^2
Offshore Area	<0.01
Nearshore Hub/Terminal Area	0.16
Pipeline Area	0.13
Total	<0.30

7.4.13.3 Impact Rating

As indicated in Sections 7.2.13 and 7.3.13, the impacts of the physical presence of project infrastructures to seabed occupation and use in the Offshore Area, Nearshore Hub/Terminal Area, and Pipeline Area include a modification in current seabed occupation on a very small area: <0.3 km^2. This modification will have no interference with other users since no anthropogenic activities have been identified in the concerned seabed area.

The intensity of the impact is low. The small adverse changes on the seabed are unlikely to be noticed. The extent of the impact will be limited to the infrastructure footprint. Its duration is considered here for the whole life of the project and beyond as the impact is permanent. Based on the combination of these criteria, the consequence of the impact will be negligible. Even if this impact is likely to happen, its overall significance is rated 1 – Negligible (details are provided in Table 7-135).

Table 7-135. Impacts to Land and Seabed Occupation and Use during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence						
Mauritania Senegal	Offshore; Nearshore/ Hub Terminal; Pipeline	Modifications in current seabed occupation on an area <0.3 km^2 due to presence of project infrastructures.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term (permanent)	Negligible	Likely	1 – Negligible

7.4.13.4 Mitigation Measures and Residual Impacts

The impact being rated 1 – Negligible, no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D41: Contractors will be expected to comply with the applicable legal requirements and standards at the time of decommissioning, including HSSE standards and performance requirements.
- D42: A preliminary decommissioning plan will be developed for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[137] for equipment and materials.
- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[138] for equipment and materials.
- D45: The relevant maritime, port or shipping authorities will be notified of all offshore facilities that remain in situ following decommissioning, as well as corresponding safety zones. The presence of these permanent facility locations will be demarcated on nautical charts.

[137] In this case, disposal includes treatment, reuse, recycling and final disposal practices.
[138] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

7.4.14 Maritime Navigation

High Level Summary

In this section on Maritime Navigation, the impact of three impact producing factors, these being Physical presence, Exclusion safety zones and Vessel movements, was evaluated. The residual impacts on Maritime Navigation during the Decommissioning Phase for routine activities were assessed as of negligible significance when mitigation measures are applied.

7.4.14.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	
Exclusion safety zones	●	●	●	
Vessel movements	●	●	●	

Exclusion safety zones around the infrastructures are addressed together with the physical presence of those infrastructures since they combine to potentially interfere with maritime navigation.

The Decommissioning Phase is planned after an estimated 20 years of operation based on anticipated FLNG contract. At this time, only high-level information on typical vessel usage during decommissioning is available. Therefore, there are some uncertainties on their use by project area.

7.4.14.2 Impact Description

The following subsections explain how the IPFs will potentially produce impacts in each of the project areas.

7.4.14.2.1 Offshore Area

Physical Presence and Exclusion Safety Zones

As indicated in Table 2-6 in Section 2.5, a drillship will be used during 21 days during the Decommissioning Phase. Typical vessel usage during decommissioning is provided in Table 2-7 in Chapter 2. This information is reported in Table 7-136 with indication on assumed use in the Offshore Area and in the Pipeline and/or Nearshore/Hub Terminal Areas.

Table 7-136. Typical Vessel Usage during Decommissioning per Project Area.

Vessel	Number Used	Days Used	Crew Compliment per Vessel	Assumed Use at Project Areas Location
Drillship	1	21	200	Offshore
Standby vessel	2	24	20 (estimated)	Offshore
Supply vessel	2	24	30 (estimated)	Offshore
ROV survey vessel	1	15	50	Offshore
Anchor vessel	2	64	16	Pipeline and/or Nearshore Hub/Terminal
Crane vessel	2	64	20	Pipeline and/or Nearshore Hub/Terminal
Tug boat	8	80	6	Pipeline and/or Nearshore Hub/Terminal
Crew boat	1	90	4	Pipeline and/or Nearshore Hub/Terminal
Multi-service vessel	2	24	25	Offshore
Total	21	406	357	

In the Offshore Area, the drillship and the other project vessels involved in decommissioning will be located about 125 km offshore. Their presence will last between 21 and 24 days. Their physical presence and the exclusion safety zone around the drillship might interfere with existing maritime shipping routes. With a radius of 500 m, the exclusion safety zone will be <1 km^2. The duration of the decommissioning activities will last less than a month.

Vessel Movements

For decommissioning operations, it is assumed that the two supply vessels and the two multi-service vessels will transit between the drillship and the Ports of Dakar and/or Nouakchott. At this time, the number of trips/week of these four vessels to Dakar and/or Nouakchott is unknown. In any case, the vessel movements would be contained inside a period estimated at 24 days.

7.4.14.2.2 Nearshore Hub/Terminal Area

Physical Presence and Exclusion Safety Zones

As previously mentioned, the Nearshore Hub/Terminal Area is located in an artisanal fishing area with a concentration of pirogues. The situation in 20 years from now could be the same or it could be different. In the absence of any data allowing a projection on the concentration of pirogues in the area in such a distant future, the current situation is used to assess the potential impacts during the Decommissioning Phase. It is assumed that the breakwater will not be removed during the Decommissioning Phase. Therefore, it is expected that the physical presence of the breakwater and its exclusion safety zone will interfere with maritime navigation of pirogues during all phases of the project and beyond (permanent impact).

Vessel Movements

At this time, the high-level information on typical vessel usage during decommissioning does not provide enough detail to distinguish their use between the Nearshore Hub/Terminal Area and the Pipeline Area. Therefore, they are discussed together in this section.

For decommissioning operations, Table 7-134 shows that 13 vessels could be used in the Nearshore Hub/Terminal Area and/or the Pipeline Area. The operations will last up to 90 days, i.e. 3 months.

It is assumed that the vessels will generally stay within the exclusion safety zone around the breakwater or the FPSO. However, they could also get in and out of the exclusion safety zone and transit to/from the Ports of Dakar and/or Nouakchott on a regular basis.

These vessel movements will be limited to a 3-month period.

7.4.14.2.3 Pipeline Area

See Section 7.4.14.2.2.

7.4.14.2.4 Support Operations Areas

Physical Presence and Exclusion Safety Zones

The activities conducted at the ports and airports of Dakar and/or of Nouakchott will have no impact on maritime navigation.

Vessel Movements

As indicated on Table 7-134, up to 20 vessels could be moving in and out of the Ports of Dakar and/or Nouakchott on a regular basis up to three months during the Decommissioning Phase. These movements will not be noticeable against background traffic in these ports.

7.4.14.2.5 Summary

Table 7-137 provides a summary of exclusion safety zones as a result of physical infrastructure emplacement and Table 7-138 provides a summary of the estimated number of project vessels by project area.

Table 7-137. Area of Exclusion Safety Zones by Project Area for the Decommissioning Phase.

Project Area	Estimated Exclusion Safety Zones in km^2
Offshore Area	<1 km^2, i.e., <500 m^2 in each country
Nearshore Hub/Terminal Area	<3.25 km^2, i.e., about 1.6 km^2 in each country
Pipeline Area	<1 km^2, i.e., <500 m^2 in each country
Total	<5.25 km^2, i.e., about 2.6 km^2 in each country

Table 7-138. Project Vessels by Project Area for the Decommissioning Phase.

Project Area	Estimated Number of Project Vessels
Offshore Area	8
Nearshore Hub/Terminal Area	13
Pipeline Area	
Total	21

7.4.14.3 Impact Rating

Physical Presence and Exclusion Safety Zones

In the Offshore Area, the physical presence of the drillship and its exclusion safety zone during decommissioning will cover an area <1 km^2 and it will last less than a month. Potential interference with the existing maritime navigation and shipping corridor will be short and it will concern a small area.

Standard communication procedures will enable offshore maritime traffic and shipping to go around the exclusion safety zone without significantly modifying their usual maritime route. The intensity of the impact will be low. Its extent will be limited to the exclusion safety zone around the drillship. The duration of the impact will be less than a month. Based on the combination of these criteria, the consequence of the impact will be negligible. Even if this impact is likely to happen, its overall significance is rated 1 – Negligible (details are provided in Table 7-139).

In the Pipeline Area and in the Nearshore Hub/Terminal Area, the exclusion safety zones for decommissioning operations will be those established since the Construction Phase of the project. At the time of the Decommissioning Phase, the artisanal fishermen will have been avoiding those exclusion safety zones for more than 20 years.

Additionally, Sections 7.2.14 and 7.3.14 have demonstrated that the need to avoid one <500 m^2 area located about 40 km from the coast and one 1.6 km^2 area located 10 km from the coast, will not significantly modify their multiple navigation routes. The intensity of the impact will be low and its extent will be limited to the immediate vicinity of the project infrastructures. The impact will last during the whole life of the project and beyond for the breakwater. Based on the combination of these criteria, the consequence of the impact will be negligible. Even if this impact is likely to happen, its overall significance is rated 1 – Negligible (details are provided in Table 7-139).

Vessel Movements

As indicated in Sections 7.2.14 and 7.3.14, vessel movements in the Offshore Area, the Nearshore Hub/Terminal Area and the Pipeline Area could potentially entail risks of collision notably with non-project vessels. As discussed in these sections, it is assumed that all project vessels will follow the Convention on International Regulations for Preventing Collisions at Sea (COLREGs) adopted by the IMO.

The exclusion safety zones established around all project facilities and the navigation rules for project vessels will minimize collision potential during all project phases. Designated travel and approach plans will be used to manage project vessels and the designated exclusion safety zones will be enforced with project patrol boats.

However, a risk of collision could happen between non-project vessels and project vessels transiting in and out of the exclusion safety zones. The total number of project vessels moving in and out the exclusion safety zones during the Decommissioning Phase is estimated at 21: 8 in the Offshore Area (including the drillship) and 13 in the Nearshore Hub/Terminal Area and/or the Pipeline Area.

The movements of the 13 project vessels moving in/out of the Nearshore Hub/Terminal Area and the Pipeline Area during a 3 months period could be noticeable if maritime traffic at the time of the decommissioning phase is similar to the current background traffic in these areas. However, there is a lot of uncertainties around the density of the maritime traffic in the Nearshore Hub/Terminal Area and the Pipeline Area in more than 20 years from now. There are also uncertainties on the type of boats that artisanal fishermen will be using in more than 20 years from now. As indicated in Section 7.2.14, the pirogues are currently particularly sensitive to a collision incident. These small boats have no reflectors or communication systems. Additionally, they lack radar equipment, lighting and life-saving equipment.

However, it is assumed that the general safety of the pirogues will improve by the decommissioning phase and their sensitivity to collision will decrease. Additionally, any risk of collision between pirogues and project vessels during the Decommissioning Phase should decrease due to the mitigation measures implemented during the 20-year Operations Phase. At this point of the project, it is assumed that no fatalities should result from project vessel movements.

The intensity of the impact is considered moderate. While an accident could be monitored and/or noticed, it would not involve a fatality. Its extent would be limited to the areas where the project activities are conducted. The duration of the impact would be short term. Based on the combination of these criteria, the consequence of the impact would be minor. To be conservative, the likelihood of the impact is still considered occasional. As a result, the overall significance of the impact is rated 2 – Low (details are provided in Table 7-139).

Table 7-139. Impacts to Maritime Navigation during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence and Exclusion Safety Zones						
Mauritania Senegal	Offshore; Pipeline	Roundabout for maritime shipping vessels to avoid one <1 km^2 area due to project infrastructures and their exclusion safety zones.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Mauritania Senegal	Pipeline; Nearshore/ Hub Terminal	Roundabout for pirogues to avoid in each country one <500 m^2 exclusion safety zone located 40 km from the coast and one <1.6 km^2 exclusion safety zone located approximately 10 km from the coast due to project infrastructures and their exclusion safety zones.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term (permanent)	Negligible	Occasional	1 – Negligible
Vessel Movements						
Mauritania Senegal	Pipeline; Nearshore/ Hub Terminal	Risk of collision between project vessels and pirogues due to project vessels movements.	Nature: Negative Intensity: Moderate Spatial Extent: Immediate vicinity Duration: Short Term	Minor	Occasional	2 – Low

7.4.14.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-140) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the design measures and operational controls already planned in the project design.

Summary of existing measures inherent to design and operational controls:

- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[139] for equipment and materials.

The measures taken at the time of decommissioning aimed at reducing the risk of collision will align with those proposed for the Construction Phase and the Operations Phase. If needed, the measures in Table 7-140 should be adjusted before the Decommissioning Phase starts to reflect the results of their implementation during the previous phases, with due consideration of the technological, societal and regulatory conditions present at the time of decommissioning.

Table 7-140. Mitigation Measures to Avoid or Reduce Impacts to Maritime Navigation from Routine Activities during the Decommissioning Phase.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Risk of collision between project vessels and pirogues due to project vessels movements.	2 – Low	M08, M09, M10, M11, M12, M13, M14, M15, M16, M17, M18, M19	1 – Negligible

Notes:

M08: Develop and implement a training and awareness program targeting local fishing communities on the specific maritime safety rules associated with the project.

M09: Provide regular notices to mariners in the appropriate form and language to artisanal fishermen on project infrastructure, associated exclusion safety zones, travel and approach plans and the approximate timing of project activities.

M10: Equip the support vessels and other project vessels that regularly move outside the construction or operational exclusion safety zones with radar or infrared systems that can detect small fishing vessels during poor visibility/night time.

M11: Provide adequate lighting aboard the support vessels and other project vessels that regularly move outside the construction or operational exclusion safety zones with the intent of maintaining high visibility during poor visibility/night time. These vessels will also feature searchlights that can be used to shine on or signal approaching pirogues and foghorns for audible signaling.

M12: Having a project patrol boat to monitor the exclusion safety zones, including patrolling ahead of the approach or exiting of larger project vessels into or out of the exclusion safety zones.

M13: Using the services of local fishermen liaison officers (FLOs) aboard the project patrol boat in the areas of artisanal fishing

M14: Equipping the support vessels and the project patrol boat with lifesaving appliances approved by the Convention for Safety of Life at Sea (SOLAS) and IMO, which can be used to assist in rescuing fishermen in the water in line with international maritime protocols or in the event of an accident involving a pirogue with a project vessel. Assist with the rescue of any fishermen involved in a collision with a project vessel or following the capsizing of their vessel due to ship wake.

M15: In case of a collision, BP will inform as soon as possible the relevant national authorities: the Mauritanian Coast Guard (Garde Côte Mauritanienne) in Mauritania and HASSMAR in Senegal.

M16: Ensuring that each project vessel keeps records of maritime safety incidents with pirogues and other vessels, including near misses, and that these are subsequently shared with the project. BP will monitor maritime safety incidents and adjust, if required, project specific maritime safety rules, security and search & rescue arrangements in place.

M17: Establishing a grievance mechanism easily accessible to fishing communities members that includes monitoring of claims and the resolution thereof.

M18: Maintaining a community liaison officer (CLO) for N'Diago and Saint-Louis to provide a direct link with the fishing communities.

[139] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

M19: Collaboration with a community council of formally nominated representatives of local key stakeholders from N'Diago and Saint-Louis set up to review local fishing communities' concerns and grievances related to the project.

7.4.15 Industrial Fisheries

High Level Summary

In this section on Industrial Fisheries, the impact of three impact producing factors, these being Physical presence, Exclusion safety zones and Vessel movements, was evaluated. All impacts on Industrial Fisheries during the Decommissioning Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

7.4.15.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●		
Exclusion safety zones	●	●		
Vessel movements	●	●		

While two IPFs include noise, only the physical presence of the infrastructures and the vessel movements can impact industrial fishing. Therefore, noise is not addressed here. Additionally, the exclusion safety zones around the infrastructures are addressed together with the physical presence of those infrastructures since they combine to potentially interfere with industrial fisheries.

7.4.15.2 Impact Description

The following subsections explain how the IPFs will potentially produce impacts in each of the project areas.

7.4.15.2.1 Offshore Area

Physical Presence and Exclusion Safety Zones

For the purpose of vessel and operation safety, non-project vessels, including industrial fishing boats, will be required to remain outside of a 500-m radius exclusion safety zone around the drillship and other project vessels during the decommissioning. Though this exclusion safety zone will ensure maritime safety, it might affect industrial fishing.

As indicated in Section 7.4.14, the exclusion safety zone around the drillship will be limited to <1 km^2 and the decommissioning operations will last less than a month.

As shown on Figures 4-26 and 4-32 in Chapter 4, there is no specific concentration of industrial fishing activities in the Offshore Area located along the Mauritania and Senegal border. Therefore, any temporary loss of <1 km^2 during less than a month is unlikely to be noticed or measurable against background industrial fishing grounds.

Vessel Movements

As indicated in Section 7.4.14, four support vessels will transit in and out of the exclusion safety zone around the drillship on a regular basis during less than a month. Those four vessels are unlikely to be noticed are measurable against background maritime traffic in the Offshore Area. Therefore, no interference is expected with industrial fishing boats in that area.

7.4.15.2.2 Nearshore Hub/Terminal Area

The physical presence of the breakwater, the exclusion safety zone around it and the vessel movements in the Nearshore Hub/Terminal Area will have no impacts on industrial fishing activities since none is conducted in this area.

7.4.15.2.3 Pipeline Area

Physical Presence and Exclusion Safety Zones

As indicated previously, a 500-m exclusion safety zone will be established around the FPSO during the whole life of the project, including decommissioning.

With a radius of 500 m, the exclusion area around the FPSO will be <1 km^2. The duration of the decommissioning operations is about 3 months. Any temporary loss of a <1 km^2 is unlikely to be noticed or measurable against background industrial fishing grounds in Mauritania and Senegal.

Vessel Movements

During the estimated up to 3 months required for decommissioning activities, 13 project vessels will be used in the Pipeline Area and/or the Nearshore Hub/Terminal Area. It is assumed that the vessels will generally stay within the exclusion safety zone around the FPSO. However, they could also get in and out of the exclusion safety zone and transit to/from the Ports of Dakar and/or Nouakchott on a regular basis.

The temporary presence of the 13 vessels is unlikely to be noticed or measurable against background maritime traffic in the Pipeline Area where industrial fishing could potentially occur. Therefore, no interference is expected with industrial fishing boats in the Pipeline Area.

7.4.15.2.4 Support Operations Areas

The Support Operation Areas being on shore, the activities conducted in those areas will have no impact on industrial fishing activities.

7.4.15.2.5 Summary

Table 7-141 provides a summary of the exclusion safety zones as a result of physical infrastructure emplacement which will preclude any industrial fishing activities.

Table 7-141. Potential Industrial Fishing Grounds Losses by Project Area for the Decommissioning Phase.

Project Area	Estimated Potential Industrial Fishing Ground Losses in km^2
Offshore Area	<1 km^2
Nearshore Hub/Terminal Area	Not applicable
Pipeline Area	<1 km^2
Total	<2 km^2

7.4.15.3 Impact Rating

Physical Presence and Exclusion Safety Zones

The impacts of the physical presence of project infrastructures and their exclusion safety zones in the Offshore Area and Pipeline Area include interference with existing potential industrial fishing grounds in the Mauritanian and the Senegalese waters. In both countries, the industrial fleet consists mainly in foreign boats. Therefore, any impact on the industrial fishing activity is considered for the industry as a whole, with no country specific considerations.

The potential loss of fishing grounds is estimated <2 km^2 and those losses would last less than three months.

Standard international and national maritime communication procedures will enable industrial fishing boats to avoid the exclusion safety zones without significantly modifying their potential fishing grounds. The intensity of the impact will be low and its extent will be limited to the exclusion safety zones. The impact will be short term. Based on the combination of these criteria, the consequence of the impact will be negligible. Even if the impact is likely to happen and it is rated 1 – Negligible (details are provided in Table 7-142).

Table 7-142. Impacts to Industrial Fisheries during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence and Exclusion Safety Zones						
Mauritania Senegal	Offshore; Pipeline	Loss of potential industrial fishing grounds of <2 km^2 due to project infrastructures and their exclusion safety zones.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible

7.4.15.4 Mitigation Measures and Residual Impacts

Impacts being rated 1 – Negligible, no mitigation measures are required.

A number of measures and controls are already planned in the project design and operational controls:

- D19: The relevant maritime, port or shipping authorities will be notified of all permanent offshore facilities, as well as safety zones and routine shipping routes to be used by project-related vessels. Permanent facility locations will be demarcated on nautical charts.
- D20: Project vessels will follow the Convention on International Regulations for Preventing Collisions at Sea (COLREGs) adopted by the IMO.
- D21: Main project vessels will be equipped with Universal Shipborne Automatic Identification System (AIS), a system of transponders installed on vessels which transmit over two dedicated digital marine VHF channels.
- D22: Standard communication procedures will be used in international maritime traffic and shipping, aided by project patrol boats or standby vessels near the drilling, pipelay and Nearshore Hub/Terminal Area to prevent collision with larger vessels.

- D23: Information will be provided to the national industrial fishing fleet of both Mauritania and Senegal to communicate and record the exclusion safety zones and applicable navigational charts.

These will be subject to further review in:

- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[140] for all equipment and materials.

7.4.16 Artisanal Fisheries and Related Activities

High Level Summary

In this section on Artisanal Fisheries and Related Activities, the impact of three impact producing factors, these being Physical presence, Exclusion safety zones and Vessel movements, was evaluated. All impacts on Artisanal Fisheries and Related Activities during the Decommissioning Phase for routine activities were assessed as positive or negative with a negligible significance. No mitigation measures were required.

7.4.16.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Exclusion safety zones		●	●	
Vessel movements		●	●	

The exclusion safety zones are addressed together with the physical presence of the infrastructures since they combine to potentially interfere with the artisanal fisheries and related activities. While two IPFs include noise, only the physical presence of the infrastructures and the vessel movements can impact the artisanal fisheries and related activities. As indicated in Section 2.12.2, the primary sources of airborne sound from project vessels and facilities are use of machinery, such as engines, generators, pumps, cranes, etc. Airborne sound generated by any activities associated with the facilities will be managed by the project. The airborne sound levels at all facilities are required to meet the applicable occupational health working limits which in turn is unlikely to result in unacceptable sound level for other sea users, especially since they will be kept out of a 500 m exclusion safety zone.

7.4.16.2 Impact Description

The following subsections explain how the IPFs will potentially produce impacts in each of the project areas.

[140] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

7.4.16.2.1 Offshore Area

The decommissioning activities in the Offshore Area will have no impacts on artisanal fishing activities since none is conducted in this area located in approximately 2,700 to 2,800 m water depth about 125 km from the coast.

7.4.16.2.2 Nearshore Hub/Terminal Area

Physical Presence and Exclusion Safety Zones

It is assumed that the breakwater will not be removed during the Decommissioning Phase. The physical presence of the breakwater could affect artisanal fishing grounds permanently. However, the exclusion safety zone around it will be lifted. As a result, the loss of access to fishing grounds will be limited to the breakwater footprint.

As indicated on Table 7-136, the physical presence of the breakwater will occupy 0.16 km^2 of the seabed. This will entail the loss of about 0.16 km^2 of potential fishing grounds, i.e. about 0.08 km^2 in Mauritanian and 0.08 km^2 in Senegal. This potential loss will last go beyond the life of the project. However, the breakwater itself may serve as an artificial reef and therefore, provide for new fishing grounds.

Vessel Movements

As indicated in Table 7-136, it is planned that 13 project vessels will be used in the Nearshore Hub/Terminal and/or the Pipeline area during up to 3 months for decommissioning activities.

Impact of project vessels movements on the navigation of artisanal fishing boats includes risks of collision in the Nearshore Hub/Terminal Area during Decommissioning Phase. This has been assessed in Section 7.4.14.

Additionally, project vessels movements could interfere with artisanal fishermen gears. Up to 13 project vessels will be coming in/out of the exclusion safety zone around the breakwater; they could cross over fishing nets (which can be up to 500 m in length) and buoys and, in some cases, damage them.

7.4.16.2.3 Pipeline Area

Physical Presence and Exclusion Safety Zones

The FPSO will be installed in the Pipeline Area, at a distance of approximately 40 km from the coast on the Mauritania and Senegal maritime border in 120 m water depth. Any fishing ground losses for artisanal fisheries around the FPSO would be less than 0.5 km^2 in each country. It is assumed that the FPSO will be removed during the Decommissioning Phase. As a result, any potential fishing ground losses for artisanal fisheries in the Pipeline Area during the Construction and Operations Phases would be regained after the decommissioning of the FPSO.

Vessel Movements

Impact of vessel movements on the navigation of artisanal fishing boats and risks of collision in the Pipeline Area have been assessed in Section 7.4.14. The risk for project vessels to cross over fishing nets and buoys and in some cases, damaging them, has been assessed under Section 7.4.16.2.2.

7.4.16.2.4 Support Operations Areas

The Support Operations Areas being on shore, the activities conducted in those areas will have no impact on artisanal fishing activities.

7.4.16.2.5 Summary

Table 7-143 provides a summary of the fishing ground losses as a result of physical infrastructure emplacement which will preclude any artisanal fishing activities. Table 7-144 summarizes the number of project vessels that could potentially interfere with fishing gears.

Table 7-143. Potential Artisanal Fishing Grounds Losses by Project Area for the Decommissioning Phase.

Project Area	Estimated Potential Artisanal Fishing Ground Losses in km^2 –Two Countries	Estimated Potential Artisanal Fishing Ground Losses in km^2 –Per Country
Offshore Area	Not applicable	Not applicable
Nearshore Hub/Terminal Area	0.16 km^2	About 0.08 km^2
Pipeline Area	None	None
Total	0.16 km^2	About 0.08 km^2

Table 7-144. Project Vessels Potentially Interfering with Artisanal Fishing Gears by Project Area for the Decommissioning Phase.

Project Area	Estimated Number of Project Vessels	Estimated Maximum Duration
Offshore Area	Not applicable	Not applicable
Nearshore Hub/Terminal Area	13 vessels	Up to 3 months
Pipeline Area		
Total	13 vessels	Up to 3 months

7.4.16.3 Impact Rating

Physical Presence and Exclusion Safety Zones

The impacts of the physical presence of project infrastructures in the Nearshore Hub/Terminal Area includes interference with existing potential artisanal fishing grounds in Mauritania and Senegal.

However, the loss of potential fishing grounds will be limited to the breakwater footprint since no exclusion safety zone will be required after decommissioning activities. About 0.08 km^2 of potential fishing grounds will be lost in each country.

Due to the very small size of the loss, the intensity of the impact will be negligible, its extent will be the footprint of the breakwater. The duration will be long term as it will last beyond the project. The consequence of this impact will be negligible and while the impact is likely to happen, its overall significance is rated 1-Negligible (details are provided in Table 7-145).

The loss of about 0.08 km^2 of potential artisanal fishing grounds in each country should not entail any increased competition on existing fishing grounds. In a similar manner, it should not entail any loss of catches.

Additionally, the breakwater itself may serve as an artificial reef and therefore, provide for new fishing ground. While there are a lot of uncertainties on the effect of this artificial reef on an increase of fishery resources, the impact would be positive (details are provided in Table 7-145).

Section 7.4.6 shows that the impacts of the project on plankton, fishes and other fishery resources during the Decommissioning Phase will be negligible. As a result, no indirect impacts are expected on artisanal fisheries and related activities. In addition, since no losses of catches are expected and due to the very small size of potential artisanal fishing ground loss in each country, no impact on activities related to artisanal fisheries such as fish transformation by women are anticipated.

As indicated previously, the perception of an impact might be very different from the impact itself. Perceived loss of fishing grounds and fishing catches during the Decommissioning Phase is discussed in Section 7.4.26 (Social Climate).

Vessel Movements

In addition to the risk of collision that has been addressed in Section 7.4.14, the impact of project vessels movements includes risks of artisanal fishing gear losses in the Nearshore Hub/Terminal Area and around the FPSO in the Pipeline Area. The risks are associated with the 13 project vessels that will be in these two areas during the Decommissioning Phase.

There is currently a large number of fishing gears in the coastal waters offshore Saint-Louis and there is a risk for project vessels to cross over them and, in some cases, damaging them. However, the situation could be very different in over 20 years from now. There is a lot of uncertainties around artisanal fishing methods in a 20-year timeframe. Even if the methods did not change, it is assumed that the risk of losing fishing gears should decrease with the implementation of mitigation measures to avoid or reduce those losses during the approximate 20-year Operations Phase.

Therefore, it is assumed that the intensity of the impact, which is moderate during the Construction Phase and the Operations Phase, should be low during the Decommissioning Phase. The loss of fishing gears due to project vessels should not be noticeable against background fishing gear losses. The extent is limited to the areas where project activities will be conducted. The duration will last not more than three months. Based on the combination of these criteria, the consequence of the impact will be negligible. Even if the impact is likely to happen, its overall significance is rated 1-Negligible (details are provided in Table 7-145).

Table 7-145. Impacts to Artisanal Fisheries and Related Activities during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence and Exclusion Safety Zones						
Mauritania Senegal	Nearshore/ Hub Terminal	Loss of potential artisanal fishing grounds of 0.16 km^2, i.e. about 0.08 km^2 in each country, due to project infrastructures.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 – Negligible
Mauritania Senegal	Nearshore/ Hub Terminal	New artisanal fishing ground due to artificial reef effect of the breakwater.	Not applicable	Not applicable	Not applicable	Positive
Vessel Movements						
Mauritania Senegal	Nearshore/ Hub Terminal; Pipeline	Potential loss of artisanal fishing gears (nets and buoys) due to project vessels movements in artisanal fishing areas.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible

7.4.16.4 Mitigation Measures and Residual Impacts

Impacts being rated 1 - Negligible, no mitigation measures are required.

Existing measures inherent to design and operational controls include:

- D19: The relevant maritime, port or shipping authorities will be notified of all permanent offshore facilities, as well as safety zones and routine shipping routes to be used by project-related vessels. Permanent facility locations will be demarcated on nautical charts.
- D24: Exclusion safety zones will be demarcated on applicable navigational charts, and a communication procedure will be developed to communicate the location of the exclusion safety zones to the local fishing communities. This is intended to allow pirogues to avoid the exclusion safety zones.
- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[141] for all equipment and materials.

Further measures aimed at avoiding the loss of artisanal fishing gears (nets and buoys) due to project vessel movements in artisanal fishing areas will be taken at the time of decommissioning. These will align with those proposed for the Construction Phase and the Operations Phase with due

[141] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

consideration of the specific technological, societal and regulatory conditions present at the time of decommissioning.

7.4.17 Other Coastal & Sea-Based Activities

High Level Summary

In this section on Other Coastal & Sea-Based Activities, the impact of three impact producing factors, these being Physical presence, Exclusion safety zones and Vessel movements, was evaluated. All impacts on Other Coastal & Sea-Based Activities during the Decommissioning Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

7.4.17.1 Impact Producing Factors and Project Areas

In addition to potentially impacting maritime navigation and fisheries, the project could potentially impact other coastal and sea-based activities.

The IPFs identified for these resources in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	
Exclusion safety zones	●	●	●	
Vessel movements	●	●	●	

Based on the current baseline situation of coastal and sea-based activities, offshore oil and gas activities are the only activities that could potentially be impacted during the Decommissioning Phase.

7.4.17.2 Impact Description

The following subsections explain how the IPFs will produce impacts in each of the project areas.

7.4.17.2.1 Offshore Area

As indicated in Sections 7.2.17 and 7.3.17, the Offshore Area is located within the limits of Block C8 in Mauritania and within Block Saint-Louis Offshore Profond in Senegal, which are under BP's licenses. Therefore, activities conducted in the Offshore Area during the Decommissioning Phase will have no impacts on oil and gas activities of other oil and gas operators.

7.4.17.2.2 Nearshore Hub/Terminal Area

Physical Presence and Exclusion Safety Zones

As indicated in Sections 7.2.17 and 7.3.17, the Nearshore Hub/Terminal Area covers an area split each side of the Mauritania and Senegal maritime border.

The physical presence of the breakwater and its exclusion safety zone would prevent any oil and gas exploration activities in a <3.5 km^2 area, i.e. about 1.6 km^2 in Block C32 in Mauritania and 1.6 km^2 in Block Saint-Louis Offshore in Senegal.

Vessel Movements

The project vessel movements and noise in the Nearshore Hub/Terminal Area could potentially disturb other oil and gas exploration activities. Disturbance would come from the up to 13 project vessels coming in and out of the exclusion safety zone. However, this disturbance would be limited to a maximum of three months.

7.4.17.2.3 Pipeline Area

Physical Presence and Exclusion Safety Zones

As indicated in Sections 7.2.17 and 7.3.17, the Pipeline Area crosses three blocks in Mauritania: C8, under BP license, C1 and C32, which are not currently under license. In Senegal, the Pipeline Area crosses Block Saint-Louis Offshore Profond, under BP license, and Block Saint-Louis Offshore, currently under Oranto license.

Any potential impact of the physical presence of infrastructures, noise and exclusion safety zones in the Pipeline Area would be similar to the potential impact identified in the Nearshore Hub/Terminal Area.

During the Construction and Operations Phases, the physical presence of the FPSO and its exclusion safety zone will prevent any oil and gas exploration activities in a <1 km^2 area, i.e. <500 m^2 in Block C1 in Mauritania and <500 m^2 in Block Saint-Louis Offshore in Senegal.

Since it is assumed that the FPSO will be removed during the Decommissioning Phase, the preclusion of any oil and gas exploration activities in a <1 km^2 area around the FPSO will stop after its decommissioning.

Exploratory drilling activities would still be precluded over the installed pipeline of 30-inch (about 76 cm) diameter that will extend from the FPSO to the breakwater if the pipeline is not removed from the seabed. However, it is assumed that exclusion of exploratory drilling inside this very narrow corridor would not be significant for other oil and gas exploration activities.

Vessel Movements

Any potential impact of the vessel movements and noise in the Pipeline Area would be identical to the potential impact identified in the Nearshore Hub/Terminal Area.

7.4.17.2.4 Support Operations Areas

Activities planned at the Support Operations Areas will have no interference with any potential offshore oil and gas activities.

7.4.17.2.5 Summary

Table 7-146 provides a summary of the total area precluded from any other potential oil and gas exploration activities during the Decommissioning Phase as a result of the physical presence of infrastructures and their exclusion safety zones. In each country, about 1.6 km^2 would be precluded from other oil and gas exploration in the breakwater area.

Table 7-146. Area Precluded from Potential Other Oil and Gas Exploration Activities by Project Area for the Decommissioning Phase.

Project Area	Total Estimated Area in km^2 Precluded from Potential Other Oil and Gas Exploration Activities	Estimated Area in km^2 Precluded from Potential Other Oil and Gas Exploration Activities- Per Country
Offshore Area	Non applicable	Non applicable
Nearshore Hub/Terminal Area	<3.25 km^2	About 1.6 km^2
Pipeline Area	None	None
Total	<3.25 km^2	About 1.6 km^2

While the movements of the 13 project vessels in the Nearshore Hub/Terminal Area and the Pipeline Area could potentially disturb other oil and gas exploration activities, the project vessels movements would unlikely be noticed by other oil and gas exploration vessels against background maritime traffic.

7.4.17.3 Impact Rating

Any future oil and gas exploration activity in the blocks where the breakwater is located would need to avoid a 1.6 km^2 area in each country where exploration will be precluded forever.

It is assumed that these exclusion safety zones would not prevent the potential identification of areas in Mauritania and Senegal where hydrocarbons could be trapped in oil or gas-filled geological large structures. Therefore, the intensity of the impact is considered low. The extent is limited to about 1.6 km^2 in each country. The duration would be long term. Based on the combination of these criteria, the consequence of the impact would be negligible. Even if this impact is likely to happen, its overall significance is rated 1-Negligible (details are provided in Table 7-147).

Table 7-147. Impacts to Other Coastal & Sea-Based Activities during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence and Exclusion Safety Zones						
Mauritania Senegal	Nearshore/ Hub Terminal; Pipeline	Preclusion of potential future oil and gas exploration activities in one small area in each country (about 1.6 km^2) due to project infrastructures and their exclusion safety zone.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 – Negligible

7.4.17.4 Mitigation Measures and Residual Impacts

Impacts being rated 1 – Negligible, no mitigation measures are required.

Summary of existing measures inherent to design and operational controls:

- D45: The relevant maritime, port or shipping authorities will be notified of all offshore facilities that remain in situ following decommissioning, as well as corresponding safety zones. The presence of these permanent facility locations will be demarcated on nautical charts.

7.4.18 Employment & Business Opportunities

High Level Summary

In this section on Employment & Business Opportunities, the impact of two impact producing factors, these being Vessel movements and Onshore logistic activities, was evaluated. All impacts on Employment & Business Opportunities during the Decommissioning Phase for routine activities were assessed as positive or negative with a negligible significance. No mitigation measures were required.

7.4.18.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Vessel movements	●	●	●	
Onshore logistic activities				●

Since the project is being conducted at sea, much of the employment will be offshore. Employment at sea opportunities are considered under the IPF “Vessel movements”. While employment opportunities offshore cover activities in the Offshore Area, the Pipeline Area and the Nearshore Hub/Terminal Area, they are discussed together under the Nearshore Hub/Terminal Area.

7.4.18.2 Impact Description

The following subsections explain how the IPFs will produce impacts in each of the project areas.

7.4.18.2.1 Offshore Area

The employment and business opportunities in the Offshore Area is discussed together with the Nearshore Hub/Terminal Area in Section 7.4.18.2.2.

7.4.18.2.2 Nearshore Hub/Terminal Area

Vessel Movements

Decommissioning activities will require the use of several vessels in the Offshore Area, the Pipeline Area and the Nearshore Hub/Terminal Area. If current technology was to be used, it is estimated that the manpower needs during decommissioning would be slightly smaller than during the Construction Phase which was estimated at 1,500 people. Additionally, the number of days for these people would be smaller since the offshore decommissioning activities will last less than three months.

However, the type and number of vessels required for decommissioning and their manpower needs will depend on the technology that will be used in more than 20 years from now.

Given such uncertainties, it is not possible at this time to estimate the number of people that will be needed on vessels during the Decommissioning Phase or to estimate how many project vessels could be contracted in Mauritania and/or Senegal and how many people could be hired directly in these countries.

7.4.18.2.3 Pipeline Area

Vessel Movements

The employment and business opportunities in the Pipeline Area is discussed together with the Nearshore Hub/Terminal Area in the Section 7.4.18.2.2.

7.4.18.2.4 Support Operations Areas

Onshore Logistic Activities

The project will require manpower for onshore logistics in Dakar and/or Nouakchott. Based on the project proponent experience in other countries, the manpower needs for onshore logistics during the Decommissioning Phase is estimated between 20 to 40 people. These 20 to 40 people will be direct employees as well as third-party contractors. While the offshore decommissioning activities will only last up to three months, it is assumed that the onshore logistic activities could last a little longer. Therefore, onshore employment needs could last around 4-5 months.

As indicated in Section 2.13.3, the project proponent will put in place an in-country employment and procurement policy. Recruitment will follow BP diversity and inclusion principles to target diverse candidates for example female, and personnel from different background. Recruitment will be open at National level, however, where possible will target local community talent. Application will be opened through different channels to increase awareness and accessibility to job offers.

It is assumed that the 20 to 40 people required for onshore logistics in Mauritania and/or Senegal will be filled in at a National level. Since the onshore logistics will be conducted out of Dakar and/or Nouakchott, it is assumed that most of the positions will be filled in by people living in these two cities.

The onshore logistics will create business opportunities for the National companies who will provide services as third-party contractors. While the number of potential National third-party contractors is not known yet, the manpower required (20 to 40) suggests that a few National companies will be contracted in total.

7.4.18.2.5 Summary

Table 7-148 provides a summary of employment opportunities in the Decommissioning Phase and Table 7-149 provides a summary of business opportunities during this phase.

Table 7-148. Potential National Employment Opportunities by Project Area for the Decommissioning Phase.

Project Area	Estimated Number of Positions and Duration
Offshore Area	A number of Mauritanian and Senegalese workers to be determined during up to 3 months
Nearshore Hub/Terminal Area	
Pipeline Area	
Support Operations Areas	20 to 40 people during 4-5 months

Table 7-149. Potential National Business Opportunities by Project Area for the Decommissioning Phase.

Project Area	Estimated Number of Business Opportunities and Duration
Offshore Area	A number of Mauritanian and Senegalese providers to be determined during up to 3 months
Nearshore Hub/Terminal Area	
Pipeline Area	
Support Operations Areas	A few service providers during about 4-5 months

7.4.18.3 Impact Rating

The project could provide onshore employment opportunities for 20-40 National workers during 4-5 months. These employment opportunities will be split between Mauritania and Senegal, and they will be concentrated in two cities: Dakar and Nouakchott. Additionally, the project could provide offshore employment opportunities for a number of National workers to be determined.

The employment opportunities created by the project will not have a significant impact on the cities employment figures. However, they will be beneficial. These employment opportunities, split between the two countries, will result in a positive impact (Table 7-150).

There are a lot of uncertainties on the profile that will be required for the employment opportunities during the Decommissioning Phase. As a result, it is not possible to determine if these opportunities will create equal employment opportunities for women and for men. Due to the limited number of employment opportunities that will be created in each country during the Decommissioning Phase, any gender imbalance would have limited consequence on the overall employment situation of women.

Business opportunities could concern a few national services providers for onshore logistics in Dakar and/or Nouakchott during 4-5 months. Additionally, services providers in Dakar and/or Nouakchott could provide a number of project vessels if available in country. Due to the small number of business opportunities and the limited scope of services that will be provided, the potential contracts will not have a significant impact on business opportunities in Dakar and Nouakchott. However, they will be beneficial to the concerned third-party contractors, resulting in a positive impact (Table 7-150).

However, these employment and business opportunities will be down weighted by the loss of employment and business opportunities entailed by the end of the Operations Phase. As indicated in Section 7.3.18, it is expected that during the 20-year Operations Phase up to 40 National employees could be working onshore while up to 400 could be working offshore. At the end of the Operations Phase, these positions will be shut down and the employees will be dismissed. The intensity of the impact will be moderate to low. The loss of employment could be noticeable within the scope of existing variability. However, the specialized skills acquired during the course of the project will be a valuable asset. It will enable some employees to find other employment opportunities in the emerging oil and gas sector in Mauritania and Senegal. In each country, the extent of the impact will be limited to the immediate vicinity of the project. The duration should be short term. With the professional skills acquired through the project, the employees should be well positioned to find other employment opportunities. Based on the combination of these criteria, the consequence of the impact will be negligible. This impact is likely to happen. Its overall significance is rated 1-Negligible (details are provided in Table 7-150).

Similarly, the business opportunities created during the Operations Phase will come to an end. The few National service providers contracted for providing the employees for onshore logistic services or vessels will not be needed any longer. Due to the small number of business opportunities created during the Operations Phase, their termination will have an impact of low intensity. The extent will be limited to the immediate vicinity of the project. The duration will be long term since the business opportunity losses will be permanent. Based on the combination of these criteria, the consequence of the impact will be negligible. This impact is likely to happen. Its overall significance is rated 1-Negligible (details are provided in Table 7-150).

Table 7-150. Impacts to Local Employment and Business Opportunities during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Vessel Movements and Onshore Logistic Activities						
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline; Support Operations	Employment opportunities for 20-40 people in Dakar and/or Nouakchott during 4-5 months and an additional number of people from Mauritanian and/or Senegal on vessels during about 3 months.	Not applicable	Not applicable	Not applicable	Positive
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline; Support Operations	Business opportunities for a few National services providers in Dakar and/or Nouakchott for onshore logistics services during 4-5 months and additional service providers for vessels during about 3 months.	Not applicable	Not applicable	Not applicable	Positive
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline; Support Operations	Loss of employment for 20-40 people working onshore in Dakar and/or Nouakchott and up to 400 people working offshore.	Nature: Negative Intensity: Moderate to Low Spatial Extent: Immediate vicinity Duration: Short term	Negligible	Likely	1 – Negligible
Mauritania Senegal	Nearshore Hub/ Terminal; Pipeline; Support Operations	End of business opportunities for a few National services providers in Dakar and/or Nouakchott for onshore logistics and for providing vessels.	Nature: Negative Intensity: Low Spatial Extent: Immediate vicinity Duration: Long term	Negligible	Likely	1 – Negligible

7.4.18.4 Mitigation Measures and Residual Impacts

Impacts to local employment and business opportunities from Decommissioning Phase activities are rated positive or negligible; no mitigation measures are required.

7.4.19 Population and Demography

High Level Summary

In this section on Population and Demography, the impact of one impact producing factor, this being Onshore logistic activities, was evaluated. No impacts are anticipated on Population and Demography during the Decommissioning Phase for routine activities.

7.4.19.1 Impact Producing Factors and Project Areas

The IPF identified for this resource in Table 7-6 is distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Onshore logistic activities				●

Activities conducted in the Offshore Area, the Pipeline Area and the Nearshore Hub/Terminal Area do not have the potential to affect National and local demography of Mauritania and Senegal. Therefore, they are not discussed further in this section.

7.4.19.2 Impact Description

The following subsections explain how this IPF will produce impacts in each of the project areas.

7.4.19.2.1 Offshore Area

Not applicable (see Section 7.4.19.1).

7.4.19.2.2 Nearshore Hub/Terminal Area

Not applicable (see Section 7.4.19.1).

7.4.19.2.3 Pipeline Area

Not applicable (see Section 7.4.19.1).

7.4.19.2.4 Support Operations Areas

Onshore Logistic Activities

As explained in Sections 7.2.19 and 7.3.19, large projects have the potential to change the demography of local communities with an influx of population: an influx of workers in the project area and an influx of jobseekers.

However, Sections 7.2.19 and 7.3.19 have shown that population influx will not be a concern for the current project during the Construction and Operations Phases. It will not be either for the Decommissioning Phase since the number of employees planned for this phase is smaller and the duration of the phase is shorter. As a result, there will be a very limited presence of project workers in Dakar and/or Nouakchott during the Decommissioning Phase. This small number is unlikely to entail changes in local demography in the two cities in 20 years from now since the cities currently count respectively over 3 million and around 1 million inhabitants. No population influx is anticipated either in N'Diago and/or Saint-Louis since no onshore operations or planned in these locations during the Decommissioning Phase.

7.4.19.2.5 Summary

No impacts are anticipated on population and demography.

7.4.19.3 Impact Rating

Not applicable (see Section 7.4.19.2.5).

7.4.19.4 Mitigation Measures and Residual Impacts

Not applicable (see Section 7.4.19.5).

7.4.20 Community Livelihoods

High Level Summary

In this section on Community Livelihoods, the impact of three impact producing factors, these being Physical presence, Exclusion safety zones and Onshore logistic activities, was evaluated. No impacts are anticipated on Community Livelihoods during the Decommissioning Phase for routine activities.

7.4.20.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Exclusion safety zones		●	●	
Onshore logistic activities				●

The three IPFs identified above could impact community livelihoods indirectly. The two first ones (physical presence and exclusion safety zones) could impact negatively artisanal fisheries and related activities on which the coastal communities livelihood is largely based. Since the impacts on the communities livelihood are indirect, the distinction between Pipeline Area and Nearshore Hub/Terminal Area is irrelevant. Therefore, impacts of these two IPFs on community livelihoods are considered globally in the impact description under the Nearshore Hub/Terminal Area.

The third IPF (onshore logistic activities) has the potential to positively impact employment and business opportunities in the Support Operations Areas. Therefore, it has the indirect potential to impact community livelihoods positively. Additionally, the onshore logistic activities have the potential to entail an influx of workers in the project area which in turn could result in an increase of living costs for local communities. An influx of workers, notably expatriates, has been associated in other projects with increases in prices of land, housing, food and services. This price inflation has the potential to impact community livelihoods negatively.

7.4.20.2 Impact Description

The following subsections explain how the projects impacts on artisanal fisheries and related activities, and on employment and business opportunities could produce indirect impacts on community livelihoods.

7.4.20.2.1 Offshore Area

Not applicable (see Section 7.4.16.2.1).

7.4.20.2.2 Nearshore Hub/Terminal Area

Physical Presence and Exclusion Safety Zones

Sections 4.6.5.2 and 4.6.6.4 provide a detailed description of the economic activities and the means of subsistence of the coastal communities in Mauritania, notably N'Diago. Sections 4.7.5.2 and 4.7.6.3 provide a similar description for the coastal communities of Senegal, notably Saint-Louis.

As previously indicated, the economy of the coastal villages and camps south of Nouakchott is almost exclusively linked to artisanal fisheries. With 1,240 inhabitants, N'Diago is the most important of those locations and the closest to the Nearshore Hub/Terminal Area (16 km).

In Senegal, the economy of Saint-Louis (230,801 inhabitants) is heavily based on artisanal fisheries and tourism. The fishing communities of Saint-Louis, located on the Langue de Barbarie and close to the Nearshore Hub/Terminal Area (13 km), count 70,532 inhabitants. Most of them make their living out of artisanal fisheries and related activities.

The number of people engaged in artisanal fishing, trade and processing in Mauritania and Senegal, presented above, reflect the current situation. Of course, these numbers will not remain static over the years. They will change over the lifetime of the project as a result of population increase and market forces.

The importance of artisanal fisheries in the livelihood of the communities of N'Diago and Saint-Louis in 20 years from now could be the similar as it is in 2018 or it could be different. In the absence of any data allowing a projection of the weight of fisheries in the community livelihoods in such a distant future, the current situation is used to assess the potential impacts of the project during the Decommissioning Phase.

The assessment of the impacts of the project on artisanal fisheries and related activities during the Decommissioning Phase has been made in Section 7.4.16. The assessment demonstrates that the project should not entail any loss in fishery resources catches in Mauritania and Senegal during the Decommissioning Phase. As a result, no impacts are expected during that phase on the means of subsistence of the fishermen and the other community members involved in activities related to artisanal fisheries.

7.4.20.2.3 Pipeline Area

See Section 7.4.20.2.2.

7.4.20.2.4 Support Operations Areas

Onshore Logistic Activities

Significant employment and business opportunities have the potential to improve community livelihoods. The assessment of the impacts of the project on employment and business opportunities during the Decommissioning Phase has been made in Section 7.4.18. The results show that since the project onshore logistic activities will be located in Dakar and/or Nouakchott, the project will have limited impacts on local employment in N'Diago or Saint-Louis. Similarly, no impacts are anticipated on business opportunities in these two locations. As a result, employment and business opportunities will have no impacts on the livelihood of local communities of N'Diago or Saint-Louis.

Section 7.4.18 shows that while there will be employment opportunities in Dakar and/or Nouakchott during the Decommissioning Phase, they will be down weighted by the loss of employment and business opportunities at the end of the Operations Phase. However, the number of employment opportunities loss will not be important enough to change the livelihood of the communities in these two big cities.

The assessment of the impacts of the project on population and demography during the Decommissioning Phase has been made in Section 7.4.19. The results show that the project will have no impact on the population and demography of Dakar and Nouakchott. Additionally, it will entail no population influx in N'Diago or Saint-Louis. Therefore, no changes in local demography and no price inflation are expected in these locations during the Decommissioning Phase. No further impacts are anticipated on the communities livelihood.

7.4.20.2.5 Summary

No impacts are anticipated on community livelihoods.

7.4.20.3 Impact Rating

Not applicable (see Section 7.4.20.2.5).

7.4.20.4 Mitigation Measures and Residual Impacts

Not applicable (see Section 7.4.20.2.5).

7.4.21 Community Health, Safety and Security

High Level Summary

In this section on Community Health, Safety and Security, the impact of five impact producing factors, these being Physical presence, Exclusion safety zones, Vessel movements, Onshore logistic activities and Presence of foreign workers, was evaluated. The residual impacts on Community Health, Safety and Security during the Decommissioning Phase for routine activities were assessed as of negligible or low significance when mitigation measures are applied.

7.4.21.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Exclusion safety zones		●	●	
Vessel movements		●	●	
Onshore logistic activities				●
Presence of foreign workers				●

The activities conducted in the Offshore Area do not have the potential to affect community health, safety and security since there are no community sea users in the Offshore Area.

The physical presence of the infrastructures and the vessels movements during the Decommissioning Phase have the potential to impact the safety of communities' sea users. The only communities' sea users in the Pipeline Area and the Nearshore Hub/Terminal Area are the artisanal fishermen and the impacts of these IPFs have been addressed in Section 7.4.14 (Maritime Navigation).

The noise from the infrastructures and from the vessels during the Decommissioning Phase does not have the potential to impact the health of communities. The Nearshore Hub/Terminal Area is the closest area from the coast. It is located about 10 km from the coast. The airborne sound levels at all facilities being required to meet the applicable occupational health working limits, the noise at these facilities will not be heard from the shore. The only community members in the vicinity of the Pipeline Area and the Nearshore Hub/Terminal Area are the artisanal fishermen. The potential impact of noise on artisanal fishermen has been addressed in Section 7.4.16 (Artisanal Fisheries and Related Activities). Therefore, no further impacts from infrastructures and vessels noise are expected on community health.

7.4.21.2 Impact Description

The following subsections explain how the IPFs will produce impacts in each of the project areas.

7.4.21.2.1 Offshore Area

Not applicable (see Section 7.4.21.1).

7.4.21.2.2 Nearshore Hub/Terminal Area

Physical Presence and Exclusion Safety Zones

For the purpose of vessel and operation safety, an exclusion safety zone will be established around the breakwater. This exclusion safety zone will ensure maritime safety for project vessels and non-project vessels.

As indicated in Section 7.3.14, the boundaries of the exclusion safety zone around the breakwater will be demarcated through several communication measures. It is however possible that some artisanal fishermen could try to make their way through the exclusion safety zone to fish in the area. While this will start during the Construction Phase, it could happen during the whole life of the project including the Decommissioning Phase.

In addition, the physical presence of the infrastructures has the potential to attract terrorists. Some of them might try to enter the exclusion safety zone around to breakwater to conduct terrorism acts. Therefore, the physical presence of the project infrastructures in the Nearshore Hub/Terminal Area could raise the level of risk of terrorism and entail national security issues in Mauritania and/or Senegal. This risk will prevail during the whole Operations Phase and it is likely to fade down with the Decommissioning Phase.

7.4.21.2.3 Pipeline Area

Physical Presence and Exclusion Safety Zones

For the purpose of vessel and operation safety, an exclusion safety zone will be established around the FPSO. The risk that artisanal fishermen or terrorists try to make their way through the exclusion safety zone around the FPSO will be similar to the risk identified around the breakwater. It will prevail during the whole Operations Phase and it is likely to fade down with the Decommissioning Phase.

7.4.21.2.4 Support Operations Areas

Onshore Logistic Activities

As already mentioned onshore logistic activities including hazardous materials have the potential to affect community health. All the material used by the project will be stored in dedicated storage areas inside the supply bases located inside the Port of Dakar and/or the Port of Nouakchott.

Chemicals (and equipment) will be shipped by boat directly to the port areas. It is assumed that the sites will be fenced and monitored by security services 24/7. In addition, the port areas themselves are guarded and non-accessible to the public. Therefore, onshore logistic activities are not anticipated to present any risks to community health in Dakar and/or Nouakchott.

Onshore logistic activities including the use of security personnel to safeguard personnel and property also have the potential to affect community security. In Dakar and/or Nouakchott, it is expected that the project will contract third parties to ensure the security of its premises and its personnel inside the port areas. The unarmed security guards will be working under the security rules of the ports. Therefore, these security arrangements are not anticipated to present any risks to community security in Dakar and/or Nouakchott.

Therefore, no impacts on community health are anticipated from onshore logistic activities during the Decommissioning Phase of the project.

Presence of Foreign Workers

As already mentioned, the presence of foreign workers has the potential to affect community health. However, this is not an important concern for the current project, as there will be a limited presence of foreign personnel onshore.

Therefore, no impacts on community health are anticipated from the presence of foreign workers during the Decommissioning Phase of the project.

7.4.21.2.5 Summary

The risk of collisions for artisanal fishing boats due to the physical presence of infrastructures and vessels has been assessed in Section 7.4.14. The other IPFs that have the potential to impact the community health, safety and security have been assessed in the current section. All potential impacts have been dismissed except for one: the enforcement of the exclusion safety zones could present a risk for local community members.

7.4.21.3 Impact Rating

As indicated in Section 7.3.21, the enforcement of the exclusion safety zones will be conducted in similar ways during the Construction and Operations Phases of the project. The project personnel will be unarmed and there is no plan to use any force in case another sea user refuses to respect the exclusion safety zones. During the Decommissioning Phase, the enforcement of the exclusion safety zones will also be based on communication procedures. Therefore, the project personnel will not present any direct threat to the security of community members.

Similarly to the Construction and Operations Phases, if some fishermen refuse to get out of the exclusion safety zones during the Decommissioning Phase, this may lead to a situation where the National authorities become involved and send the public security forces to escort the fishermen out of the area. In this process, there is a risk that the public security forces might use force and harm some artisanal fishermen.

There is a lot of uncertainties around the behavior of artisanal fishermen and public security forces in more than 20 years from now. However, it is assumed that any risk of incidents between artisanal fishermen and public security forces during the Decommissioning Phase should be much lower than during the Operations Phase due to the mitigation measures implemented during that 20-year phase. At this point of the project, it is assumed that artisanal fishermen should rarely try to enter the exclusion safety zones and if they did, the incidents should not involve any fatality.

Therefore, the intensity of the impact is considered moderate. While an accident could be monitored and/or noticed, it would not involve a fatality. Its extent would be limited to the areas where the project activities are conducted. The duration of the impact would be short term. Based on the combination of these criteria, the consequence of the impact would be minor. To be conservative, the likelihood of the impact is still considered occasional. As a result, the overall significance of the impact is rated 2 – Low (details are provided in Table 7-151).

In addition to this security risk at a local community level, there is a security risk at a national level during the Decommissioning Phase resulting from the presence of the project infrastructures in the Nearshore/Hub Terminal Area and at the FPSO location. While the gas production activities conducted at those two offshore locations will be over after the Production Phase, the decommissioning activities at those facilities could attract terrorists, which in turn will raise the level of a terrorism risk in Mauritania and/or Senegal. There is a lot of uncertainties around national security and international terrorism in more than 20 years from now. While the risk of incidents during the Decommissioning Phase should be lower than during the Operations Phase due to the mitigation measures implemented during that 20-year phase, a terrorist attack could include fatalities. Therefore, the intensity of the impact is still considered high. The extent of the impact would be regional (and beyond). The impact would be irreversible in case of a fatality. Based on the combination of these criteria, the consequence of the impact would be severe. There are some uncertainties around the likelihood of the impact. While threats might be occasional, an attack could be rare. As a result, the overall impact significance is rated 4 – High (see Table 7-151).

Table 7-151. Impacts to Community Health, Safety and Security during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence and Exclusion Safety Zones						
Mauritania Senegal	Nearshore/ Hub Terminal; Pipeline	Risk of conflicts between artisanal fishermen and public security forces if some fishermen need to be escorted out of the exclusion safety zones.	Nature: Negative Intensity: Moderate Spatial Extent: Immediate vicinity Duration: Short term	Minor	Occasional	2 – Low
Mauritania Senegal	Nearshore/ Hub Terminal; Pipeline	Risk of terrorism act targeting the gas production facilities which in turn will raise the level of terrorism risk at a national level.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Long term	Severe	Rare to Occasional	4 – High

7.4.21.4 Mitigation Measures and Residual Impacts

Impacts are reported below (Table 7-152) and potential applicable mitigation measures are identified. The measures proposed to reduce the risks of conflicts with artisanal fishermen during the Decommissioning Phase are identical to the measures identified for the Operations Phase. If needed, the measures in Table 7-152 should be adjusted before the Decommissioning Phase starts to reflect the results of their implementation during the Operations Phase.

These mitigation measures are in addition to the measures and controls already planned in the project design, summarized as follows:

- D24: Exclusion safety zones will be demarcated on applicable navigational charts, and a communication procedure will be developed to communicate the location of the exclusion safety zones to the local fishing communities. This is intended to allow pirogues to avoid the exclusion safety zones.

- D26: A site security plan will be developed that considers the security arrangements for each of the facilities including the modalities of support provided by government.
- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[142] for all equipment and materials.

Moreover, the Inter-state Cooperation Agreement (ICA) requires that the “two states (Mauritania and Senegal) are to consult with a view to jointly setting appropriate security and safety measures for each of the facilities and surrounding areas”. This arrangement is expected to remain valid during the decommissioning phase.

Table 7-152. Mitigation Measures to Avoid or Reduce Impacts to Community Health, Safety and Security during the Decommissioning Phase from Routine Activities.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Risk of conflicts between artisanal fishermen and public security forces if some fishermen need to be escorted out of the exclusion safety zones.	2 – Low	M08, M17, M19, M25, M26	1 – Negligible
Risk of terrorism act targeting the gas production facilities which in turn will raise the level of terrorism risk at a national level.	4 – High	M25, M26	2 – Low

Notes:

M08: Develop and implement a training and awareness program targeting local fishing communities on the specific maritime safety rules associated with the project.

M17: Establishing a grievance mechanism easily accessible to fishing communities members that includes monitoring of claims and the resolution thereof.

M19: Collaboration with a community council of formally nominated representatives of local key stakeholders from N’Diago and Saint-Louis set up to review local fishing communities’ concerns and grievances related to the project.

M25: The project will seek to work with the public security forces to establish an appropriate response and security framework which may include resource, equipment, training and response protocols.

M26: Include in the security stakeholder engagement plan, provisions around response, management and interface with Public security forces for security incidents scenario such as act of terrorism and unlawful entry in the exclusion safety zones.

7.4.22 Public Infrastructure and Services

High Level Summary

In this section on Public Infrastructure and Services, the impact of four impact producing factors, these being Exclusion safety zones, Vessel movements, Onshore logistic activities and Presence of foreign workers, was evaluated. All impacts on Public Infrastructure and Services during the Decommissioning Phase for routine activities were assessed as of negligible significance. No mitigation measures were required.

[142] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

7.4.22.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Exclusion safety zones	●	●	●	
Vessel movements	●	●	●	
Onshore logistic activities				●
Presence of foreign workers				●

The IPFs identified above could impact public infrastructures and services indirectly. The exclusion safety zones could indirectly impact the National authorities called in to enforce the exclusion safety zones. The risk of collision associated with vessel movements could indirectly impact the National authorities in charge of search and rescue operations.

Additionally, the onshore logistic activities and the presence of foreign workers have the potential to indirectly impact existing port and airport infrastructures, accommodation and health services.

The following sections explain how the projects impacts have the potential to produce indirect impacts on public infrastructure and services.

7.4.22.2 Impact Description

7.4.22.2.1 Offshore Area

Exclusion Safety Zones and Vessel Movements

The project proponent will take care of all operations planned in the Offshore Area during the Decommissioning Phase of the project. The only operation for which a direct support from public services could be required is the handling of an incident with other sea users entering the exclusion safety zone.

Offshore, the other sea users are industrial fishing boats and shipping vessels. Based on similar projects, it is unlikely that other sea users will try to enter the 500 m exclusion safety zones around the vessels conducting decommissioning activities. There is not a significant risk of incident with other sea users or collision. Therefore, it is not expected that the project will need the support from National authorities to handle a security incident or a search and rescue operation offshore.

7.4.22.2.2 Nearshore Hub/Terminal Area

Exclusion Safety Zones and Vessel Movements

The project proponent will take care of all operations planned in the Nearshore Hub/Terminal Area during the Decommissioning Phase of the project. However, direct support from public services could be required to handle an incident with other sea users entering the exclusion safety zones.

As indicated in Section 7.4.21, the project proponent will manage the enforcement of the exclusion safety zone through communication procedures with other sea users notably the artisanal fishermen. If an artisanal fisherman enters the exclusion safety zone, this may lead to a situation where the National authorities become involved and would likely send the public security forces to escort the fishermen out of the area.

The public security forces will also need to be available to handle search and rescue operations if a collision happens in the Nearshore Hub/Terminal Area.

In addition to being involved in handling incidents with artisanal fishermen and search and rescue operations, the National authorities of Mauritania and/or Senegal will need to be available and ready to handle a National security threat or incident at the Nearshore Hub/Terminal Area.

7.4.22.2.3 Pipeline Area

Exclusion Safety Zones and Vessel Movements

The support potentially required from the National authorities for the enforcement of the exclusion safety zones around the FPSO will be the same as in the Nearshore Hub/Terminal Area.

7.4.22.2.4 Support Operations Areas

Onshore Logistic Activities

As indicated in Sections 7.2.22 and 7.3.22, the onshore logistic activities will be conducted out of the ports and airports of Dakar and/or Nouakchott. The services required for project purposes will be similar to those required from other operators in the ports and airports of the two cities. The project will not put significant additional demands on the ports and airports.

Presence of Foreign Workers

As indicated in Sections 7.2.22 and 7.3.22, the presence of foreign workers has the potential to put additional demands on accommodation and health care services. However, it is not expected to be the case for the current project during the Construction and Operations Phases. It is not expected either during the Decommissioning Phase.

7.4.22.2.5 Summary

Several potential impacts on public infrastructure and services have been assessed, but only two could be significant.

A direct support from the public security forces could be required for handling incidents with artisanal fishermen entering the exclusion safety zones in the Nearshore Hub/Terminal Area and the Pipeline Area. Their direct support would also be required for search and rescue operations. This will involve having the public security forces available 24/7 during the Decommissioning Phase of the project and this could place additional demands on their resources if those are not increased. Additionally, the project may place additional demands on the National security services of Mauritania and Senegal who will need to prevent and be prepared to handle terrorist incidents during this phase.

7.4.22.3 Impact Rating

As indicated in Sections 4.6.10.4 and 4.7.10.4, the public security forces of Mauritania and Senegal operate with a small number of vessels. They have limited means with regards to the length of the coast under their responsibility. The availability required from the public security forces to handle project specific incidents could place additional demands on their limited resources if those are not increased and/or decrease their availability for other public services under their responsibility.

There is a lot of uncertainties around the capacity of public security forces in more than 20 years from now. However, it is assumed that any additional demands on the public security forces during the Decommissioning Phase would be much lower than during the Operations Phase. As indicated in Section 7.4.21, the number of incidents with fishermen should be reduced during the Decommissioning Phase. Additionally, the mitigation measures implemented to enhance the capacities of the public security forces during that 20-year Operations Phase should reduce the additional demands on the public security forces. Finally, the services of the public security forces will only be required during a short period since the decommissioning activities will last about three months.

As a result, the intensity of the impact will be low. The small adverse changes are unlikely to be measurable against background coast guard activities. The extent of the impact would be local since it could comprise services provided by public security forces beyond the project zone. The impact will be short term as it will last during about three months. Based on the combination of these criteria, the consequence of the impact would be negligible. The probability of the impact should be lower during the Decommissioning Phase than during the Operations Phase. After the 20-year Operations Phase, the need to use the services of the public security forces should be reduced. During the 3-month decommissioning activities, the need should be occasional to rare. The overall significance of the impact is rated 1 – Negligible (details are provided in Table 7-153).

In addition to being involved in handling incidents with artisanal fishermen and search and rescue operations, the National authorities of Mauritania and/or Senegal will need to be available and ready to prevent and handle a National security threat or incident at the Nearshore Hub/Terminal Area. Mauritania and Senegal have limited means with regards to National security in general, and offshore threats or incidents in particular. The availability required from the National security services to handle National threats or incidents resulting from the presence of gas production infrastructures may place additional demands on their limited resources if those are not increased and/or decrease their availability for other public services under their responsibility.

As indicated in Section 7.4.21, there are a lot of uncertainties around National security and international terrorism in more than 20 years from now. Additionally, there are a lot of uncertainties around the capacities of National security services of Mauritanian and Senegal in such a distant future. However, it is assumed that any additional demands on the National security services involved in preventing and handling terrorist attacks would be much lower during the Decommissioning Phase than during the Operations Phase. The mitigation measures implemented to enhance the capacities of these services during that 20-year Operations Phase should reduce the additional demands on the National security services. Additionally, the decommissioning activities will only last about three months.

As a result, the intensity of the impact will be low. The small adverse changes are unlikely to be measurable against background security services activities. The extent of the impact would be regional since it could comprise services provided by National authorities beyond the project zone. The impact will be short term as it will last during about three months. Based on the combination of these criteria, the consequence of the impact would be negligible. Due to the short duration of the Decommissioning Phase, the need for the National security services should be reduced. The probability of the impact is considered occasional to rare. Its overall significance is rated 1 – Negligible (details are provided in Table 7-153).

Table 7-153. Impacts to Public Infrastructure and Services during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Exclusion Safety Zones and Vessel Movements						
Mauritania Senegal	Nearshore/ Hub Terminal; Pipeline	Placing additional demands on the public security forces limited resources since the public security forces will be required to be available 24/7 to handle a safety incident with artisanal fishermen or a search and rescue operation if needed.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Occasional to Rare	1 – Negligible
Mauritania Senegal	Nearshore/ Hub Terminal; Pipeline	Placing additional demands on National security authorities who will need to prevent and be available 24/7 to handle a national security threat or incident at sea resulting from the presence of project offshore gas production infrastructures.	Nature: Negative Intensity: Low Spatial Extent: Regional Duration: Short term	Negligible	Occasional to Rare	1 – Negligible

7.4.22.4 Mitigation Measures and Residual Impacts

Impacts being rated 1 – Negligible, no mitigation measures are required.

Measures and operational controls already planned in the project design, summarized as follows:

- D24: Exclusion safety zones will be demarcated on applicable navigational charts, and a communication procedure will be developed to communicate the location of the exclusion safety zones to the local fishing communities. This is intended to allow pirogues to avoid the exclusion safety zones.
- D26: A site security plan will be developed that considers the security arrangements for each of the facilities including the modalities of support provided by government.
- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[143] for all equipment and materials.

[143] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

Moreover, the Inter-state Cooperation Agreement (ICA) requires that the “two states (Mauritania and Senegal) are to consult with a view to jointly setting appropriate security and safety measures for each of the facilities and surrounding areas”. This arrangement is expected to remain valid during the Decommissioning Phase.

7.4.23 Women and Vulnerable Groups

High Level Summary

In this section on Women and Vulnerable Groups, the impact of one impact producing factor, this being Presence of foreign workers, was evaluated. No impacts are anticipated on Women and Vulnerable Groups during the Decommissioning Phase for routine activities.

7.4.23.1 Impact Producing Factors and Project Areas

The IPF identified for this resource in Table 7-6 is distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Presence of foreign workers				●

As previously explained, most of the project activities will be conducted from vessels offshore. There are no potential interactions between activities in these project areas and local communities’ women and vulnerable groups. Only onshore activities have been retained for a potential impact on women and vulnerable groups.

7.4.23.2 Impact Description

The following subsections explain how this IPF will produce impacts in the Support Operations Areas.

7.4.23.2.1 Offshore Area

Not applicable (see Section 7.4.23.1).

7.4.23.2.2 Nearshore Hub/Terminal Area

Not applicable (see Section 7.4.23.1).

7.4.23.2.3 Pipeline Area

Not applicable (see Section 7.4.23.1).

7.4.23.2.4 Support Operations Areas

The only IPF considered for this discussion is the presence of foreign workers. This discussion is limited to direct impacts to women and vulnerable groups. Indirect impacts to these receptors may ensue from impacts on community livelihoods, community health and safety, and employment and business opportunities, public infrastructure and services. These indirect impacts have been discussed under the respective headings, if required.

Presence of Foreign Workers

Section 4.6.11 and 4.7.11 have provided a description of the situation of women and vulnerable groups in Mauritania and Senegal with more specific information on those living in the coastal fishing communities. The following groups have been identified as vulnerable in the two countries: women, youth, the disabled, HIV positive people/households. Specific vulnerable groups included for Mauritania, descendants of former slaves and refugees who returned from Senegal in 1989, and for Senegal, the communities living on the Langue de Barbarie due to the erosion process that threatens the physical integrity of the dwellings on this narrow strip of land. Women and vulnerable groups generally rely on their families which provide the only significant social net in these communities. There are a lot of uncertainties on who will be the vulnerable groups in Mauritanian and Senegal in more than 20 years from now. For the purpose of this assessment, it is assumed that these groups will not change.

In large onshore projects, the presence of foreign workers has the potential to contribute to prostitution in the local population and sexually transmitted diseases such as HIV/AIDS. This is the case, for instance, with some mining projects. Generally speaking, some women and other vulnerable groups are more at risk of prostitution than other members of the population because of their precarious financial situation. However, the current assessment did not need to examine if it was also the case in Mauritania and Senegal because, as indicated previously, the contribution to prostitution is not a significant concern for the current project due to the limited presence of project foreign workers. Therefore, no impacts from the presence of foreign workers are expected on women and other vulnerable groups during the Decommissioning Phase.

7.4.23.2.5 Summary

No impacts are anticipated on women and other vulnerable groups.

7.4.23.3 Impact Rating

Not applicable (see Section 7.4.23.2.5).

7.4.23.4 Mitigation Measures and Residual Impacts

Not applicable (see Section 7.4.23.2.5).

Specific measures aimed at improving the position of women and vulnerable groups during and after decommissioning will be considered near that time.

7.4.24 Cultural and Archaeological Heritage

High Level Summary

In this section on Cultural and Archaeological Heritage, the impact of one impact producing factor, this being Physical presence, was evaluated. No impacts are anticipated on Cultural and Archaeological Heritage during the Decommissioning Phase for routine activities.

7.4.24.1 Impact Producing Factors and Project Areas

The IPF identified for this resource in Table 7-6 is distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence	●	●	●	

Support Operations Areas have not been retained since the supply bases will be located in existing ports and airports locations.

7.4.24.2 Impact Description

The physical presence of infrastructures offshore has a potential to impact cultural and archaeological heritage in the Offshore Area, the Pipeline Area and the Nearshore Hub/Terminal Area. Therefore, the potential impacts are considered globally in the impact description under one of these areas, the Nearshore Hub/Terminal Area.

7.4.24.2.1 Offshore Area

See Section 7.4.24.2.2.

7.4.24.2.2 Nearshore Hub/Terminal Area

Physical Presence

If there are any marine archaeological artifacts in the vicinity of the planned infrastructures, their installation or construction could impact them through seafloor disturbance. Any loss of archaeological marine artifacts would occur at the Construction Phase. Since no additional construction or installation of equipment on the seabed is planned during the Decommissioning Phase, no impacts are on archaeological heritage are expected during the Decommissioning Phase of the project.

As previously mentioned, one of the important aspects of Saint-Louis intangible cultural heritage is the protective goddess of the city, Mame Coumba Bang, whose abode is believed to lie near the mouth of the Senegal River. The intangible cultural heritage includes also mystical rituals practiced from an uninhabited location on the Langue de Barbarie, Sal Sal, located in front of the location for the Nearshore Hub/Terminal Area. The project infrastructures planned about 10 km offshore, their physical presence or removal during the Decommissioning Phase should not interfere with the intangible cultural heritage of local populations of N'Diago and Saint-Louis.

Finally, the physical presence of the project infrastructures will not interfere with the historical and cultural heritage of the island of Saint-Louis which is a UNESCO world heritage site. The island of Saint-Louis is located on the Senegal River. No project activities will be conducted on the river. Therefore, there is no potential interference between the project infrastructures and the island of Saint-Louis during the Decommissioning Phase.

7.4.24.2.3 Pipeline Area

See Section 7.4.24.2.2.

7.4.24.2.4 Support Operations Areas

Not applicable (see Section 7.4.24.1).

7.4.24.2.5 Summary

No impacts are anticipated on cultural and archaeological heritage.

7.4.24.3 Impact Rating

Not applicable (see Section 7.4.24.2.5).

7.4.24.4 Mitigation Measures and Residual Impacts

Not applicable (see Section 7.4.24.2.5).

Summary of existing measures inherent to design and operational controls:

- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[144] for all equipment and materials.

7.4.25 Landscape and Seascape

High Level Summary

In this section on Landscape and Seascape, the impact of two impact producing factors, these being Physical presence and Vessel movements, was evaluated. No impacts are anticipated on Landscape and Seascape during the Decommissioning Phase for routine activities.

7.4.25.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence			●	
Vessel movements			●	

While this section addresses landscape and seascape, the project will not impact the landscape. The only onshore operations will be support operations conducted inside the ports and airports of Dakar and/or Nouakchott. They will have no effect on the landscape. The only potential impacts considered in this section are those on the seascape. The Offshore Area and Pipeline Area are too far from the coast for the decommissioning activities to be seen.

While the two above IPFs include noise, only the physical presence of the infrastructures and the vessel movements can impact the seascape.

7.4.25.2 Impact Description

7.4.25.2.1 Offshore Area

Not applicable (see Section 7.4.25.1).

[144] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

7.4.25.2.2 Nearshore Hub/Terminal Area

Physical Presence and Vessel Movements

The physical presence of infrastructures and vessel movements in the Nearshore Hub/Terminal area could potentially impact the seascape. However, they will be located about 10 km from the coast. The closest locations, Saint-Louis and N'Diago, are located respectively at 13 and 16 km from the breakwater. The physical presence of infrastructures and vessel movements at these distances are unlikely to be noticed. Therefore, no impact is anticipated on the seascape for the onshore viewers.

The physical presence of infrastructures and vessel movements in the Nearshore Hub/Terminal Area (and also in the Pipeline Area) will be observable by other sea users. However, the observations by people navigating or fishing in the surrounding areas will be very localized. It will be limited to their time being in a specific area from which they will have a view on the infrastructures and vessel movements. Consequently, no significant impact on the seascape is anticipated for offshore viewers.

7.4.25.2.3 Pipeline Area

Not applicable (see Section 7.4.25.1).

7.4.25.2.4 Support Operations Areas

Not applicable (see Section 7.4.25.1).

7.4.25.2.5 Summary

No impacts on landscape and seascape are anticipated from routine operations during the Decommissioning Phase of the project.

7.4.25.3 Impact Rating

Not applicable (see Section 7.4.25.2.5).

7.4.25.4 Mitigation Measures and Residual Impacts

Not applicable (See Section 7.4.25.2.5).

7.4.26 Social Climate

High Level Summary

In this section on Social Climate, the impact of four impact producing factors, these being Physical presence, Exclusion safety zones, Onshore logistic activities and Presence of foreign workers, was evaluated. The residual impacts on Social Climate during the Decommissioning Phase for routine activities were assessed as of negligible significance when mitigation measures are applied.

7.4.26.1 Impact Producing Factors and Project Areas

The IPFs identified for this resource in Table 7-6 are distributed by project area as follows:

IPF	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area	Support Operations Areas
Physical presence		●	●	
Exclusion safety zones		●	●	
Onshore logistic activities				●
Presence of foreign workers				●

The IPFs identified above could impact the social climate indirectly. These IPFs are the same as those identified for the Construction and the Operations Phases.

The impact assessment made in Section 7.4.16 shows the physical presence of infrastructures and their exclusion safety zones in the Nearshore Hub/Terminal Area and in the Pipeline Area will have a negligible impact on artisanal fisheries and related activities. No losses of catches are expected and no impacts on activities related to artisanal fisheries, such as fish transformation by women, are expected neither.

However, based on other similar projects, there could be a perception of loss of fishing grounds and catches by fishermen and other community members whose revenues are based on artisanal fisheries. This perception could lead to social discontent. Since the impacts of the physical presence of infrastructures and their exclusion safety zones on social climate are indirect, the distinction between Pipeline Area and Nearshore Hub/Terminal Area is irrelevant. Therefore, they are considered globally in the impact description under the Nearshore Hub/Terminal Area.

The onshore logistic activities have been identified as an IPF that could impact the social climate. Again, the impact is indirect. The impact assessment made in Section 7.4.18 shows that the onshore logistic activities will create limited employment and business opportunities N'Diago and/or Saint-Louis. Limited employment and business opportunities could lead to social discontent in these communities. Therefore, the onshore logistics is considered as an indirect IPF in the impact description under the Support Operations Areas.

The presence of foreign workers has also been identified as an IPF that could lead to social discontent and could impact the social climate. However, the impact assessment made in Section 7.4.19 shows that the presence of foreign workers will not be significant. Therefore, this IPF does not need to be furtherly discussed in the present section.

As indicated previously, the social climate in any country can change anytime due to non-project related events. Therefore, assessing the impacts of a project on the social climate includes some uncertainties. Additionally, these uncertainties increase the further the projections are made in the future. The assessment of the potential impacts of the project during the Construction Phase, presented in Section 7.2.26, was based on the current social climate in Mauritania and Senegal in general, and in N'Diago and in Saint-Louis in particular. Given that the Construction Phase should start in 2018, the level of incertitude revolving around the potential impacts on social climate was relatively small. However, assessing the potential impacts of the project during the Operations Phase which is planned to start in 2022 included a much greater level of incertitude. Assessing the potential impacts of the project on the social climate during the Decommissioning Phase which is planned after approximately 20 years of operations includes an even larger level of uncertainties.

The social climate in N'Diago and in Saint-Louis after approximately 20 years of operations includes a lot of uncertainties. No data can allow any projections or predictions on the social climate in these two communities in more than 20 years from now. Additionally, the population growth over the course of the over 20-year Operations Phase adds to uncertainties around the social climate at the time of the decommissioning phase. Therefore, the impact assessment of the project on the social climate during

Decommissioning Phase is based on the current situation in N'Diago and in Saint-Louis. The assessment will need to be updated before the Decommissioning Phase starts to ensure that the results are still accurate and the proposed mitigation measures are still appropriate.

7.4.26.2 Impact Description

7.4.26.2.1 Offshore Area

Not applicable (see Section 7.4.26.1).

7.4.26.2.2 Nearshore Hub/Terminal Area

As detailed in Section 7.2.26, the current social climate in N'Diago and Saint-Louis is very different. The social climate in N'Diago, a village of about 1,240 people, is calm. With regard to the perceptions of oil and gas activities, community members are hopeful to be able to take advantage of the present project in terms of employment opportunities and social investments. In Saint-Louis (230,801 inhabitants), the social climate is generally calm. However, the social climate in the fishing communities of the Langue de Barbarie, which count 70,532 people, has been tense since the beginning of 2017.

While the loss of fishing grounds in the breakwater area and the FPSO area will be negligible and the project will not entail loss in fishing catches during the Decommissioning Phase, the fishermen are likely to have a different perception of the losses. This perception is likely to be shared by all community members whose revenues are linked to artisanal fisheries and related activities. Perceived inadequate resolution of grievances may compound the matter. This could lead to discontent in N'Diago and Saint-Louis.

7.4.26.2.3 Pipeline Area

See Section 7.4.26.2.2.

7.4.26.2.4 Support Operations Areas

As indicated in Sections 7.2.26 and 7.3.26, expectations for employment opportunities are high in N'Diago and Saint-Louis. While the project will include employment opportunities in the Support Operations Areas in Dakar and/or Nouakchott, the project will provide limited employment opportunities in N'Diago and Saint-Louis during the Decommissioning Phase. This could add to social discontent, if any, during the Decommissioning Phase.

Additionally, the perception that the project is not providing satisfactory resolution of grievances and/or compensation claims (e.g. for lost gear) or is causing elevated risk of injury/death of fishermen at sea due to presence of project vessels could also lead to social discontent during the Decommissioning Phase

7.4.26.2.5 Summary

The perception of loss of fishing grounds and fishing catches combined with the limited employment opportunities, the perception of unsatisfied grievances and/or compensation claims (e.g. for lost gear), and elevated risk of injury/death of fishermen at sea due to presence of project vessels. could lead to social discontent in N'Diago and Saint-Louis.

However, there are a lot of uncertainties around the social climate in N'Diago and Saint-Louis at the time of the decommissioning phase. The population growth over more than 20 years adds to this uncertainty.

7.4.26.3 Impact Rating

Section 7.3.26 has assessed that the social discontent could lead to conflicts and potentially involve fatalities during the Operations Phase. As a result, this impact was rated 4 – High for the Operations Phase. There are a lot of uncertainties around the social climate more than 20 years from now in Mauritania and/or Senegal in general and in N'Diago and Saint-Louis notably. However, the mitigation measures implemented during the 20-year Operations Phase to avoid or reduce social discontent should result in a decrease of social discontent at the end of the project, if any. At that time of the project, it is expected that social discontent over issues linked to the project, if any, should have faded down.

As a result, the intensity of the impact should be moderate. The extent of the impact would be local. The duration of the impact would be limited to the duration of the decommissioning activities. Based on the combination of these criteria, the consequence of the impact is minor. It is likely that the impact could happen during the course of the Decommissioning Phase. As a result, this impact is rated 2 – Low (details are provided in Table 7-154).

Table 7-154. Impacts to Social Climate during the Decommissioning Phase from Routine Activities.

Country	Project Area	Impact	Criteria	Consequence	Likelihood	Significance
Physical Presence, Exclusion Safety Zones, Onshore Logistic Activities, and Presence of Foreign Workers						
Mauritania Senegal	Nearshore/ Hub Terminal Pipeline Support Operations	Social discontent in N'Diago and Saint-Louis due to the potential perception of loss of fishing grounds and fishing catches combined with the limited employment opportunities, the perception of unsatisfied grievances and/or compensation claims (e.g. for lost gear), and elevated safety risk for fishermen at sea due to presence of project vessels.	Nature: Negative Intensity: Moderate Spatial Extent: Local Duration: Short term	Minor	Likely	2 – Low

7.4.26.4 Mitigation Measures and Residual Impacts

The impact is reported below (Table 7-155) and potential applicable mitigation measures are identified. The measures proposed to reduce the risk of social discontent during the Decommissioning Phase are similar to the measures identified for the Operations Phase. However, as indicated in Section 7.4.26.1, the impact assessment of the project on the social climate during Decommissioning Phase is based on the current situation in N'Diago and Saint-Louis. Before the Decommissioning Phase starts, a new assessment of the social climate should be done to ensure that the proposed mitigation measures are still appropriate and more specific ones are identified as required.

These measures are in addition to the existing measures inherent to design and operational controls:

- D19: The relevant maritime, port or shipping authorities will be notified of all permanent offshore facilities, as well as safety zones and routine shipping routes to be used by project-related vessels. Permanent facility locations will be demarcated on nautical charts.
- D24: Exclusion safety zones will be demarcated on applicable navigational charts, and a communication procedure will be developed to communicate the location of the exclusion safety zones to the local fishing communities. This is intended to allow pirogues to avoid the exclusion safety zones.
- D43: A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities that considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[145] for all equipment and materials.

Table 7-155. Mitigation Measures to Avoid or Reduce Social Discontent during the Decommissioning Phase from Routine Activities.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Social discontent in N'Diago and Saint-Louis due to the perception of loss of fishing grounds and fishing catches combined with limited employment opportunities, the perception of unsatisfied grievances and/or compensation claims (e.g. for lost gear), and elevated safety risk for fishermen at sea due to presence of project vessels.	2 – Low	M17, M18, M19, M24, M27, M28, M46	1 – Negligible

Notes:

M17: Establishing a grievance mechanism easily accessible to fishing communities members that includes monitoring of claims and the resolution thereof.

M18: Maintaining a community liaison officer (CLO) for N'Diago and Saint-Louis to provide a direct link with the fishing communities.

M19: Collaboration with a community council of formally nominated representatives of local key stakeholders from N'Diago and Saint-Louis set up to review local fishing communities' concerns and grievances related to the project.

M24: Provide technical assistance to mutually agreed marine resource research programs notably the national oceanographic research centers of both countries (CRODT and IMROP).

M27: Developing a social investment program to enhance project benefits for the directly affected N'Diago and Saint-Louis communities, including livelihood enhancement activities.

M28: Engaging in an on-going dialogue with national, regional and local authorities to monitor the social climate in the local communities in order to help identify and support, if needed, ad hoc measures to prevent social discontent linked to project activities and its escalation into conflicts.

M46: Review the social climate in N'Diago and in Saint-Louis prior to the Decommissioning Phase to adjust as needed the mitigation measures identified to avoid or reduce social discontent.

[145] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

7.5 Impacts of Accidental Events

The following section addresses accident-related impacts to the biophysical and social environments. A description of the accidental event scenarios and the spill prevention and response measures is first provided, followed by the impact assessment on a resource by resource basis.

The following impact analysis draws upon the available and relevant scientific literature to support impact determinations. Included in these sources are the *Deepwater Horizon*, *Exxon Valdez*, *Tricolor*, *Prestige*, *Erika*, and *Montara* spills, as they may differ from the environment and attributes of potential accidents associated with the GTA LNG project and associated impact assessment:

- GTA LNG project: loss of condensate (light oil) and associated gas at depth in deep water; loss of condensate and fuel at the surface in moderate water depth; loss of multiple fuels at the surface in shallow water, all in a semi-tropical marine environment;
- *Deepwater Horizon*: loss of heavier crude oil and associated gas at depth in deepwater in a semi-tropical marine environment;
- *Exxon Valdez*: loss of heavier crude oil at the surface (via grounding in open sound waters) in a cold temperate marine environment;
- *Tricolor*: loss of heavy bunker fuel at depth from vessel sinking in shallow water in a cold temperate marine environment;
- *Prestige*: loss of heavy fuel oil at depth from vessel sinking in moderate depth in a cold temperate marine environment;
- *Erika*: loss of heavy fuel oil at depth from vessel sinking in moderate depth in a cold temperate marine environment; and
- *Montara*: loss of light oil (condensate) and natural gas from a blowout at depth in shallow water in a tropical marine environment.

Similarities to and differences between these historic spills and the GTA LNG project will be noted in this analysis. Of the historic spills noted, the *Deepwater Horizon* may represent the most important source of recent spill-related impact studies to date. While the characteristics of the *Deepwater Horizon* release are different from the condensate and gas of the GTA field, the scientific findings resulting from the *Deepwater Horizon* have substantial merit, particularly as they relate to the potential for 1) deepwater wellhead failure and subsurface plume formation; 2) toxicity and weathering potential of hydrocarbon constituents (e.g., PAHs, alkanes, etc.) present in most spills; and 3) recovery of biophysical resources following acute or chronic exposure to spill constituents.

7.5.1 Description of Accidental Events and Spill Prevention and Response Measures

The purpose of this section is to:

- Explain the framework used to identify potential hydrocarbon spill scenarios and outline the approach taken for hydrocarbon spill modeling (Sections 7.5.1.1 to 7.5.1.3)
- Present an overview of the fate of an oil spill using the *Deepwater Horizon* incident as an example (Section 7.5.1.4); and
- Explain the methods of oil spill prevention and response which can be employed to avoid or reduce impacts as well as methods of verifying and assuring activities associated with spill planning and response (Section 7.5.1.5).

Before an offshore development project is sanctioned, it is necessary to identify the range of potential spill scenarios from the smallest spill up to and including the worst case discharge at all stages of the project. These scenarios then form the basis of planning for what is needed to respond effectively to an oil spill.

The likelihood of a spill event occurring depends on many factors. Industry statistics generally provide a useful first indication of the likelihood. The consequence of the impact of an oil spill is dependent on the release rate, duration (i.e., volume) and type of oil spilled, the location, behavior and fate of the oil and the sensitivity of any receptors that may be affected by the spill.

As explained in Section 7.2.1, a large number of spills can happen, most of which are small (e.g., rupture of a hose, spillage of lubricant). They generally occur on board drilling rigs or vessels, and are easily contained using a range of design and operational controls. Procedures will be put in place to ensure that hoses are inspected and operated correctly to minimize the risk of an unintended release. Drip pans or designated storage areas for hazardous materials will be used to prevent loss of containment. The vessels, drillship and supply base will be equipped with primary spill contingency equipment to deal with spills in the unlikely event they should occur.

For potential medium and large spills that may occur during the project, BP identified a representative range of planning scenarios through a multi-disciplinary workshop including subsurface, well engineering and operations, pipeline and facilities engineering, health and safety, environment, crisis management and oil spill response specialists (BP, 2017).

The objective of the workshop was to identify, select and confirm the range of oil spill planning scenarios up to and including worst credible cases in which oil could be released to the environment, which in turn can inform the definition of response strategies and confirmation of response capabilities. These scenarios were defined by:

- Event (i.e., location, causes, and barriers failed and/or intact);
- Oil type(s) (i.e., physical and chemical properties);
- Release rate;
- Duration; and
- Volume.

Through this workshop, BP has selected the following planning scenarios for modeling and as IPFs:

- Well blowout – subsurface release that could occur during the Construction (drilling) or Operations Phases;
- Failure of FPSO due to a ship collision – surface release that could occur during the Operations Phase; and
- Pipelaying vessel collision – surface release that could occur during the Construction Phase.

These three scenarios were considered to have the potential for highest environmental impact. In order to appreciate their full potential impacts, these scenarios were subsequently modelled. Many other scenarios were discussed during the workshop but these were not considered to represent the most challenging response conditions, due to either location, oil type or volume or environmental impact. In other words, the modelled planning scenarios are to be considered worst case scenarios that cover the range of oil types and volumes characteristic of the project.

Oil spill models predict the behavior of a spill by estimating the potential ’footprint of impact’ of an oil spill over time. Modeling results serve two main purposes:

- to inform planning by identifying response capability needed, to effectively respond to and manage any spill event, however large or small; and
- to inform the assessment of environmental and social impacts resulting from such an event.

The likelihood of the three IPFs to happen, based on the results of the risk study, are as follows:

- Well blowout: 1/455 years (0.2%)[146];
- Failure of FPSO due to a ship collision: 1/392 years (0.2%)[147]; and
- Pipelaying vessel collision: in-between 1/10,000 years to 1/100,000 years (0.01 to 0.001%)[148].

It should be noted that the likelihood of occurrence of each of the three IPFs is different than the probabilities of oiling that result from modeling. Oiling probabilities are separately evaluated and described in this section and detailed in Appendix N-1. Using the impact likelihood parameters outlined in Section 7.1.4.2, the likelihood of these accidental events occurring during the life of the project are considered remote. The remote likelihood classification is used throughout the impact assessment, in conjunction with impact consequence, to determine overall impact significance.

Potential release scenarios for each of the three IPFs were examined using oil spill modeling and are summarized in the sections that follow. Further, employing a worst-case approach, modeling of the potential impact of these scenarios suggested a potential risk of condensate entrained or dissolved in the water column in and around the Senegal River mouth, and entering the Senegal River estuary. This scenario (resulting from the failure of FPSO IPF) was further investigated, and oil spill risk statistics for the mouth of the Senegal River estuary were extracted from the modeling data. Model outputs were scaled using salinity as a proxy for how oil would potentially dilute as it traveled upstream and interacted with the freshwater from the river. These results are summarized under the failure of FPSO IPF (e.g., Section 7.5.1.2).

For the present assessment (all three IPFs), analysts from Oil Spill Response Limited (OSRL) used the three-dimensional (3D) SINTEF Oil Spill Contingency and Response model (OSCAR)[149] to calculate the predicted distribution of contaminants (in units of thickness, concentration, and mass per unit area) on the water surface, in the water column, on shorelines, and in (underwater) sediments. The OSCAR model allowed multiple oil release simulations, each with a specified beginning and end to the release. For subsurface releases (i.e., the well blowout IPF in this analysis), a multi-component integral plume model embedded in the OSCAR model was used for near-field calculations. This near-field model accounted for buoyancy effects of oil and gas, as well as effects of ambient stratification and cross-flow on the dilution and rise time of the subsurface plume.

The model is able to simulate the behavior of different types of oil over time. The oil type is characterized by its physical and chemical properties, including the weathering profile (see Section 7.5.1.4.1). For the present assessment, three different oils were considered, notably condensate, MDO and HFO.

The OSCAR model computed surface spreading, slick transport, entrainment into the water column, evaporation, emulsification, and shoreline interactions to determine oil drift and fate on the sea surface. In the water column, horizontal and vertical transport by currents, dissolution, adsorption, settling and degradation were simulated. Changes in composition of released oil due to evaporation and degradation were modelled by representing the oil in terms of a number of sub-components (e.g., benzenes, decalines, different groups of PAHs).

Both deterministic (single spill trajectory) and stochastic (random probability) scenarios can be simulated in the OSCAR model. In general, stochastic modeling is used to predict the probability of oil occurrence or contact at the sea surface, on shorelines, or in the water column following an oil spill event. It involves running numerous individual spill trajectory simulations using a range of prevailing wind and current conditions that are historically representative of the time period during which the spill

146 As per Table 8-31 of Chapter 8, a blowout or well release has a frequency of 2.2×10^{-3} per year.

147 As per Table 8-31 of Chapter 8, the FPSO spill frequency has been calculated as the sum of F-14 (tank fire/explosion – 1.6×10^{-3} per year), F-15 (loss of stability – 1×10^{-4} per year), F-17 (offtake tanker collision – 3.7×10^{-4} per year) and F-18 (passing vessel collision – 4.8×10^{-4} per year), i.e., 3.55×10^{-3} per year.

148 For the pipelaying vessel collision, no statistical spill data exist. The likelihood range has been derived assuming a fixed vessel not in a shipping lane, with a collision arising from bad weather or engine failure based on a review of generic shipping accidents.

149 For more information on SINTEF see www.sintef.no.

event may occur. The numerous trajectory results are then collectively analyzed to develop statistical probabilities of where oil might travel and the time taken for the oil to reach a given shoreline (based on the numerous individual model runs).

The stochastic modeling results provide an insight into the probabilities of landfall or surface oiling in a particular location or near a receptor, and exceedance of a given threshold (e.g. oil layer thickness at surface, mass of oil stranded, concentration in the water column). The stochastic model output does not represent the extent of any one oil spill event (which would be substantially smaller in geographic footprint) but rather provides a probability summary of the total individual simulations for a given scenario and/or oil type. Stochastic models are used for planning purposes.

In general, deterministic modeling (or single spill trajectory analysis) is used to predict the fate (transport and weathering behavior) of spilled oil over time under predefined hydrodynamic and meteorological conditions. For each spill scenario modeled, predefined conditions were selected to produce a worst-case scenario; for the purposes of this analysis, worst case was defined as most oil ashore.

It should further be noted that the modeling output is a conservative prediction without the benefit of mitigation or response activities. In the event of an oil spill, response procedures would reduce the volumes spilled and/or the oil dispersion and transport from the spill site.

The selected release scenarios and modeling results from each of the IPFs are briefly described in this section, including summary figures showing composite results for two seasons (boreal Summer and boreal Winter). Further details on the modeling activities and maps illustrating spill trajectories, probabilities of landfall, and modeling set up and assumptions for worst-case spill scenarios are provided in Appendix N-1.

The hydrodynamic modeling data used for all spill scenarios was derived from two primary data sets – BMT ARGOSS and hybrid coordinate ocean model (HYCOM). The hydrodynamic database was constructed from 3D current velocity fields suitable for use in oil model simulations. The dataset was comprised of ocean currents (i.e., non-tidal residual) from a global ocean circulation model, combined with tidal current velocities.

Tidal current information was obtained from the integration of approximately 5,000 tidal stations and 15 years of satellite radar altimeter into depth-averaged global and regional tidal models (2DH model). The tidal model provides tidal currents (u, v components) as well as surface elevation. The spatial resolution of the tidal model varies from 1/60 to 1/12 degrees globally. The tidal model provides data at a spatial resolution of 4 minutes in the area of interest.

Ocean currents were obtained from the HYCOM global ocean current model with the following characteristics:

- Spatial resolution: 1/12 degree;
- Temporal resolution: Daily;
- Data type: 3D current speed and direction;
- Depth: 3D datasets consisting of up 33 depth layers from surface to seabed and spread across the water column; individual layers and their distribution over the water column vary and depend upon the local depth; and
- Timeframe for data availability: 2009-2012.

The resultant data, representative of total current velocity, was provided to the model as hourly current vectors at selected depth levels at 1/12 degree spatial resolution across the area of interest. In deep water, beyond the continental slope, tidal current velocity is considered to be negligible.

In all modeling analyses, it has been presumed that no spill response has been applied either at the spill source or at distal locations; in several instances, spill thicknesses and the effectiveness of spill response techniques are noted. Additional details regarding modeling setup, input parameters, and modeling results for each spill scenario are provided in Appendix N-1.

7.5.1.1 Well Blowout

The well blowout spill scenario encompasses a worst-case subsurface release of condensate from a wellhead failure, resulting in the total release of 227,000 m^3 of condensate over a 60-day period[150]. The well blowout scenario could result from a loss of well control and full bore rupture during drilling (Construction Phase), or from a well head failure during the Operations Phase.

Model results suggest that a well blowout scenario of this magnitude from the project's well could potentially affect Mauritania's offshore surface waters within less than an hour of the event (in both boreal Summer and boreal Winter). Model results predict Senegal's waters could also be affected in less than an hour as a result of a blowout in boreal Summer, or within three hours if the event occurred during boreal Winter. EEZ waters offshore of Cape Verde, Guinea, Guinea-Bissau, Sierra Leone, The Gambia, and Western Sahara could potentially also be affected within a longer time period, depending on the season (see Appendix N-1 for more details).

Model results show the predicted thickness of condensate on the ocean surface would be limited to mostly sheen (0.04 µm to 0.3 µm) and rainbow sheen (0.3 µm to 5 µm) that would readily disperse. A small amount of metallic sheen (thickness 5 µm to 50 µm) may be found in the local area around the well (i.e., within ~25 km). Because of the high turbidity created by the gas at the wellsite, condensate droplets are predicted to be very small and would rise more slowly if at all.

The predicted probabilities of oil contacting shorelines as a result of the well blowout scenario of this magnitude are shown in Figure 7-9. Only the coastlines of Mauritania and Senegal would see shoreline oiling as a result of a well blowout during both boreal Summer or boreal Winter, with both countries having a greater chance of oiling during boreal Summer (i.e., predominantly 75% or less during boreal Summer; 25% or less during boreal Winter).

Additional figures in Appendix N-1 show shoreline oiling categories (light, moderate, and heavy based on the International Tanker Owners Pollution Federation Limited [ITOPF] classification system). No heavy (>10 mm) shoreline oiling was predicted by modeling during either season; only moderate and light oiling was predicted by the model.

Under the worst case, moderate and light shoreline oiling in boreal Summer may affect 300 km and 185 km of shoreline, respectively, via deposition of 11,000 metric tonnes of spilled hydrocarbons. In boreal Winter, moderate shoreline oiling may affect 54 km of shoreline via deposition of 2,200 metric tonnes of spilled hydrocarbons.

Additional figures in Appendix N-1 show shoreline oiling arrival times. Modeling results of the well blowout scenario of this magnitude show a 10% chance of shoreline oiling within ~7 days and a 50% chance of shoreline oiling within ~49 days.

[150] Over a period of 60 days, total condensate loss at the wellhead would be 227,000 m^3 under a scenario of this magnitude. The worst credible discharge (WCD) rate from a well was determined based on a range of factors, including predicted rock properties of the formations to be penetrated such as porosity, permeability, temperature and pressure. The WCD rate for the Tortue wells was calculated by BP subject matter experts following the methodology outlined in BP Global Engineering Practice. A 60-day timeframe is assumed, as a worst-case for modeling, to mobilize and drill the relief well.

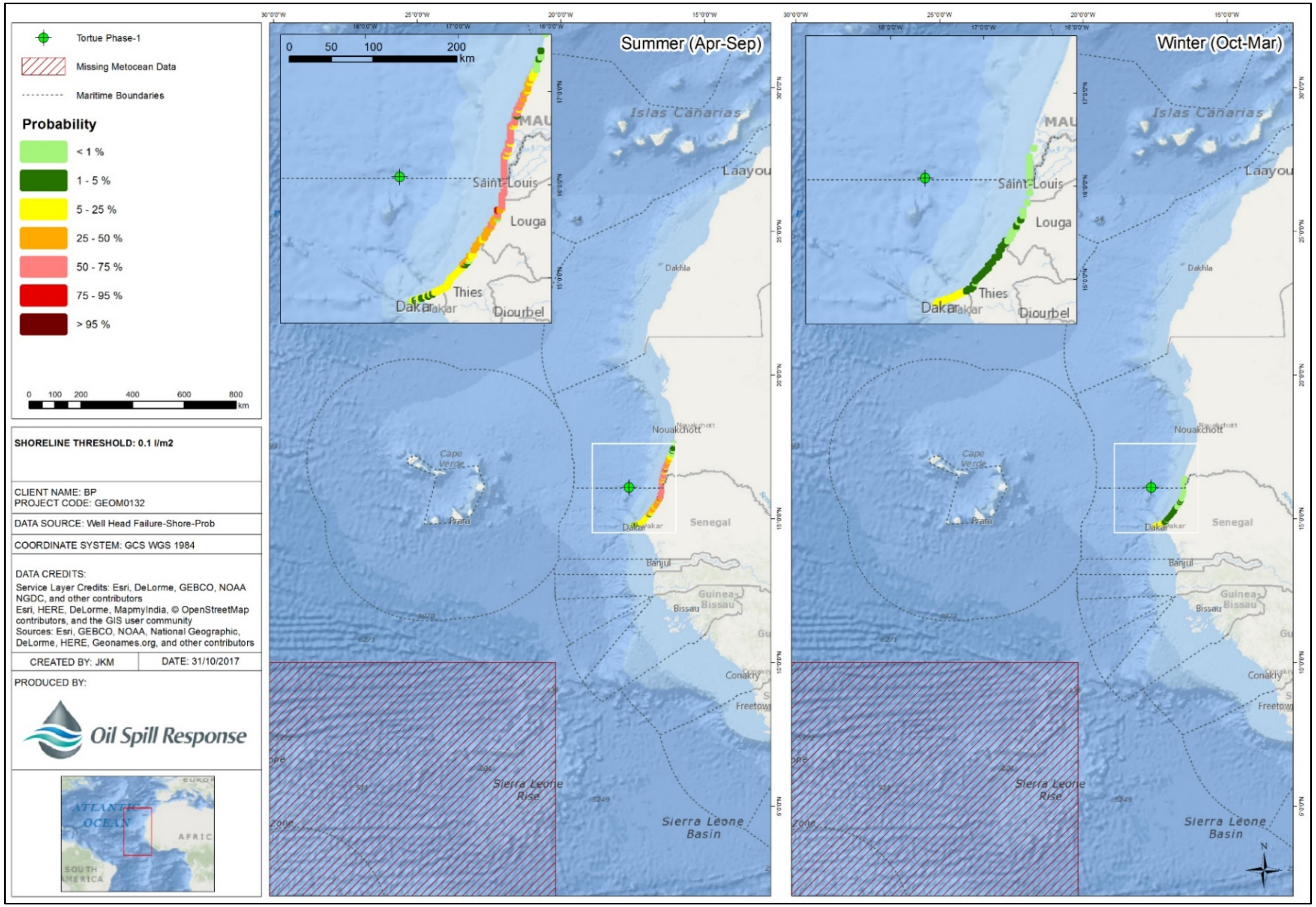


Figure 7-9. Well Blowout: Shoreline Probability of Being Affected – Boreal Summer (left) and Boreal Winter (right).

7.5.1.2 Failure of FPSO Due to a Ship Collision

At the FPSO location, this accidental event scenario includes the catastrophic failure of storage and fuel tanks due to a ship collision, resulting in the release at the sea surface of 160,000 m^3 of condensate over a 160-hour period and of 3,200 m^3 of MDO over 3.2 hours[151]. Failure of the FPSO under this scenario during the Operations Phase would involve the total loss of inventory resulting from the initial rupture of tanks and fire.

Model predictions indicate surface waters offshore of Senegal water would be reached under an FPSO failure scenario of this magnitude. Surface waters offshore of Mauritania waters may not be affected due to a southerly flowing current occurring in some scenarios. The EEZ waters of Cape Verde, Guinea-Bissau and The Gambia would also potentially be at risk in both boreal Summer and boreal Winter scenarios.

Model predictions show surface waters offshore of Mauritania and Senegal could be affected by surface thicknesses of more than 5 µm, which would represent potential candidacy for containment and recovery techniques. The waters of other neighboring countries could be affected by oil sheen on the surface waters, but not at a thickness that would allow for efficient containment and recovery.

The shorelines of Mauritania and Senegal would be at risk in the case of a scenario of catastrophic FPSO storage tank and diesel tank failure due to a ship collision. Figure 7-10 illustrates the probability of shoreline contact. Additional figures in Appendix N-1 show shoreline arrival times. The boreal Summer scenario model results suggest shoreline contact would be worse than the boreal Winter scenario. Model predictions show a 90% chance that condensate and diesel would reach the shoreline within ~4 days in boreal Summer, and a 50% chance that condensate and diesel would reach the shoreline within ~5 days in boreal Winter.

Modeling results for failure of the FPSO due to a ship collision during boreal Summer show a 50% chance that the amount of oil reaching the shore would exceed 9,500 metric tonnes. During boreal Winter, this is reduced to a 13% chance that the same amount of oil would reach the shore. Model predictions show Senegal would likely experience more shoreline oiling than Mauritania, both in terms of greater probability of contact and in a shorter time period.

Additional figures in Appendix N-1 show shoreline oiling categories based on the ITOPF classification system. Failure of the FPSO due to a ship collision in boreal Summer is predicted to result in primarily moderate shoreline oiling in Senegal and parts of Mauritania (and possibly some heavy oiling). However, the length of shoreline predicted to be affected by heavy oiling would be less than 7 km. In the worst-case boreal Summer scenario, the amount of oil on the shore peaks at 20,040 metric tonnes after about 27 days.

Spill trajectories for condensate and MDO released from the FPSO, likelihood of landfall, and worst-case spill scenarios are presented in more detail in Appendix N-1.

[151] The released quantities are based on storage capacity on board at the time of the workshop and the duration of release are based on these quantities. This scenario represents the worst-case surface release volume, and assumes the complete loss of inventory.

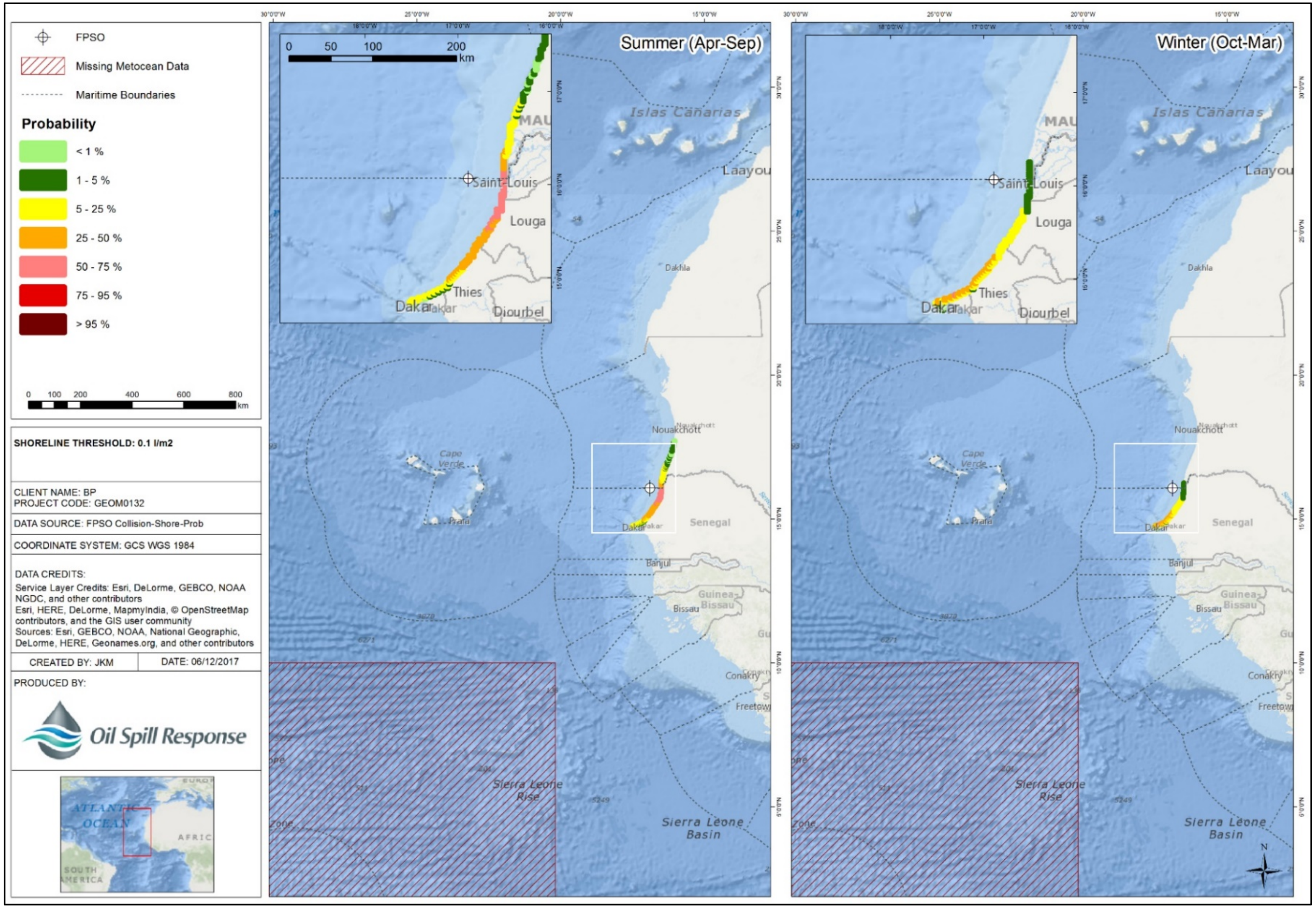


Figure 7-10. Failure of FPSO Due to a Ship Collision: Shoreline Probability of Being Affected – Boreal Summer (left) and Boreal Winter (right).

As mentioned in Section 7.5.1, the risk specific to the area in and around the mouth of the Senegal River and upstream into the Senegal River estuary associated with this accidental event scenario has also been assessed. This modeling effort estimated worst case conditions (i.e., surface, water column, shoreline) at the Senegal River mouth and maximum dissolved and total concentrations at various locations on the river and their probability of occurrence. Based on these results, oil and condensate entrained or dissolved in the water column may reach the river mouth, the island of Saint-Louis, and small islands upstream, but it would not reach the Diama dam located about 25 km upstream of the island of Saint-Louis. Appendix N-1 provides further details regarding results of the analysis of potential spill movement resulting from an FPSO failure due to a ship collision to the Senegal River mouth and into the Senegal River estuary.

7.5.1.3 Pipelaying Vessel Collision

Under the scenario modeled, at the Nearshore Hub/Terminal, the collision of the pipelaying vessel and subsequent vessel loss would result in the release at the surface of the ocean of 2,960 m^3 of MDO over 3 hours, of 3,370 m^3 of HFO over 3.4 hours, and of 92 m^3 of lubricating oil over 1 hour[152]. While it is possible that project supply vessels may also collide resulting in fuel loss, the pipelaying vessel collision spill scenario was chosen for modeling because of the location of release, its close proximity to the shoreline, and the volume of the fuel released (i.e., pipelaying vessel fuel volume [3,650 m^3] would be higher compared to the supply vessel [~1,200 m^3]). The number of vessels which would be utilized during the Construction Phase at this location also increases the likelihood occurrence for the pipelaying vessel collision scenario.

Model predictions show surface waters of Mauritania and Senegal could be affected by surface thicknesses of more than 5 μm, which would represent potential candidacy for containment and recovery techniques. Figures in Appendix N-1 show stochastic modeling results of surface probabilities. The probabilities of surface oil reaching Mauritania waters ranges from 13% in boreal Winter to 43% in boreal Summer. Modeling results show 100% probability that surface waters offshore of Senegal would be affected regardless of season. The EEZ waters of other neighboring countries would not be affected during boreal Summer, but would be affected by oil up to 3 μm in thickness during boreal Winter, according to model predictions.

The coastlines of Mauritania and Senegal would be at risk due of impact, in the event of a spill, resulting from a pipelaying vessel collision. Figure 7-11 below illustrates the probability of shoreline contact (within 1 day in some cases; within 7 days in most cases). Additional figures in Appendix N-1 show shoreline arrival times. The boreal Summer scenario model results suggest shoreline contact would be worse than the boreal Winter scenario. Model predictions show a 100% chance of shoreline contact within ~4.5 days in boreal Summer, and a 100% chance of shoreline contact within ~57 days in boreal Winter.

Model results show that this scenario in boreal Summer has an 80% chance that the amount of oil reaching the shore would exceed 3,000 metric tonnes, while in boreal Winter there is a 50% chance that approximately the same amount (2,900 MT) of oil would reach the shore. Senegal would be expected to see more oiling than Mauritania. Additional figures in Appendix N-1 show shoreline oiling categories based on the ITOPF classification system. A boreal Summer spill may also result in more heavy shoreline oiling than boreal Winter. However, the length of shoreline that could be affected by heavy oiling would be restricted to less than 4 km. The trajectories undertaken show that while shoreline oiling may initially be substantial, oil properties indicate the produce would evaporate and biodegrade relatively quickly, with shoreline oiling peaking at 4,500 metric tonnes after about 10 days.

Spill trajectories for MDO, HFO and lubricating oil released from a sunken pipelaying vessel, probability of landfall, and worst-case spill scenarios are presented in more details in Appendix N-1.

[152] The released quantities are based on storage capacity on board at the time of the workshop and the duration of release are based on these quantities. For the pipelaying vessel, the *Seven Borealis* was used as a representative vessel. This scenario represents the worst-case surface release volume at the location of the Hub and assumes the complete loss of fuel inventory of the vessel assumed to have the largest volume of fuel onboard (i.e., pipelaying vessel).

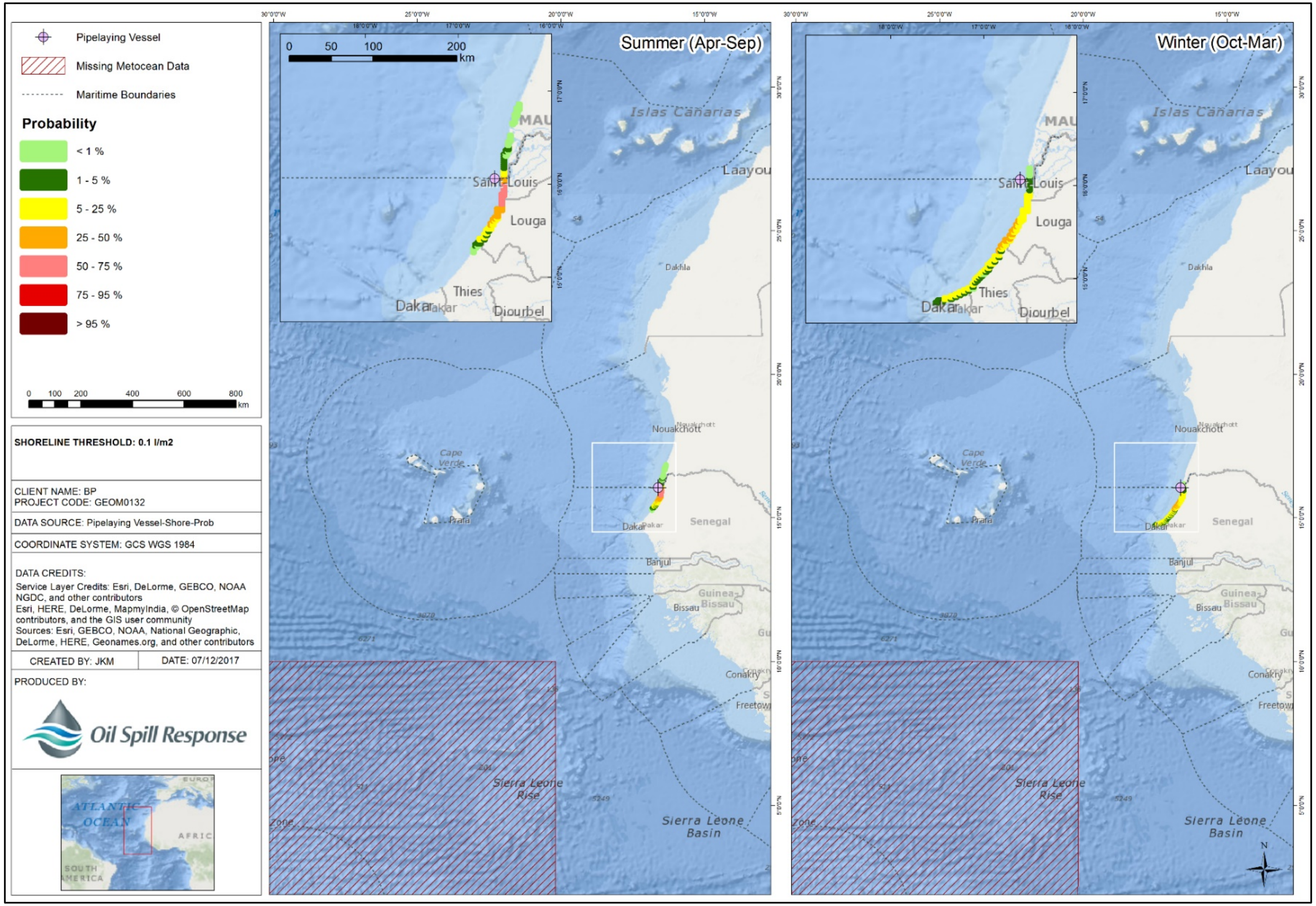


Figure 7-11. Pipelaying Vessel Collision: Shoreline Probability of Being Affected – Boreal Summer (left) and Boreal Winter (right).

7.5.1.4 Fate of a Hydrocarbon Spill – Overview

The following discussion provides a general overview of the fate of a hydrocarbon spill in the marine environment. Summary information has been derived from multiple sources, including the extensive amount of data collected following the *Deepwater Horizon* spill in 2010.

7.5.1.4.1 Weathering Processes

The following weathering processes are expected:

- **Evaporation** begins as soon as the oil is released and is exposed to sunlight and the atmosphere (i.e., oil released at depth must reach the sea surface before evaporation begins); the rate of evaporation is highest for light oils because the majority of VOCs evaporate within 12 hours. For lighter products (e.g., condensate), up to 90% or more may evaporate within the first 24 hours. Evaporation is dependent on ambient temperature and wind speed, as well as chemical composition of spilled material.

- **Natural dispersion** (spreading) is the dispersion of oil under the influence of sea state conditions into small droplets, increasing the total surface area of the oil and thereby speeding biodegradation. Dispersion may produce crude oil losses between 20% and 50% per day, depending on low (<1 m wave height) or high (>6 m wave height) sea state, respectively (Blaikley et al., 1977).

- **Dissolution**, the dissolving of soluble components of oil into seawater, takes place early in a release. Most hydrocarbons, however, are not highly soluble in water; therefore, dissolution is generally considered to be a relatively minor component of weathering.

- **Biodegradation** is the biochemical breakdown of oil by bacteria, mold, yeast, fungi, unicellular algae, and protozoa. The rate and extent of biodegradation depends on the abundance and variety of such organisms, availability of oxygen and nutrients, water temperature, and oil composition. The rate of biodegradation increases as the oil is dissolved and/or dispersed, and as oil droplets decrease in size.

- **Photo-oxidation** is the oxidation of oil in sunlight and is a relatively minor component of weathering.

- **Emulsification** occurs when oils take up water and form a water-in-oil emulsion. Emulsions may contain from 20% to 80% water; the rate of emulsification is related to sea state (i.e., increased sea state produces higher levels of emulsification). Emulsions can also inhibit biodegradation of the oil.

- **Sedimentation and sinking** is the process whereby floating oil (e.g., droplets) adheres to particles of sediment or organic matter and sink to the seabed. Most oils have a sufficiently low specific gravity to remain afloat; sedimentation and sinking are more likely to occur in shallow coastal waters, however, these processes are generally minor components of weathering.

7.5.1.4.2 Spill Fate

There are no spill data that are fully applicable to the potential well blowout scenario outlined in Section 7.5.1.1 – an uncontrolled release of condensate and associated natural gas from a well in deepwater. However, the *Deepwater Horizon* incident has several relevant similarities which provide insight into hydrocarbon fate following a deepwater release. The *Deepwater Horizon* spill was a large volume release that originated from a 1,525 m water depth and contained both crude oil and associated gas. Though the *Deepwater Horizon* spill differs from a condensate spill in the type and expected volume of hydrocarbon potentially spilled during the GTA LNG project, the incident does illustrate the potential fate and effects. The following discussion summarizes the current scientific findings from the *Deepwater Horizon* incident, complemented by pertinent spill-related research.

Additionally, the fate of the surface release of hydrocarbons, applicable to FPSO failure due to a ship collision (Section 7.5.1.2) and pipelaying vessel collision (Section 7.5.1.3), is also characterized.

A hydrocarbon release at the seafloor would be expected to rapidly rise toward the sea surface, resulting in elevated hydrocarbon concentrations in the water column and development of a sheen or slick on the sea surface. In addition, for deepwater hydrocarbon releases, a portion of the release may remain at depth as a subsea plume, as evidenced during the *Deepwater Horizon* spill.

The *Deepwater Horizon* spill incident in 2010, and the extensive sampling and analyses conducted during and subsequent to the spill, provide insight into the short-term fate of a catastrophic subsea release. Approximately three weeks after the leaking well was capped, the US government (Lubchenko et al. (2010), issued the following estimate of the total volume and fate of oil released in the *Deepwater Horizon* spill, split between various weathering and spill response processes:

- Residual oil: 26%. Residual oil includes oil that a) is on or just below the surface, as light sheen and weathered tar balls; b) has washed ashore or been collected from the shore; or c) has washed ashore and is buried in sand and sediments.
- Evaporated or dissolved: 25%.
- Direct recovery (from the wellhead): 17%.
- Dispersed naturally: 16%.
- Chemically dispersed: 8%.
- Burnt: 5%.
- Skimmed: 3%.

These estimates were used to help the government develop an effective oil spill response, (Lubchenko et al., 2012), and we use them for a similar purpose here, although the estimates were based on limited data and assumptions, and were later revised[153]. Refinements to the initial mass balance have been documented in the literature since 2010, including estimates of error, which can be as high as 50% (e.g., Fingas, 2017). Residual oil, naturally dispersed oil, and chemically dispersed oil continue to undergo natural degradation either in the water column or atop or buried in intertidal and subtidal sediments.

Subsurface Behavior

In general, when oil and gas are released at depth, they are expected to break into bubbles or droplets of various sizes. These sizes can vary widely. In field trials off Norway (Chen and Yapa, 2003), droplets were generally between 1 and 10 mm in diameter. Leifer (2010) has suggested, however, that the gas bubbles for the *Deepwater Horizon* spill were smaller than the North Sea experiments, effectively reducing their buoyancy. Larger droplets have a relatively stronger buoyancy force to friction force than smaller droplets (i.e., the buoyancy to friction force ratio increases with diameter); consequently, larger droplets move toward the surface faster than smaller droplets (Lehr et al., 2010).

Droplets, regardless of size, are subject to cross currents that may move them laterally, while buoyancy acts to move them vertically (upward). Lateral movement by cross currents has a greater influence on smaller diameter droplets. Consequently, larger and smaller droplets may not come to the surface at the same location or at the same time. If droplets are of a very fine scale, it may take weeks or months for them to surface (Galt, 2010). For large droplets, the rise time may be on the order of several hours (Galt, 2010; Yapa et al., 2010). For droplets in the 100 to 200 µm range, the

[153] Lubchenko et al. (2012) revised the initial estimates in the oil budget in 2012, finding, for example, that the percentage of chemically dispersed oil should rise to 16%. A trial court subsequently found that the 2010 estimate overstated the total oil volume released by ~20% and understated the percentage of oil recovered (U.S. District Court, Eastern District of Louisiana, 2015). A further trial to evaluate the remaining estimates in 2015 ended in settlement.

time required to reach the surface would be sufficiently long enough that these droplets were effectively dispersed. This would be considerably larger than the common maximum diameter size limit for dispersed oil droplets of around 60 to 80 µm (Lehr, 2001; National Research Council, 2005). Spaulding et al. (2000) estimated that the rise time for 20-µm droplets with specific gravity of 0.81, less dense than this oil, would have a rise time from this depth on the order of a week.

Dispersion

Oil released at depth from the *Deepwater Horizon* spill was immediately subjected to weathering. Because of the nature of the material flowing from the riser – a miscible mixture of oil and natural gas – a significant amount of dispersion of the liquid oil occurred near the wellhead. Some of the oil droplets were so small (i.e., <100 µm in diameter) that the turbulent diffusivity of the water was enough to overcome the natural buoyancy of the oil; the result was a dispersion of small oil droplets at depth (i.e., little to no further ascent through the water column; transport and spreading as a subsurface plume). Larger droplets ascended through the water column, rising to the ocean surface; the speed of the ascent was determined by the size of the drops. Larger accumulations of droplets of oil rose fairly quickly while smaller droplets rose slowly and were dispersed farther from the spill site by currents in the water column (Lehr et al., 2010).

Oil droplets, regardless of size, were exposed to weathering processing. Both the oil droplets remaining at depth and those rising to the surface realized weathering. As the small droplets moved through the marine environment, they were continually exposed to ambient, uncontaminated Gulf water in their transit.

Dissolution of water-soluble compounds from the smaller oil droplets was not controlled by equilibrium factors, resulting in a near-continuous molecular extraction of these fractions by the water column. Results of this continuous extraction are that marginally soluble oil components were extracted from the droplets. Lehr et al. (2010) suspect that dissolution was a much more important factor in the weathering of *Deepwater Horizon* spilled oil than it is in more common surface oil spills.

Evaporation

Laboratory and field studies of oil weathering under wide-ranging conditions and for a wide range of crude oils demonstrate that surface slicks quickly lose volatile components to evaporation. As the more volatile compounds are lost, the rate of evaporation slows. Evaporation is often the most significant loss mechanism from surface slicks during the first week following a spill. Generally, after a week at sea, evaporation is no longer a significant loss mechanism for surface oil. For light crude oils, such as this oil, the great majority of the evaporative loss occurs within a couple days of its exposure to the air.

Evaporation changes several characteristics of an oil spill – volume and chemical composition. Through evaporation, the smaller, more volatile chemical compounds are preferentially lost, altering the relative abundance of individual chemical compounds within the oil. Evaporation, in conjunction with other weathering processes (e.g., dissolution), can appreciably change the composition of the oil. Camili et al. (2010) measured the composition of oil collected from the top 30 m of the water column during the *Deepwater Horizon* spill, noting the loss of the more volatile compounds to substantial evaporative loss.

Emulsification

Fingas (2010) has evaluated the formation of emulsions by surface oils, noting that an important factor to the formation of emulsions is the requirement that oils often must realize a certain percentage of weathering before emulsion formation can occur. The formation of an emulsion requires that asphaltenes and resins must be at a sufficient content to stabilize the oil; oil stabilization must also be accompanied by a sufficiently high viscosity to retain water droplets.

Lehr et al. (2010) note that crude oils from similar production fields have a tendency to form similar emulsions with similar weathering tendencies. Crude oils from the Gulf of Mexico that have exhibited stable emulsions had weathering percentages ranging between 16.4% and 37.7%, with an average of

26.8%. The *Deepwater Horizon* oil exhibited similar tendencies, with weathering percentages estimated to range between approximately 16% and 38%.

Experimental studies by S.L. Ross Ltd. (2010) and studies at The Foundation for Scientific and Industrial Research (SINTEF) based in Trondheim, Norway (Daling et al., 2014), showed that an evaporative loss of at least 40 to 45 wt % (representing a 200 to 250C+ residue) is needed for this *Deepwater Horizon* crude oil to form a significant and stable emulsion. Lehr et al. (2010) observed large amounts of emulsified oil following the *Deepwater Horizon* spill. The proportion of C25+ components in the condensate is relatively low (i.e., <18%), suggesting that emulsion formation is not expected or may be very limited. Fuel oils, particularly the heavy fuel oil, have higher proportions of C25+ components, suggesting that these spilled products may form emulsions as weathering progresses.

Dispersant Use

The use of dispersants on surface oil (i.e., on the ocean surface) is a common practice to reduce surface slicks; make oil more available to weathering, degradation, and biological processes; and to protect sensitive coastal or shoreline resources. Dispersants applied to oil on the ocean surface alter the physico-chemical properties of the oil and allow it to enter the water column, thereby exposing water column and potentially benthic fauna (e.g., in shallower waters) to potentially toxic effects of the treated oil and the dispersants themselves.

Because natural weathering of the oil changes its properties, there is a small application window for dispersants applied to surface oil to be effective. This is generally within 12 to 48 hours after a spill; dispersants applied to surface oil would be applied only in the fairly close vicinity of the spill.

In the case of a subsurface release of oil (e.g., blowout at the wellhead), spill response involving dispersants can be based on treatment of surfaced oil, treatment of oil at the wellhead (i.e., subsurface dispersant use), or a combination of the two approaches, which was the approach used during the *Deepwater Horizon* spill response. Peterson et al. (2012) note that the *Deepwater Horizon* blowout presents two incidents: a familiar buoyant oil spill with surface effects of short residence times, and a more unique deepwater plume with chronic subsurface effects that suppress population recovery of exposed animals. Figure 7-12, from Ryerson et al. (2012), depicts the fate of the two plumes.

As noted previously, several different dispersants were applied during the *Deepwater Horizon* incident. Dispersants applied at the surface included 6,800 m^3 of Corexit 9500A and Corexit EC9527. Subsurface applications, at the wellhead, included 3,000 m^3 of Corexit 9500A only (Zuijdgeest and Huettel, 2012).

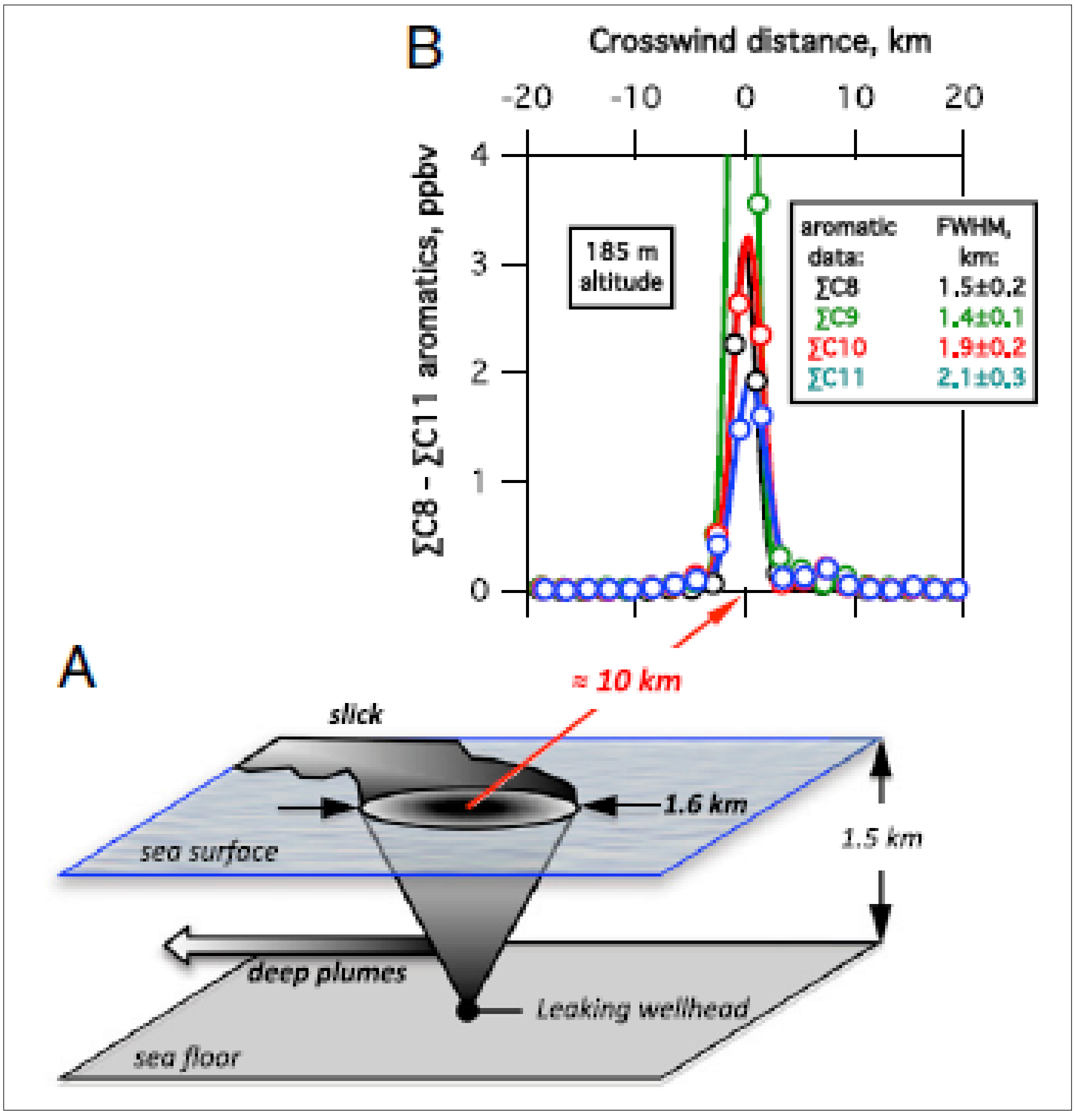


Figure 7-12. (A) Scale Diagram of Surfacing Hydrocarbon Plume Dimensions for the *Deepwater Horizon* Spill. (B) Gaussian Fits to Hydrocarbon Composition Data and Corresponding Full Width at Half Maximum from Crosswind P-3 Aircraft Transects of the Evaporating Plume 10 km downwind of the *Deepwater Horizon*.

Atmospheric Plume Data are Consistent with a Surface Source Area of Approximately 1.6 km in Diameter. Data from a Single Transect are Shown as an Example (From: Ryerson et al., 2012).

The following analysis was taken, with minor modification, from Lehr et al. (2010) regarding subsurface use of dispersants during the *Deepwater Horizon* spill.

> A typical commercial dispersant is a mixture of three types of chemicals, including solvents, additives, and surfactants. The surfactants are the active ingredient and contain both hydrophobic and hydrophilic groups. This allows them, when coating the oil surface, to reduce its surface tension by as much as a factor of 20 or more, reducing mean droplet size in droplet formation caused by turbulent shearing (Li and Garret, 1998).
>
> Caneveri et al. (1989) measured declines in oil-water interfacial tensions from 18 mN/m without dispersant to 0.1 mN/m with dispersant. More recently, Khelifa and So (2009) measured declines of oil-brine interfacial tension for three different oils. Declines from

18.3 mN/m without dispersant to 6.5 × 10^{-4} mN/m with Corexit 9500 at 1:20 dispersant to oil ratio (DOR) were measured. The same study showed that corresponding droplet size decreases from about 220 mm to 25 mm when the DOR increases from 1:500 to 1:10. (Note: DOR is often expressed with the 1: omitted. Therefore, a DOR of 20 and a DOR of 1:20 refer to the same ratio).

Clayton et al. (1993) noted that successful dispersion of oil in actual dispersant applications only occurs if five requirements are met:

- *The dispersant must reach the oil surface;*
- *The dispersant must penetrate the oil surface;*
- *The surfactant must orient at the oil-water interface;*
- *The surface tension must be reduced; and*
- *Sufficient mixing energy must be applied.*

Measurement of subsurface operation was, at best, highly indirect. The most directly applicable were the findings of Camilli et al. (2010), who reported results from a subsurface hydrocarbon survey using an autonomous underwater vehicle and a ship-cabled sampler. Using BTEX results as an indicator of oil concentration, they concluded that an observed plume of oil at approximately 1,100 m depth represented about 6-7% of the oil leaking from the wellhead. The plume location was consistent with the expected location of subsurface dispersed oil based upon the Clarkson well blowout model (Latimer and Zheng, 2003).

Most of the experts believed that the conditions subsurface were good for dispersant operations. It is likely that all five of the conditions listed by Clayton et al. (1993), noted above, were generally met. However, the addition of dispersant at 7 to 12 gal/min through a narrow diameter wand held by a ROV into the flow of escaping oil and gas would probably not have added dispersant to all of the oil; some oil would have escaped into the water column untreated with any dispersant. Without carrying out some experimentation, it is not possible to say what proportion of the escaping oil would and would not have been treated with dispersant.

The US government limited the use of subsea dispersant to a maximum of 15,000 gallons per day during much of the response, even though the estimated volume of oil flowing out of the well varied over time. Using the estimated flow rate and the data available on the daily rate of dispersant applications, the dosage of chemical dispersant (the dispersant to oil ratio or DOR) used in the *Deepwater Horizon* response is estimated to range from at approximately 1:90 to 1:150 or higher on most days. In spite of this variability in application, laboratory studies showed that Corexit 9500 was effective on this type of oil and there was more than sufficient turbulent energy for dispersion.

Hydrocarbon Spill Fate – at Depth

Oil and gas released at the wellhead during the *Deepwater Horizon* spill experienced a unique set of processes following its release in deepwater (e.g., see Camilli et al., 2010; Hazen et al., 2010; Valentine et al., 2010; Kessler et al., 2011). Reddy et al. (2012) indicated that the spill demonstrated the importance of interwoven chemical, physical, and biological processes in regulating the transport and fate of hydrocarbons in the deep marine environment. Reddy et al. (2012) demonstrated that most of the C1-C3 hydrocarbons and a significant fraction of water-soluble aromatic compounds were retained in the deepwater column, whereas relatively insoluble petroleum components were predominantly transported to the sea surface or deposited on the seafloor, although the relative proportions are not known. Reddy et al. (2012) further noted that the resulting apportionments of hydrocarbon transfers to the water column and atmosphere were very different for a deepwater oil spill versus a spill occurring at the ocean surface. During oil spills at the ocean surface, highly water-soluble components (e.g., BTEX, C3-benzenes, and naphthalene) quickly volatilize and are rapidly lost to the atmosphere within hours to days, thereby limiting the extent of aqueous dissolution into the water column. In the case of the *Deepwater Horizon* oil spill, however, gas and oil experienced a significant residence time in the water column with no opportunity for the release of volatile species to the atmosphere. Water-soluble petroleum compounds dissolved into the water column to a much greater extent than is typically observed for surface spills.

Montagna et al. (2013) summarized two different perspectives regarding the fate of the deep-sea plume. Simulation modeling results suggest that the plume followed variable flow paths at different depths (Weisberg et al., 2011). Direct tracking of the plume and observed oxygen anomalies in the water column follow an overall trajectory to the southwest at depths of 1,100 to 1,200 m, consistent with deepwater currents at that depth (Camilli et al., 2010; Kessler et al., 2011). The deep-sea oil plume was as much as 200 m thick and 2 km wide in some locations and provided a potential mechanism for the transfer of released hydrocarbons to reach deep-sea communities (Camilli et al., 2010). During and following the Deepwater Horizon incident, the Joint Analysis Group (JAG) studied subsea oil and dissolved oxygen concentrations, in an effort to track and monitor the subsea oil plume as it travelled, dispersed and degraded over time using various research vessels. The results indicate a fluorometric anomaly strongest near the release site, generally decreasing with distance, and trending primarily southwest to northeast consistent with the water movement along the isobaths. The oxygen signal could not be reliably interpreted from in situ measurements collected during these cruises.

Oil released from the wellhead and retained within the deepwater plume could have been transported to deepwater sediments via multiple pathways that include adsorption of small oil droplets onto suspended particles in marine snow, incorporation into sinking copepod fecal pellets in either surface or subsurface layers, onshore-offshore transport of oil-laden particles, sinking of heavier oil byproducts resulting from the burning of oil, or settling of oil-mud complexes resulting from the injection of drilling muds during top-kill operations (Montagna et al., 2013; Unified Area Command, 2010). Drilling-related materials associated with drilling muds, drilling additives, and other chemicals (e.g., heavy metals such as Ba) were also likely released and deposited on the seafloor during the blowout event.

In summary, hydrocarbons ascending through the water column (or remaining at depth) undergo dissolution (i.e., dissolution of water soluble fractions, including monocyclic aromatic hydrocarbons [MAHs] and polycyclic aromatic hydrocarbons [PAHs]), dispersion, and (for water soluble fractions) dilution. While in the water column, spilled hydrocarbons would be subject to adsorption to suspended particulate matter and degradation. By comparison, a hydrocarbon release at the sea surface would spread across the sea surface, creating a sheen, undergoing weathering, and spreading via dispersion and dissolution.

Hydrocarbon Spill Fate – Sea Surface

Once at the sea surface (for a subsurface release or from a surface release from the rig), each discharge would spread and be subject to various forces, including weathering (i.e., degradation, evaporation), emulsification, and transport processes. The surface area temporarily affected by the elevated hydrocarbon concentrations would depend on the oceanographic conditions (winds, currents, waves) present at the time of the spill. For spills originating at the sea surface (i.e., condensate from the FPSO; fuels from the pipelaying vessel), weathering processing would begin immediately upon release; of particular note, evaporation would play a significant role, where the volatile components of the release would undergo rapid evaporation.

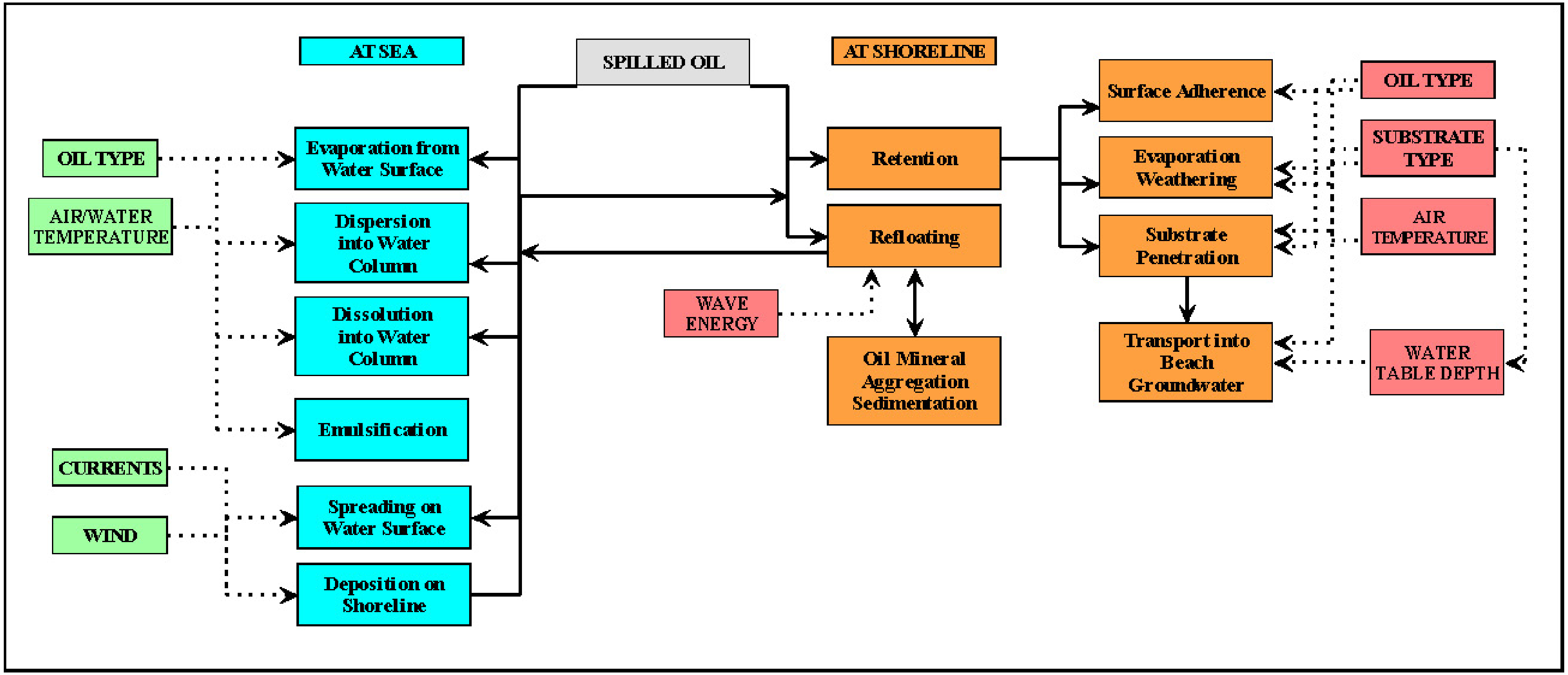
Weathering processes are major controlling factors that affect the toxicity of the release. Rapid evaporation of MAHs (i.e., benzene, toluene, ethylbenzene, and xylenes [BTEX] compounds) and a concomitant decrease in acute toxicity of the water-accommodated fraction was noted by Neff et al. (2000). With weathering processes and the loss of the MAH compounds, they become more important toxicity-determining factors of weathered hydrocarbons. Other factors that may contribute to alterations in toxicity include photodegradation and photoactivation (Neff, 1990; Mallakin et al., 1999; Little et al., 2000).

Etkin et al. (2007) conducted a comprehensive review of case studies, empirical data from past spills, technical literature, and conference proceedings related to the physical and chemical interactions between various oil types and the range of shoreline types that occur in the first 10 to 30 days after shoreline oiling. The following summary has been derived from Etkin et al. (2007) in their analysis and summarization of oil spill fate, identifying factors that affect spilled oil both at sea and after it reaches shore (Figure 7-13).

The behavior of oil when it is initially deposited or stranded on a shoreline is complex and depends on a number of interrelated factors, including as follows:

- The type and characteristics of the oil (e.g., viscosity);
- The thickness of oil already on the shoreline;
- Time until shoreline contact;
- Timing of the spilled oil arrival with regard to tides;
- Shoreline type;
- Weather at the time of and after the spill; and
- Wave energy at the shoreline.

The adhesiveness of oil to shoreline substrates depends on the oil type and its characteristics, especially viscosity. Fresh oils tend to be less adhesive than more weathered oils. Light fuels (e.g., diesel) or volatile distillates (e.g., jet fuel or gasoline) tend to be relatively non-adhesive. Heavier fuels (e.g., intermediate fuel oils or No. 6 fuel oil) tend to be more adhesive than lighter oils. The degree of weathering can have a significant impact on oil viscosity. Evaporation increases viscosity. For example, if 40% of oil (by weight) evaporates, its viscosity can increase as much as a thousand-fold (Fingas, 2001). Oil behavior at the shoreline is also highly dependent on the shoreline characteristics, particularly substrate permeability. Shoreline type is often described by an Environmental Sensitivity Index classification (NOAA, 2010). The degree of penetration into shoreline substrate depends in large part on the permeability of the substrate (Harper et al., 1995).



(From: Etkin et al., 2007)

Figure 7-13. Oil Fate Processes at Sea and at the Shoreline.

Oil penetration would be less on a beach with very fine substrate granules that are packed closely together. Penetration would be greater in a more coarse-grained substrate. If the pores are large and interconnected, the substrate would be more permeable and allow deeper penetration and even lateral movement through capillary action. The pore space, and in turn the permeability, would depend on the size of the granules on the beach.

Bedrock shorelines are largely impermeable to oil, except when the oil is able to enter crevices or fractures in rock surfaces. Gravel beaches tend to have large interconnected pore spaces that would allow oil to readily penetrate. Sand and mud beaches tend to have tightly packed sediments with small pore spaces that are less permeable to oil, though some lighter oils can penetrate. Some shorelines have features that can influence oil retention and penetration that are not related to granule size. Tidal flats often have holes from burrowing animals that would allow oil penetration (Howard and Little, 1987). Oil adhesion can be influenced by the presence of vegetation (e.g., wetlands or mangroves; Michel et al., 1998; Lytle and Lytle, 1987; Baca et al., 1983).

Wave energy at the shoreline can affect the degree of initial deposition and penetration (Humphrey, 1993). The effectiveness of wave energy in removing or re-floating oil is dependent on the permeability of the shoreline substrate and the oil type and weathering condition with respect to adhesiveness. Wave energy can effectively remove oil from a bedrock shoreline where there is little, if any, penetration. Wave action can also cause the shoreline substrate to redistribute itself, as in the case of gravel or sand. This action can affect the degree of oil retention and re-floating.

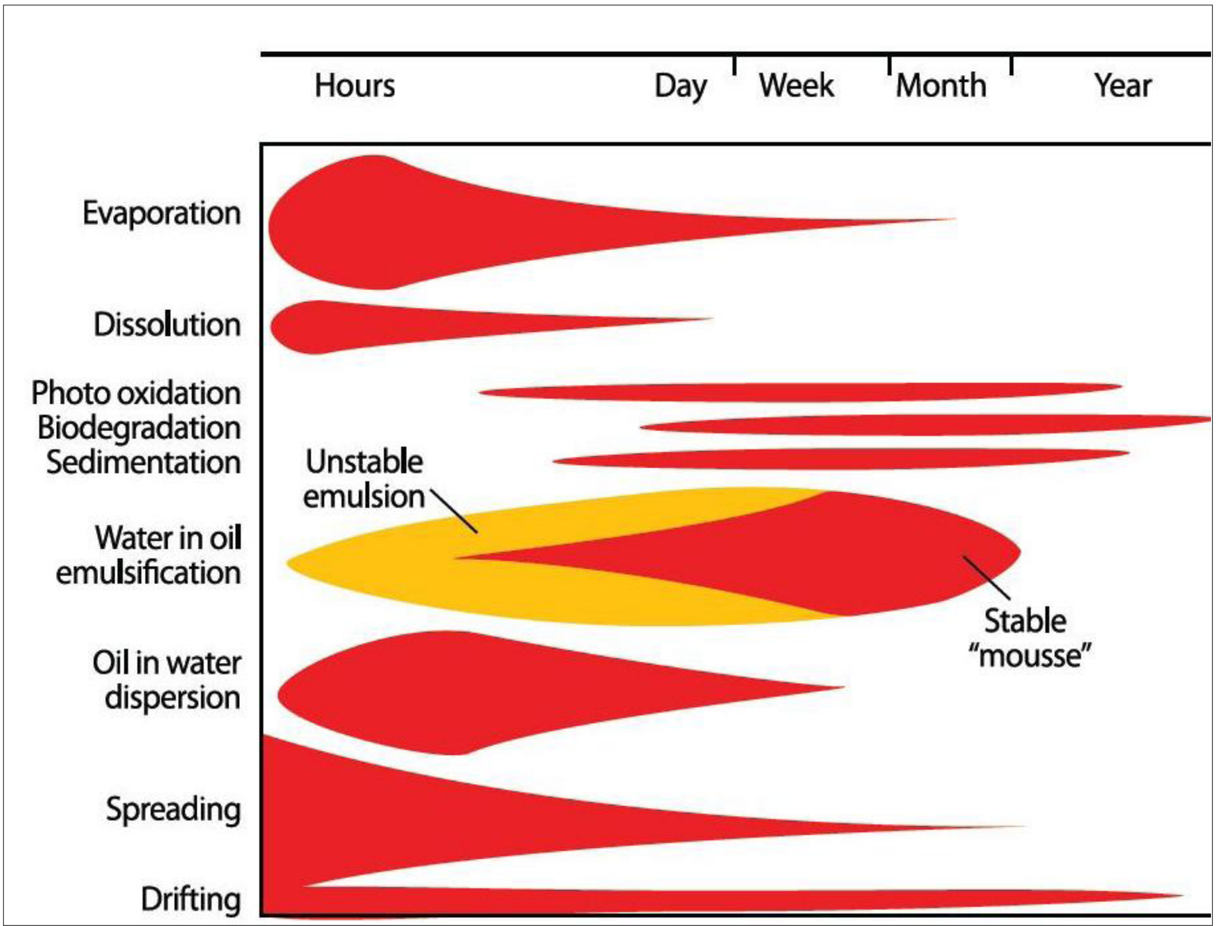
The extent of oiling on the shoreline also depends on the tidal stage at the time of oil deposition. Once stranded, oil would continue to weather, and several additional physical processes become important such as re-flotation, penetration into the substrate, erosion by wave action, and retention/transport in the beach-groundwater system. The interrelated factors and processes that affect the short-term fate (days to weeks) of the stranded oil include the permeability of the substrate (which controls the depth of penetration into sediments); wave energy at the shoreline (which affects re-floating of oil from the surface and erosion of oiled sediments); and air temperature (which influences viscosity and evaporation rates).

Longer term fate (months to years) is controlled by the depth of oil penetration and/or burial, the seasonal wave energy at the shoreline, oil-fines interaction, reworking by biological processes, and microbial degradation. The degree of re-flotation of the oil after stranding would depend on oil type, weathering, wave energy, tidal changes, and degree of penetration. The penetration of the oil into the substrate after initial deposition on the shoreline is, in turn, dependent on a complex set of factors, including oil type, weathering, and characteristics of the substrate, particularly with regard to granular size, and pore size and interconnectivity. High-energy wave action, especially on a highly exposed shoreline, can erode oil from the shoreline and redeposit it into the water, where it may or may not be re-stranded on the shoreline.

On the other hand, oil can remain adhered to shorelines for decades in sheltered coves and beaches. Storms can create unusually high-energy waves that can re-float and remove large amounts of oil that may be stranded even above the high-tide line. Along with the degree and duration of wave energy, the condition of the oil with regard to oil type and degree of weathering, as well as the depth of penetration into the shoreline substrate, would influence the amount of oil that would be eroded during normal wave action or re-floated during storms. Once oil has penetrated the shoreline substrate, it may become incorporated into the groundwater system of the beach. The degree to which oil is retained and/or transported in this system depends on a number of factors, such as the depth of the water table, the depth of oil penetration, the permeability of the shoreline substrate, and the structure of the beach.

Another process in coastal waters that should be considered is oil-mineral aggregation (OMA). Oil near and on shorelines sometimes interacts with fine mineral particles (i.e., fines) that are suspended in the water column near the shoreline and may move onto the shoreline with tidal and wave action. Oil may adhere to these particles and be transferred into the water column and sediment. The oil may then detach and re-float. The process may be dynamic, with the oil alternately adhering and detaching from the particles. The interaction of fine mineral particles with stranded oil in an aqueous medium reduces the adhesion of oil to solid surfaces, such as sediments or bedrock. The net result is the formation of stable, micron-sized oil droplets that can be dispersed into the water column by wave action. In turn, the increase in surface area makes the oil more available for biodegradation. In general, the evidence examined indicates that OMA does not play a significant role in the fate of oil in the early stages after oil deposition on the shoreline. Reed et al. (1988) concluded that the OMA formation process was not important in the surf zone relative to transport processes. OMA may, however, play a role in longer term shoreline processes (Fingas, 2001). It may be very important in areas where there are significant concentrations of fine-grained materials (e.g., river mouths, estuaries, nearshore coastal waters where riverine discharges are deposited).

Over time, the volume of a hydrocarbon spill (e.g., crude oil, diesel fuel, condensate) would be reduced naturally by weathering processes including evaporation, natural dispersion (spreading), dissolution, biodegradation, and photo-oxidation (Figure 7-14).



(From: Arctic Monitoring and Assessment Program, 2007)

Figure 7-14. Fate of Spilled Oil, Important Weathering Processes, and their Time Windows.

Timeframes are not to Scale.

Spill volume may also be reduced as a result of various spill response measures (i.e., use of dispersants, *in situ* burning, and mechanical/manual cleanup) (ITOPF, 2002). Weathering processes also may be impeded by emulsification and sedimentation and sinking.

7.5.1.5 Spill Prevention and Response

The assessment of the risk of accidental spillages is used to identify measures that:

- reduce the possibility of accidental events occurring, i.e. preventive measures (e.g. more reliable Blowout Preventers (BOP), corrosion protection on pipeline, additional barriers);
- reduce the potential size of spills from actual events, i.e. response/source control measures (e.g. subsea isolation valves, well capping and containment solutions); and
- reduce the consequences if accidental events should occur, i.e. mitigating measures (e.g. oil spill preparedness, plan for high-risk activities during seasons or yearly quarters with lower consequence potential).

This section outlines the comprehensive prevention and mitigation measures for deep water drilling.

7.5.1.5.1 Oil Spill Prevention Measures

BP invests significant effort to designing operations and employing procedures that prevent spills from occurring in the first instance and improving the efficacy and speed of clean-up operations should an incident occur. BP and the wider oil industry constantly incorporate new research and lessons learned to improve spill prevention.

In the unlikely event that an oil spill does occur, the industry's primary goal is to minimize the impact of the spill on people, the environment and communities. This is achieved by ensuring a well-planned, rapid and effective response. While specific response objectives will vary depending on the specific circumstances of the spill, the overall goal will be:

- safeguarding the safety and health of people -both of responders and communities;
- stopping the source of the spill as quickly as possible;
- minimizing environmental and community impact; and
- minimizing the risk of oil reaching the shore in offshore scenarios.

BP has standardized global requirements for well design and construction aimed at preventing an oil spill from loss of well control. These include:

- Documented engineering practices and procedures related to well design and construction. A number of these practices and procedures relate specifically to required well control barriers and isolation of any permeable zone;
- Competencies of personnel responsible for well control are defined and assessed;
- Conformance to practices is verified;
- A documented decision approval process and independent review if a deviation is requested; and
- A change management process throughout planning and execution.

A standard global process provides dedicated 'stage gates' during well planning. These act as hold points during the assurance process, where BP internal stakeholders have the right to exercise their decision on the well progressing to the next stage gate and subsequently to execution. Each stage gate has a standard decision support package which must be completed prior to progressing to the next stage.

These global requirements are applied to the design and management of all GTA project drilling operations.

For a drilling campaign, the largest potential spill event is usually a well blow out. During the drilling phase, this is commonly associated with a loss of well control and full bore rupture. During the Operations Phase, a well blow out may arise from a well head failure.

In the well blow-out scenario, oil under high pressure escapes through the well bore to the surface, until the well can be capped or relief wells are drilled and the well is killed. These events are of a very low frequency but often of high consequence, and BP builds its response capability to manage such events, however unlikely.

BP will develop a Source Control Emergency Response Plan (SCERP) to be prepared for the unlikely event of a major accident. This includes provisions for BOP Intervention, Well Capping and Containment and drilling of a relief well.

7.5.1.5.2 Blowout Preventer (BOP) Intervention

BP first response would be to attempt direct intervention measures intended to close in the original BOP. The BOP will be equipped with multiple shear rams to provide additional options to close the BOP.

BP will maintain equipment and capability to perform external intervention on the BOP within the region.

7.5.1.5.3 Well Capping and Containment

BP requires all deep water wells to have detailed well capping plans and relief well plans in place in case primary and secondary well controls fail.

Capping and containment plans outline steps to be taken which seek to reduce the amount of oil spilled into the environment. This plan includes well specific technical response capabilities, and associated personnel, processes, resources and logistical support. The capping and containment plan includes but is not limited to:

- Ability to monitor the seabed and interface well control equipment on the seabed with a Remote Operated Vehicle (ROV);
- Subsea Dispersant Injection from support vessel;
- Seabed Debris Clearance;
- Lower Marine Riser Package removal;
- Well Capping Equipment; and
- Containment Cap Installation.

BP has contributed to the provision of industry capping stacks, and along with other operators in industry, continues to refine and enhance the deployment of capping stacks being developed today.

A number of capping stacks are stored in strategic locations across the globe in Brazil, Norway, Singapore and South Africa. Capping equipment is stored ready for immediate use and onward transportation by sea or air in the event of an incident.

For the GTA project, the current primary BP plan is to access the capping stack stored in Stavanger, Norway, which is a capping stack capable of managing up to 15,000 psi.

If a blowout incident were to occur, BP would immediately commence the transfer of the primary capping stack from Stavanger in accordance with existing and robustly tested mobilization plans.

The capping and containment plan will define the steps for deploying a capping stack to Mauritania/Senegal operations offshore. This plan will address all aspects of the capping response with particular emphasis on:

- Detailed logistics plans to be ready for mobilization;
- GTA project specific interface verifications for different capping scenarios (wellhead, top of lower BOP, top of flex joint adapter);
- Deployment of an ROV from a support vessel;
- Subsea Dispersant Injection Capability; and
- Backup plans for using alternative capping support tools.

BP has conducted engineering and logistics studies to verify that the identified capping devices are compatible with the well design and could be mobilized to the appropriate well location in the event of a loss of primary and secondary well control.

7.5.1.5.4 Relief Well Drilling

All BP wells are required to demonstrate the capability to drill a relief well to stem the flow of hydrocarbon (and kill the well if necessary) as a contingency to the well capping strategy.

Areas addressed within the Relief Well Plan include:

- Organizational capability;
- Field and well data;
- Metocean conditions;
- Dynamic well kill modelling;
- Relief well design;
- Detailed Ranging and Interception strategy; and
- Equipment and relief well rig availability.

The Relief Well Plan contains technical details of how BP would drill relief wells in the event of a blowout. It contains specific details of how rigs, personnel and drilling resources would be mobilized.

7.5.1.5.5 Development of Oil Spill Response Strategies

The preliminary work outlined in the previous sections enables the project to develop spill response strategies which are appropriate for the whole operating envelope of the project. By identifying a range of representative oil spill planning scenarios, BP has been able to plan and prepare for the entire range of oil spill risks that are possible. The planning scenarios chosen have allowed identification of all sensitive environmental and socioeconomic receptors. Response strategies are based on a tiered approach which is accepted industry wide.

Tiered preparedness and response is recognized as the basis on which to establish a robust oil spill preparedness and response framework. The established three-tiered structure allows those involved in contingency planning to describe how an effective response to any oil spill will be provided; from small operational spillages to a worst-case release at sea. The structure provides a mechanism to identify how individual elements of capability will be cascaded. The aim is to provide suitable response resources at the right place at the right time,

Tier 1 capabilities describe the operator's locally held resources used to mitigate spills that are typically operational in nature occurring on or near an operator's own facility.

Tier 2 resources are generally required for incidents greater than Tier 1 in their scale. They include events that could potentially reach beyond the operator's operational area with a wider range of potential impacts. To mount the most effective response, additional support from regional or national tier 2 providers is required. Tier 2 regional assistance includes additional resources obtained through mutual aid agreements, other operators to increase response capacity or to introduce more specialist technical expertise.

Tier 3 resources will be mobilized when the spill complexity and operational response needs exceed the capability of local and regional resources. These resources include specialist manpower and equipment from international sources. The resources held at the three tiers work to complement and enhance the overall capability by enabling seamless escalation according to the requirements of the incident.

The local circumstances will dictate the extent of Tier 2 capability available and therefore inform what the company needs to develop as Tier 1 and what Tier 3 arrangements will need to be put in place.

Figure 7-15 and Table 7-156 indicate the BP approach to the tiered response strategy including the methods of response that may be applied.

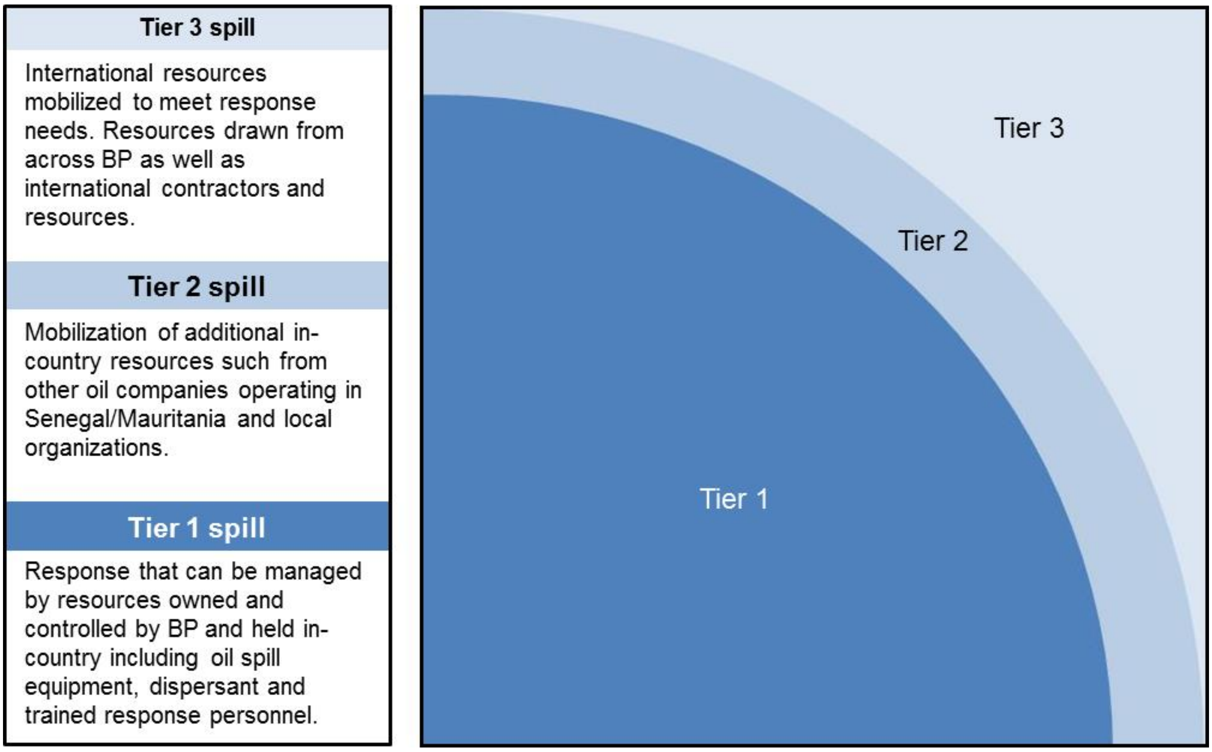


Figure 7-15. BP Tiered Response Strategy.

Table 7-156. BP Response Techniques.

Strategy
Aerial Surveillance
Vessel Dispersant application
Subsea Dispersant application
Offshore Containment & Recovery
Shoreline Protection Booming
Aerial Dispersant application
In-situ Burning
Shoreline Containment & Recovery
Shoreline Clean up
Oiled Wildlife Response

7.5.1.5.6 Spill Response Contingency Plans

Oil spill contingency planning is the process of developing a suitable spill response capability that is in compliance with the regulatory framework and commensurate with the oil spill risks of BP. As part of the overall planning process, an oil spill contingency plan (OSCP) and supporting documents have been developed that provide guidance on how BP will respond to an oil spill of any tier. The OSCP will facilitate an effective and efficient initial response to incidents and will provide the decision-making tools and information needed to organize and support an ongoing or escalating response while adjusting to the realities of changing conditions.

The process for developing and maintaining the plans is cross-functional and fully integrated – the plans are designed to work together in the event of a significant incident, or be used separately on a smaller scale as required.

Figure 7-16 below shows the pieces of the BP approach to oil spill preparedness and response, through the three stages of: (1) Spill Scenario Planning, (2) Response Strategy Planning and (3) Response Implementation and Demonstrating Capability.

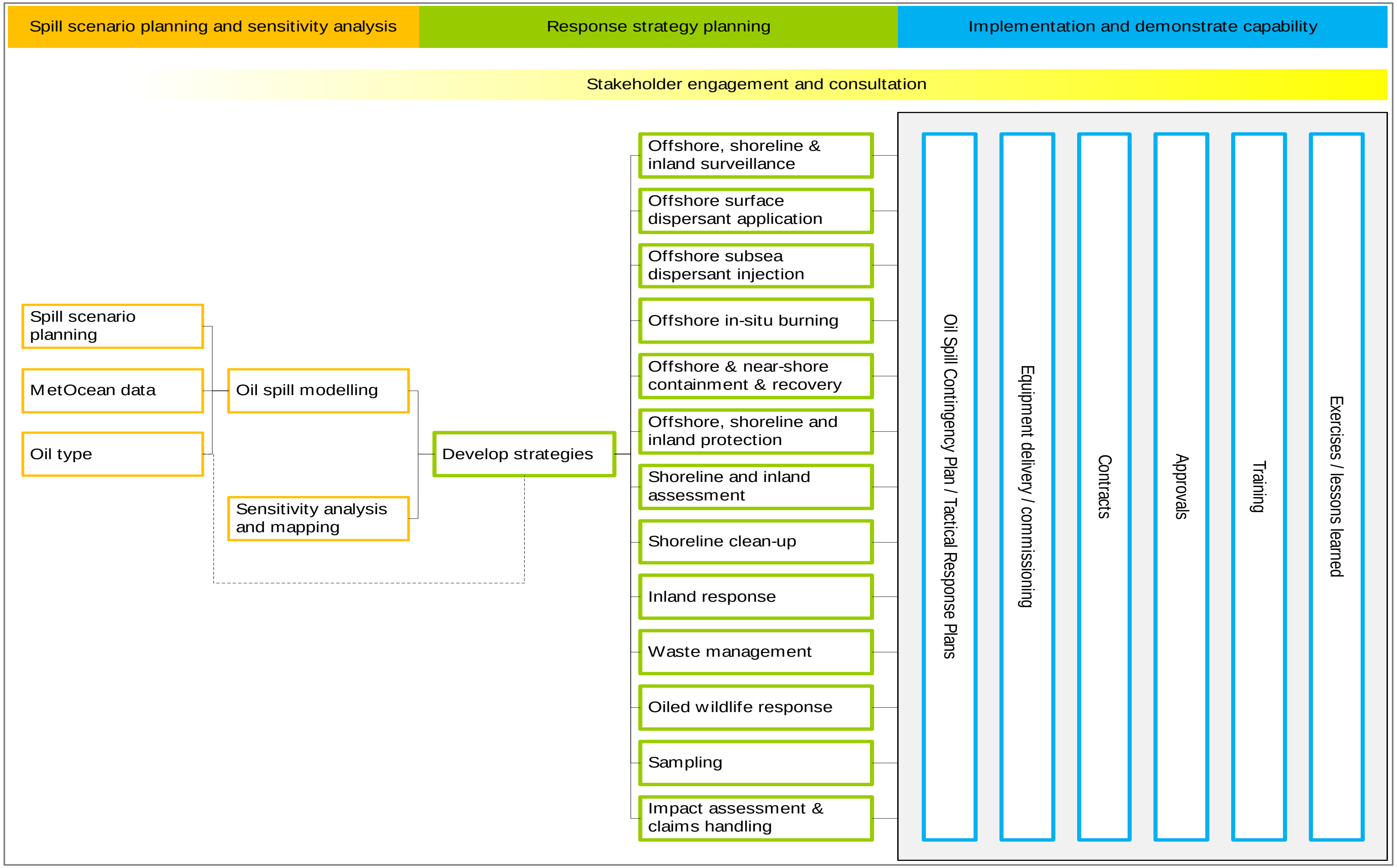


Figure 7-16. BP Approach to Oil Spill Preparedness and Response.

7.5.1.5.7 Response Capability

The three chosen representative oil spill planning scenarios allow a tactical planning framework to be developed, enabling the determination of an overall oil spill response strategy, which will utilize resources as effectively as possible, and provide the most overall and effective response, as described earlier.

A response planning team will be required to ensure this overall response capability is built and ready. Logistical and tactical planning will ensure that the necessary resources are available, and can be supplemented as required. To this end, the response planning team will prepare for the necessary contracts, approvals and access to equipment to be in place if and when an incident where to occur. The process considers the supporting logistics required to mobilize deployment within an appropriate timescale, manage the incident and sustain the operation.

In the case of an emergency situation[154] the project will deploy an Incident Management Team (IMT) which will be located in dual locations; in country, with a small, core team, supported by a larger IMT based in London, UK. All IMTs base their response structure and processes on ICS (Incident Command System). Support to the in-country IMT may be provided via the Country Support Team (also based in country) but can also draw on resources beyond the region, particularly the Mutual Response Team (MRT).

The MRT comprises approximately 100 experienced IMT responders, based in entities around the BP world who are trained and ready to support an incident in any region. For business continuity and other business issues there is a Region Business Support Team based in London, UK, plus support from the Executive Support Team in BP Head Quarters should the situation require. Figure 7-17 below illustrates the organizational structure and capabilities.

[154] When an incident of a serious and urgent nature is ongoing demanding immediate action to bring it under control or it could escalate to injury to persons, environment or asset damage.

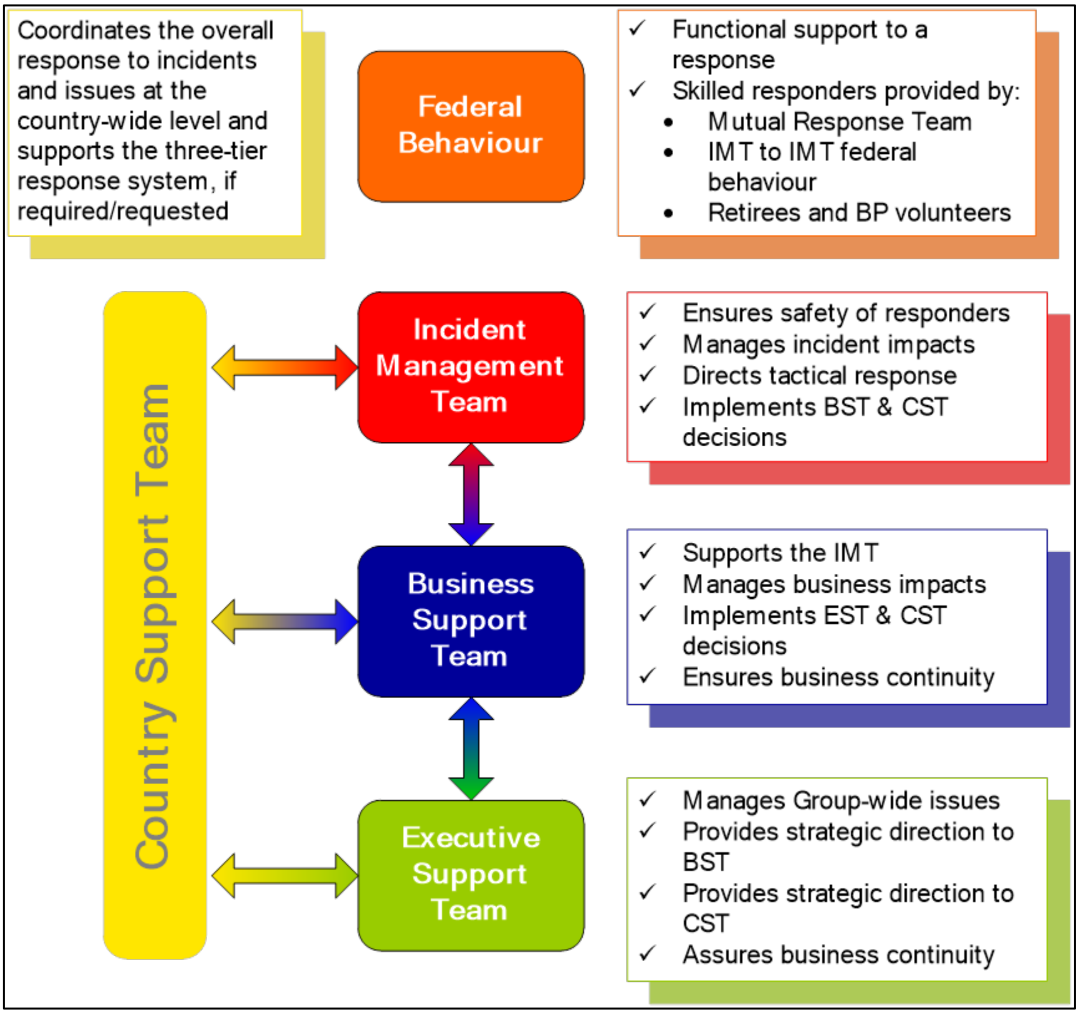


Figure 7-17. Incident Management Team Diagram.

Availability of dispersant and dispersant application systems, surveillance and shoreline protection and clean-up resources are included in BPs Tier 3 response capability contracts. The BP OSRL contract allows access to 50% of their stockpile of the global spill response equipment, and access to 5,000 m^3 of dispersants located at strategic locations worldwide, Timescales for mobilization of such resources would be dependent upon in country customs protocols.

7.5.1.5.8 Demonstrating Readiness - Oil Spill Preparedness and Response Verification and Assurance

Maintaining a team of trained personnel is a cornerstone of operation. Tests and drills are conducted to verify their competency. Regular training is set up to prepare responders for a well control event.

Oil spill exercises are also regularly organized in accordance with the Oil Spill Contingency Plan. This includes simulation exercises to test different aspects of preparedness, build familiarity and ensure competence.

As part of capacity building and engagement efforts, BP will work with regulators and other stakeholders to establish clear understanding of the relationship between BP and national response agencies and partners for incident response through training and exercises.

Lessons learned and corrective actions are generated and tracked to closure from both verification and assurance and tests and drills to enable continuous improvement and rectification of identified issues.

7.5.2 Air Quality and Greenhouse Gases

High Level Summary

In this section on Air Quality and GHG, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. All impacts on Air Quality and GHG from Accidental Events were assessed as of negligible significance. No mitigation measures were required.

7.5.2.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

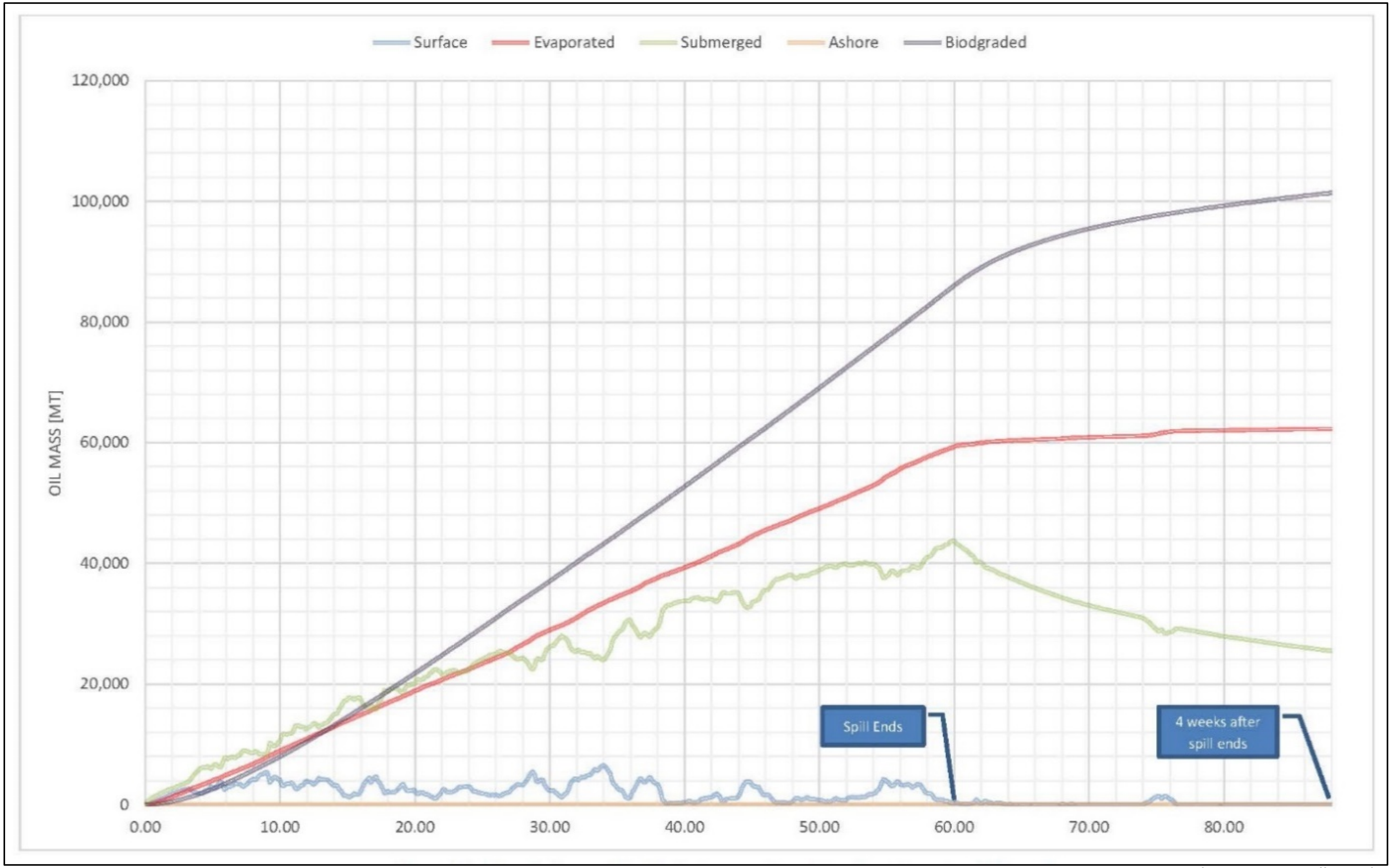
7.5.2.2 Impact Description

The accidental events, as described in Section 7.5.1, would introduce large volumes of contaminant materials into the receiving environment of the project areas. Whether the release of hydrocarbons occurs at depth (blowout) or at the sea surface (FPSO failure due to a ship collision, pipelaying vessel collision), weathering processes would begin immediately. One of these processes, evaporation, would introduce volatile components of the release into the atmosphere. The following subsections explain how these accidental event IPFs would produce impacts to air quality.

Well Blowout

An uncontrolled subsurface release of condensate and associated gas from the Offshore Area would affect air quality in the vicinity of the release once it reaches the sea surface by introducing methane and VOCs through evaporation. The rate of evaporation of spilled hydrocarbons is dictated by chemical composition; more importantly, the initial fate of deepwater oil and gas mixtures is determined by the solubility and volatility of individual hydrocarbon compounds (Ryerson et al., 2011). The condensate plume resulting from wellhead failure contains more than 60% of the lighter hydrocarbon compounds (C15 or less), including C1-C4 gases, C5-C10 saturates, benzenes, phenols, naphthalenes, and aromatics. Several of these compounds are water soluble and would disperse in the water column. Hydrocarbons containing carbon chains exceeding 15 (C15+) do not readily evaporate (see Appendix N-1).

In general, the evaporation of spilled hydrocarbons is greatest within the first several days following a spill and the more toxic, light aromatic and aliphatic hydrocarbons are lost rapidly by evaporation and dissolution. In the case of a continuous subsurface release (e.g., blowout), the evaporative loss would begin as the spill reaches the sea surface and would continue as long as condensate reaches the sea surface. Mass balance data (Appendix N-1) indicate that evaporative loss from a blowout occurring in the Offshore Area would occur at a nearly constant rate until the spill ends (Figure 7-18).



(From: Appendix N 1)

Figure 7-18. Mass Balance for a Well Blowout in the Offshore Area.

Ryerson et al. (2011) observed significant atmospheric increases at and downwind of the *Deepwater Horizon* spill site, primarily attributed to evaporation of C2 through C11 hydrocarbons; narrow plumes (~2 km wide at 10 km distance) were observed extending downwind of the spill site, while no elevations of VOCs were measured upwind. Measurements of organic aerosols suggested that an additional portion of spill-related semi-volatile hydrocarbons (i.e., >C11) were evaporating over a 10 to 100-hour time scale after surfacing (de Gouw et al., 2011).

Evaporated hydrocarbons in the lower atmosphere are degraded rapidly by sunlight. Biodegradation of crude oil on the water surface and in the water column by marine bacteria and fungi initially removes the n-alkanes and subsequently the light aromatics. Other components are biodegraded more slowly (Hazen et al., 2016). Photo-oxidation attacks mainly the medium and high molecular weight PAHs of a crude oil spill.

The extent and persistence of impacts to air quality would depend on meteorological and oceanographic conditions at the time of the release as well as its duration. Impacts to air quality in the offshore environment would be concentrated in the vicinity of the release location, within the Offshore Area and downwind of the release site (i.e., outer reaches of the Pipeline Area). Significant increases in both primary and secondary aerosols would be expected resulting from evaporation of the condensate.

If *in situ* burning is feasible and implemented, local air quality impacts offshore would be expected, with increases in ambient particulates (black carbon). Minor to moderate effects on air quality are expected in the vicinity of the Offshore Area, with lower effects predicted in closer proximity to shore. Along those coastal segments where higher concentrations are expected, condensate coming ashore would have undergone extensive weathering (i.e., several days to several weeks). As a result of weathering, the most volatile components of the oil are expected to be significantly reduced and subsequently limiting the potential for significant air quality impacts.

Socolofsky et al. (2016) noted that limited measurements made within 5 km of the wellhead demonstrated that there was near complete dissolution of methane, significant dissolution of small hydrocarbon molecules (Ryerson et al., 2011), and near complete oxidation of methane in the water column (Du and Kessler, 2012). The dissolution and oxidation of methane in the water column indicates that low levels of greenhouse gas (GHG) emissions from the *Deepwater Horizon* incident initially reached the ocean surface.

For the condensate spill at depth, methane represents only a small portion of the release at the wellhead; the C1-C4 gases (i.e., C1 represents methane) comprise only 2% of the spill (Appendix N-1). With expected dissolution and oxidation of available methane within the water column during release at the wellhead and ascent, the amount of GHG reaching the ocean surface would be extremely small. There is also the possibility that methane released at depth may form hydrates (NRC, 2003b).

The chemical composition of the condensate (see Appendix N-1) indicates that it is comprised of a combination of very volatile organic compounds (VVOC), volatile organic compounds (VOC), semivolatile organic compounds (SVOC), plus methane and ethane which are not considered as VOCs. In general, these may be defined as follows:

- VVOCs: including C1-C4 gases (exclusive of methane and ethane); C5-saturates; C6-saturates; Benzene; and C7-saturates;
- VOCs: C1-benzene; C8-saturates; C2-benzene; C9-saturates; C3-benzene; C10-saturates; C4-benzene; C11-C12 (total saturates + aromatics); Phenols; Naphthalenes (C0-C1 alkylated); and C13-C14 (total saturates + aromatics);
- SVOCs: Naphthalenes 2 (C2-C3 alkylated); C15-C16 (total saturates + aromatics); C17-C18 (total saturates + aromatics); C19-C20 (total saturates + aromatics); C21-C25 (total saturates + aromatics); PAH 1 (low soluble polyaromatic hydrocarbons); PAH 2 (low soluble polyaromatic hydrocarbons); and C25+ (total).

Per Appendix N-1, condensate contains 19% VVOCs, 39% VOCs, and 42% SVOCs.

Little or no effect on air quality in coastal areas would be expected due to the distance of the Offshore Area from shore, the degree of atmospheric evaporation and dispersion expected, and the time necessary for the spill to reach shore. Based on the stochastic simulations, a spill originating from the Offshore Area would have a 96% probability of shoreline contact (light oiling or higher) if the spill happens in boreal Summer and a 33% chance of shoreline contact if it occurs in boreal Winter.

Spill modeling results indicate that under the worst-case spill scenario (Appendix N-1), oil would take approximately 4 days to reach shore in boreal Summer. However, there would be a 50% chance that condensate would not make landfall within approximately 2 weeks; in the best-case scenario, condensate would not reach shore for 8.5 weeks.

During boreal Winter under the worst-case scenario, a spill may affect the shore in approximately 5 days after the release. However, there would be a 50% chance that condensate would not make landfall within approximately 7 weeks; in the best-case scenario, condensate would not reach shore.

Given these probabilities, a spill reaching shore would have undergone considerable weathering, with volatile components evaporating quickly following the release. Dispersion and dilution would also act to reduce the amount of oil reaching shore.

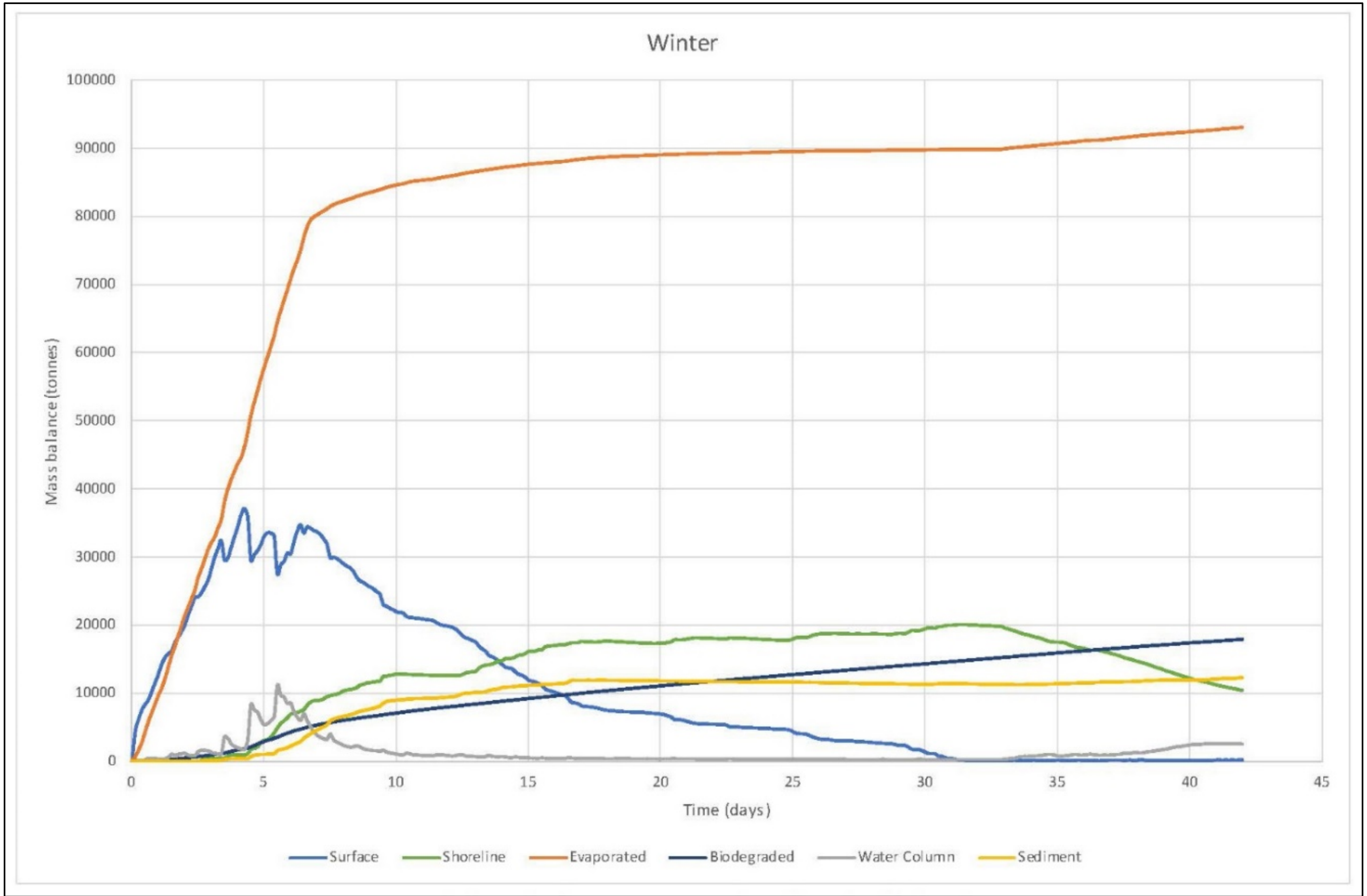
Failure of FPSO Due to a Ship Collision

As previously described in Section 7.5.1, the failure of FPSO accidental event scenario includes the catastrophic sea surface release of condensate and MDO from the FPSO due to a ship collision. As noted previously, the evaporation of spilled hydrocarbons would be greatest within the first several days following a spill and the more toxic, light aromatic and aliphatic hydrocarbons are lost rapidly by evaporation and dissolution.

The physical characteristics and short-term fate of condensate have been discussed previously (e.g., >60% composition of lighter hydrocarbon compounds, C15 or less; relatively high dispersibility in seawater).

MDO is a blend of MGO (marine gas oil, a distillate fuel oil) and heavy fuel oil (HFO), although the specific gravity of the fuel is relatively light (0.843). NRC (2003b) summarized the general fate of hydrocarbons in the marine environment, including light distillates (e.g., diesel fuel, No. 2 fuel oil, MGO, jet fuel, kerosene). Light distillates are narrow-cut fractions that have low viscosity and spread rapidly into thin sheens; they do not form emulsions except under very cold conditions. NRC (2003b) indicated that light distillates exhibit a medium level of horizontal transport (i.e., evaporation), showing moderate and incomplete evaporation compared to lighter fuel products (e.g., gasoline). Light distillates tend to disperse readily into the water column with minimal surface agitation (e.g., light wave action), giving them a high potential for vertical mixing and greater potential for dissolution of surface sheens and droplets. Water soluble fractions are moderately volatile. Light distillates possess light to intermediate molecular weight constituents and can be readily degraded by aerobic microbial degradation. Long-term persistence in sediments would be greatest under heavy loading and reducing conditions, where biodegradation rates for anaerobic bacteria are low (NRC, 2003b). MDOs would readily disperse in the open ocean environment, but are characterized as having high aquatic toxicity due to their relatively high naphthalenes content (Environment Canada, 2006).

In the case of an instantaneous surface release (e.g., FPSO failure due to a ship collision in the Pipeline Area), modeling results indicated that the most significant evaporative loss would occur during the first 7-10 days (Figure 7-19), although evaporative loss would continue at a decreased rate until the end of the modeling simulation (40 days).



(From: Appendix N-1)

Figure 7-19. Mass Balance for an FPSO Failure Due to a Ship Collision in the Pipeline Area in Boreal Winter.

Methane, as a GHG, represents only a small portion of the carbon compounds present in the condensate and MDO, and released as result of FPSO failure due to a ship collision. C1-C4 gases contribute <0.03% to the MDO and 2% to the condensate (Appendix N-1). While C1-C4 gases released to the ocean surface as part of the condensate/MDO spill would readily disperse into the atmosphere, only a small volume of GHG would be released.

Adverse effects on air quality in coastal areas would be expected due to the proximity of the FPSO to shore (40 km), the limited amount of atmospheric evaporation and dispersion expected prior to landfall, and the relatively short time necessary for the spill to reach shore. Based on the stochastic simulations, a spill originating from the Pipeline Area would have a 100% probability of making shoreline impact (light oiling or higher) if the spill happens in boreal Summer and an 82% chance of shoreline impact if it occurs in boreal Winter.

Spill modeling results indicate that under the worst-case spill scenario (Appendix N-1), oil would take approximately 1-1/2 days to reach shore in boreal Summer. However, there would be a 10% chance that condensate and MDO would not make landfall within 4 days; in the best-cast scenario, condensate and MDO would not reach shore for 8 days.

During boreal Winter under the worst-case scenario, a spill may impact the shore in more than 2 days after the release. However, there would be a 50% chance that condensate and MDO would not make landfall within approximately 5 days; in the best-case scenario, condensate and MDO would not reach shore.

Spill modeling results provide predictive estimates of spilled hydrocarbons from an FPSO failure due to a ship collision reaching shore, or total (entrained) or dissolved in the water column. Modeling results also provide a mass balance of spill fate. Spilled hydrocarbons reaching shore would continue to release volatile and semivolatile components into the atmosphere, potentially affecting local air quality. The available amounts of these components entering the atmosphere along the shoreline have not been quantified, aside for total amounts that may reach shore; the percentage of volatile and semivolatile components remaining once spilled hydrocarbons reach shore would be dependent upon how long weathering processes have been acting on the spill.

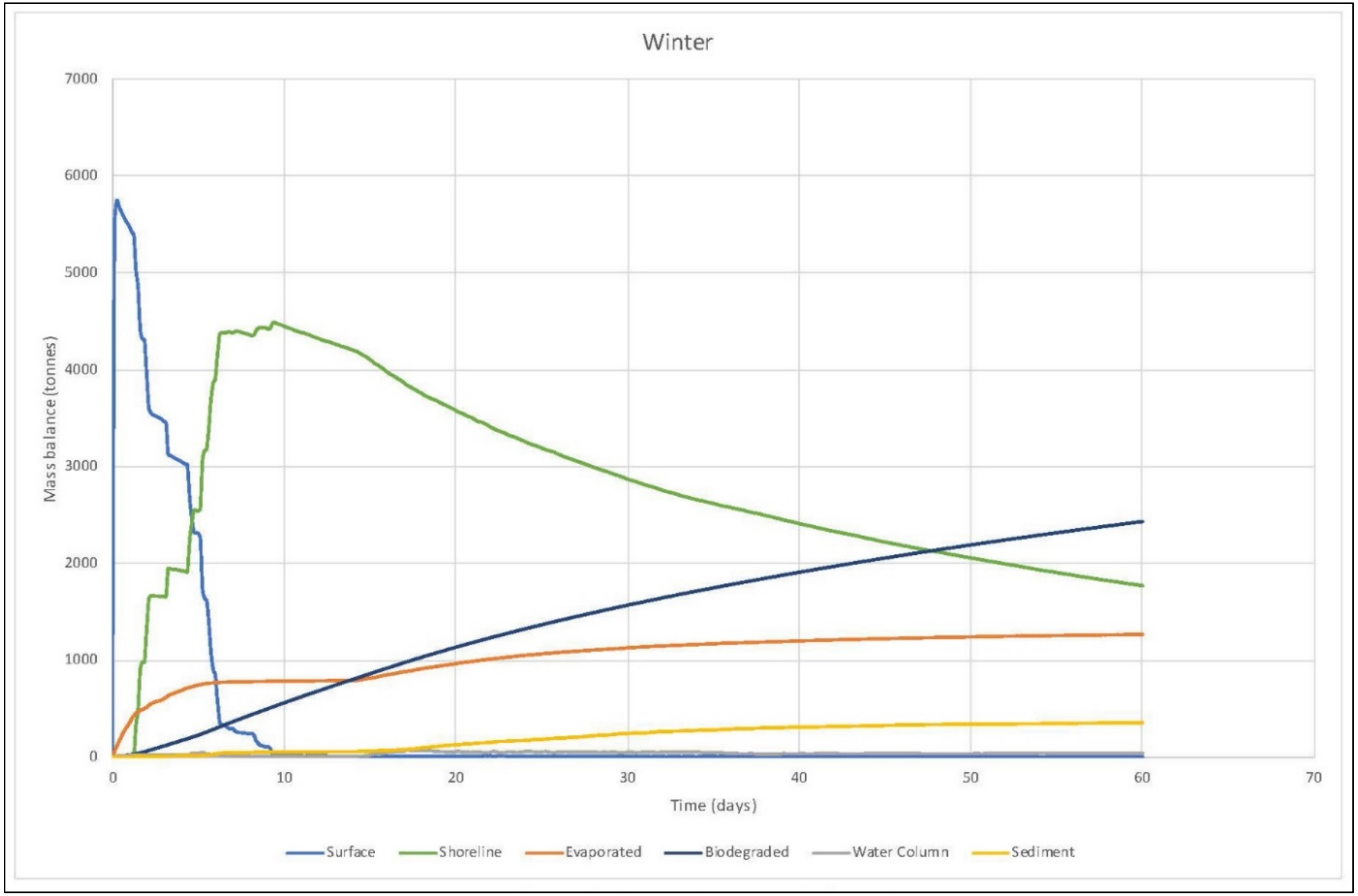
Pipelaying Vessel Collision

As previously described in Section 7.5.1, the collision of the pipelaying vessel and subsequent vessel loss would result in the sea surface rapid release of relatively large quantities of MDO, HFO, and lubricating oil. Spill trajectories for MDO, HFO and lubricating oil released from a sunken pipelaying vessel were developed for an incident within the Nearshore Hub/Terminal Area.

MDO would readily disperse in the open ocean environment, but is characterized as having high aquatic toxicity due to its relatively high naphthalenes content (Environment Canada, 2006). HFO, with its heavier, more stable components, would be more persistent to weathering processes.

Methane, as a GHG, represents only a small portion of the fuel and lubricating oil released at the Nearshore Hub/Terminal. C1-C4 gases contribute <0.03%, 0.00%, and 1.41% to the MDO, HFO, and lubricating oil, respectively (Appendix N-1). While C1-C4 gases reaching the ocean surface would readily disperse into the atmosphere, only a small volume of GHG would be released due to these low percentages.

In the case of an instantaneous surface release (e.g., loss of fuels and lubricant oil at the Nearshore Hub/Terminal Area), modeling results indicated that the most significant evaporative loss would occur during the first 5 days (Figure 7-20), although evaporative loss would continue at a decreased rate until the end of the modeling simulation (60 days).



(From: Appendix N-1)

Figure 7-20. Mass Balance for a Pipelaying Vessel Collision in the Nearshore Hub/Terminal Area during Boreal Winter.

As noted previously, spill modeling results provide predictive estimates of spilled hydrocarbons from a pipelaying vessel collision reaching shore, or total (entrained) or dissolved in the water column. Modeling results also provide a mass balance of spill fate (Figure 7-18). Spilled hydrocarbons reaching shore would continue to release volatile and semivolatile components into the atmosphere, potentially affecting local air quality. The available amounts of these components entering the atmosphere along the shoreline have not been quantified, aside for total amounts that may reach shore; the percentage of volatile and semivolatile components remaining once spilled hydrocarbons reach shore would be dependent upon how long weathering processes have been acting on the spill.

Adverse effects on air quality in coastal areas would be expected due to the close proximity of the Hub to shore (~10 km), the limited amount of atmospheric evaporation and dispersion expected prior to landfall, and the relatively short time necessary for the spill to reach shore. Based on the stochastic simulations, a spill originating from the Hub would have a 100% probability of making shoreline impact (light oiling or higher), regardless of season.

Spill modeling results indicate that under the worst-case spill scenario (Appendix N-1), oil would take approximately 2 days to reach shore in boreal Summer. The volume of the spill reaching shore in boreal Summer would vary between 1,500 and 4,500 metric tonnes. During boreal Winter under the worst-case scenario, a spill may impact the shore in ~1 day after the release. The volume of the spill reaching shore varies between several metric tonnes to more than 4,500 metric tonnes.

7.5.2.3 Impact Rating

Well Blowout

The consequence of impacts to air quality from a well blowout event include elevated levels of methane and VOCs in the atmosphere for the duration of the spill, with highest concentrations at and downwind (i.e., predominantly towards the east and southeast) of the release site. With the exception of the Offshore Area, the impact intensity of the well blowout to air quality would be low (small adverse changes unlikely to be noticed or measurable against background levels); in the Offshore Area, at and downwind of the spill location, moderate intensity impacts to air quality may be expected. With a regional extent and short-term duration, impact consequence at the Offshore Area would be minor; along the coast, impact consequence would be negligible. Given the remote likelihood of the blowout, overall impact significance is expected to be 1 – Negligible in the Offshore Area, the Nearshore Area and along the coast (see Table 7-157 below for details on selected criteria).

The release of GHG into the atmosphere from a blowout would be extremely small, as most methane would be dissolved or oxidized in the water column. Impact intensity for GHG release would be low, with a local spatial extent and short-term duration, resulting in a negligible impact consequence. Given the remote likelihood of the blowout, overall impact significance is expected to be 1 – Negligible (see Table 7-157 below for details on selected criteria).

Failure of FPSO Due to a Ship Collision

The failure of FPSO due to a ship collision event with sea surface release of condensate and MDO would have the potential for adversely affecting air quality. At the FPSO, impact intensity to air quality would be moderate; at the Nearshore Area and along the coast, impact intensity would be low. With a regional extent and short-term duration, impact consequence at the Pipeline Area/FPSO would be minor; along the coast, impact consequence would be negligible. Given the remote likelihood of this accidental event, overall impact significance is expected to be 1 – Negligible in the Pipeline Area, the Nearshore Area and along the coast (see Table 7-157 below for details on selected criteria).

The release of GHG into the atmosphere from an FPSO failure due to a ship collision would be extremely small, due to the low level of C1-C4 gases in the spilled condensate. Impact intensity for GHG release would be low, with a local spatial extent and short-term duration, resulting in a negligible impact consequence. Given the remote likelihood of this accidental event, overall impact significance is expected to be 1 – Negligible (see Table 7-157 below for details on selected criteria).

Pipelaying Vessel Collision

Vessel collision with sea surface rapid release of MDO, HFO, and lubricating oil would likely affect local air quality. At the Nearshore Hub/Terminal Area and adjacent coastal areas, impact intensity to air quality would be moderate. With a regional extent and short-term duration, impact consequence would be minor. Given the remote likelihood of pipelaying vessel collision, overall impact significance is expected to be 1 – Negligible (see Table 7-157 below for details on selected criteria).

The release of GHG into the atmosphere from a pipelaying vessel collision would be extremely small, due to the low level of C1-C4 gases in the spilled MDO, HFO, and lubricating oil. Impact intensity for GHG release would be low, with a local spatial extent and short-term duration, resulting in a negligible impact consequence. Given the remote likelihood of this accidental event, overall impact significance is expected to be 1 – Negligible (see Table 7-157 below for details on selected criteria).

Summary

A summary of impact to air quality from accidental events is presented in Table 7-157.

Table 7-157. Impacts to Air Quality and Greenhouse Gases from Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout					
Mauritania Senegal	Decreased air quality at/near the spill site due to introduction of VOCs.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 – Negligible
Mauritania Senegal	Decreased onshore air quality due to introduction of VOCs.	Nature: Negative Intensity: Low Spatial Extent: Regional Duration: Short term	Negligible	Remote	1 – Negligible
Mauritania Senegal	Release of GHG from a blowout.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Remote	1 – Negligible
Failure of FPSO Due to a Ship Collision					
Mauritania Senegal	Decreased air quality at/near the spill site due to introduction of VOCs.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 – Negligible
Mauritania Senegal	Decreased onshore air quality due to introduction of VOCs.	Nature: Negative Intensity: Low Spatial Extent: Regional Duration: Short term	Negligible	Remote	1 – Negligible
Mauritania Senegal	Release of GHG from an FPSO failure due to a ship collision.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Remote	1 – Negligible
Pipelaying Vessel Collision					
Mauritania Senegal	Decreased air quality at/near the spill site and onshore due to introduction of VOCs.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 – Negligible

Country	Impact	Criteria	Consequence	Likelihood	Significance
Mauritania Senegal	Release of GHG from a pipelaying vessel collision.	Nature: Negative Intensity: Low Spatial Extent: Local Duration: Short term	Negligible	Remote	1 – Negligible

7.5.2.4 Mitigation Measures and Residual Impacts

Impacts to air quality and greenhouse gases from accidental events are rated 1 – Negligible; no mitigation measures are required.

Summary of existing mitigation and monitoring measures inherent to design and operational controls:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea X-mas trees), other well control barriers and isolation of any permeable zone.
- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.
- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.
- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.
- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.
- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.

- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.
- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.
- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.
- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Despite the impact being ranked as negligible, the following mitigation measure will be implemented:

- M112: In the unlikely event of a spill of high intensity, specific monitoring (e.g., environmental effects monitoring) may be required and developed in consultation with applicable national authorities.

7.5.3 Water Quality

High Level Summary

In this section on Water Quality, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. The residual impacts on Water Quality from Accidental Events were assessed as of low significance when mitigation measures are applied.

7.5.3.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.3.2 Impact Description

The accidental events, as described in Section 7.5.1, would introduce large volumes of contaminant materials into the receiving environment of the project areas. Whether the release of hydrocarbons occurs at depth (during a well blowout scenario) or at the sea surface (during FPSO failure due to a ship collision or pipelaying vessel collision scenarios), weathering processes would begin immediately. Two of these processes, dispersion and dissolution, would introduce volatile components of the release into the water column. Several other weathering processes – biodegradation, emulsification, and sedimentation/sinking – would contribute to the removal of hydrocarbons from the water column. The following subsections explain how these accidental event IPFs could produce impacts to water quality, based on stochastic modeling results detailed in Appendix N-1.

Well Blowout

A subsurface release of condensate and associated gas would affect marine water quality by increasing hydrocarbon concentrations due to dissolved components and small oil droplets. For condensate released at the wellhead, a portion of the plume would likely remain at depth, undergoing dispersion and natural biodegradation; this phenomenon was noted in the *Deepwater Horizon* incident. Hazen et al. (2010) studied the impacts and fate of deepwater oil releases. Initial studies suggested that the potential exists for rapid intrinsic bioremediation (bacterial degradation) of subsea dispersed oil in the water column by deep sea indigenous microbial activity without significant oxygen depletion (Hazen et al., 2010), although other studies have shown that oil bioremediation caused oxygen drawdown in deep waters (Kessler et al., 2011, Dubansky et al., 2013). Bioremediative capacity and whether or not microbial degradation leads to hypoxia may results in multiple effects to water quality – via removal of hydrocarbons (or select hydrocarbons) from the water column, and via changes in oxygen concentration.

Additional studies investigated the effects of deepwater dissolved hydrocarbon gases (e.g., methane, propane, and ethane) and the microbial response to a deepwater oil spill. Results suggest deepwater dissolved hydrocarbon gases may promote rapid hydrocarbon respiration by low-diversity bacterial blooms, thus priming indigenous bacterial populations for rapid hydrocarbon degradation of subsea oil (Kessler et al., 2011, Du and Kessler, 2012, Valentine et al., 2014). Liu et al. (2017) identified water temperature, taxonomic composition of the initial bacterial community, and dissolved nutrient levels as factors that may regulate oil degradation rates by deep-sea indigenous microbes.

Formation of a deepwater plume containing oil droplets and dissolved gases was also documented by several researchers studying the *Deepwater Horizon* spill. For example, Reddy et al. (2011) determined, via field sampling, that most of the C1-C3 hydrocarbons and a significant fraction of water-soluble aromatic compounds were retained in the deep water column, while the relatively insoluble petroleum components were predominantly transported to the sea surface or deposited on the seafloor, although the relative proportions are not known. Socolofsky et al. (2016) noted that limited measurements made within 5 km of the wellhead confirmed the strong plume behavior of the oil and gas plume, and demonstrated that there was near complete dissolution of methane, significant dissolution of small hydrocarbon molecules (Ryerson et al., 2011), and near complete oxidation of methane in the water column (Du and Kessler, 2012).

With a subsurface release, condensate released at depth and reaching the sea surface would undergo natural weathering processes as it passes through the water column during ascent. Portions of the crude oil release remaining on the surface would undergo dispersion, remain on the sea surface, or be transported to shore. For oil reaching the sea surface, the water soluble fractions would disperse into surface waters; non-soluble fractions and heavier components would remain on or immediately below the sea surface, and would be subject to weathering processes and biodegradation.

Mass balance estimates of condensate remaining in the water column are presented in Appendix N-1. Based on model predictions, no condensate remained on the ocean surface after 82 days. A total of 13% of the total hydrocarbon release from the wellhead was dispersed in the water column following the blowout. Model results also predict that dissolved concentrations of condensate in the water column would drop below the threshold level of 6 ppb after approximately 11 days, while total concentrations of condensate are expected to drop below the threshold level of 70 ppb after approximately 15 days.

Appendix N-1 outlines the bases for these thresholds: 6 ppb (dissolved) represents the low level, in-water dissolved hydrocarbon threshold established by French et al. (1999) and French-McCay (2002, 2003), which showed that species sensitivity (i.e., fish, invertebrates) to dissolved aromatics in a standard toxicity test (i.e., mortality to 50% of the test organisms, LC50) under different environmental conditions varied between 6 and 400 ppb (mean: 50 ppb). This range covered 95% of aquatic organisms tested, which included species during sensitive life stages (i.e., eggs and larvae). A 6 ppb exposure level is not considered to be of significant biological impact and corresponds to a low level exposure to dissolved hydrocarbon in the water column. The 70-ppb total entrained hydrocarbon exposure level corresponds to the OSPAR predicted no effect concentration (PNEC).

By comparison, French (2000) estimated that a condensate concentration (in seawater) of 1,000 ppb produced mortality to 50% of the test organisms (i.e., LC50). INPEX (2010) determined that condensate concentrations of 270 ppb produced no observable acute toxicity effects in fish larvae (i.e., no observed effect concentration, NOEC), the latter of which was the most sensitive test species evaluated. Other LC50 determinations include 500 to 600 ppb (Tsvetnenko, 1998), 1,500 ppb for the water soluble fraction (Woodside, 1997), and 109,000 ppb for whole condensate (Woodside, 1997), all of which utilized reservoir-specific condensate samples with varying levels of BTEX and other hydrocarbon species.

Conservative thresholds of 50 ppb and 400 ppb are considered to be indicative of potentially harmful exposure to fixed habitats over short exposure durations (French-McCay, 2002), with each concentration potentially affecting a different percentage of biota. For example, French-McCay (2002) indicates that an average 96-hour LC50 of 50 ppb could serve as an acute lethal threshold to 5% of biota. Similarly, an average 96-hour LC50 of 400 ppb could serve as an acute lethal threshold to 50% of biota. The key considerations associated with these water column hydrocarbon concentrations include: 1) diminished water quality would be realized via the introduction of hydrocarbons (i.e., condensate, fuel oils, lubricating oil) under different spill scenarios; and 2) effects on biota will result from elevated hydrocarbon exposures, with the severity of biota impact dependent upon water column concentrations and duration of exposure. For the purposes of this water quality impact assessment, hydrocarbon water column concentrations, the spatial distribution of spilled hydrocarbons, and their persistence in the environment are assessed. Impacts to various marine resources (biota) and protected areas or areas of conservation interest are addressed in each respective section.

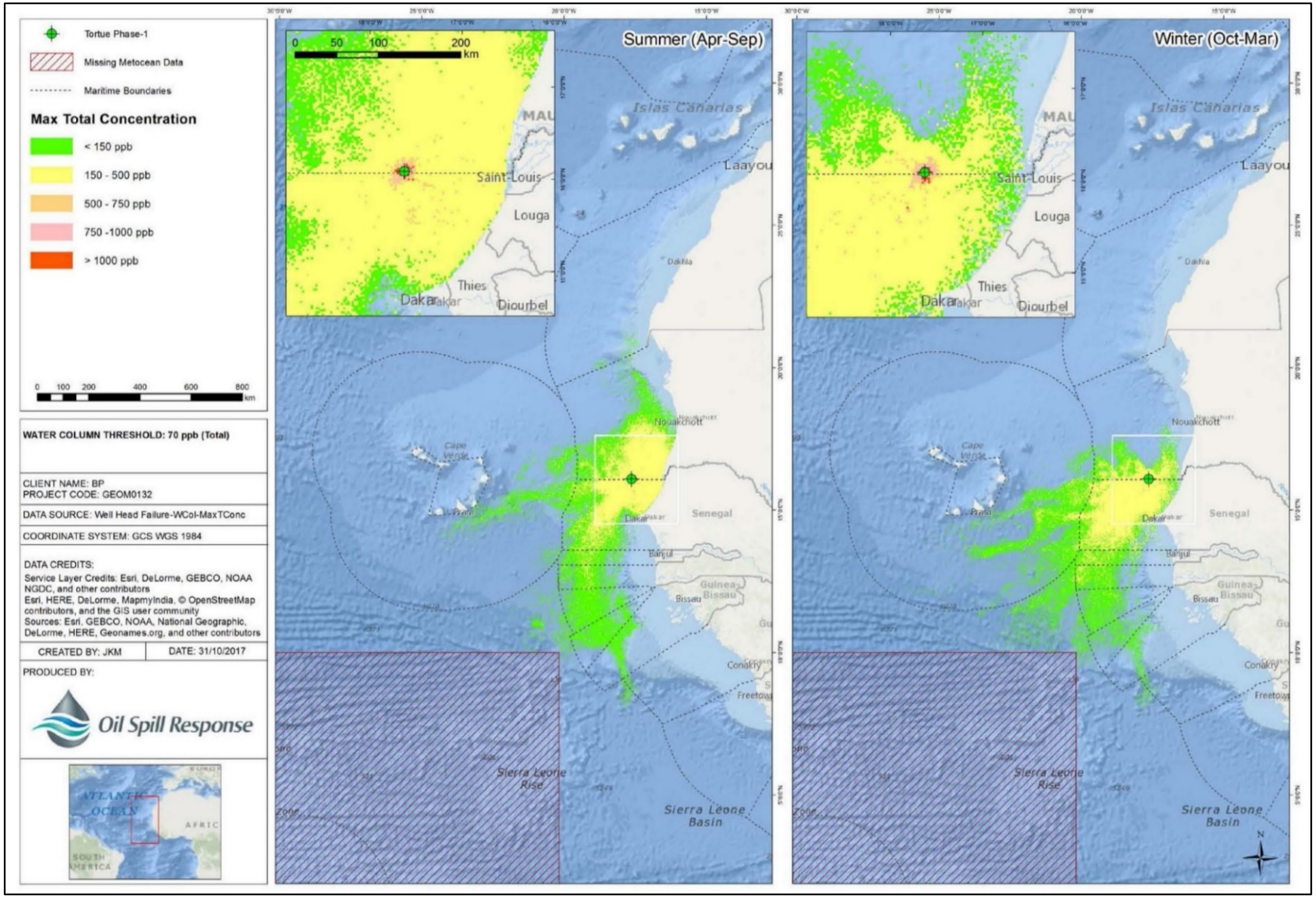
Impacts to water quality in the Offshore Area would be concentrated in the vicinity of the spill location as the water-soluble fractions and volatile components are dissolved and dispersed in the water column as they ascend from the wellhead. Heavier fractions may be subject to mousse or tarball formation and surface transport. Condensate in the water column, depicted as total hydrocarbon concentrations in the water column reflecting stochastic modeling results (Appendix N-1), would be transported both towards shore and parallel to the Mauritania and Senegal coastline (Figure 7-21), with potential effects to water quality in the Pipeline and Nearshore Hub/Terminal Areas. Water column concentrations of total hydrocarbons are predicted to be predominantly in the <150 ppb and 150 to 500 ppb range in boreal Summer and Winter, although the distribution of total water column hydrocarbons would be more extensive in boreal Summer. Higher concentrations are evident in proximity to the release, where total water column concentrations of 500 to 750 ppb are found within 20 to 25 km of the wellhead; patchy occurrences greater than 1,000 ppb are also predicted by the model at the same general spatial scale (Figure 7-21).

Results of the stochastic modeling indicate that maximum concentrations of dissolved condensate in the water column (Figure 7-22) would be more localized, with only minor expansion of the plume towards shore (i.e., the dissolved condensate plume generally moves parallel to the Mauritania and Senegal coastline). Water column concentrations of dissolved hydrocarbons are predicted to be predominantly in the <50 ppb and 50 to 400 ppb range in boreal Summer and Winter; only minor seasonal differences in the distribution of dissolved water column hydrocarbons are evident. Highest concentrations are evident in proximity to the release, where dissolved water column concentrations of greater than 400 ppb are found within ~15 to 20 km of the wellhead (Figure 7-22). Dissolved hydrocarbons would affect water quality in the Offshore Area, with limited potential for effects in the Pipeline and Nearshore Hub/Terminal Areas.

The physical presence of a large surface slick resulting from a blowout may also cause physico-chemical changes to marine water quality – e.g., lower oxygen levels, reduced light levels. While these changes may be of minor importance to water quality, there may be potential effects on marine fauna and flora, as discussed in subsequent resource-specific sections. The extent that these physico-chemical changes may affect other biophysical resources would be dependent upon prevailing metocean conditions and the effectiveness of any spill response measures.

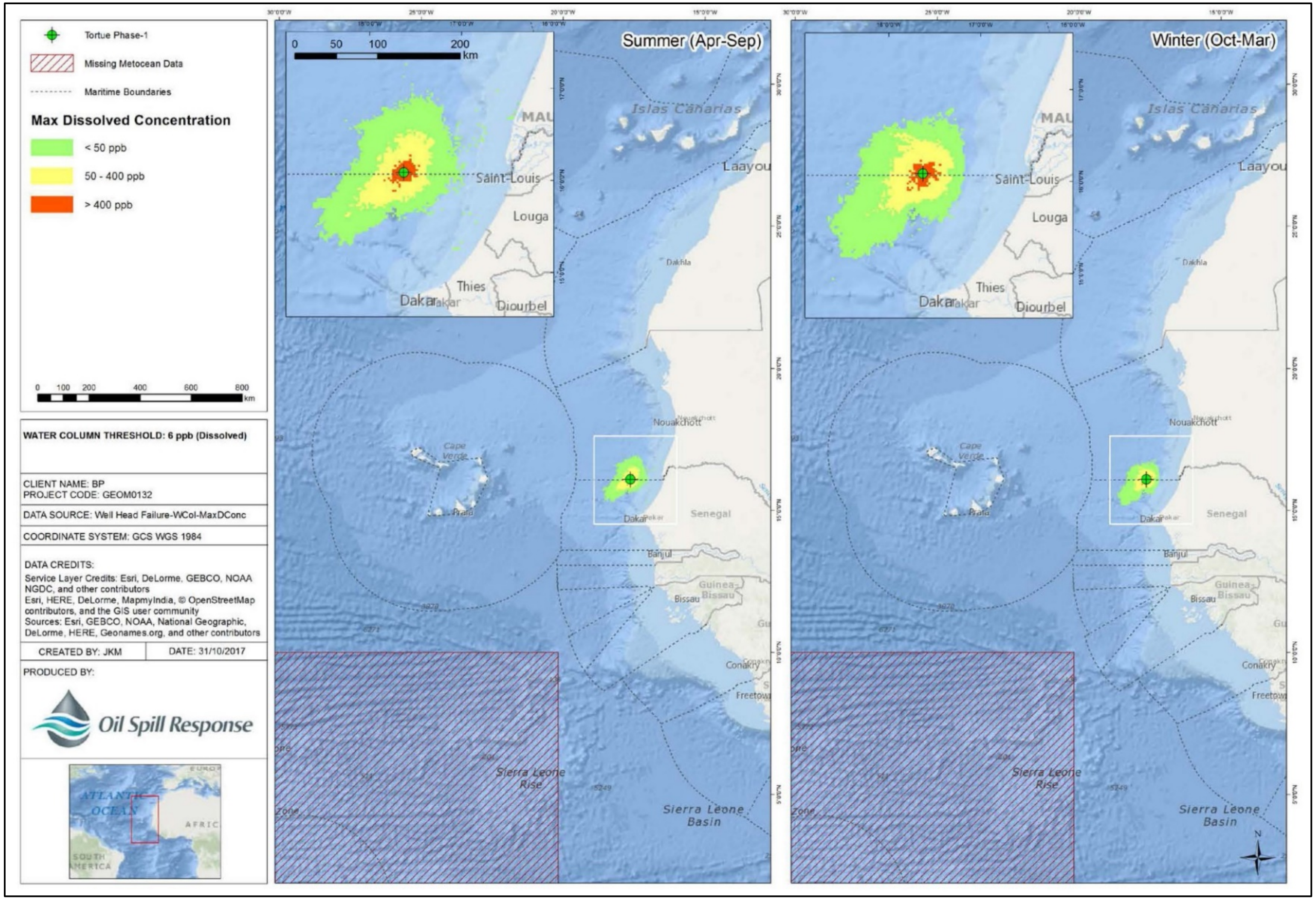
In terms of surface concentrations of condensate, modeling results indicate that both Mauritania and Senegal waters would be affected by a blowout. The thickness of the condensate spill would be limited to mostly sheen and rainbow sheen that would more readily disperse. A small amount of metallic sheen (>5 μm thickness) may be found at the sea surface in the local area around the well (~25 km).

The extent and persistence of impacts on water quality would depend on meteorological and oceanographic conditions at the time of the spill. Condensate within the water column has been modeled based on both dissolved and total (entrained) hydrocarbon concentrations. Dissolved hydrocarbons in the water column, in general, would remain offshore; total hydrocarbons in the water column would be more widespread, and may be expected to reach coastal waters. Condensate on the sea surface would be limited to sheen and rainbow sheen thicknesses, except within ~25 km of the wellhead where metallic sheen may be realized. Offshore waters are likely to realize decreased water quality from both dissolved and total hydrocarbons in the water column, and surface hydrocarbons. Predictive modeling results indicate that reduced water quality in the Pipeline or Nearshore Hub/Terminal Areas, or along the coastline, may result from total water column hydrocarbons and surface oiling, the latter of which would occur in minimal thicknesses.



(From: Appendix N-1)

Figure 7-21. Maximum Total Hydrocarbon Concentrations in the Water Column, by Season, for a Well Blowout.



(From: Appendix N-1)

Figure 7-22. Maximum Dissolved Hydrocarbon Concentrations in the Water Column, by Season, for a Well Blowout.

Failure of FPSO Due to a Ship Collision

As previously described in Section 7.5.1, the failure of FPSO accidental event scenario includes the catastrophic sea surface release of condensate and MDO from the FPSO due to a ship collision.

Impacts to water quality in the Pipeline Area would be concentrated in the vicinity of the surface spill location as the water-soluble fractions and volatile components are weathered. Weathering processes acting on the surface spill would include dissolution and dispersion. Heavier fractions may be subject to mousse or tarball formation and surface transport.

Condensate and MDO in the water column, depicted as total hydrocarbon concentrations in the water column reflecting stochastic modeling results (Appendix N-1), would be transported offshore, towards shore, and north and south of the spill location (Figure 7-23), with potential effects to water quality in the Pipeline and Nearshore Hub/Terminal Areas. Water column concentrations of total hydrocarbons are predicted to be predominantly in the <150 ppb and 150 to 500 ppb range in boreal Summer and Winter, although the distribution of total water column hydrocarbons would be seasonally distinct. Higher concentrations are evident in proximity to the release, and north and south of the release, where total water column concentrations of 500 to 750 ppb and 750 to 1,000 ppb are evident. Patchy occurrences greater than 1,000 ppb are also predicted by the model (Figure 7-23).

Results of the stochastic modeling indicate that maximum concentrations of dissolved condensate and MDO in the water column (Figure 7-24) exhibit a similar pattern to total hydrocarbons. Water column concentrations of dissolved hydrocarbons are predicted to be predominantly in the <50 ppb and 50 to 400 ppb range in boreal Summer and Winter. Highest concentrations are evident in proximity to the release, where dissolved water column concentrations of greater than 400 ppb are generally found within several kilometers of the FPSO (Figure 7-24). Dissolved hydrocarbons from an FPSO failure due to a ship collision spill would affect water quality in the Pipeline and Nearshore Hub/Terminal Areas.

The physical presence of a surface slick resulting from FPSO failure due to a ship collision may also cause physico-chemical changes to marine water quality, as noted previously (e.g., lower oxygen levels, reduced light levels). The extent that these physico-chemical changes may affect other biophysical resources would be dependent upon prevailing metocean conditions and the effectiveness of any spill response measures.

In terms of surface concentrations of condensate and MDO, modeling results indicate that both Mauritania and Senegal waters would be affected. The thickness of the FPSO spill would be comprised of both discontinuous true color (50 to 200 µm thickness) and continuous true color (>200 µm thickness).

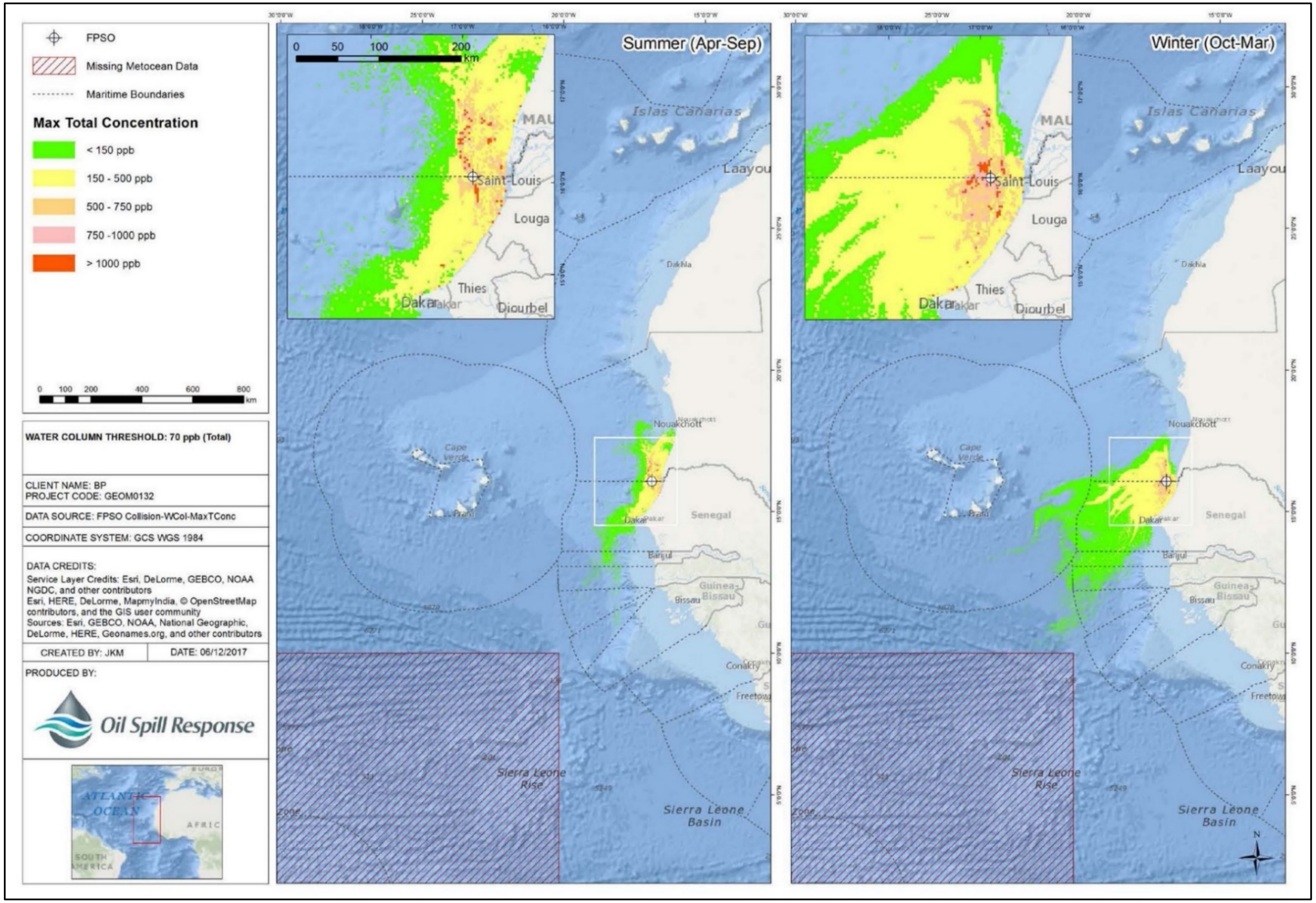
The extent and persistence of impacts on water quality would depend on meteorological and oceanographic conditions at the time of the spill. Condensate and MDO within the water column have been modeled based on both dissolved and total (entrained) hydrocarbon concentrations. Dissolved hydrocarbons and total hydrocarbons in the water column would be widespread, and are expected to reach coastal waters. Condensate and MDO on the sea surface would be both discontinuous true color (50 to 200 µm thickness) and continuous true color (>200 µm thickness). All project area waters are likely to realize decreased water quality from both dissolved and total hydrocarbons in the water column, and surface hydrocarbons. Predictive modeling results indicate that reduced water quality in all project areas, or along the coastline, may result from total water column hydrocarbons and surface oiling, the latter of which would occur in moderate thicknesses near shore.

Failure of FPSO Due to a Ship Collision and Potential Impacts to the Senegal River Estuary

A separate analysis was also conducted to provide a semi-quantitative determination of spills potentially entering the lower Senegal River estuary[155] (see Section 7.5.1). The failure of the FPSO due to a ship collision provided the worst case accidental event scenario for hydrocarbons entering the estuary, based on comparisons to other accidental event scenarios (i.e., highest hydrocarbon levels at and near the Senegal River mouth were noted in association with the condensate and MDO accidental release from the FPSO). The worst case scenario would be a release due to FPSO failure caused by a ship collision during boreal Summer. Table 7-158 provides estimated total (entrained) and dissolved hydrocarbon concentrations at various locations within the estuary, based on probabilities (i.e., using results of the stochastic scenarios and establishing boundary conditions at the Senegal River mouth).

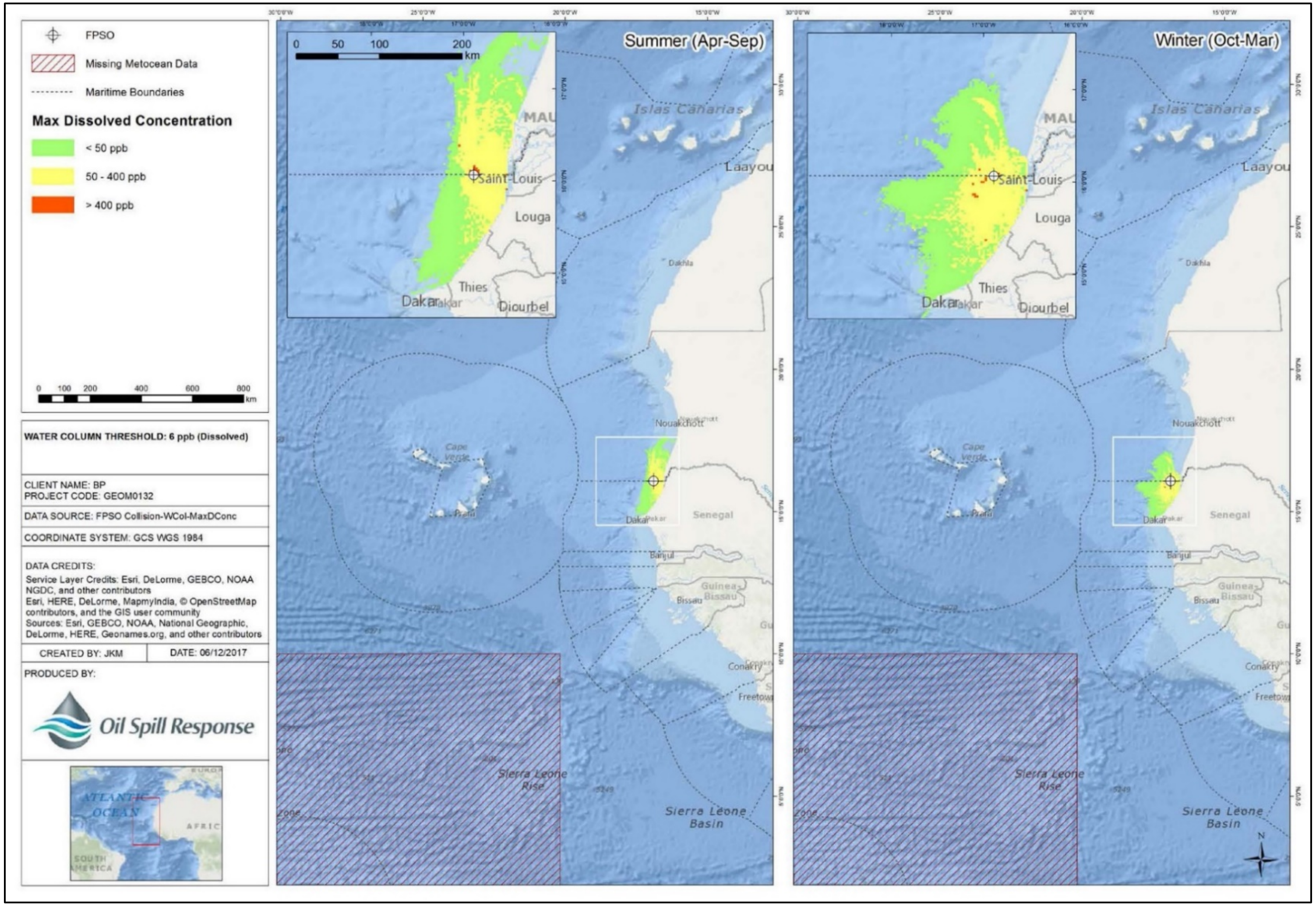
A complete table showing all probabilities is provided in Appendix N-1, concurrently with the assumptions explicit with the Senegal River estuary exercise. Key assumptions and limitations of the Senegal River modeling, in summary, include: 1) the worst case release (i.e., failure of the FPSO) is a highly improbable worst-case event with no spill response mitigation measures put into effect; 2) limitations (i.e., variability) of nearshore, coastal metocean data employed in the modeling; and 3) limitations on available spill models to account for the complex hydrodynamic environment at and near the Senegal River mouth.

[155] The oil spill model data created as part of the oil spill modeling studies for the Well Blowout, Failure of FPSO due to a Ship Collision, and Pipelaying Vessel Collision were filtered to represent the area surrounding the mouth of the Senegal River. To mitigate for several modeling assumptions, all data within 10 km of the river mouth was considered representative of the river mouth. The worst-case scenario for the Senegal River, represented by the failure of the FPSO due to a ship collision during boreal Summer, provided the basis for this aspect of the impact analysis.



(From: Appendix N-1)

Figure 7-23. Maximum Total Hydrocarbon Concentrations in the Water Column, by Season, for a Failure of FPSO Due to a Ship Collision.



(From: Appendix N-1)

Figure 7-24. Maximum Dissolved Hydrocarbon Concentrations in the Water Column, by Season, for a Failure of FPSO Due to a Ship Collision.

Table 7-158. Summary of Maximum Dissolved and Total (Entrained) Hydrocarbon Concentrations (ppb) at Select Locations within the Senegal River Estuary.

Location	Probability 5%	Probability 10%	Probability 25%
Maximum Dissolved Concentration (ppb)			
River Mouth	420	250	195
Saint-Louis	356	212	165
Ile aux Bois South	318	189	148
Ile aux Bois North	267	159	124
Dakar Bango Dam	229	136	106
Diama Dam	0	0	0
Maximum Total (Entrained) Concentration (ppb)			
River Mouth	950	750	600
Saint-Louis	806	636	509
Ile aux Bois South	720	568	455
Ile aux Bois North	605	477	382
Dakar Bango Dam	518	409	327
Diama Dam	0	0	0

(From: Appendix N-1)

Table 7-159 presents the probabilities of a spill reaching the river mouth at certain peak concentrations. For example, modeling results indicate that 5% of the spills where dissolved oil reaches the river mouth have maximum dissolved concentrations of 420 ppb. In 10% and 25% of the spill simulations, dissolved hydrocarbons concentrations reached 250 ppb and 195 ppb, respectively. Dissolved and total (entrained) hydrocarbon concentrations diminish with increasing distance from the river mouth.

Pipelaying Vessel Collision

As previously described in Section 7.5.1, the collision of the pipelaying vessel and subsequent vessel loss would result in the sea surface rapid release of relatively large quantities of MDO, HFO, and lubricating oil. Spill trajectories for MDO, HFO and lubricating oil released from a sunken pipelaying vessel were developed for an incident within the Nearshore Hub/Terminal Area (Appendix N-1).

Impacts to water quality in the Nearshore Hub/Terminal Area would be concentrated in the vicinity of the surface spill location as the water-soluble fractions and volatile components are weathered. Weathering processes acting on the surface spill of MDO, HFO, and lubricating oil would include primarily evaporation, with limited amounts of dissolution and dispersion.

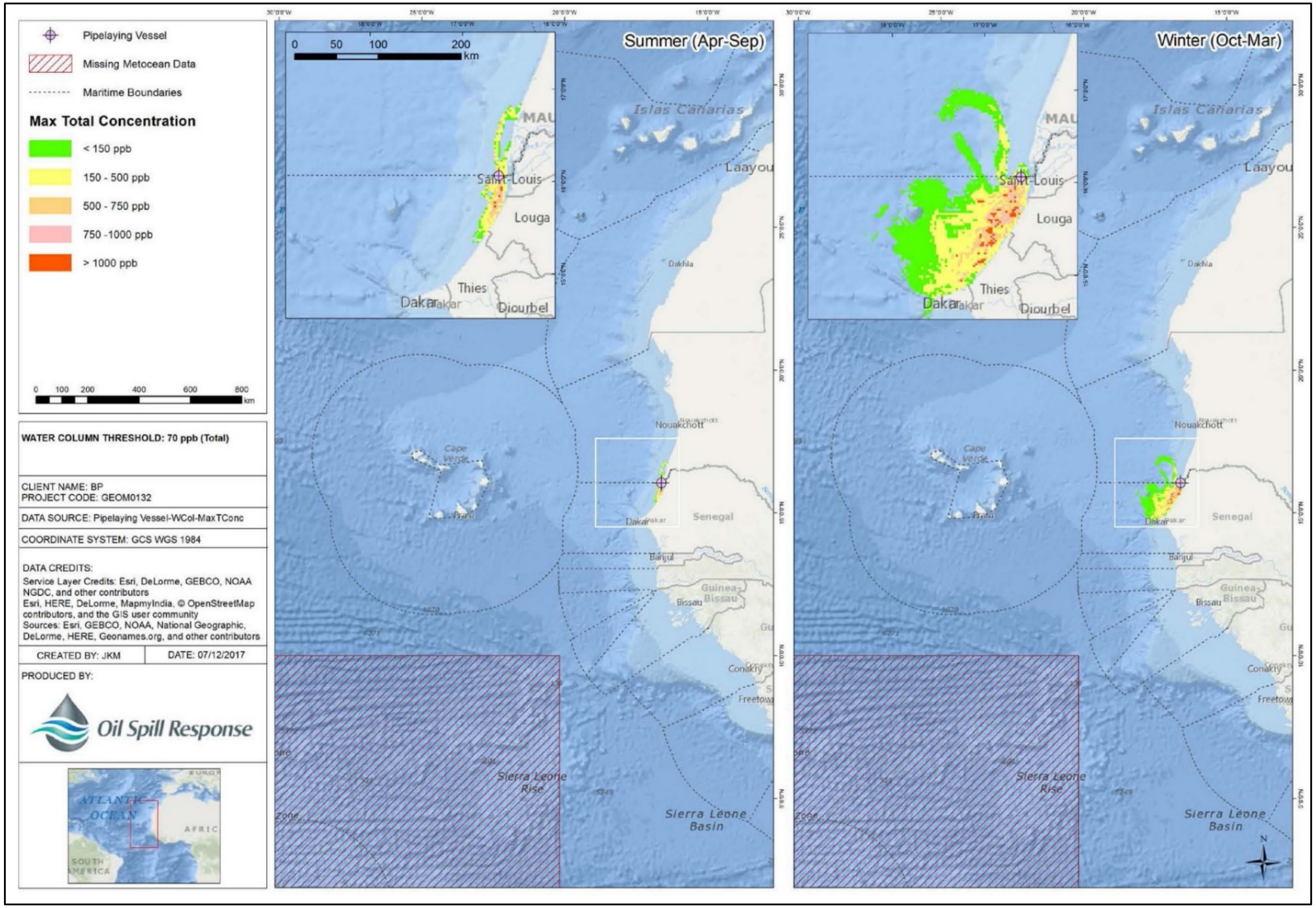
Fuel and lubricating oil in the water column, depicted as total hydrocarbon concentrations in the water column reflecting stochastic modeling results (Appendix N-1), would be transported towards shore, and generally south of the spill location; minor amounts of transport northward into Mauritania waters may also be realized (Figure 7-25). Potential effects to water quality are expected in Nearshore Hub/Terminal Area and along the coastline both northward and southward. Offshore water quality may also be affected, as spilled materials would be transported into the Pipeline and Offshore Areas. Water column concentrations of total hydrocarbons are predicted to be predominantly in the <150 ppb and 150 to 500 ppb range in boreal Summer and Winter, although the distribution of total water column hydrocarbons would be seasonally distinct (i.e., more widespread distribution in boreal Winter). Higher concentrations are evident in proximity to the release, and north and south of the release, where total water column concentrations of 500 to 750 ppb and 75 to 1,000 ppb are evident. Patchy occurrences of concentrations greater than 1,000 ppb are also predicted by the model (Figure 7-25).

Results of the stochastic modeling indicate that maximum concentrations of dissolved fuel and lubricating oil in the water column (Figure 7-26) exhibit a similar pattern to total hydrocarbons. Water column concentrations of dissolved hydrocarbons are predicted to be predominantly in the <50 ppb and 50 to 400 ppb range in boreal Summer and Winter. Highest concentrations are evident in proximity to the release, where dissolved water column concentrations of greater than 400 ppb are generally found near the Nearshore Hub/Terminal and intermittently to the south of the Hub facility (Figure 7-26). Dissolved hydrocarbons from a pipelaying vessel collision and subsequent spill would affect water quality in the Nearshore Hub/Terminal Area and along the coast, with limited transport offshore into the Pipeline and Offshore Areas.

The physical presence of a surface slick resulting from a pipelaying vessel collision failure may also cause physico-chemical changes to marine water quality, as noted previously (e.g., lower oxygen levels, reduced light levels). The extent that these physico-chemical changes may affect other biophysical resources would be dependent upon prevailing metocean conditions and the effectiveness of any spill response measures.

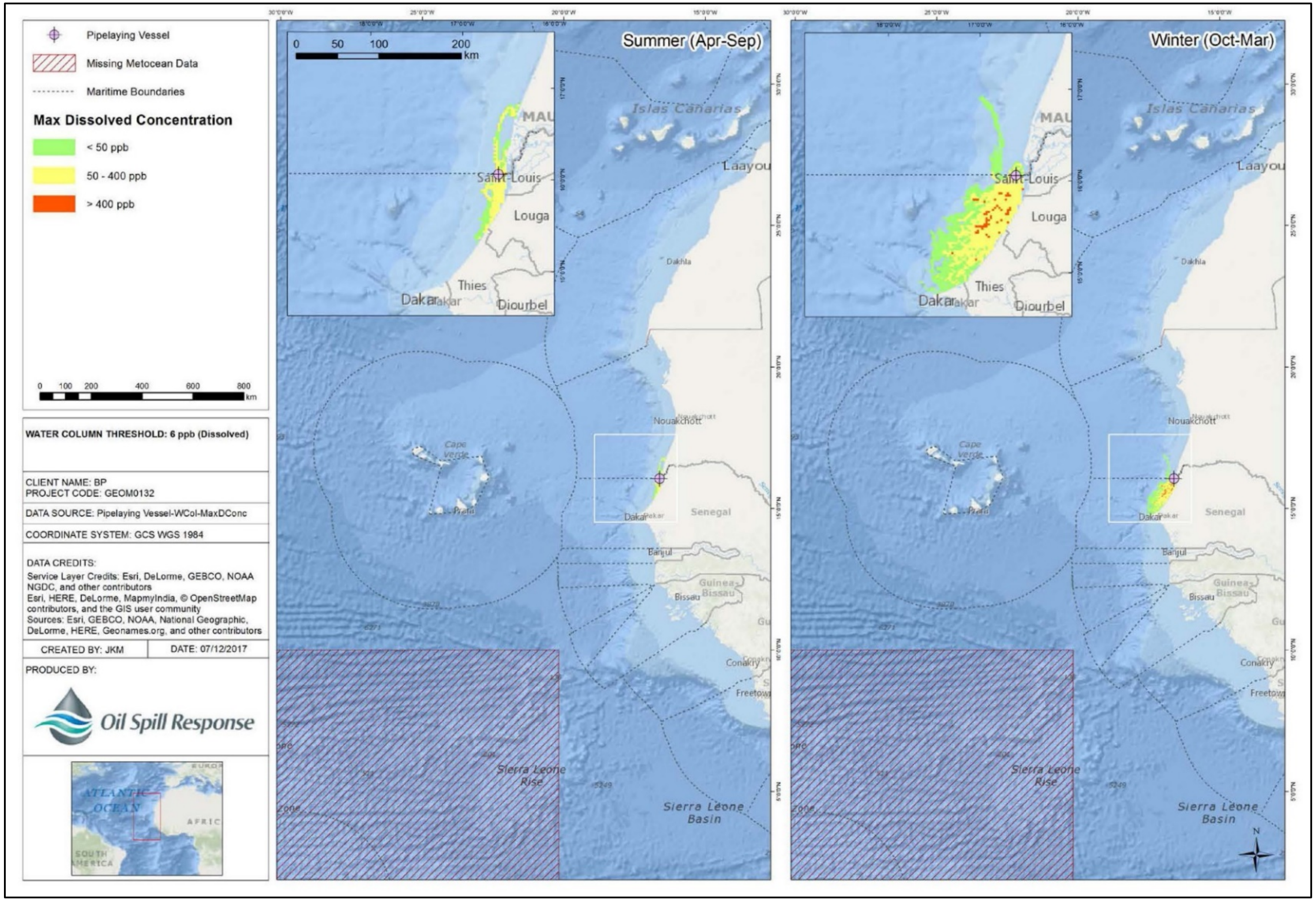
In terms of surface concentrations of fuel and lubricating oil, modeling results indicate that primarily Senegal waters and coastline would be affected. The thickness of the fuel and lubricating oil spill would be comprised of both discontinuous true color (50 to 200 µm in thickness) and continuous true color (>200 µm in thickness).

The extent and persistence of impacts on water quality would depend on meteorological and oceanographic conditions at the time of the spill. Spilled fuel and lubricating oil would be transported towards shore and southward, affecting coastal waters. Fuel and lubricating oil on the sea surface would be both discontinuous true color (50 to 200 µm in thickness) and continuous true color (>200 µm in thickness). Waters of the Nearshore Hub/Terminal Area and coastal waters are likely to realize decreased water quality from total hydrocarbons in the water column, and surface hydrocarbons; portions of the Pipeline Area would also realize diminished water quality from this spill. Predictive modeling results indicate that reduced water quality may result from total water column hydrocarbons and surface oiling, the latter of which would occur in moderate thicknesses near shore.



(From: Appendix N-1)

Figure 7-25. Maximum Total Hydrocarbon Concentrations in the Water Column, by Season, for a Pipelaying Vessel Collision.



(From: Appendix N-1)

Figure 7-26. Maximum Dissolved Hydrocarbon Concentrations in the Water Column, by Season, for a Pipelaying Vessel Collision.

7.5.3.3 Impact Rating

Well Blowout

The consequence of impacts to water quality from a well blowout event include elevation of hydrocarbons in the water column and at the sea surface. Impact intensity of the well blowout on water quality would be high. These high intensity impacts would be of short duration but regional extent, producing a moderate impact consequence. Given the remote likelihood of a blowout, overall impact significance is 2 – Low (see Table 7-159 below for details on selected criteria).

Failure of FPSO Due to a Ship Collision

The failure of FPSO event with sea surface release of condensate and MDO would have the potential for high intensity impacts to water quality, including potential impacts to the Senegal River estuary. This impact would be of short duration but regional extent, producing a moderate impact consequence. Given the remote likelihood of an FPSO failure due to a ship collision, overall impact significance is 2 – Low (see Table 7-159 below for details on selected criteria).

Pipelaying Vessel Collision

Vessel collision with sea surface rapid release of MDO, HFO, and lubricating oil would likely affect water quality. As previously mentioned, adverse effects to water quality in Mauritanian waters and Senegalese waters would be different because of local meteorological conditions. Most of the fuels and lubricating oil released from the Nearshore Hub/Terminal would be transported southward, with minor amounts moving northward into Mauritania waters.

For Mauritania, impact intensity from this accidental event on water quality is moderate. This impact would be of short duration but regional extent, producing a minor impact consequence. Given the remote likelihood of a pipelaying vessel collision, overall impact consequence is 1 – Negligible (see Table 7-159 below for details on selected criteria).

For Senegal, impact intensity from this accidental event on water quality is high. This impact would be of short duration but regional extent, producing a moderate impact consequence. Given the remote likelihood of a pipelaying vessel collision, overall impact consequence is 2 – Low (see Table 7-159 below for details on selected criteria).

Summary

A summary of impact to water quality from accidental events is presented in Table 7-159.

Table 7-159. Impacts to Water Quality from Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout					
Mauritania Senegal	Changes in water quality from elevated hydrocarbon concentrations in both water column and at the sea surface from a well blowout.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term	Moderate	Remote	2 – Low
Failure of FPSO Due to a Ship Collision					
Mauritania Senegal	Changes in water quality from elevated hydrocarbon concentrations in both water column and at the sea surface from FPSO failure due to a ship collision.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term	Moderate	Remote	2 – Low
Failure of FPSO Due to a Ship Collision – Senegal River Estuary					
Mauritania Senegal	Changes in water quality within the Senegal River estuary from elevated hydrocarbon concentrations in the water column from FPSO failure due to a ship collision.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term	Moderate	Remote	2 – Low
Pipelaying Vessel Collision					
Mauritania	Changes in water quality from elevated hydrocarbon concentrations in both water column and at the sea surface from pipelaying vessel collision.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 – Negligible
Senegal	Changes in water quality from elevated hydrocarbon concentrations in both water column and at the sea surface from pipelaying vessel collision.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term	Moderate	Remote	2 – Low

7.5.3.4 Mitigation Measures and Residual Impacts

Impacts to water quality from accidental events are rated 2 – Low. Table 7-160 outlines the available mitigation measures recommended to reduce impact likelihood associated with accident-related impacts to water quality. While these measures may further reduce accident likelihood, they would not alter overall impact significance. These mitigation measures are in addition to the measures and controls already planned in the project design, summarized as follows:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea X-mas trees), other well control barriers and isolation of any permeable zone.
- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.
- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.
- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.
- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.
- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.
- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.

- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.
- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.
- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Table 7-160. Mitigation Measures to Avoid or Reduce Impacts to Water Quality from Accidental Events.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Changes in water quality from elevated hydrocarbon concentrations in both water column and at the sea surface from a well blowout.	2 – Low	M101, M102, M103, M104, M105, M112	2 – Low
Changes in water quality from elevated hydrocarbon concentrations in both water column and at the sea surface from FPSO failure due to a ship collision.	2 – Low	M101, M102, M103, M104, M105, M112	2 – Low
Changes in water quality within the Senegal River estuary from elevated hydrocarbon concentrations in the water column from FPSO failure due to a ship collision.	2 – Low	M101, M102, M103, M104, M105, M112	2 – Low
Changes in water quality from elevated hydrocarbon concentrations in both water column and at the sea surface from pipelaying vessel collision (Senegal waters).	2 – Low	M101, M102, M103, M104, M105, M112	2 – Low

Notes:

M101: In the unlikely event of a spill, tactical response methods that may be considered under the OSCP include: surveillance and monitoring, offshore containment and recovery; subsea and at surface dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.

M102: All response measures will be continuously monitored to ensure that they remain effective. The response team will maintain situational awareness of the event and response effort.

M103: In the unlikely event of a spill reaching the shoreline, a Shoreline Clean-up and Assessment Technique (SCAT) program will be implemented to inform shoreline clean-up and remediation as applicable.

M104: In the unlikely event of a spill reaching the shoreline, a shoreline clean-up and remediation team will be mobilized to the affected areas. BP will also engage specialized expertise to mitigate impacts to sensitive areas and wildlife species as needed.

M105: In the unlikely event of a spill, follow national regulatory requirements for reporting and notification, using established protocols, which extends to all relevant external stakeholders.

M112: In the unlikely event of a spill of high intensity, specific monitoring (e.g., environmental effects monitoring) may be required and developed in consultation with applicable national authorities.

7.5.4 Sediment Quality

High Level Summary

In this section on Sediment Quality, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. All impacts on Sediment Quality from Accidental Events were assessed as of negligible significance. No mitigation measures were required.

7.5.4.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.4.2 Impact Description

The accidental events, as described in Section 7.5.1, would introduce large volumes of contaminant materials into the receiving environment of the project areas. Fallout of these materials onto the seafloor would have the potential for impacting sediment quality. Most of the seafloor in the project area consists of soft-bottom benthic habitat of which the conditions concerning the sediment matrix parameters were characterized during the 2016 EBS (Appendix D).

Impacts to sediment quality from accidental events are primarily from exposure to hydrocarbons; a well blowout event may also have localized effects on sediment quality from drilling-related discharges from the requisite relief well. The accidental events include both a subsurface release and surface releases of hydrocarbons. It is expected that these events would be predominantly associated with sea surface exposures. Very low percentages of the released hydrocarbons are predicted to have a fate associated with the sediment matrix; the distribution of this sediment bound hydrocarbons was not predicted from the models. Hydrocarbons retained in the water column following an accidental release may be transported to seafloor sediments via multiple pathways, including direct sinking of oil, adsorption of small oil droplets (alone or mixed with dispersant) onto suspended organic and inorganic particles in marine snow (i.e., SPM), and incorporation into sinking zooplankton fecal pellets in either surface or subsurface layers.

Sediments may be exposed to hydrocarbons from these accidental releases but are unlikely to measurably affect sediment quality unless carried into the shallow water portions of the project area. Following *Deepwater Horizon*, Montagna et al. (2013) documented reduction in sediment quality, faunal abundance, and faunal diversity primarily within 3 km of the release (i.e., at the wellhead); however, this was following a long-term release which was much greater in volume and temporal persistence than the current scenario.

Water column to sediment transport processes in shallower water and nearshore would more readily facilitate exposing the sediments to elevated hydrocarbons and affecting sediment quality. Likewise, these shallow water areas and associated oceanographic conditions would facilitate expeditious hydrocarbon weathering due to dispersion, dissolution, and biodegradation. Accidental events, as described in Section 7.5.1, would have minimal effect on seafloor sediment quality with the exception of the localized area in proximity to the event.

The following subsections explain how these accidental event IPFs would produce impacts to sediment quality.

Well Blowout

Based on discharge trajectories as presented in Appendix N-1, the water column around the wellsite and waters of the Offshore Area would be exposed to relatively high hydrocarbon concentrations for a relatively long period of time, approximately 40 days. In a catastrophic release (or well blowout), discharged materials – whether oil, gas, condensate, or a mixture of gaseous and liquid hydrocarbons – would rise within the water column. As the discharge plume moves upward, it continues to entrain sea water, reducing the plume's velocity and buoyancy and increasing its radius. As the plume reaches the sea surface or its termination height (when all momentum is lost), it can be deflected in a radial pattern where ambient currents and wind-generated waves determine the subsequent transport and dispersion of the discharged material. The buoyance of the release and the deep water depth (>2,500 m) of the Offshore Area would most probably preclude sufficient hydrocarbon water column to sediment transport to produce measurably elevated sediment hydrocarbon concentrations.

Similarly, a well blowout event would cause the water column within portions of the Pipeline Area (further from the source) to have a relatively long-term exposure to elevated hydrocarbon concentrations. A portion of the hydrocarbon based materials released from the wellhead could remain at depth. The density difference between the discharge plume and the receiving water results in a buoyant force that drives the discharge plume upward. As the plume rises, it entrains ambient seawater reducing the plume's velocity and buoyancy. If the buoyant driving force for the plume is dissipated by 1) entrainment, 2) dissolution of gas bubbles, or 3) formation of gas hydrates before it reaches the surface, the plume would terminate while low-density components would continue to ascend within the water column. Process for water column to sediment hydrocarbon transport are as previously described in this Section 7.5.4.2 introduction. Prediction for worst-case blowout scenario indicates that the fate of 1 to 7% of the discharged oil would be in the sediment; it would be highly probable that portions of the Pipeline Area would be affected by a well blowout via elevated sediment hydrocarbon concentrations.

Based on discharge trajectories as presented in Appendix N-1, in the event of a boreal summer time (April to September) well blowout, there is a relatively high probability (>50%) the Nearshore Hub/Terminal Area water column would have a short duration exposure to elevated hydrocarbon concentrations. Light (0.1 – 1 litres/m^2) and moderate (1 – 10 litres/m^2) oiling would occur along the Nearshore Hub/Terminal Area adjacent to the shoreline. Prediction for the worst-case blowout scenario indicates that fate of 1 to 7% of the discharged oil would be in the sediment; the distribution of this sediment-bound oil was not predicted from the model. It would be very likely that the Nearshore Hub/Terminal Area sediment quality would be affected by well blowout due to high probability for water column exposure in conjunction with nearshore conditions of relatively high SPM. TSS levels observed during the EBS (Appendix D) were commonly above 10 mg L^{-1}; these levels would facilitate considerable oil/SPM interactions with subsequent transport and deposition (Boehm, 1987).

Depending on phase of the program, it has been assumed that a release would occur from the BOP wellhead, located on the seafloor and form a buoyant plume that would rise towards the sea surface. Depending on the orientation and location of the release point relative to the seafloor (e.g., vertical or horizontal, at or below the sediment surface), the seafloor sediments in the immediate vicinity of the discharge may be exposed to the condensate plume with potential impacts generally localized to within several meters of the release point. Condensate would be expected to float to the sea surface and limit the potential for extensive contact with seafloor sediments. Some portion of the condensate could adhere to particulates and eventually sink to the seafloor possibly resulting in elevated increased sediment hydrocarbon concentrations within the Offshore Area. In addition, drilling muds could be released from the wellhead in conjunction with condensate and settle to the seafloor near the release point. Depending upon the phase of drilling, WBM or SBDF would be deposited, affecting trace metal and, possibly, hydrocarbon concentrations in sediments in the field of deposition.

Suspended particulate material (SPM) in the water column can interact with physically or chemically dispersed oil droplets to form agglomerates or aggregates (Sun and Zheng, 2009), and dissolved components can also adsorb to SPM on a molecular level. In addition, oil can interact abiotically with biological particulates (e.g., phytoplankton agglomerates); zooplankton can ingest oil and subsequently release it as fecal pellets (Conover, 1971; Parker et al., 1971; Johansson et al., 1980). This increase in particle size (due to agglomeration or biological pelletization) effectively increases the rate of sedimentation of particulate matter, accelerating the deposition of this material to benthic habitats.

Boehm (1987) characterized open ocean and nearshore oil-SPM interactions with estimated potential oil/SPM flux to the bottom as follows: at SPM concentrations ranging from 1 to 10 mg L^{-1}, no appreciable transport of particle-associated oil to the seabed occurs; at SPM loads from 10 to 100 mg L^{-1}, considerable oil/SPM interactions with subsequent transport and deposition are possible in the presence of sufficient turbulent mixing; and at SPM concentrations greater than 100 mg L^{-1} massive oil transport and deposition may occur. In this case, adsorption of dispersed oil droplets onto SPM may provide a relatively efficient mechanism for the transport of significant fractions of discharged hydrocarbon to the seafloor.

Payne et al. (2003) summarized research related to SPM interactions and their effects on sedimentation. Major conclusions noted by Payne et al. (2003) included:

- Sedimentation of oil droplets in coastal and open ocean waters can be enhanced by agglomeration, electrochemical flocculation, binding by dissolved organic material, and ingestion by filter feeding planktonic and benthic organisms and packaging into fecal or pseudo-fecal material;
- Whole oil droplet/SPM interactions during an oil spill overwhelm dissolved component SPM adsorption and transport to the bottom;
- SPM particle number densities control the rate of whole oil droplet/SPM interactions more than any other variable; and
- After whole oil droplet/SPM interactions have subsided, dissolved-phase individual-component/SPM interactions can continue and may become environmentally significant over time.

Hydrocarbons ascending through the water column (or remaining at depth) undergo dissolution (i.e., dissolution of water soluble fractions, including monocyclic aromatic hydrocarbons [MAHs] and PAHs), dispersion, and (for water soluble fractions) dilution. While in the water column, spilled hydrocarbons would be subject to adsorption to SPM and degradation. This residual oil that becomes associated with sediment would continue to naturally degrade whether atop or buried in the sediments.

The shoreline oiling associated with the well blowout event would have the potential for longer term fate of the oil relative to subtidal sediment deposition. The duration of potential sediment hydrocarbon exposure from shoreline oiling would be influenced by the depth of oil penetration and/or burial, the seasonal wave energy at the shoreline, oil-fine (sediment) fraction interaction, reworking by biological processes, and microbial degradation. The degree of re-flotation of the oil after stranding would depend on oil type, weathering, wave energy, tidal changes, and degree of penetration. High-energy wave action, especially on a highly exposed shoreline, can erode oil from the shoreline and redeposit it into the water, where it may be transported offshore and incorporated into possible sediment depositional processes.

Another nearshore oil transport process that could affect sediment quality and possible exposure to hydrocarbons is oil-mineral aggregation (OMA). Oil near and on shorelines sometimes interacts with fine mineral particles (i.e., fines) that are suspended in the water column near the shoreline and may move onto the shoreline with tidal and wave action. Oil may adhere to these particles and be transferred into the water column and subtidal sediments. The oil may then detach and re-float, in a repetitive process, resulting in the formation of stable, micron-sized oil droplets that can be dispersed into the water column by wave action. On one hand, OMA could extend the potential for subtidal sediment hydrocarbon exposure from shoreline oiling; on the other hand, it could reduce that same potential since the droplet proportional surface area increases, making the oil more available for biodegradation. OMA may play a role in longer term shoreline processes (Fingas, 2001) and could be very important in areas where there are significant concentrations of fine-grained materials (e.g., river mouths, estuaries, nearshore areas of riverine-based sediment deposition).

A well blowout would require the drilling of a relief well that would further subject the Offshore Area sediments, in close vicinity to the well, to inputs primarily associated with drilling-related discharges as previously described in Section 7.2.4.2.

Failure of FPSO Due to a Ship Collision

As previously described in Section 7.5.1, the failure of FPSO accidental event scenario includes the catastrophic sea surface release of condensate and MDO from the FPSO due to a ship collision. Based on the spill trajectories as presented in Appendix N-1, this accidental event would possibly result in Offshore Area water column exposure to hydrocarbons during the boreal Winter (i.e., October through March). There would be a low probability (≤50%) that the Offshore Area water column would have relatively short-term exposure to elevated hydrocarbon concentrations ranging from 150 to 500 ppb. Sea surface release of condensate and MDO from the FPSO would have very remote possibility of affecting Offshore Area sediments, due primarily to low probability for water column exposure in conjunction with open ocean conditions of low SPM precluding the potential transport of particle-associated oil to the seabed.

In the event the FPSO failure due to a ship collision occurs during the boreal Summer (April to September), the Pipeline Area shoreward of the release would have a high probability (>50%) of short-term exposure to relatively to high hydrocarbon concentrations; this exposure probability would be lower (<50%) during a boreal Winter event. There would be a low probability that the Pipeline Area seaward of the event would have short-term water column exposure to relatively high hydrocarbon concentrations. Consequently, the FPSO release would have an effect on sediment hydrocarbon concentrations that would be directly correlated with water depth within the Pipeline Area, with the minimal effect at the most seaward extent of the area and maximum effect at the most shoreward of the area. Predicted moderate oiling along the shoreline associated with the FPSO release could contribute to the sediment quality effects within the shoreward portion of the Pipeline Area.

Based on discharge trajectories as presented in Appendix N-1, in the event there was a boreal Summer time catastrophic sea surface release of condensate and MDO from the FPSO, there would be a relatively high probability (>50%) the Nearshore Hub/Terminal Area water column would have a relatively long-term exposure to high hydrocarbon concentrations. Moderate (1 to 10 litres m^{-2}) oiling would occur along the shoreline adjacent to the Nearshore Hub/Terminal Area. Prediction for worst-case FPSO release scenario indicates that the fate of up to approximately 10% (13,500 metric tonnes) of the released hydrocarbons would be associated with the sediment; the distribution of this sediment bound oil was not predicted from the model. The rationale for expecting very likely effects on Nearshore Hub/Terminal Area sediment quality, specific to elevated hydrocarbon concentrations, are similar to the well blowout incident; shallow-water conditions and high probability for water column exposure in conjunction with high potential for SPM/oil transport and deposition with presence of moderate shoreline oiling.

Worst-case scenario for impacts to the Senegal River estuary would be an FPSO failure due to a ship collision during the Summer months (April to September). Based on worst-case trajectories as presented in Appendix N-1, there would be a high probability that the Senegal River mouth, specific to the shoreline and water column, would have relatively long-term exposure (i.e., over 30 days) to elevated hydrocarbons. Qualified modeling results indicate that there would be a very low probability these elevated hydrocarbon levels would extend up river and affect riverine sediment quality.

Pipelaying Vessel Collision

As previously described in Section 7.5.1, the collision of the pipelaying vessel and subsequent vessel loss would result in the sea surface rapid release of relatively large quantities of MDO, HFO and lubricating oil. Spill trajectories for MDO, HFO and lubricating oil released from a sunken pipelaying vessel were developed for an incident within the Nearshore Hub/Terminal Area (Appendix N-1). Based on the discharge trajectories, this accidental event could possibly result in Offshore Area water column exposure to hydrocarbons during the boreal Winter. There would be a very low probability (≤1%) that the Offshore Area water column would have relatively short-term exposure to low hydrocarbon concentrations (<150 ppb). Trajectories indicate that it is most probable Offshore Area sediments would not have any hydrocarbon exposure from the vessel collision event.

Based on discharge trajectories from specified location as presented in Appendix N-1, in the event there is a vessel collision and subsequent sea surface of relatively large quantities of MDO, HFO and lubricating oil there would be a very low probability (≤5%) the Pipeline Area water column would have a very short-term exposure to elevated hydrocarbon concentrations. Light (0.1 to 1 litres m^{-2}) and moderate (1 to 10 litres m^{-2}) oiling is predicted to occur along the shoreline adjacent to the Nearshore Hub/Terminal Area due to vessel collision. The worst-case scenario indicates that the fate of approximately 7 to 8% (approximately 350 metric tonnes) of the released material would be in the sediment matrix, most likely in close proximity to the shoreward-most portion of the project areas. Predictive modeling for this surface release indicates that the Pipeline Area would have limited, if any, exposure of sediments to elevated hydrocarbons.

Expected conditions for the Nearshore Hub/Terminal Area would be similar to the Pipeline Area during the modeled vessel collision but with a much higher probability (<50%) of water column exposure to elevated hydrocarbons. By virtue of having hydrocarbons within the shallow area water column and the presence of moderate shoreline oiling, it is probable that the Nearshore Hub/Terminal Area sediment quality (due to elevated hydrocarbon concentrations) would be affected by vessel collision. These oil transport and sediment depositional processes are described for the Nearshore Hub/Terminal Area well blowout event.

7.5.4.3 Impact Rating

Well Blowout

The consequence of impacts to sediment quality from a well blowout event include potential exposure of elevated hydrocarbons and localized deposition of drilling fluids that could influence sediment metal concentrations in proximity to the wellhead. With the exception of the Offshore Area, the impact intensity of the well blowout would be low with changes to sediment quality unlikely to be noticed against background. Primary impact from a well blowout in the Offshore Area would be from the drilling-related discharges from the relief well drilling activities which would likely be restricted to within 5 km of the release. These impacts are expected to produce localized impacts to sediment quality of moderate intensity. These Offshore Area moderate intensity impacts, having a remote likelihood would have a duration ranging from long to short term; recovery of sediment quality following cessation of drilling discharges may require more than 5 years in close proximity (<500 m) to the wellsite. Based on the combination of these criteria, the consequence of the impact would be minor for the Offshore Area and negligible for the Nearshore Hub/Terminal and Pipeline Areas. Considering the remote likelihood associated with a well blowout, the overall impact significance is rated 1 – Negligible for all areas (see Table 7-161 below for details on selected criteria).

Failure of FPSO Due to a Ship Collision

The failure of FPSO event with sea surface release of condensate and MDO would have the potential for detectable impact sediment quality depending on the proximity relative to the particular project areas. With the exception of the Nearshore Hub/Terminal Area, the impact intensity of the failure of the FPSO event would be low with changes to sediment quality unlikely to be noticed against background. Due to shallow water and coastal oceanographic conditions with proximity to moderate shoreline oiling, impact intensity was considered moderate by virtue of the high probability for water column exposure in conjunction with high potential for SPM/oil transport and sediment deposition in the Nearshore Hub/Terminal Area. The overall impact significance to sediment quality from the failure of the FPSO event is 1 – Negligible since impacts are of remote likelihood, regional extent and short-term duration (see Table 7-161 below for details on selected criteria).

Pipelaying Vessel Collision

Vessel collision with sea surface rapid release of MDO, HFO and lubricating oil would likely affect sediments as spilled fuel would be carried into shallow water, based on the trajectories and weathering characteristics. For reasons similarly described for the failure of FPSO event, the overall impact significance is 1 – Negligible (see Table 7-161 below for details on selected criteria).

Summary

A summary of impact to sediment quality from accidental events is presented in Table 7-161.

Table 7-161. Impacts to Sediment Quality from Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout					
Mauritania Senegal	Exposure of sediment to elevated hydrocarbons; localized changes to bottom contours, grain size, and some chemical parameters from drilling muds and cuttings discharges.	Nature: Negative Intensity: Low to Moderate Spatial Extent: Regional; Immediate vicinity for drilling-related discharges Duration: Short to long term[156]	Negligible to Minor	Remote	1 – Negligible
Failure of FPSO Due to a Ship Collision					
Mauritania Senegal	Exposure of sediment to elevated hydrocarbons from FPSO failure due to a ship collision.	Nature: Negative Intensity: Low to Moderate Spatial Extent: Regional Duration: Short term	Negligible to Minor	Remote	1 – Negligible
Pipelaying Vessel Collision					
Mauritania Senegal	Exposure of sediment to elevated hydrocarbons associated with pipelaying vessel collision.	Nature: Negative Intensity: Low to Moderate Spatial Extent: Regional Duration: Short term	Negligible to Minor	Remote	1 – Negligible

7.5.4.4 Mitigation Measures and Residual Impacts

Impacts to sediment quality from accidental events are rated 1 – Negligible; no mitigation measures are required.

Summary of existing mitigation and monitoring measures inherent to design and operational controls:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea X-mas trees), other well control barriers and isolation of any permeable zone.

[156] Recovery of sediment quality following cessation of drilling discharges may require more than 5 years in close proximity (<500 m) to the wellsite.

- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.
- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.
- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.
- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.
- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.
- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.

- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.
- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Despite the impact being ranked as negligible, the following mitigation measure will be implemented:

- M112: In the unlikely event of a spill of high intensity, specific monitoring (e.g., environmental effects monitoring) may be required and developed in consultation with applicable national authorities.

7.5.5 Benthic Communities

High Level Summary

In this section on Benthic Communities, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. All impacts on Benthic Communities from Accidental Events were assessed as of negligible significance. No mitigation measures were required.

7.5.5.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.5.2 Impact Description

The accidental events, as described in Section 7.5.1, would introduce large volumes of contaminant materials, primarily hydrocarbon compounds, into the receiving environment of the project areas. Fallout of these materials onto the seafloor would have the potential for impacting benthic communities. Soft-bottom benthic communities within the project areas were characterized during the 2016 EBS (Appendix D). Accidental events also have the potential for affecting epibenthic fouling communities that have developed on project-related subsea structures.

Average PAH sediment concentrations measured in the 2016 EBS study conducted by CSA Ocean Sciences Inc. (Appendix D) ranged from 10.5 ng g^{-1} (ppb) to 77.1 ng g^{-1}. To assess potential for impacts to benthic communities, hydrocarbon exposure levels were evaluated relative to a benchmark value. A benchmark is a chemical concentration in sediment above which there is the possibility of harm to organisms and the USEPA recommends benchmark values such as the effects range low (ERL) to assess the potential risk to fish and other marine life (Long and Morgan, 1990). The most applicable ERL benchmark value for this assessment was for total PAHs of 4,022 ng g^{-1} (ppb); sediment substrate with hydrocarbon concentrations below the ERL value are considered to pose low risks of causing adverse biological effects.

PAHs are one on the more toxic components of oil. They are present in condensate, are included as one of the 16 USEPA priority contaminants, and are readily removed from the discharge plume via weathering processes. PAH concentrations have been used to assess potential biological impacts associated with hydrocarbon exposure since the aromatic hydrocarbons are considered to be the components causing most observed biological effects after spills (Lee and Page, 1997). It is noteworthy that for other hydrocarbon compounds such as alkanes, TPH, and total oil and grease levels, there are no defined standards or guidelines for marine sediment. The lack of defined standards for these hydrocarbons is related to difficulties associated with developing standards for parameters that are operationally defined and vary depending on location, anthropogenic activities, natural seeps of hydrocarbons, and, where applicable, the nature or composition of the hydrocarbons.

The accidental events were modeled to generally assess the fate of the hydrocarbon releases and all events indicated the water column would be exposed to elevated hydrocarbon concentrations typically less than 750 ppb, with minor exception; please see Section 7.5.3 for a more detailed description of water column concentrations of dissolved and total (entrained) hydrocarbons. The exposure times for these releases at depth were relatively short, ranging from less than a half day to a maximum of 20 days. Specific to the soft-bottom benthic communities, there would likely be effects on project area sediment quality, but it is very unlikely there would be sufficient hydrocarbon sediment incorporation to elevate baseline concentrations by at least 50-fold to above the total PAH ERL benchmark value. Potential impacts from direct contact with oily material could possibly occur in the most shoreward portion of the project area.

Concerning established fouling communities, assemblages near the sea surface would be most susceptible to oiling impacts from direct contact with hydrocarbon emulsions. A summary overview of oil impacts to marine invertebrate communities was prepared by Suchanek (1993) which provides an understanding of potential effects from these accidental events on subsea hard substrate communities that have grown onto the deployed project structures. Invertebrate communities respond to acute catastrophic oil pollution at both the individual and population levels. Most discernible individual effects are mortality and physiological function impairment (e.g., adherence of oil that impedes filter feeding). Population-wide impacts are primarily changes in community structure concerning diversity, species composition and dominance, and overall abundance. There is a certain degree of species specificity concerning sensitivity and resistance to oil exposure impacts (Suchanek, 1993; Valentine and Benfield, 2013; Blackburn et al., 2014). Exposed hard substrate (e.g., rock) fauna recover from oil exposure within a three to four year period; recovery of invertebrate communities in more sheltered habitats may require more than 10 years to recover (Blackburn et al., 2014).

The drilling-related discharges associated with the relief well would produce local deposition of muds and cuttings resulting in a localized decrease in the infaunal and megafaunal community specific to the Offshore Area in proximity to the well.

The following subsections explain how these accidental event IPFs would produce impacts to benthic communities in each of the project areas.

Well Blowout

Based on discharge trajectories as presented in Appendix N-1, the conditions of the hydrocarbon releases and the potential for sediment deposition are described in Section 7.5.4.2. Some portion of the released condensate and associated hydrocarbon compounds could adhere to particulates and eventually sink to the seafloor, possibly resulting in elevated sediment hydrocarbon concentrations within the Offshore Area. Prediction for worst-case blowout scenario indicates that fate of 1 to 7% of the discharged hydrocarbons would be in the sediment; the distribution of these sediment-bound hydrocarbons has not been determined. A well blowout event would cause a portion of the water column within the Offshore Area to be exposed to relatively high hydrocarbon concentrations that are estimated to be greater than 1,000 ppb (ppb = ng g^{-1}). The buoyance of the release and the deep water depth (>2,500 m) of the wellheads within the Offshore Area would most probably preclude sufficient hydrocarbon water column to sediment transport to produce sediment hydrocarbon levels exceeding the PAH ERL range of 4,022 ng g^{-1} that could cause alterations to the soft bottom benthic communities.

Associated with a well blowout, drilling muds could be released from the wellhead in conjunction with condensate and settle to the seafloor near the release point. Additionally, a well blowout would require the drilling of a relief well that would further subject the sediments to inputs primarily associated with drilling-related discharges as previously described in Section 7.2.4.2. Contaminants transported to the sediments could potentially impact benthic communities. Assessment of the *Deepwater Horizon* accident (a crude oil spill with dispersant use) indicated that most severe impact to benthic communities were in close proximity to the release point and correlated to elevated sediment TPH, PAH, and barium concentrations (Montagna et al., 2013).

As previously discussed in Section 7.5.4.2, it is highly probable that portions of the Pipeline Area would be affected by a well blowout resulting in elevating sediment hydrocarbon concentrations. Based on discharge trajectories as presented in Appendix N-1, a well blowout event would cause the water column within portions of the Pipeline Area to be exposed to hydrocarbon concentrations estimated to be less than 750 ppb. It is unlikely there would be sufficient sediment hydrocarbon incorporation to produced toxic contaminant levels exceeding the PAH ERL range of 4,022 ng g^{-1}.

Discharge trajectories (Appendix N-1) indicate that, in the event of a well blowout, there is a relatively high probability (>50%) the Nearshore Hub/Terminal Area water column would be exposed to elevated hydrocarbon concentrations. This hydrocarbon water column exposure would occur in conjunction with light (0.1 to 1 liters m^{-2}) and moderate (1 to 10 liters m^{-2}) oiling at the Nearshore Hub/Terminal Area and along the adjacent shoreline. As previously described in Section 7.5.4.2, it is very likely that the Nearshore Hub/Terminal Area sediment would be exposed to elevated hydrocarbons. Estimates for some large spills suggest that up to 13% of the spilled oil can enter subtidal regions and hydrocarbon concentrations within these subtidal zones are generally orders of magnitude lower than shoreline sediments (Lee and Page, 1997).

The presence of hydrocarbons in the Nearshore Hub/Terminal Area sediment does not necessary result in impact to benthic communities. Blanchard et al. (2002) conducted a monitoring study to investigate the possible correlation of sediment hydrocarbon accumulation and faunal changes in the benthic community. Study results confirmed sediment hydrocarbon concentrations exceeding the ecotoxicological ERL threshold were sufficient to influence alterations in the benthic community that were apparent as increased numbers of opportunistic taxa and anomalous trends in abundance and diversity (Blanchard et al., 2002). Impacts to benthic communities in the Nearshore Hub/Terminal Area would require significant input of hydrocarbons that would increase the baseline PAH sediment concentrations from 10.5 ng g^{-1} (Appendix D) over 350-fold to levels in the total PAH ERL range of 4,022 ng g^{-1}. The principal hydrocarbon source for these subtidal sediments would most probably be the shoreline oil that would be exposed to considerable weathering during the onshore to offshore transport process.

If the well blowout were to occur during the Operations Phase, the effects on hard substrate fouling communities would be variable due primarily to depth of the substrate and distance from the release. It is very unlikely that the fouling communities, if present, on subsea structures in the project areas would be exposed to the condensate release and significantly elevated hydrocarbon concentrations at depth due primarily to the buoyancy of the release. Surface structures that include the FPSO, FLNG, and breakwater with berthings would likely come in direct contact with hydrocarbon compounds of variable concentrations in the form of a very thin emulsion layer of <50 µm, which would be thinner than a layer of newsprint. Fauna and flora present at the sea surface may be smothered; oil adherence would impede physiological functions to varying degrees. Expected impact would include loss of epibenthos but not at a significant level due primarily to relatively short exposure and thin oily surface layer. Adherence of hydrocarbon compounds could create excess weight and shearing forces making them susceptible breakage and holdfast detachment (Suchanek, 1993).

Failure of FPSO Due to a Ship Collision

Based on the spill trajectories for the catastrophic sea surface release of condensate and MDO from the FPSO as presented in Appendix N-1, the water column within the project may be exposed to elevated hydrocarbon concentrations. Exposure time for these elevated hydrocarbons are relatively short (<14 days). A sea surface release of condensate and/or MDO from the FPSO would have limited potential to expose sediments to elevated hydrocarbons; subsequently, no impacts to soft-bottom benthic communities in the Offshore and Pipeline Areas are expected from an FPSO failure due to a ship collision.

Similar to the other accidental events, a release resulting from FPSO failure due to a ship collision may be transported to the Nearshore Hub/Terminal Area and adjacent shoreline. As previously described for the well blowout, very high levels of sediment hydrocarbons would need to be present to measurably affect the benthic community. Although there would likely be effects on Nearshore Hub/Terminal Area sediment quality from an FPSO failure due to a ship collision, impacts to benthic communities are not expected.

Effects to the hard substrate fouling communities from the failure of the FPSO due to a ship collision would be as generally described for the well blowout event. Due to the predicted thickness of the surface emulsification around the FPSO and in the Nearshore Hub/Terminal Area, there would be an expected significant loss of fauna and flora present at the immediate sea surface. Marine algae and seaweed may become more dominant in recovery since most vegetation appears to recover following spills (U.S. Fish and Wildlife Service, 2018).

Pipelaying Vessel Collision

Similar to the FPSO failure event, this vessel collision event is characterized by the sea surface rapid release of relatively large quantities of MDO, HFO and lubricating oil. This accidental event scenario would be a sea surface and water column dominated event and subsequently would have very limited potential to expose sediments to elevated hydrocarbons. Worst-case scenario for this accidental event predicts that fate of approximately 7 to 8% of the release materials would be in the sediment. Although the distribution of this sediment bound oil was not predicted from the model, it is assumed that the sediment-bound hydrocarbons would be predominantly located in the Nearshore Hub/Terminal Area, due primarily to the extremely low probability of elevated hydrocarbons being present in the water column of the Offshore and Pipeline Areas.

The modeled vessel collision event, as a small volume sea surface release, most likely would not measurably affect benthic communities due to insufficient hydrocarbon sediment incorporation, as previously discussed.

7.5.5.3 Impact Rating

Well Blowout

The impact intensity of the well blowout would be low with potential changes to soft bottom benthic communities that would unlikely be noticed against background. The effects to soft bottom benthic communities in the Offshore Area, Nearshore Hub/Terminal Area and Pipeline Area from a well blowout event include potential alteration of community structure and localized decrease in abundance and diversity, attributed to burial, sediment grain size changes, and an influx of organic material from the accidental release of drilling muds, as described in Section 7.2.5.2. Potential fallout of hydrocarbons released into the water column in combination with drilling-related discharges from the relief well drilling activities would be limited to the Offshore Area and are expected to produce localized impacts to benthic communities of low intensity. If the well blowout were to occur during the Operations Phase, there would be expected loss of fauna and flora from the hard substrate fouling community present at the immediate sea surface; the impact intensity is expected to be low due to short exposure and very light oiling.

Impacts to benthic communities from a well blowout would be of low intensity. Spatial extent and duration are regional and of short-term duration, respectively, resulting in a negligible impact consequence. Given the remote likelihood of a well blowout, overall impact significance is 1 – Negligible (see Table 7-162 below for details on selected criteria).

Failure of FPSO Due to a Ship Collision

The failure of the FPSO due to a ship collision with a subsequent sea surface release of condensate and MDO would not be expected to have a detectable impact on soft bottom benthic communities. Impacts to benthic communities from an FPSO failure event would result in a low impact intensity. Effects to hard substrate fouling communities from the failure of the FPSO would have a moderate impact intensity due to significant loss of fauna and flora. Spatial extent and duration are regional and of short-term duration, respectively, resulting in a negligible impact consequence for benthic communities and minor impact consequence for fouling communities. Given the remote likelihood of this accidental event, overall impact significance is 1 – Negligible for both benthic communities and fouling communities (see Table 7-162 below for details on selected criteria).

Pipelaying Vessel Collision

Vessel collision with a subsequent sea surface rapid release of MDO, HFO and lubricating oil would be unlikely to affect benthic communities. Impacts to benthic communities from this accidental event would result in low impact intensity. Spatial extent and duration are regional and of short-term duration, respectively, resulting in a negligible impact consequence for benthic communities. Given the remote likelihood of a pipelaying vessel collision, overall impact significance is 1 – Negligible (see Table 7-162 below for details on selected criteria).

Summary

A summary of impact to benthic communities from accidental events is presented in Table 7-162.

Table 7-162. Impacts to Benthic Communities from Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout					
Mauritania Senegal	Alteration of community structure and localized decrease in the soft bottom benthic community and hard substrate fouling community.	Nature: Negative Intensity: Low Spatial Extent: Regional Duration: Short term	Negligible	Remote	1 – Negligible
Failure of FPSO Due to a Ship Collision					
Mauritania Senegal	Alteration of soft bottom community structure and localized decrease in the soft bottom benthic community and hard substrate fouling community.	Nature: Negative Intensity: Low to Moderate Spatial Extent: Regional Duration: Short term	Negligible to Minor	Remote	1 – Negligible
Pipelaying Vessel Collision					
Mauritania Senegal	Alteration of soft bottom community structure and localized decrease in the soft bottom benthic community.	Nature: Negative Intensity: Low Spatial Extent: Regional Duration: Short term	Negligible	Remote	1 – Negligible

7.5.5.4 Mitigation Measures and Residual Impacts

Impacts to benthic communities from accidental events are rated 1 – Negligible; no mitigation measures are required.

Summary of existing mitigation and monitoring measures inherent to design and operational controls:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea Xmas trees), other well control barriers and isolation of any permeable zone.

- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.

- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.

- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.

- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.

- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.

- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.

- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.

- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.

- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.

- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.

- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.

- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.

- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.

- D115: Conduct routine spill response drills and training.

- D116: Development of an oil spill sensitivity map highlighting resources at risk

- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.

- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.
- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Despite the impact being ranked as negligible, the following mitigation measure will be implemented:

- M112: In the unlikely event of a spill of high intensity, specific monitoring (e.g., environmental effects monitoring) may be required and developed in consultation with applicable national authorities.

7.5.6 Plankton & Fish and Other Fishery Resources

High Level Summary

In this section on Plankton & Fish and Other Fishery Resources, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. All impacts on Plankton & Fish and Other Fishery Resources from Accidental Events were assessed as of negligible significance. No mitigation measures were required.

7.5.6.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.6.2 Impact Description

Impacts from these three potential accidental events may directly or indirectly affect plankton, fish, and other fishery resources (e.g., shrimps, crabs, cephalopods) by releasing hydrocarbons into the surrounding environment. Direct effects include smothering of gills, feeding appendages, and swimming appendages via direct contact. Indirect effects occur when spilled dissolved, bioavailable hydrocarbons become incorporated into food webs or when structural habitats (e.g., reefs, mangrove shoreline, seagrass meadows) become covered in thick, emulsified material. Levels of direct or indirect effects would vary depending on seasonal or environmental context (e.g., shelf, slope, coast, or estuary). These effects may be lethal or sub-lethal (i.e., delayed development of eggs or embryos, developmental malformations, or genetic defects).

Mobile adult fishes and invertebrates of the region are generally expected to sense spilled hydrocarbons and vacate affected areas (IPIECA, 1997; Fodrie et al., 2014). This would happen in pelagic and demersal habitats, but species would differ depending upon water depth and distance along the cross-shelf gradient. For example, in depths greater than 200 m, pelagic (and mesopelagic) species such as lanternfishes, bristlemouths, light fishes, tunas, some sharks, billfishes and others would actively avoid spilled oil. In shelf waters (<200 m), little tunny, jack crevalles, sharks, jack mackerels, sardines, anchovies and many others would also avoid spilled oil. This would also be true of demersal species (fishes, shrimps, and crabs) living near a spill site, but would be more likely to be in the case of an IPF for a subsurface release (i.e., blowout) whether in slope or shelf environments. These species would also be expected to actively avoid spilled oil. Demersal and pelagic assemblages of the region are described in Chapter 4 and Appendices G and M.

Spilled hydrocarbons could reach the seafloor where many of the fishes and invertebrates including flatfishes, sciaenids, shrimps, octopus, and crabs are associated with the seafloor and feed on sedimentary substrates (see Chapter 4; Appendices G and M). As discussed in Section 7.5.4, there is little evidence regarding the spatial extent of spilled oil into seafloor sediments beyond a very near-field footprint for the blowout; releases from the FPSO are unlikely to reach the seafloor, whereas fuel and lubricating oils released at the Nearshore Hub/Terminal may reach the seafloor via adsorption to suspended particulates and sinking. Other potential effects on fishery resources involve tainting, gear interactions, and fishery closures. Adult fishes may become tainted by external or internal contact with spilled hydrocarbons. A taint is commonly defined as an odor or flavor that is foreign to a food product. Tainting may affect the consumer perception of seafood products and greatly reduce marketability both locally and regionally. These effects are considered as part of the assessment of potential impacts of accidental spills in on fishing (see Sections 7.5.15 and 7.5.16).

Unlike the mobile adult and juvenile life stages of fishes, shrimps, crabs, and squids, the plankton, including eggs and larvae of invertebrates and fishes have limited or no mobility and may suffer from direct contact with toxic fractions of spilled hydrocarbons. Eggs and larvae concentrate in near-surface layers of the water column, bringing them within the same water column stratum as the spilled hydrocarbons. In addition, early life stages do not have fully developed organ systems needed to process toxic compounds and would be more susceptible to mortality from direct contact with hydrocarbons than adults (e.g., Langangen et al., 2017; Hjermann et al., 2007). Lethal concentrations of hydrocarbons in general have been assayed for a range of species including eggs and larvae (French-McCay, 2002, 2003). These values, used in establishing threshold levels for the spill trajectories presented Appendix N-1, varied between 6 and 400 ppb and included tests on a range of species as well as eggs and larvae. The 6-ppb level is not considered to represent a significant biological impact, but corresponds to low level exposure to dissolved hydrocarbon in the water column. Overall, French-McCay (2002) suggests that an average 96-h LC_{50} of 400 ppb would serve as a lethal threshold for 50% of the biota. These values are explained in more detail in Section 7.5.3. The particularly toxic component of hydrocarbon mixtures are the PAHs. PAHs have been reported to be toxic at concentrations as low as 1 ppb in laboratory studies (Fodrie et al., 2014; Incardona et al., 2015), although these same effects have not been documented at the population level in the marine environment (Fodrie et al. 2014). Combined PAH fractions in the mixtures considered for the accidental event scenarios in Appendix N-1 were generally low (<1.0% of the total hydrocarbon mixture; see Sections 7.2.4 and 7.2.5).

Fisheries in Mauritania and Senegal are composed of artisanal and industrial operations, targeting a range of pelagic and demersal species (fishes and invertebrates). Demersal species in coastal waters include sparids, sciaenids, octopus, shrimps, gastropods and in deeper waters the black cods. Of the various fisheries, the most important group sought by artisanal fishermen are the small pelagic species including sardines (*Sardinella* spp., *Sardina pilchardus*), jack mackerels (*Trachurus* spp.), bonga shad (*Ethmalosa fimbriata*), and anchovies (*Engraulis encrasicolus*). These small pelagic fishes are broadcast spawners that thrive along the inner edge of the Canary Current system which promotes upwelling of deep, nutrient-laden water onto the shelf, creating fertile spawning/retention areas. Researchers have used broad-scale collections of eggs and larvae, coupled with seasonal circulation patterns, to map areas of recurrent fish spawning and plankton concentration and along the shelf (Roy, 1998; Arkhipov, 2009; Tiedemann, 2017; Badji et al., 2017). The interaction between seasonal upwelling, the position of the Canary Current, prevailing winds, shelf width and geomorphology converge to create predictable areas of retention and spawning (Roy, 1998; Mbaye et al., 2015; Badji et al., 2017; Tiedemann and Brehmer, 2017). Such areas would be particularly vulnerable to spilled oil (IPEICA, 1997; Muhling et al., 2012; Rooker et al., 2013; Hjermann et al., 2007: Langengen et al., 2017).). Several researchers (Roy, 1998; Arkhipov, 2015; Tiedemann and Brehmer, 2017; Badji et al., 2017; Tiedemann et al., 2017) identified three areas that predictably occur on the shelf: just south of Cape Vert, Senegal; off Saint-Louis, Senegal; and off Banc d'Arguin, Mauritania. Another area important to developing young of some fish and invertebrate species is the lower portion of the Senegal River estuary. In this area, the young of shrimps, crabs, and fishes spawned in offshore waters make their way into the estuary where they settle and grow for varying periods of time (Degeorges and Reilly, 2006; Champalbert et al., 2007; Caverivière and Andriamirado, 1997).

Because early life stages are most vulnerable to elevated hydrocarbon concentrations and they are important in determining recruitment and replenishment of local stocks, the focus of the present impact analysis was to examine the degree of overlap of a deterministic (worst-case) modeled oil with the generalized spawning/retention areas. Areas of overlap were assessed qualitatively considering the hydrocarbon concentration (thickness) at the surface and in the water column along with the expected exposure time in days. The retention areas have high concentrations of plankton included eggs and larvae of fishes, cephalopods, shrimps, and crabs as well as zooplankton (Roy 1998, Arkhipov, 2015; Mbaye et al., 2015; Tiedemann, 2017; Tiedemann and Brehmer, 2017; Badji et al., 2017). Studies on these areas focused on small pelagic fishes, mostly *Sardinella aurita* and *S. maderensis*. Examining overlap between egg and larval habitat and oil spill trajectories has been employed to evaluate species specific effects from the *Deepwater Horizon* incident (Muhling et al., 2012; Rooker et al., 2013), as well as modeled simulations (Vikebø et al., 2014; Carroll et al., 2018).

The lowest level for water soluble hydrocarbons used in the trajectories presented in Appendix N-1 was 6 ppb, a value determined from ecotoxicity or LC_{50} (the concentration at which 50% of the test organisms die) tests (French-McCay, 2002, 2003). These values varied between 6 and 400 ppb and included tests on a range of species as well as eggs and larvae. The 6 ppb level is not considered to represent a significant biological impact and corresponds to a low level exposure to dissolved hydrocarbons. Overall, French-McCay (2002) suggests that an average of 96-h LC_{50} of 400 ppb would serve as a lethal threshold for 50% of the biota.

For most plankton, fishes, and other fishery resources the impacts of accidents are difficult to predict. Despite the fact of organismal level effects of low concentration hydrocarbons (e.g., PAHs) on eggs and larvae having been observed in laboratory studies (e.g., French-McCay, 2002, 2003; Fodrie et al., 2014; Laramore et al., 2014: Incardona et al., 2015), demonstrating population-level effects for fishery species following oil spills has been elusive (IPIECA, 1997; Fodrie et al., 2014; Langangen et al., 2017). Recently, Carroll et al. (2018) demonstrated with detailed models that a major oil spill would not negatively impact exploited cod populations in the Arctic.

Although acute mortality to early life stages of fish and invertebrates could be extensive in the area of a continuous oil release such as the site of a well blowout, impacts at the population-level are not expected (Fodrie et al., 2014). In the ocean the oil is rapidly dispersed and degraded to concentrations below the toxicity threshold as it moves away from the source.

When dynamic, rapidly decreasing concentrations of oil are present, short-term exposures above laboratory-derived toxicity thresholds do not last long (hours to days), and generally occur in the upper layers of the water column. Lower concentrations are sustained longer in the water column and may result in organisms experiencing sub-lethal chronic effects. Chronic toxicity information on crude oils and associated PAHs should be determined from standardized tests designed to examine chronic not acute toxicity (e.g., Lee et al., 2015). Unfortunately, chronic toxicity data for oil and associated polycyclic aromatic hydrocarbons (PAHs) is limited (Lee et al. 2015). A few studies have examined potential chronic effects on growth, including studies of cardiac toxicity (Brette et al. 2014; Incardona et al. 2014), mutagenicity (Paul et al. 2013), and developmental deformities (Barron 2012; Incardona et al. 2013; Dubansky et al. 2013). However, those studies generally used novel test procedures that have not been shown to yield reliable results, and do not show that the test results can be reproduced if the test is repeated.

For this ESIA, we looked at chronic toxicity studies that used the type of accepted standard aquatic toxicity test procedures typically used by regulatory authorities to make decisions in environmental, health and safety assessments, since those methods provide greater assurance of data quality and greater ability to reproduce tests results for oil exposures.

Echols et al. (2016) studied the chronic toxicity of fresh and weathered oil using two standard test species (mysids and inland silversides), and standardized / approved aquatic test guideline methods for Whole-Effluent Toxicity testing (USEPA 2002). These species were exposed for 21 to 28 days to oil loading rates up to 1 g/l of fresh or weathered oil collected from the Deepwater Horizon spill. The highest exposure levels contained an average TPAH concentration of 165 µg/l for fresh source oil, and 5 to 18 µg/l for weathered oil, which is similar to the highest concentrations of TPAHs in water column samples collected during the Deepwater Horizon incident, although these concentrations were uncommon (Boehm et al., 2016). Lower exposure levels of 0.1 g/l of oil were used to study the oil concentrations that are more commonly found in the upper surface water layer after oil has been treated with chemical dispersants (Neff, 1990).

Echols et al. (2016) found that fresh oil had some effect on the survival and growth of mysid shrimp and inland silversides at ~132 µg/l TPAH (LOEC), which approaches the higher concentrations of fresh oil and TPAH seen near the site of the oil release in the Deepwater Horizon spill. As the concentration of TPAH increased, mortality also increased and growth decreased. Weathered oil also had some effect on silverside survival at a lower concentration of ~5-8 µg/l TPAH, and on growth at ~<2 to <8 µg/l TPAH (LOEC). However, weathered oil had no effect on the survival and growth of mysid shrimp, even at the highest levels tested, at 1 g/l oil of weathered oil (~5 to 18 µg/l TPAH). This data was used to estimate the potential for chronic toxicity in the well blowout model.

Well Blowout

The mechanics and short term fate of the plume from a well blowout and release of condensate at depth are detailed in Section 7.5.3; this accidental event would result in an oil and gas release at depth, creation of a plume composed of small oil droplets, some of which would rise to the sea surface, and some of which may remain in a subsurface plume at depth. Details of the worst-case scenario used for this analysis are provided in Appendix N-1.

Model predictions show that in boreal Summer, the surface component of the worst-case scenario could spread into the Saint-Louis spawning/retention area with a thickness up to 50 µm within two days of the release. Minimal fractions of thicker material (50 to 200 µm) could pass through the Saint-Louis area as well (Figure 7-27). In boreal Winter, lower amounts of oil would enter the Saint-Louis spawning/retention area within three days with a thickness of up to 5.0 µm. Model predictions of oil in the water column trajectories with maximum dissolved hydrocarbon concentrations of <50 ppb partially overlap the Saint-Louis spawning/retention area in both boreal Summer and boreal Winter (Figure 7-28).

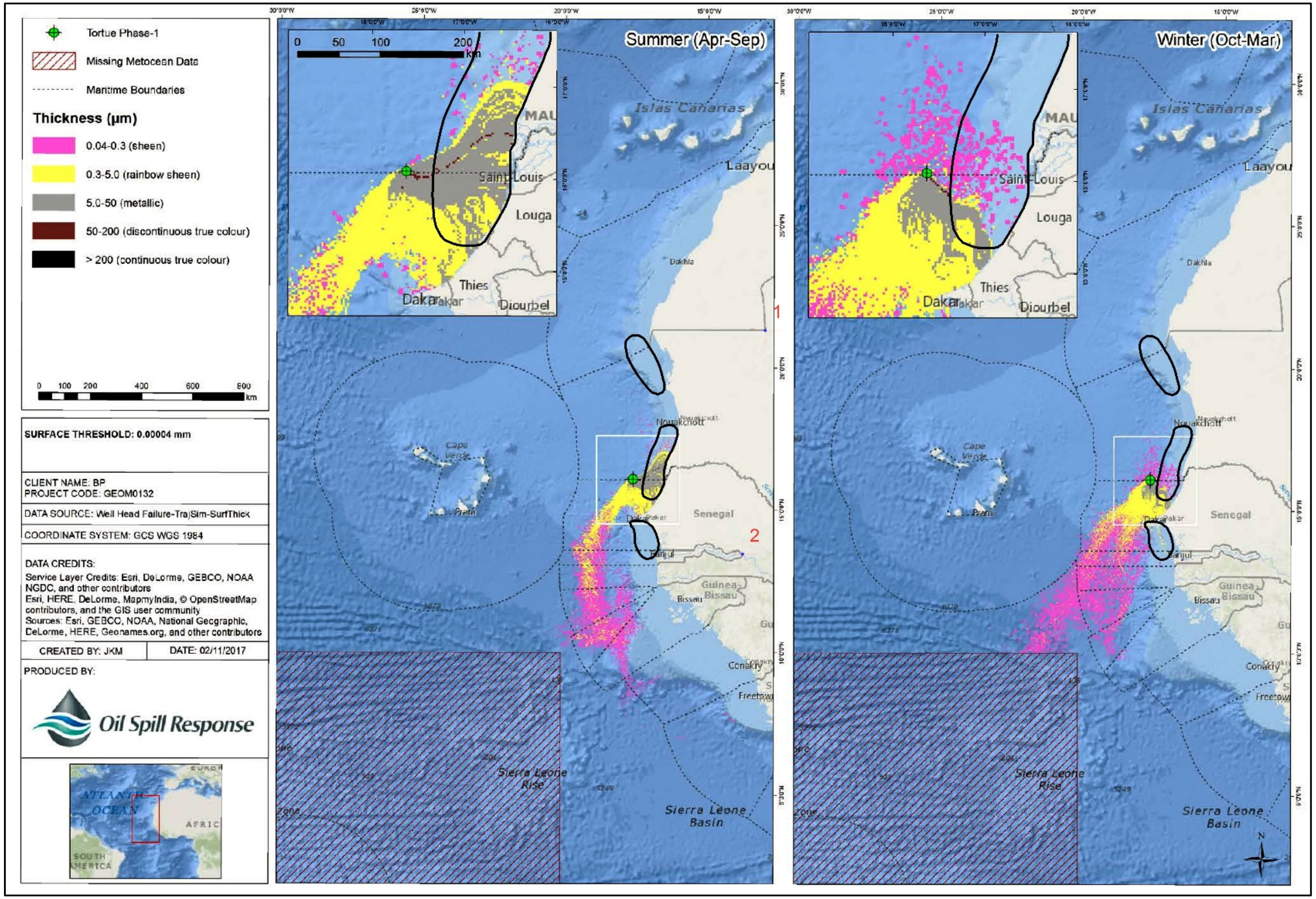
Concentrated fractions in the water column would remain offshore of the retention/spawning areas during both boreal Summer and Winter months. Model predictions of potential surface oil distributions sow it reaching spawning/retention areas off Saint-Louis during boreal Winter within 1 to 7 days, with up to 21 days of exposure to water soluble hydrocarbon concentrations of up to 500 ppb. Under the worst-case scenario, the Banc d'Arguin spawning/retention area would receive no surface oil in boreal Summer or Winter. Some surface oil could drift into the Cape Vert spawning/retention area in boreal Winter. In boreal Summer months, the probability of spilled oil (431 ppb) entering the Senegal River was predicted to be 78%. In boreal Winter months, models showed a 1% chance of 148 ppb oil entering the Senegal River estuary (Appendix N-1).

As discussed in Section 7.5.1, a well blowout would require drilling a relief well nearby; this action would involve discharges of fluids and cuttings at the seafloor. Impacts at the seafloor would be similar those described in Section 7.2.6.2.1 or the Construction Phase in the Offshore Area. Demersal fishes and invertebrates would be precluded from small areas of sedimentary bottom due to smothering by drill muds and cuttings and alteration of infaunal assemblages.

Failure of FPSO Due to a Ship Collision

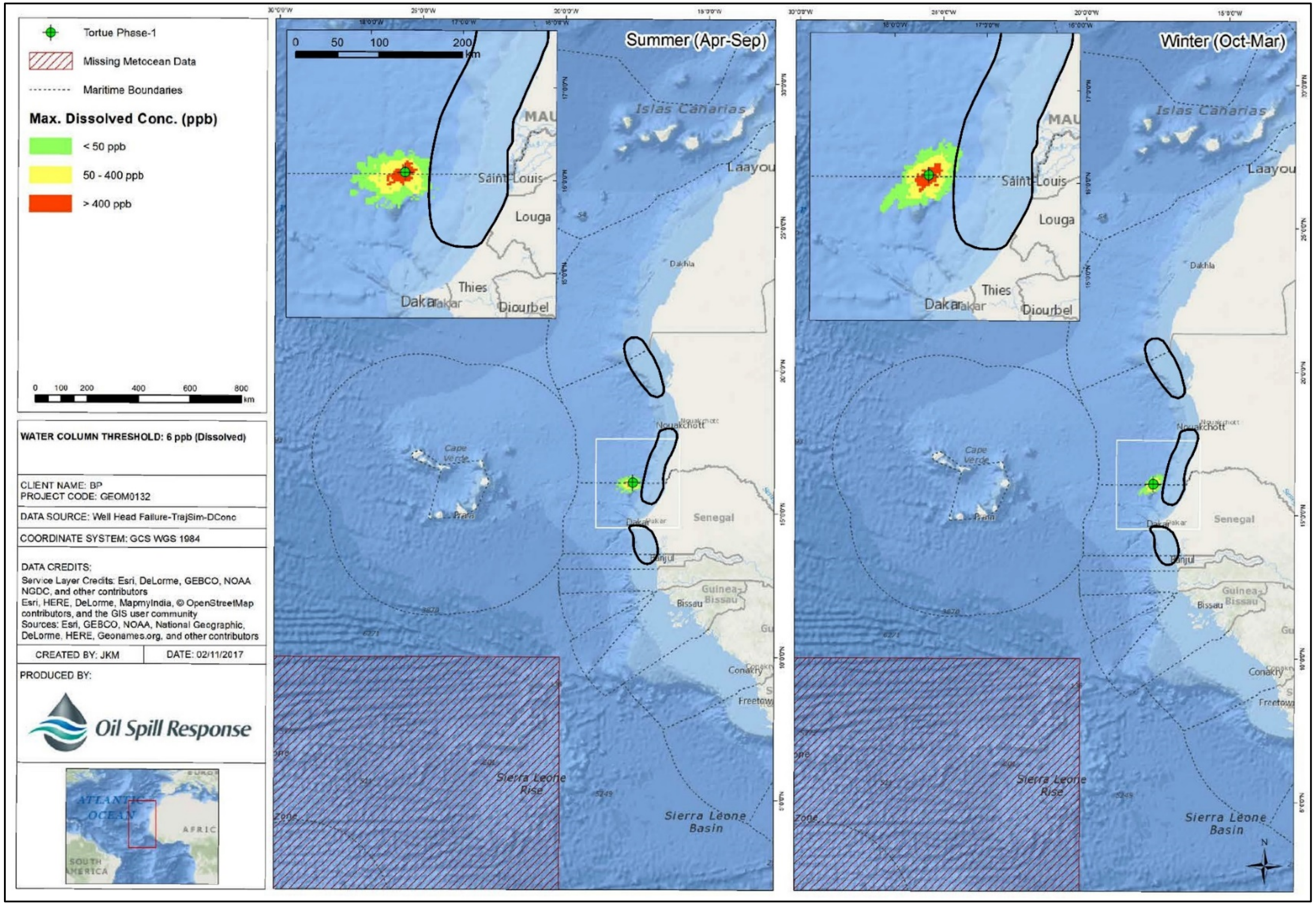
The scenario of a catastrophic failure of storage and fuel tanks on the FPSO, resulting in the release of 160,000 m^3 of condensate at the sea surface of the FPSO location is described in Section 7.5.1. The FPSO is located within the Saint-Louis spawning/retention area. Modeling results under the worst-case scenario showed that in boreal Summer, condensate and MDO spilled during this event would move towards shore and into water depths <20 m with maximum thickness of greater than 200 µm; the water column component would peak in about 6 days with some fraction present for up to 28 days. Maximum dissolved hydrocarbon concentrations of up to 400 ppb (with several patches greater than 400 ppb) would be present following the spill (Figure 7-29). In boreal Winter, the water column component of the spill would reach the coast in 1 to 3 days. The exposure time would be about 31 days and maximum dissolved water column concentrations of 50 to 400 ppb (with patches greater than 400 ppb) would be expected in the Saint-Louis spawning/retention area (Figure 7-30).

None of the spilled hydrocarbons in the worst-case scenario would reach the spawning/retention area south of Cape Vert. Also, the worst-case projection for an FPSO failure due to a ship collision did not reach the Banc d'Arguin spawning/retention area (Figures 7-29 and 7-30). Spilled oil would have a 67% probability of reaching the Senegal River estuary in boreal Summer at concentrations of up to 1,764 ppb. In boreal Winter, there would be a 5% chance of less concentrated oil (maximum 981 ppb) reaching the estuary. Dissolved hydrocarbon fractions would decrease with distance upstream (see Table 7-163).



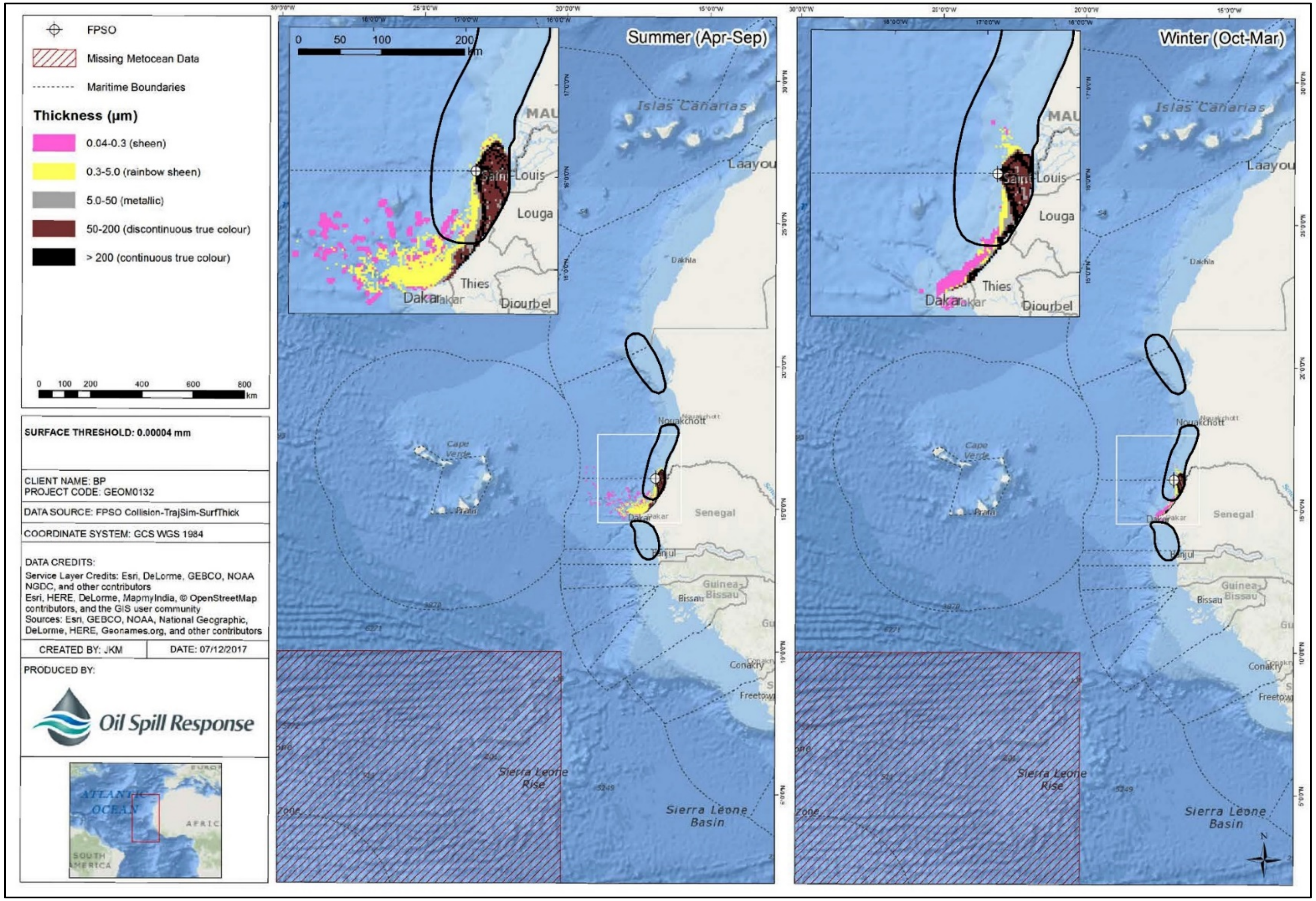
(Modified from: Appendix N-1)

Figure 7-27. Maximum Total Hydrocarbon Concentrations in the Water Column, by Season, for the Worst Case Well Blowout Scenario Relative to Known Spawning/Retention Areas for Small Pelagic Species.



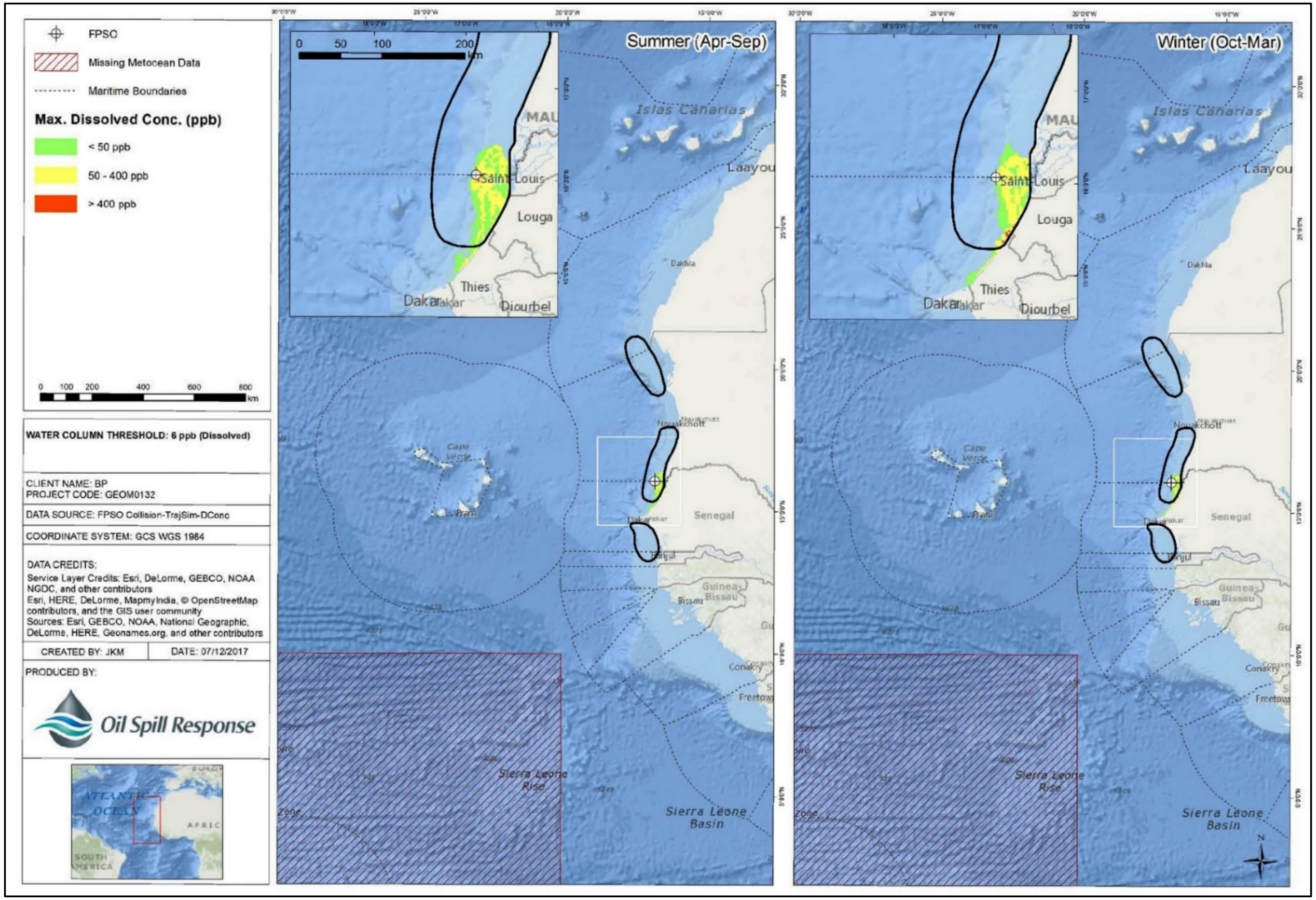
(Modified from: Appendix N-1)

Figure 7-28. Maximum Dissolved Hydrocarbon Concentrations in the Water Column, by Season, for the Worst Case Well Blowout Scenario Relative to Known Spawning/Retention Area for Small Pelagic Species.



(Modified from: Appendix N-1)

Figure 7-29. Maximum Total Hydrocarbon Concentrations in the Water Column, by Season, for the Worst Case FPSO Failure Due to a Ship Collision Scenario Relative to Known Spawning/Retention Areas for Small Pelagic Species.

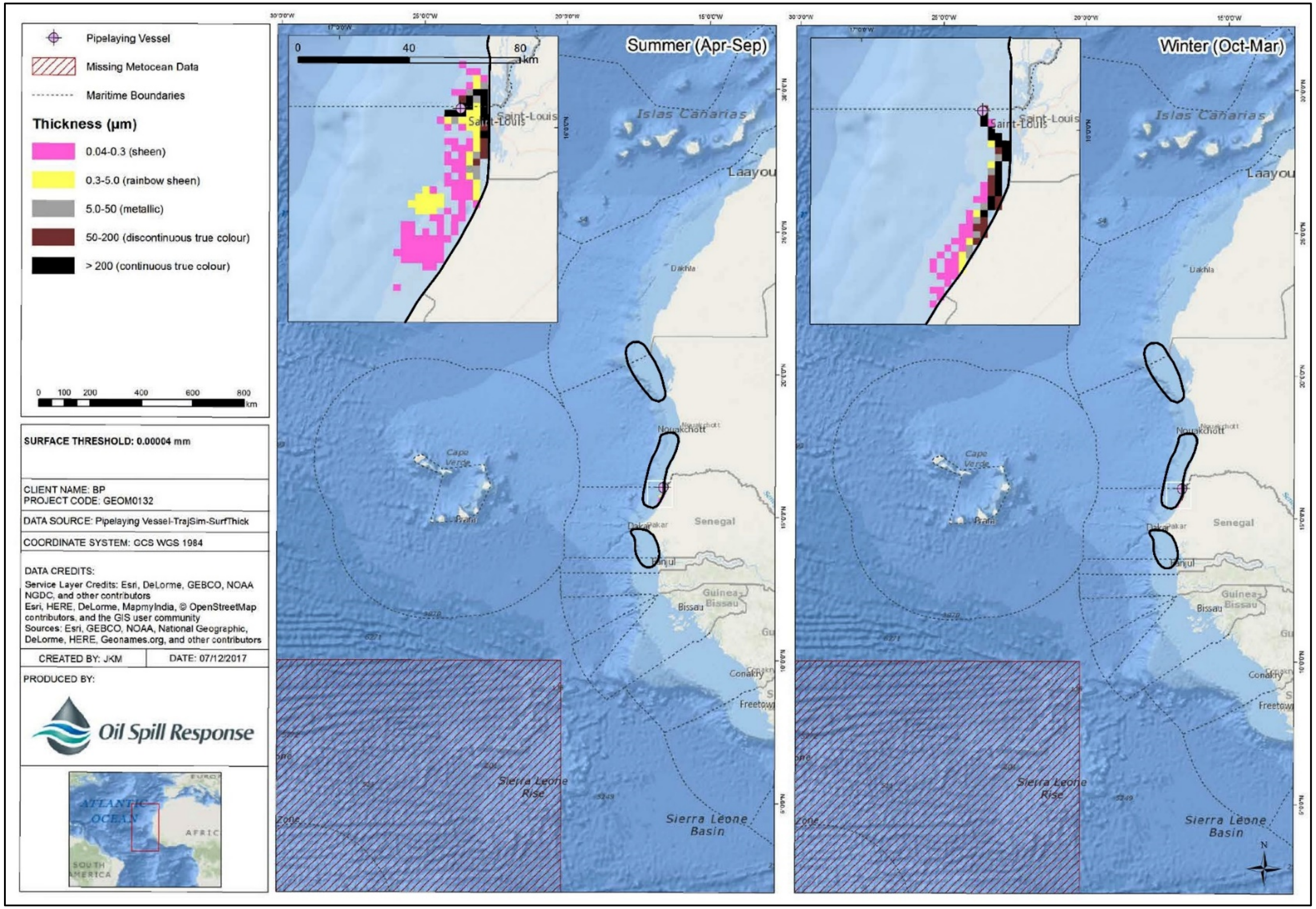


(Modified from: Appendix N-1)

Figure 7-30. Maximum Dissolved Hydrocarbon Concentrations in the Water Column, by Season, for the Worst Case FPSO Failure Due to a Ship Collision Scenario Relative to Known Spawning/Retention Areas for Small Pelagic Species.

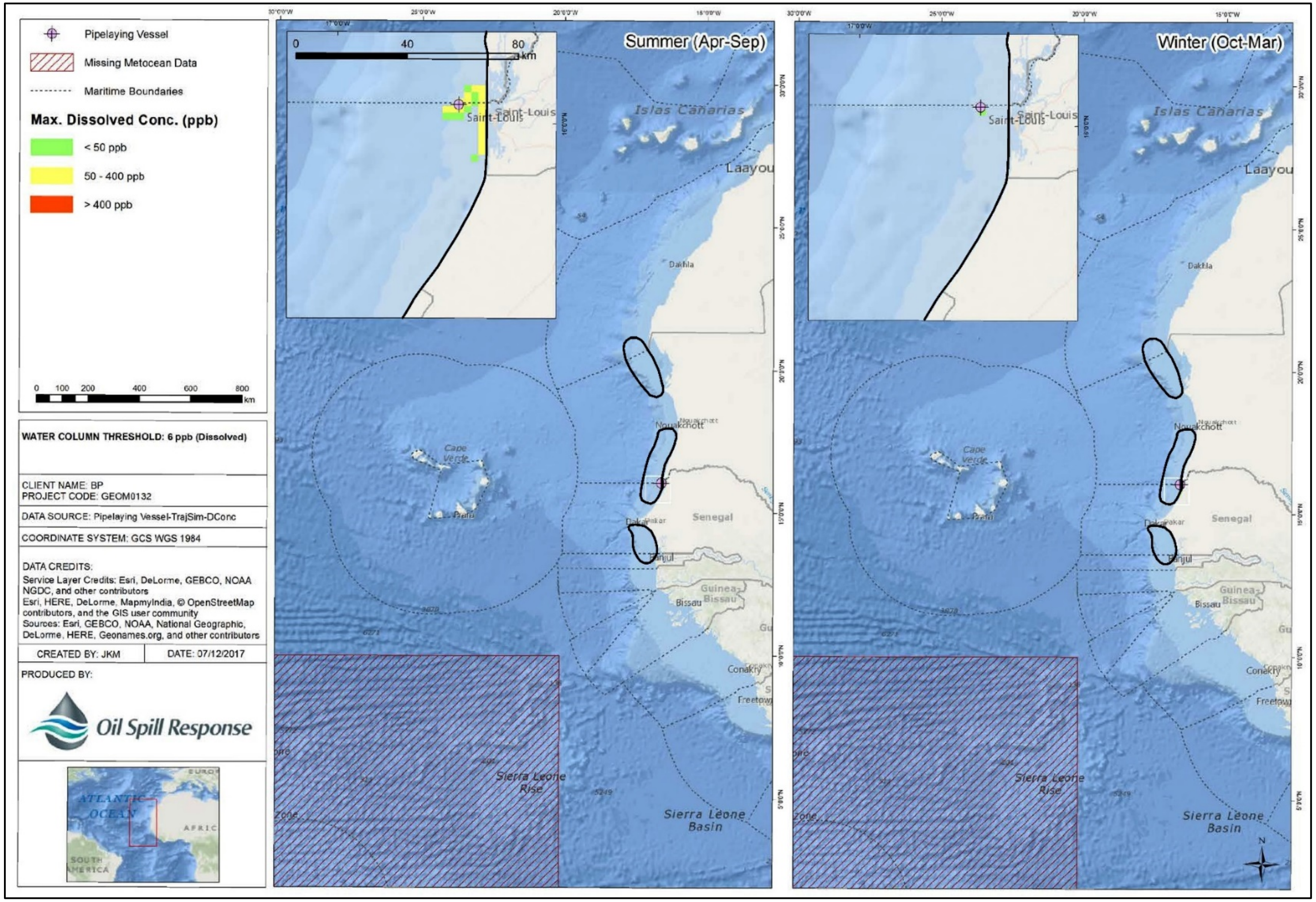
Pipelaying Vessel Collision

Under the worst-case scenario modeled (Appendix N-1), at the Nearshore Hub/Terminal, the collision of the pipelaying vessel and subsequent product loss would result in the release at the surface of the ocean of 2,960 m^3 of MDO over 3 hours, of 3,370 m^3 of HFO over 3.4 hours, and of 92 m^3 of lubricating oil over 1 hour (Section 7.5.1). This event would take place within the Saint-Louis spawning/retention area. The model results show that surface oil up to 200 µm thick and covering a relatively small portion of the Saint-Louis spawning/retention area would reach the shoreline in about 2 days during boreal Summer. Water column concentrations up to 400 ppb would be present for about 4 days in small areas nearshore. In boreal Winter, the spill trajectory indicated a small, patchy spread of oil within 2 days and with concentrations up to 400 ppb could occur (Figure 7-31). Neither boreal Summer nor boreal Winter models predicted that dissolved hydrocarbons would reach either the Cape Vert or the Banc d’Arguin spawning/retention areas during either boreal Winter or Summer (Figure 7-32). During boreal Summer, spilled oil would have an 87% chance of entering the Senegal River estuary with a maximum concentration of 1,194 ppb. The chance of spilled oil entering the Senegal River estuary during boreal Winter was 24% at a maximum concentration of 764 ppb.



(Modified from: Appendix N-1)

Figure 7-31. Maximum Total Hydrocarbon Concentrations in the Water Column, by Season, for the Worst Case Pipelaying Vessel Collision Scenario Relative to Known Spawning/Retention Areas for Small Pelagic Species.



(Modified from: Appendix N-1)

Figure 7-32. Maximum Dissolved Hydrocarbon Concentrations in the Water Column, by Season, for the Worst Case Pipelaying Vessel Collision Scenario Relative to Known Spawning/Retention Areas for Small Pelagic Species.

7.5.6.3 Impact Rating

Well Blowout

For a well blowout at the seafloor, surface oil would be predicted to reach spawning and retention areas in boreal Summer and boreal Winter at dissolved water column concentrations of ≤500 ppb. Water column trajectories from the offshore release site mostly remained offshore, marginally reaching the Saint-Louis spawning/retention area in boreal Summer or boreal Winter. This scenario would not be expected to adversely affect early life stages which may be concentrated in the area. The highest amounts of weathered total hydrocarbons (≤500 ppb) would end up at the Saint-Louis spawning/retention area and the Senegal River estuary. The impact intensity rating for this scenario is moderate because even though a modeled single spill was shown to distribute oil over a relatively large surface, the concentration and toxicity were low. Spatial extent and duration are considered to be regional but short term (months) in nature, resulting in a minor impact consequence. Given the remote likelihood of this accidental event, overall impact significance is 1 – Negligible (see Table 7-163 below for details on selected criteria).

Failure of FPSO Due to a Ship Collision

An FPSO failure due to a ship collision approximately 40 km from shore would send relatively concentrated hydrocarbons into the Saint-Louis spawning/retention area and the Senegal River estuary in both boreal Summer and Winter months. Small amounts of spilled oil would potentially reach the Cape Vert spawning/retention area. The impact intensity rating for this scenario is moderate because although the amounts released were low, the concentrations were high enough to produce localized mortality. Spatial extent and duration are considered to be regional but short term in nature, resulting in a minor impact consequence. Given the remote likelihood of this accidental event, overall impact significance is 1 – Negligible (see Table 7-163 below for details on selected criteria).

Pipelaying Vessel Collision

A collision involving a pipelaying vessel would result in rapid transport of fuel and lubricating oil into the Saint-Louis spawning/retention area and the Senegal River estuary. The impact intensity rating for this scenario is moderate although the spill would be restricted, the spilled oil would be highly concentrated and only lightly weathered. Spatial extent and duration are considered to be regional but short term in nature, resulting in a minor impact consequence. Given the remote likelihood of this accidental event, overall impact significance is 1 – Negligible (see Table 7-163 below for details on selected criteria).

A summary of impact to plankton, fish, and other fishery resources from accidental events is presented in Table 7-163.

Table 7-163. Impacts to Plankton & Fish and Other Fishery Resources from Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout					
Mauritania Senegal	Exposure of water column containing early life history stages to low-concentration hydrocarbons; Overlap of surface spill components with known spawning/retention area off Saint-Louis; Bottom disturbance from drilling relief well.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 – Negligible
Failure of FPSO Due to a Ship Collision					
Mauritania Senegal	Exposure of water column containing early life history stages to elevated hydrocarbons; Overlap of surface and water column spill components with known spawning/retention area off Saint-Louis.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 – Negligible
Pipelaying Vessel Collision					
Mauritania Senegal	Exposure of water column containing early life history stages to elevated hydrocarbons; Overlap of surface and water column spill components with known sardine spawning area off Saint-Louis	Nature: Negative Intensity: Moderate Spatial Extent: Local Duration: Short term	Minor	Remote	1 – Negligible

7.5.6.4 Mitigation Measures and Residual Impacts

Impacts to plankton and fish and other fishery resourced from accidental events are rated 1 – Negligible. No mitigation measures are required. Measures and controls already planned in the project design are summarized as follows:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea X-mas trees), other well control barriers and isolation of any permeable zone.
- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.

- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.
- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.
- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.
- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.
- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.
- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.

- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Despite the impact being ranked as negligible, the following mitigation measure will be implemented:

- M112: In the unlikely event of a spill of high intensity, specific monitoring (e.g., environmental effects monitoring) may be required and developed in consultation with applicable national authorities.

7.5.7 Marine Flora

High Level Summary

In this section on Marine Flora, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. All impacts on Marine Flora from Accidental Events were assessed as of negligible significance. No mitigation measures were required.

7.5.7.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 include:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.7.2 Impact Description

The following subsections discuss an overview of the effects of oil on marine flora, followed by a summary of modeled environmental impacts from each accidental event in offshore and shoreline environments (from Appendix N-1) and a brief assessment of potential impacts from each event to marine flora within continental shelf waters and shoreline environments. A description of the contaminants to seafloor environments associated with proposed accidental events are discussed in Section 7.5.5.2.

Well Blowout

There are no marine flora communities present or expected to develop within waters of the continental slope during the project period. As discussed in Section 4.5.2, prior to construction activities, the distributions of marine flora (seagrasses and macroalgae) are limited to discrete areas within the photic zone. The introduction of certain infrastructure during the Construction Phase, such as the FPSO and associated ground tackle and flowlines, and the Nearshore Hub/Terminal would provide suitable substrate for colonization by macroalgae.

As discussed in Section 7.5.5.2, the presence of hydrocarbons in the Nearshore Hub/Terminal Area sediment does not confirm impact to the macrofloral communities. If the well blowout were to occur during the Operations Phase, the effects on these hard substrate fouling communities would be variable due primarily to depth of the substrate and distance from the release. It would be very unlikely that marine flora, if present, on subsea structures in the project areas would be exposed to the condensate release and significantly elevated hydrocarbon concentrations at depth due primarily to the buoyancy of the release. Surface structures that include the FPSO, FLNG, breakwater with berthings, and supply base docking facilities would likely come in direct contact with hydrocarbon compounds of variable concentrations in the form of a very thin emulsion layer of <50 µm which would be thinner than a layer of newsprint. There would be some degree of impact to flora that are present at the immediate sea surface with potential smothering and adherence that would impede to varying degrees physiological functions. The expected impact to these communities would include loss of plant cover, but not at a significant level due primarily to relatively short exposure and thin oily surface layer. In addition, the physical adherence of hydrocarbon compounds to surface flora could create excess weight and shearing forces making them susceptible breakage and holdfast detachment (Suchanek, 1993).

Failure of FPSO Due to a Ship Collision

Based on the spill trajectories for the catastrophic sea surface release of condensate and MDO from the FPSO, as presented in Appendix N-1, there are no marine flora communities present or expected to develop within waters of the continental slope during the project period. Similar to the well blowout event, the failure of the FPSO due to a ship collision would introduce hydrocarbons to the Nearshore Hub/Terminal Area that would be present in the water column and adjacent shoreline. As previously described for the well blowout, very high levels of sediment hydrocarbons would need to be present to measurably affect seafloor marine floral communities.

Effects to the hard substrate fouling communities from the failure of the FPSO due to a ship collision would be as generally described for the well blowout event. Due to the predicted thickness of the surface emulsification around the FPSO and in the Nearshore Hub/Terminal Area, there would be an expected significant loss of marine flora present at the immediate sea surface. Marine algae and seaweed may become more dominant in recovery since most vegetation appears to recover following spills (USFWS, 2010).

Pipelaying Vessel Collision

Similar to the FPSO failure event, the pipelaying vessel collision event is characterized by the rapid release of relatively large quantities of MDO, HFO and lubricating oil on the sea surface. This event would be a water column-dominated event with very limited potential to expose seafloor sediments to elevated hydrocarbons. Worst-case scenario for this accidental event predicts that fate of approximately 7 to 8% of the release materials would be in the sediment. While the distribution of this sediment-bound oil was not predicted from the model, it is assumed that the sediment-bound hydrocarbons would be predominantly located in the Nearshore Hub/Terminal Area, due primarily to the extremely low probability of elevated hydrocarbons being present in the water column of the Offshore and Pipeline Areas. It is assumed that marine floral communities within impacted seafloor in this area would be lost.

Effects to the hard substrate fouling communities from the pipelaying vessel collision would be as generally described for the FPSO failure event. Due to the predicted thickness of the surface emulsification around the FPSO, in the Nearshore Hub/Terminal Area, and in the supply base port, there would be an expected significant loss of marine flora present at the immediate sea surface. Marine algae and seaweed may become more dominant in recovery since most vegetation appears to recover following spills (USFWS, 2010).

7.5.7.3 Impact Rating

Well Blowout

The effects to marine flora communities in the Nearshore Hub/Terminal Area, Pipeline Area, and the supply base dock from a well blowout event include a potential localized decrease in abundance and diversity, attributed to burial, sediment grain size changes, and an influx of organic material, as described in Section 7.5.5. The impact intensity of the well blowout to would be low with potential changes to seafloor marine flora communities that would unlikely be noticed against background. If the well blowout were to occur during the Operations Phase, there would be expected loss of fauna and flora from the hard substrate fouling community present at the immediate sea surface.

The impact intensity of a well blowout is expected to be low due to short exposure and very light oiling. Impacts are expected to be short term in duration though regional in extent. Given the remove likelihood of this accidental event, overall impact significance is 1 – Negligible (see Table 7-164 below for details on selected criteria).

Failure of FPSO Due to a Ship Collision

The failure of FPSO event with sea surface release of condensate and MDO is not expected to have detectable impact on nearshore marine flora communities; however, communities that may develop on shallow substrates surrounding the Nearshore Hub/Terminal during the Operations Phase may be lost.

The intensity of impacts to seafloor marine flora is expected to be low. Impacts are expected to be short term in duration though regional in extent. Given the remove likelihood of this accidental event, overall impact significance is 1 – Negligible (see Table 7-164 below for details on selected criteria).

Effects to hard substrate marine flora (fouling) communities on the FPSO, Nearshore Hub/Terminal and supply base dock from the failure of the FPSO event would result in a substantial loss of surface and near surface plants. The intensity of impacts to the hard substrate fouling communities would be moderate, due to significant loss of flora. Impacts are expected to be short term in duration though regional in extent. Given the remove likelihood of this accidental event, overall impact significance is 1 – Negligible (see Table 7-164 below for details on selected criteria).

Pipelaying Vessel Collision

Vessel collision with sea surface rapid release of MDO, HFO, and lubricating oil would be unlikely to affect nearshore marine flora communities; however, communities that may develop on shallow substrates surrounding the Nearshore Hub/Terminal during the Operations Phase may be lost.

The intensity of impacts to seafloor marine flora is expected to be low. Impacts are expected to be short term in duration though regional in extent. Given the remove likelihood of this accidental event, overall impact significance is 1 – Negligible (see Table 7-164 below for details on selected criteria).

Effects to hard substrate marine flora (fouling) communities on the FPSO, Nearshore Hub/Terminal and supply base dock from pipelaying vessel collision would result in a substantial loss of surface and near surface plants. The intensity of impacts to the hard substrate fouling communities would be moderate, due to significant loss of flora. Impacts are expected to be short term in duration though regional in extent. Given the remove likelihood of this accidental event, overall impact significance is 1 – Negligible (see Table 7-164 below for details on selected criteria).

Summary

A summary of impact to marine flora communities from accidental events is presented in Table 7-164.

Table 7-164. Impacts to Marine Flora Communities from Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout					
Mauritania Senegal	Localized decrease in the seafloor marine flora community and hard substrate fouling community from a well blowout.	Nature: Negative Intensity: Low Spatial Extent: Regional Duration: Short term	Negligible	Remote	1 – Negligible
Failure of FPSO Due to a Ship Collision					
Mauritania Senegal	Localized decrease in the seafloor marine flora community from an FPSO failure due to a ship collision.	Nature: Negative Intensity: Low Spatial Extent: Regional Duration: Short term	Negligible	Remote	1 – Negligible
Mauritania Senegal	Localized decrease in the hard substrate seafloor marine flora (fouling) community from an FPSO failure due to a ship collision.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 – Negligible
Pipelaying Vessel Collision					
Mauritania Senegal	Localized decrease in the seafloor marine flora community from a pipelaying vessel collision,	Nature: Negative Intensity: Low Spatial Extent: Regional Duration: Short term	Negligible	Remote	1 – Negligible
Mauritania Senegal	Localized decrease in the hard substrate seafloor marine flora (fouling) community from a pipelaying vessel collision.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 – Negligible

7.5.7.4 Mitigation Measures and Residual Impacts

Impacts to marine flora from accidental events are rated 1 – Negligible; no mitigation measures are required.

Summary of existing mitigation and monitoring measures inherent to design and operational controls:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea Xmas trees), other well control barriers and isolation of any permeable zone.

- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.
- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.
- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.
- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.
- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.
- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.

- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.
- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

7.5.8 Birds

High Level Summary

In this section on Birds, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. The residual impacts on Birds from Accidental Events were assessed as of medium significance when mitigation measures are applied.

7.5.8.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.8.2 Impact Description

Accidental events as described in Section 7.5.1 would introduce large volumes of contaminant materials into the receiving environment of the project areas. The following subsections present an overview of the effects of oil on birds, followed by a summary of modeled environmental impacts from each accidental event in offshore and shoreline environments (from Appendix N-1) and a brief assessment of potential impacts from each event to regional birds within oceanic (continental slope) waters, outer and middle continental shelf waters, and inner shelf waters and shoreline environments.

7.5.8.2.1 Effects of Oil Spills on Birds

Marine birds represent the faunal group that would be most seriously affected by spilled oil in the marine environment. Reported direct mortalities from large oil spills can be dramatic:

- US agencies collected over 8,500 oiled birds, and estimated bird mortality at ~51,600 to 84,500 birds, in the *Deepwater Horizon* oil spill (Deepwater Horizon Natural Resource Damage Assessment Trustees, 2016);
- 40,000 to 100,000 from the *Tricolor* spill (Camphuysen and Leopold, 2004);
- 100,000 to 300,000 due to the *Prestige* spill (Castege et al., 2007);
- 80,000 to 150,000 from the *Erika* grounding (Cadiou et al., 2004); and
- 250,000 from the *Exxon Valdez* spill (Piatt and Ford, 1996).

Of particular concern are oil spills in regions where threatened, endangered, or vulnerable species are known to occur. As mentioned in Section 4.5.5.1, the distribution and relative densities of marine bird species within Mauritania and Senegal are strongly influenced by regular seasonal upwelling in offshore waters. These offshore waters are an important wintering area for high-latitude migrant seabird species, as well as local species. From regional studies, a similar suite of seabird species aggregate within and utilize common offshore habitats in both Mauritania and Senegal, depending on the presence of upwelling events and frontal zones.

The effects of spilled oil on birds may be direct and indirect. Direct contact of marine and coastal birds with condensate fluids, particularly in close proximity to the spill location, may impact birds and other animals through four primary pathways, per Day et al. (1997):

- Physical contact with plumage – when oil contacts and matts or fouls plumage;
- Ingestion – when animals swallow oil particles directly or consume prey items that have been exposed to oil;
- Absorption – when animal skin or mucous membranes come into direct contact with oil; and
- Inhalation – when animals breathe volatile organics released from oil.

Physical contact with spilled oil can result in the fouling or matting of feathers with subsequent limitation or loss of flight capability, and insulating or water-repellent capabilities. In extreme cases, contact with higher concentrations of surface oil may disrupt feather integrity, displacing insulating air between feathers and leading to loss of waterproofing, thermal insulation, and buoyancy. This extreme may make the birds become unable to fly so they cannot forage to feed. Even small exposures to oil reduce the integrity of feathers, and could impair flight performance.

Maggini et al. (2017) assessed western sandpipers (*Calidris mauri*), monitoring endurance flight performance after birds were exposed to weathered crude oil; they found that oiling tended to decrease flight control and that these changes reflected poorer lift production and increased drag on the wings and body. Overall, sublethal effects of oiling of feathers would increase the difficulty and energy costs of locomotion for daily and seasonal activities such as foraging, predator evasion, territory defense, courtship, chick provisioning, commuting and long-distance migration.

After bird plumage is oiled, fat reserves in the birds may become depleted and ultimately birds become severely hypothermic and emaciated (Jenssen, 1994; Piatt and van Pelt, 1997). The oil that is ingested from preening oiled feathers and feeding on oiled prey may result in oral exposure to hydrocarbon chemicals present in spilled oil. A significant proportion of these are toxic polycyclic aromatic hydrocarbons (PAHs) which, depending on the type of oil, degree of weathering and water content, can constitute up to 30% of total hydrocarbons present (Crude Oil IARC, 1989).

The degree of physical oiling and ingestion of oil can cause gastrointestinal irritation, ulcers, bleeding, diarrhea, and digestive complications. These complications may impair the ability of animals to digest and absorb foods, which ultimately leads to reduced health and fitness. Direct contact with skin can cause irritation or inflammation of skin or sensitive tissues, such as eyes and other mucous membranes, or toxic effects from absorption of hydrocarbons. Inhalation of volatile components can cause respiratory inflammation, irritation, emphysema, or pneumonia, respectively (Kennicutt et al., 1991; Mazet et al., 2002; NOAA, 2016).

Indirect effects of spilled oil on birds include infection, reductions in longevity or fitness due to behavioral, metabolic or genetic aberrations, transfer of oil from parents to eggs or young, or from prey to predator, and changes in food availability or predation pressure due to the effects of oil on the populations of other species (Eppley and Rubega, 1990). Seabirds can transfer oil from their feathers to the surface of their eggs during incubation. Depending on the type of oil on the feathers and the presence of toxic components, embryos in the affected eggs may fail to develop. Oil can also indirectly affect the survival or reproductive success of marine birds and mammals by affecting the distribution, abundance or availability of prey (NRC, 2003b).

The magnitude of bird mortality following an oil spill would be dependent upon a number of factors, including the quantity of oil spilled and its persistence, the size of the local bird population, foraging behavior, and the distribution of the bird populations present at the time of the spill (i.e., dispersed vs. aggregated) (NRC, 1985). It is assumed that spilled oil and/or fuel would rapidly spread to a layer of varying thickness and break up into narrow bands or windrows parallel to the wind direction. The rate at which the fuel spreads would be determined by the prevailing conditions such as temperature, water currents, tidal streams, and wind speeds. Lighter, volatile components of the condensate, fuel, or oil would evaporate to the atmosphere almost completely in a few days. Evaporation rate may increase as the oil spreads because of the increased surface area of the slick. Rougher seas, high wind speeds, and high temperatures also tend to increase the rate of evaporation and the proportion of oil lost by this process (American Petroleum Institute, 1999; USDOC, NOAA, 2006).

7.5.8.2.2 Assessed Scenarios

Well Blowout

Based on discharge trajectories as presented in Appendix N-1 and summarized in Section 7.5.3, the water column would be exposed to elevated hydrocarbon concentrations for approximately 40 days. In a catastrophic release such as a well blowout, discharged materials – whether oil, gas, condensate, or a mixture of gaseous and liquid hydrocarbons – would rise within the water column as a plume and entrain sea water during the ascent, which would reduce the plume's velocity and buoyancy and increase its radius. As the plume reaches the sea surface, ambient currents and wind-generated waves would determine the subsequent transport and dispersion of the discharged material.

Sea Surface Effects

Modeled trajectories of surface condensate (Appendix N-1; summarized in Section 7.5.3) show a broad spread of surface oil from the well to the shoreline and within waters offshore of the well. The shape of the trajectory varies for each modeled season (boreal Summer [April – September] and boreal Winter [October – March]). Both Mauritania and Senegal waters would be impacted by these spill scenarios. The thickness of the modeled condensate spill would be limited to mostly sheen (0.04 μm to 0.3 μm layer thickness) and rainbow sheen (0.3 μm to 5 μm layer thickness) that would readily disperse. A small amount of metallic sheen (layer thickness >5 μm) may be found in the local area around the well (~25 km). Because of the high turbulence created by a well blowout at the well site, it would be assumed the condensate droplets are very small; consequentially, they rise more slowly and do not concentrate in the same way as if there was an absence of gas.

Shoreline Effects

As modeled, a boreal Summer spill would have a high (96%) probability of reaching the shoreline, and a 33% probability of reaching the shoreline if it occurs in boreal Winter. In both cases, Mauritania and Senegal are at risk of shoreline impact, but Senegal would be most likely to be more severely impacted.

In the worst-case scenario, a boreal Summer spill may impact the shore in approximately 4 days after the release, although there would be a 50% probability that condensate would not make landfall within approximately 2 weeks and in the best-cast scenario, condensate would not reach the shore for 8.5 weeks. The severity of the shoreline impact in boreal Summer ranges from negligible (4% probability) in the best-case scenario, to more than 11,000 metric tonnes in the worst-case. There would be a 50% chance that more than 3,000 metric tonnes may wash ashore. There would be an 84% probability that moderate shoreline oiling (i.e., at a thickness of 1 to 10 mm and a concentration of 1 to 10 liters m^{-2}) would occur and may extend along the coast for a distance of up to nearly 300 km. There may also be an additional 185 km of light shoreline oiling (at a thickness of 0.1 to 1.0 mm and a concentration of 0.1 to 1 liters m^{-2}).

In the worst-case scenario, a boreal Winter spill may impact the shore in approximately 5 days after the release. However, there would be a 50% probability that condensate would not make landfall within approximately 7 weeks. In the best-cast scenario, condensate would not reach the shore. Similar to the boreal Summer spill, the severity of the shoreline impact in boreal Winter ranges from no significant impact (67% probability) in the best-case scenario, to more than 2,200 metric tonnes in the worst-case. There would be a 19% probability that moderate shoreline oiling would occur during a boreal Winter spill and may extend along the coast for a distance of nearly 54 km.

Impacts to Birds

Based on the modeled trajectories for a boreal Summer and boreal Winter spill (Appendix N-1; Section 7.5.3), it is likely that some marine birds within regional oceanic waters (i.e., waters of the continental slope) would encounter and may make physical contact with surface oil over the 60-day period. Birds that may occur near the affected well and within the trajectory swath between southern Mauritania and Dakar, Senegal would encounter the highest surface hydrocarbon concentrations. Both spill scenarios carry surface oil in light sheen thicknesses as far west as the Cape Verde archipelago, north to Morocco, and south as far as Guinea. The risk of physical contact with oil within these areas would be limited to seabirds that may land on the sea surface to rest or feed on or below the sea surface. In the region, most seabird species feed on the surface (e.g., procellariids and gulls) or may make shallow dives (e.g., terns) or plunge dives (e.g., Northern Gannet) for prey.

As discussed above, the degree of potential impact to birds that may make physical contact with surface oil in these waters depends upon the concentration of petroleum hydrocarbons within a specific area, their length of exposure to the oil, and the persistence and bioavailability of specific hydrocarbons (i.e., the state of surface oil toxicity based on weathering processes). Because of the size of the spill trajectory, it would be possible that individual birds may be directly exposed to surface oil more than once while feeding or roosting. Based on the size of the spill, the relatively short duration of the spill, and the overall low surface thickness of surface oil within the spill trajectory, it is likely that few seabirds in regional oceanic waters may perish from direct effects of oiling, and impacts to a larger percentage of birds that come into contact with surface oil in sheen concentrations may be limited to sublethal effects. It is not possible to quantify the extent of mortality or sublethal impacts; however, it is expected that these effects would not significantly affect regional populations or species.

On outer and mid-continental shelf waters, there would be a 50 to 75% probability that surface condensate from a boreal Summer spill would extend as far north as Nouakchott, Mauritania and south to Dakar, Senegal. In boreal Winter, the trajectory extends mostly to the south as far as southern Senegal. The surface thickness of condensate within these areas would be largely rainbow sheen (3 to 5 µm thickness); close to the well, thicknesses would be metallic sheen (5 to 50 µm), as described in Appendix N-1 and Section 7.5.3. In both areas, the condensate spill would readily disperse.

Birds associated with shelf waters include seabirds (e.g., some procellariids, gulls, and terns) as well as cormorants and possibly few wading birds (herons and egrets) on structures within the Nearshore Hub/Terminal Area. Cormorants may be more susceptible to direct oiling, based on their feeding behavior (i.e., underwater swimming and extended periods of time on or passing through the air water interface). Based on modeling results, this area is likely to receive the highest concentrations of condensate during both boreal Winter and boreal Summer spill scenarios. Based on the size of the spill, the relatively short duration of the spill, and the overall low surface thickness of surface oil within the spill trajectory, it is likely that few seabirds in regional shelf waters may perish from direct effects of oiling, and impacts to a larger percentage of birds that come into contact with surface oil in sheen concentrations may be limited to sublethal effects. It is not possible to quantify the extent of mortality or sublethal impacts; however, it is expected that these effects would not significantly affect regional populations or species.

On inner shelf waters and adjacent shorelines, there would be a 50 to 75% probability that surface condensate from a boreal Summer spill would extend from southern Mauritania to northern Senegal. In boreal Winter, the probability of surface condensate reaching shore would be less than 25%. During both seasons, the surface thickness of condensate within these areas would be almost entirely rainbow sheen (3 to 5 µm thickness), which would be expected to dissipate rapidly (Appendix N-1; Section 7.5.3).

Birds associated with inner shelf waters and the shoreline include diverse seabird, wader, and shorebird species. Furthermore, several protected areas that support large populations of coastal and marine birds are located within the modeled trajectory path. In southern Mauritania, these include the Chatt Tboul Reserve, Diawling National Park, and Aftout Es Sahli IBA. In northern Senegal, these include the Saint-Louis Marine Protected Area, Cayar Marine Protected Area, and Langue-de-Barbarie National Park.

Modeling results presented in Section 7.5.1 and Appendix N-1 predict that in the event of a well blowout in the Offshore Area, marine protected areas including the Saint-Louis Marine Protected Area, the Cayar Marine Protected Area, or offshore EBSAs such as the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal, Cayar Seamount Complex EBSA, or the Cayar Canyon EBSA have a 25 to 50% probability of surface oiling in boreal Summer and a 5 to 25% chance of surface oiling in boreal Winter. Impacts to these protected areas are discussed in Section 7.5.11.2.

It is expected that the majority of the spilled oil that reaches the shoreline on these coasts would contact high energy sandy beaches. Oil can be worked into these unconsolidated sediments during different tidal cycles. Beach-dwelling species, such as diverse shorebird species and some seabirds such as gulls and terns, may be directly oiled or may ingest oiled prey items. Some inland wetland habitats may also receive spilled oil when an open exchange exists between coastal waters and the inland coastal habitats. Contamination within inland wetland habitats would be limited to tidal flow. In these cases, a more diverse suite of waterbird species may be affected by spilled oil.

Based on the size of the spill, the relatively short duration of the spill, and the overall low surface thickness of surface oil within the spill trajectory, it is likely that few birds in regional inner shelf waters and along the impacted shoreline may perish from direct effects of oiling via direct contact and the ingestion of oiled prey, particularly benthic intertidal invertebrates along the affected shoreline (Section 7.5.5). It is also assumed that impacts to a far larger percentage of birds that come into contact with the surface oil in sheen concentrations may be limited to sublethal effects. It is not possible to quantify the extent of mortality or sublethal impacts; however, it is expected that these effects would not significantly affect regional populations or species.

Failure of FPSO Due to a Ship Collision

Oil spill modeling for FPSO storage tank (condensate spill) and diesel tank failure resulting in release of 160,000 m^3 of condensate over 160 hours and 3,200 m^3 of MDO over 3.2 hours was performed using two seasonal scenarios: boreal Summer (April through September) and boreal Winter (October through March) (Appendix N-1).

Sea Surface Effects

During both modeled seasons, Senegal waters are more than likely to be impacted by these spills than Mauritania, primarily as a result of a southerly flowing current. During boreal Summer, there would be a greater than 50% probability that the spill would reach southern Mauritania and Senegal (south to the border of Dakar) within 1 to 3 days. Within nearshore waters of Senegal and southern Mauritania, the modeled spill may reach a surface thickness ranging from a metallic sheen (5 to 50 µm layer thickness) to a discontinuous true color (50 to 200 µm layer thickness), and a continuous true color (>200 µm layer thickness) in some areas. The inner shelf waters of other neighboring countries may experience oil sheen on the surface waters but at a thickness of 3 to 5 µm.

During boreal Winter, the southerly currents move the majority of the spill trajectory into Senegal waters, with highest probabilities (>50%) as far south as Dakar within a period of 1 to 7 days. Concentrations of hydrocarbons within inner shelf waters during the modeled boreal Summer are similar to those modeled during the boreal Winter scenario.

Shoreline Effects

A spill at the FPSO, approximately 40 km from the shore, would have a 100% chance of making a considerable shoreline impact (light oiling or higher) if the spill happens in boreal Summer and an 82% chance of shoreline impact if it occurs in boreal Winter. Mauritania and Senegal are the only two countries at risk of shoreline impact, but Senegal would be most likely to be more severely impacted.

During boreal Summer, the probability of shoreline impact within northern Senegal (and east of the FPSO) would be 50 to 75%, whereas, the probability of contact along the coast from southern Mauritania and southward as far as Dakar would be 25 to 50% (percentage rating from south to north). The emulsion thickness along the impacted area would be classified as moderate (1 to 10 mm) at a concentration of 1 to 10 liters m^{-2}.

In boreal Winter, the greatest probability for shoreline contact would be in the southern part of the Grande Côte up to Dakar, Senegal, whereas the probability for contact in Mauritania would be less than 5%. As in the case of the boreal Summer scenario, the emulsion thickness along the impacted area would be classified as moderate (1 to 10 µm in thickness) at a concentration of 1 to 10 liters m^{-2}.

Impacts to Birds

Based on the modeled trajectories for a boreal Summer and boreal Winter spill (Appendix N-1), it is likely that some seabirds within oceanic waters of the continental slope would encounter and may make physical contact with surface oil over the 160-hour release period only if the spill were to occur in boreal Winter. During boreal Summer, the spread of surface oil would trend mostly southward from the source. The impacts from the FPSO spill would be expected to affect only seabirds within slope waters. Groups that may be present in these waters are listed above for the well blowout event. The surface thickness of spilled condensate and diesel fuel in this area would be listed as rainbow sheen (0.3 µm to 5 µm layer thickness) that would readily disperse. Based on the size of the spill, the relatively short duration of the spill, and the overall low surface thickness of surface oil within the spill trajectory, it would not be likely that seabirds in regional oceanic waters would perish from direct effects of oiling; rather, impacts to the few individuals that may come into contact with surface oil in sheen concentrations are expected to be limited to sublethal effects. It is expected that these sublethal effects would not significantly affect regional populations or species.

Birds that may occur along the mid and outer continental shelf, and in waters near the FPSO and within the trajectory swath between southern Mauritania to Dakar, Senegal would encounter the highest surface hydrocarbon concentrations from this event, ranging from a surface thickness ranging from a metallic sheen (5 to 50 µm layer thickness) to a discontinuous true color (50 to 200 µm layer thickness), and a continuous true color (>200 µm layer thickness) in some areas. As in the case of the well blowout event, it is likely that the condensate and MDO spilled from the FPSO would result in the mortality of individual seabirds, along with a greater percentage of impacted birds that would suffer sublethal effects.

Birds associated with shelf waters include seabirds (e.g., some procellariids, gulls, and terns) as well as cormorants and possibly few wading birds (herons and egrets) on structures within the Nearshore Hub/Terminal Area. The accidental event involving a spill at the FPSO is for this analysis may occur during the Operations Phase; for this assessment, it is would be assumed that infrastructure at the Nearshore Hub/Terminal would support diverse shallow water epibiota similar to those described in the baseline environment (see Sections 7.3.7.2.3 and 4.5.3.1). Therefore, numerous inner shelf seabird and coastal waders may be attracted to this infrastructure as well. Cormorants may be more susceptible to direct oiling, based on their feeding behavior, including underwater swimming and extended periods of time on or passing through the air-water interface. Based on modeling results, this area would likely receive the highest concentrations of condensate and MDO during both boreal Winter and boreal Summer spill scenarios.

Based on the size of the spill, the relatively short duration of the spill, and the overall low surface thickness of surface oil within the spill trajectory, it is likely that few seabirds in regional shelf waters may perish from direct effects of oiling, and impacts to a larger percentage of birds that come into contact with surface oil in sheen concentrations may be limited to sublethal effects. It is not possible to quantify the extent of mortality or sublethal impacts; however, it is expected that these effects would not significantly affect regional populations or species.

The fate of a spill at the FPSO on coastal habitats is described above. Birds associated with inner shelf waters and the shoreline include diverse seabird, wader, and shorebird species. Based on the size of the spill, the relatively short duration of the spill, and the overall moderate surface thickness of surface oil within the spill trajectory, it is likely that individual birds in regional inner shelf waters and along the impacted shoreline may perish from direct effects of oiling via direct contact and the ingestion of oiled prey, particularly benthic intertidal invertebrates along the impacted shoreline (Section 7.5.5). It would also be assumed that impacts to a far larger percentage of birds that come into contact with the surface oil in sheen concentrations may be limited to sublethal effects. It is not possible to quantify the extent of mortality or sublethal impacts; however, it is expected that these effects would not significantly affect regional populations or species.

Pipelaying Vessel Collision

Oil spill modeling for a pipelaying vessel collision resulting in the release of 2,960 m^3 of MDO over 3 hours, 3,370 m^3 of HFO over 3.4 hours; and 92 m^3 of lubricating oil over 1 hour was performed using two seasonal scenarios: boreal Summer and boreal Winter (Appendix N-1).

Sea Surface Effects

From the modeling results, Senegal waters are more likely to be impacted by this spill scenario during both seasons than Mauritania, due to a southerly flowing current.

The inner shelf waters of northern Senegal and southern Mauritania are at risk in the boreal Summer, with a 50 to 75% probability of spilled oil reaching nearshore waters off the northern part of the Grande Côte. Probabilities of contact with surface waters drop off significantly to the north and south of this swath. The maximum thickness of surface oil within surface waters in this area would be greater than 200 μm. To the north and south of this area, the oil thickness drops to a sheen (0.04 μm to 0.3 μm layer thickness) and rainbow sheen (0.3 μm to 5 μm layer thickness) that would readily disperse.

During boreal Winter, the spill trajectory extends much further offshore of southern Mauritania and south to Dakar. During boreal Winter, there would be a 25 to 50% probability that spilled oil would reach inner shelf waters in southern shores of Grande Côte (Senegal), although the probability of oil reaching outer shelf and slope waters in the area are low (<5%). Emulsion thicknesses greater than 200 μm and between 50 to 200 μm extend much further offshore and south to the Dakar Peninsula. Sheen level concentrations (<3 μm) extend offshore into slope waters.

Shoreline Effects

A spill at this location, approximately 10 km from the shore, would have a 100% probability of making a sizeable shoreline impact (with light oiling or higher) whether the spill happens during boreal Summer or boreal Winter. Mauritania and Senegal are the only two countries at risk of shoreline impact, but Senegal would be most likely to be more severely impacted.

A spill in boreal Summer may impact the shore in 2 days after the release, and the severity of the shoreline impact in boreal Summer ranges from a 1,500 metric tonnes in the best-case scenario, to more than 4,500 metric tonnes in the worst-case. There would be a 60% probability that more than 3,300 metric tonnes may wash ashore. A shoreline impact in boreal Summer would be expected to have a 91% probability of moderate shoreline oiling, with a 9% probability of heavy shoreline oiling. Spatially, however, only a few km of shoreline would be expected to have heavy shoreline oiling, but up to 62 km could be impacted by moderate oiling.

A spill in boreal Winter would have a lower risk to the shoreline of the two modeled seasons. In the worst-case scenario, a boreal Winter spill may impact the shore in a little more than 1 day after the release. The severity of a shoreline impact in boreal Winter ranges from a few metric tons in the best-case scenario, to greater than 4,500 metric tonnes in the worst-case. There would be a 30% probability that more than 3,300 metric tonnes may come ashore.

A boreal Winter spill would be expected to have a 1% probability of heavy shoreline oiling, a 91% probability of moderate shoreline oiling, and 1% probability of light shoreline oiling. Spatially, however, only a few km of shoreline would be expected to have heavy shoreline oiling, but up to 58 km may be impacted by moderate oiling.

Impacts to Birds

The modeled trajectories for a boreal Summer and boreal Winter spill from a pipelaying vessel collision (Appendix N-1) suggest that that some marine birds within oceanic waters of the continental slope would encounter and may make physical contact with surface oil over the 3.4-hour release period only if the spill were to occur in boreal Winter (October through March). During a boreal Summer spill (April through September), the spill trajectory extends inshore of the continental slope. The spread of MDO, HFO and lubricating oil on the sea surface trends mostly southward and westward from the source during boreal Winter. Birds that may occur near the point of entry and within the trajectory swath between southern Mauritania to Dakar, Senegal would encounter the highest surface hydrocarbon concentrations. It is likely that the oil spill would result in the mortality of individual seabirds, along with a greater percentage of impacted birds that would suffer sublethal effects. The numbers of impacted birds within waters of the continental slope are expected to be much lower than those affected by the well blowout event and, although it is not possible to quantify the extent of mortality or sublethally impacted birds, these effects are not expected to significantly affect regional populations or species.

During boreal Summer, there would be a less than 25% probability that spilled oil would travel through outer and mid-continental shelf waters. During boreal Winter, this probability increases to 25 to 50% in waters south of the point of release and extends south into Senegal waters. The maximum surface thickness of oil within outer and mid-continental shelf waters greater than 200 µm (Appendix N-1). Birds associated with shelf waters include seabirds (e.g., some procellariids, gulls, and terns). Based on the size of the spill, the relatively short duration of the spill, and the relatively high surface thickness of surface oil within the spill trajectory, it is likely that individual seabirds in regional shelf waters may perish from direct effects of oiling. Impacts to a larger percentage of birds that come into contact with surface oil in sheen concentrations may be limited to sublethal effects. It is not possible to quantify the extent of mortality or sublethal impacts; however, it is expected that these effects would not significantly affect regional populations or species.

As previously mentioned, over inner shelf waters and along adjacent shorelines, a spill at this location would have a 100% probability of making a sizeable shoreline impact; up to 62 km could be affected by moderate oiling in boreal Summer and up to 58 km may be affected by moderate oiling in boreal Winter (Appendix N-1). Birds associated with inner shelf waters and the shoreline include diverse seabird, wader, and shorebird species. Based on the size of the spill, the relatively short duration of the spill, and the relatively high shoreline thickness of oil within the spill trajectory, it is likely that numerous birds in regional inner shelf waters and along the impacted shoreline may perish from direct effects of oiling via direct contact and the ingestion of oiled prey, particularly benthic intertidal invertebrates along the impacted shoreline (Section 7.5.5). It would also be assumed that a far larger percentage of birds that come into contact with the surface oil in sheen concentrations may suffer sublethal effects. It is not possible to quantify the extent of mortality or sublethal impacts; however, it is expected that these effects would not significantly affect regional populations or species.

7.5.8.3 Impact Ratings

Well Blowout

The consequence of impacts to birds from a well blowout event include acute effects from both direct and indirect exposure to released condensate hydrocarbons. As modeled, the fate of a well failure, as manifested by the spatial trajectory of released condensate, depends upon the seasonal wind and current conditions.

Assuming the worst case scenario between seasonal modeling results, the impact intensity of the well blowout is high, based on the anticipated numbers of birds killed and sublethally affected by the released condensate, which is a function of the relative sea surface thickness or shoreline thickness of condensate and associated hydrocarbons and other toxins (e.g., metals). The extent of these impacts would be regional. Although the duration of the spill in open water environments is short term, it is anticipated that elevated concentrations of hydrocarbons and other contaminants associated with the spill may linger in intertidal environments and particularly within wetland habitats, including sensitive habitats for many marine and coastal bird species. Due to the potentially high levels of bird mortalities and other sublethal impacts from the spill, it is anticipated that these impacts may affect local populations, particularly within these habitats. Assuming the worst case scenario, overall impacts from a wellhead failure blowout is therefore long term. Consequently, the impact consequence is severe. As an accidental event, its likelihood is remote and the overall impact significance is 3 – Medium (see Table 7-165 below for details on selected criteria).

Failure of FPSO Due to a Ship Collision

The failure of FPSO event with sea surface release of condensate and MDO would have the potential for detectable impacts to regional birds, particularly within inner shelf waters off Senegal. Within waters of the outer continental shelf and slope, and inner shelf waters of other countries, including southern Mauritania, Cape Verde, Guinea-Bissau, and The Gambia, released condensate and MDO concentrations are relatively low and classified as a sheen. There is a significant probability that condensate and MDO would reach shoreline habitats of southern Mauritania and especially Senegal, where the emulsion thickness in areas are modeled as moderate. Birds within slope waters may experience spill concentrations of only rainbow sheen and impacts are not likely. However, birds on the continental shelf may experience much higher concentrations in some area, resulting in potential mortalities and sublethal impacts. Within shoreline environments, primarily in Senegal, the spill thickness is rated as moderate and it is expected that coastal birds and inner shelf seabirds may experience numbers of mortalities from direct and indirect exposures.

As discussed above, when assuming the worst case scenario between seasonal modeling results, the impact intensity of the FPSO failure due to a ship collision is high, based on the anticipated numbers of birds killed and sublethally affected by the released oil. The duration of the spill in waters of the continental shelf is short term, although it is anticipated that elevated concentrations of hydrocarbons and other contaminants associated with the spill may linger for a longer period of time within intertidal environments and particularly within wetland habitats, including sensitive habitats for many marine and coastal bird species. Due to the potentially high levels of bird mortalities and other sublethal impacts from the spill, it is anticipated that these impacts may affect local populations, particularly within these habitats. Assuming the worst case scenario, overall impacts from this accidental event scenario is therefore long term. Consequently, the impact consequence is severe. As an accidental event, its likelihood is remote and the overall impact significance is 3 – Medium (see Table 7-165 below for details on selected criteria).

Pipelaying Vessel Collision

A vessel collision resulting in a sea surface rapid release of MDO, HFO, and lubricating oil is likely to affect regional birds as spilled fuel would be carried into shallow water and shorelines, based on the trajectories and weathering characteristics. Similar to the FPSO failure event, the inner shelf waters and shorelines of northern Senegal and southern Mauritania are at most risk, with areas of moderate oiling and some discrete areas with heavy oiling. Birds within slope waters may experience spill concentrations of only rainbow sheen in for a boreal Winter spill, and impacts are not likely. However, birds on the continental shelf may experience much higher concentrations in some area, resulting in potential mortalities and sublethal impacts. On shoreline environments, primarily in Senegal, it is expected that coastal birds and inner shelf seabirds might experience numbers of mortalities from direct and indirect exposures.

As discussed above, when assuming the worst case scenario between seasonal modeling results, the impact intensity of spilled oil and fuel from the pipelaying vessel collision is high, based on the anticipated numbers of birds killed and sublethally affected by the released oil. As discussed above, the duration of the spill in waters of the continental shelf is short term, although it is anticipated that elevated concentrations of hydrocarbons and other contaminants associated with the spill may linger for a longer period of time within intertidal environments and particularly within wetland habitats, including sensitive habitats for many marine and coastal bird species. Due to the expected high levels of bird mortalities and other sublethal impacts from the spill, it is anticipated that these impacts may affect local populations, particularly within these habitats. Assuming the worst case scenario, overall impacts from a pipelaying vessel collision is therefore long term. Consequently, the impact consequence is severe. As an accidental event, its likelihood is remote and the overall impact significance is 3 – Medium (see Table 7-165 below for details on selected criteria).

Summary

A summary of impact to birds from accidental events is presented in Table 7-165.

Table 7-165. Impacts to Birds from Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout					
Mauritania Senegal	Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from a blowout.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: IPF in shelf waters - Short Term; Impacts to regional birds – Long Term	Severe	Remote	3 – Medium
Failure of FPSO Due to a Ship Collision					
Mauritania Senegal	Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: IPF in shelf waters - Short Term; Impacts to regional birds – Long Term	Severe	Remote	3 – Medium
Pipelaying Vessel Collision					
Mauritania Senegal	Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from pipelaying vessel collision.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: IPF in shelf waters - Short Term; Impacts to regional birds – Long Term	Severe	Remote	3 – Medium

7.5.8.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-166) and available mitigation measures recommended to reduce impact likelihood associated with accident-related impacts to birds are identified. While these measures may further reduce accident likelihood, they would not alter overall impact significance. These mitigation measures are in addition to the measures and controls already planned in the project design, summarized as follows:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea X-mas trees), other well control barriers and isolation of any permeable zone.
- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.

- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.
- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.
- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.
- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.
- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.
- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.

- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Table 7-166. Mitigation Measures to Avoid or Reduce Impacts to Birds from Accidental Events.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from a blowout.	3 – Medium	M101, M102, M103, M104, M105, M112	3 – Medium
Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.	3 – Medium	M101, M102, M103, M104, M105, M112	3 – Medium
Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from pipelaying vessel collision.	3 – Medium	M101, M102, M103, M104, M105, M112	3 – Medium

Notes:

M101: In the unlikely event of a spill, tactical response methods that may be considered under the OSCP include: surveillance and monitoring, offshore containment and recovery; subsea and at surface dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.

M102: All response measures will be continuously monitored to ensure that they remain effective. The response team will maintain situational awareness of the event and response effort.

M103: In the unlikely event of a spill reaching the shoreline, a Shoreline Clean-up and Assessment Technique (SCAT) program will be implemented to inform shoreline clean-up and remediation as applicable.

M104: In the unlikely event of a spill reaching the shoreline, a shoreline clean-up and remediation team will be mobilized to the affected areas. BP will also engage specialized expertise to mitigate impacts to sensitive areas and wildlife species as needed.

M105: In the unlikely event of a spill, follow national regulatory requirements for reporting and notification, using established protocols, which extends to all relevant external stakeholders.

M112: In the unlikely event of a spill of high intensity, specific monitoring (e.g., environmental effects monitoring) may be required and developed in consultation with applicable national authorities.

7.5.9 Marine Mammals

High Level Summary

In this section on Marine Mammals, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. The residual impacts on Marine Mammals from Accidental Events were assessed as of medium significance when mitigation measures are applied.

7.5.9.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.9.2 Impact Description

Accidental events as described in Section 7.5.1 would introduce large volumes of contaminant materials into the receiving environment of the project areas. The following subsections discuss an overview of the effects of oil on marine mammals, followed by a summary of modeled environmental impacts from each accidental event in offshore and shoreline environments (from Appendix N-1) and a brief assessment of potential impacts from each event to regional marine mammals within oceanic (continental slope) waters, outer and middle continental shelf waters, and inner shelf waters.

Effects of spilled oil on marine mammals are discussed in a series of seminal journal publications or treatises, including Geraci and St. Aubin (1980, 1982, 1985, 1990) and Lee and Anderson (2005), as well as within spill-specific study results (e.g., *Exxon Valdez*: Frost and Lowry, 1994; Paine et al., 1996; Hoover-Miller et al., 2001; Peterson et al., 2003; *Deepwater Horizon*: Takeshita et al., 2017; Helm et al., 2015; Wallace et al., 2017). As discussed above in Section 7.5.8.2 for birds, the effects of spilled oil on marine mammals may be direct and indirect. Direct contact of marine mammals with condensate fluids, particularly in close proximity to the spill location, may impact animals by physical contact with skin and mucous membranes, ingestion of oil or oiled prey, absorption of oil toxins through the skin or mucous membranes and inhalation. Per Oiledwidllife (2018), the external effects of oil on marine mammals would vary, depending on the species, but may include:

- Hypothermia in pinnipeds (e.g., Mediterranean monk seal), particularly pups;
- Skin lesions in cetaceans;
- Eye irritation;
- Loss of body weight when they cannot feed due to contamination of their environment by oil; and
- Reduced ability to forage due to fouling of the baleen of surface feeding whale species.

Internal effects also vary by species, but may include the following:

- Congestion of lungs and damaged airways from inhalation of oil vapors and droplets;
- Emphysema and pneumonia are possible in most marine mammal species where volatile chemicals from petroleum are strongest and cetaceans who come to the surface to breathe;
- Kidney, liver and brain damage, as well as anemia and immune suppression from ingestion and inhalation of oil;
- Gastrointestinal ulceration and hemorrhage;
- Anemia from damaged red blood cells; and
- Damage to mucous membranes.

The potential for impacts to marine mammals would depend greatly on the size and location of a spill, and meteorological conditions at the time of the spill. It is assumed that spilled oil and/or fuel would rapidly spread to a layer of varying thickness and break up into narrow bands or windrows parallel to the wind direction. The rate at which the fuel spreads would be determined by the prevailing conditions such as temperature, water currents, tidal streams, and wind speeds. Lighter, volatile components of the condensate, fuel, or oil would evaporate to the atmosphere almost completely in a few days. Evaporation rate may increase as the oil spreads because of the increased surface area of the slick. Rougher seas, high wind speeds, and high temperatures also tend to increase the rate of evaporation and the proportion of oil lost by this process (American Petroleum Institute, 1999; USDOC, NOAA, 2006).

Well Blowout

Discharge trajectories and probabilities, and sea surface effects of the proposed wellhead failure blowout are discussed in Section 7.5.3 and are detailed in Appendix N-1. In this event, the water column would be exposed to elevated hydrocarbon concentrations for approximately 40 days. The shape of the sea surface spill trajectory varies for each modeled season (boreal Summer [April through September] and boreal Winter [October through March]). However, the thickness of the modeled sea surface condensate spill would be limited to mostly sheen concentrations that would readily disperse. The modeled trajectories of water column condensate concentrations are similar for both boreal Summer and boreal Winter, showing a broad northeast-southwest trajectory of mostly low (<50 ppb) concentrations and a relatively small circular pattern of higher concentrations (>400 ppb) around the wellsite.

Impacts to Marine Mammals

Based on the modeled trajectories for a boreal Summer and boreal Winter spill (Appendix N-1), it is likely that some cetaceans within regional oceanic waters (i.e., waters of the continental slope) would encounter and may make physical contact with surface oil over the 60-day release period. Animals that may occur near the release and within the trajectory swath between southern Mauritania to Dakar, Senegal would encounter the highest surface hydrocarbon concentrations. In the region, cetacean species within oceanic waters include mysticete whales, sperm whale, and most other odontocete whales and dolphins except the Atlantic humpbacked dolphin.

The degree of potential impact to marine mammals that may make direct contact with surface oil in these waters depends upon the concentration of petroleum hydrocarbons within a specific area, their length of exposure to the oil, and the persistence and bioavailability of specific hydrocarbons (i.e., the state of surface oil toxicity based on weathering processes). Because of the size of the spill trajectory, it would be possible that individual mammals may be directly exposed to surface oil more than once while breathing and feeding. Based on the size of the spill, the relatively short duration of the spill, and the overall low surface thickness of surface oil within the spill trajectory, it is not likely that marine mammals in regional oceanic waters would perish from direct effects of oiling; however, it is expected that impacts to a number of individuals of several species that come into contact with surface oil in sheen concentrations may include only sublethal effects. It is not likely that marine mammals would approach the wellsite during the spill and be exposed to higher concentrations of condensate both at the surface and within the water column. It is not possible to quantify the extent of sublethal impacts; however, it is expected that these effects would not significantly affect regional populations or species.

In continental shelf waters, there would be a 50 to 75% probability that surface condensate from a boreal Summer spill would extend as far north as Nouakchott, Mauritania and south to Dakar, Senegal. In boreal Winter, the trajectory extends mostly to the south as far as southern Senegal. The surface thickness of condensate within these areas would be largely sheens that would readily disperse, as described in Appendix N-1.

Marine mammals associated with shelf waters include all odontocetes and possibly some mysticete whales. The distributions of these species are likely most concentrated near or over the continental shelf-slope topographic break, as well as areas of current convergences. It is likely that the Mediterranean monk seal, if or when present within the area, may also occur within shelf waters. Based on modeling results, the middle shelf, including the area around the Nearshore Hub/Terminal, would likely receive the highest concentrations of condensate during both boreal Winter and boreal Summer spill scenarios. It is likely that the bottlenose, Atlantic spotted, and Atlantic humpbacked dolphins would occur within middle shelf waters in the project area. Overall, based on the size of the spill, the relatively short duration of the spill, and the overall relatively low surface thickness of surface oil within the spill trajectory, it is not likely that marine mammals in regional shelf waters would perish from direct effects of oiling; however, it is expected that impacts to a number of individuals that come into contact with surface oil in sheen concentrations may be limited to sublethal effects. It is not possible to quantify the extent of mortality or sublethal impacts; however, it is expected that these effects would not significantly affect regional populations or species.

Failure of FPSO Due to a Ship Collision

Oil spill modeling for FPSO tank failure discharge trajectories and probabilities, and sea surface and water column effects of an FPSO storage tank and diesel tank failure are discussed in Section 7.5.3 and are detailed in Appendix N-1. During both modeled seasons, Senegal waters are most likely to be impacted by these spills, primarily as a result of a southerly flowing current. During boreal Summer, the modeled spill may reach a surface thickness ranging from a sheen between 5 to 50 µm to thicknesses between 50 and greater than 200 µm in some areas. During boreal Winter, the southerly currents move the majority of the spill trajectory into Senegal waters, with similar concentrations of hydrocarbons within inner shelf waters to those modeled during the boreal Summer.

Impacts to Marine Mammals

Based on the modeled trajectories for a boreal Summer and boreal Winter spill (discussed in Section 7.5.3 and Appendix N-1), it is likely that some marine mammals within oceanic waters of the continental slope (groups and species listed above) would encounter and may make physical contact with surface oil over the 160-hour release period only if the spill were to occur in boreal Winter (October through March). During a boreal Summer spill (April through September), the spill trajectory extends inshore along the continental shelf. The spread of surface oil trends mostly southward from the source during boreal Winter. Species and groups that may be present in oceanic waters are listed above for the well blowout event.

The surface thickness of spilled condensate and MDO in this area would occur as rainbow sheen (0.3 µm to 5 µm layer thickness) that would readily disperse. Based on the size of the spill, the relatively short duration of the spill, and the overall low surface thickness of surface oil within the spill trajectory, no mortalities of marine mammals in regional oceanic waters would perish from direct effects of oiling. However, it is expected that individuals that may come into contact with surface oil in sheen concentrations may suffer sublethal effects. It is expected that these sublethal effects would not significantly affect regional populations or species.

Marine mammals that may occur along the continental shelf (groups and species listed above), and especially those in waters near the FPSO and within the trajectory swath between southern Mauritania to Dakar, Senegal would encounter the highest surface hydrocarbon concentrations from this event, ranging from a surface thickness ranging from a metallic sheen (5 to 50 µm layer thickness) to a discontinuous true color (50 to 200 µm layer thickness), and a continuous true color (>200 µm layer thickness) in some areas. Overall, based on the size of the spill, the relatively short duration of the spill, and the distribution of modeled surface oil thicknesses within the spill trajectory, it would be possible but not likely that within these areas of higher concentration, the condensate and MDO spill from the FPSO may result in the mortality of individual marine mammals.

Based on current sightings data, the likelihood of the Mediterranean monk seal occurring within the project area appears to be very low; however, it is likely that exposure of a monk seal to surface condensate within areas of highest concentrations could result in the mortality of the individual(s), based on the extent of physical oiling of the seal's pelage and contact and absorption of contaminants through the skin, inhalation of contaminants, or ingestion of contaminants either directly or by consuming contaminated prey (Calkins et al., 1994). It is also expected that numbers of marine mammals will suffer sublethal effects from direct and indirect exposures. Information on the effects of spilled oil on Mediterranean monk seal are not well known. However, based on the protected status of this species, a conservative approach has been taken in this assessment for determining potential impacts to this species. It is not possible to quantify the extent of sublethal impacts; however, it is expected that these effects will not significantly affect regional populations or species.

Pipelaying Vessel Collision

Oil spill modeling for a pipelaying vessel collision was performed using two seasonal scenarios: boreal Summer (April through September) and boreal Winter (October through March) (Appendix N-1). As in the case of the FPSO failure event discussed above, Senegal waters are more likely to be impacted by this spill scenario during both seasons than Mauritania due to a southerly flowing current. Inner shelf waters of northern Senegal and southern Mauritania are at risk in the boreal Summer, and probabilities of spread drop off significantly to the north and south of this swath. The maximum thickness of surface oil within surface waters in this area would be greater than 200 µm. To the north and south of this area, the oil thickness drops to sheen categories that would readily disperse. During boreal Winter, the spill trajectory extends much further offshore of southern Mauritania and south to Dakar, Senegal. During a boreal Winter spill in shelf waters, emulsion thicknesses between 50 to greater than 200 µm are expected, although they extend much further offshore and south to Dakar/Cap Vert. Sheen level concentrations (<3 µm) also extend offshore into slope waters.

Impacts to Marine Mammals

The modeled trajectories for a boreal Summer and boreal Winter spill suggest that that some marine mammals within oceanic waters of the continental slope would encounter and may make physical contact with surface oil only if the spill were to occur in boreal Winter (October through March). During a boreal Summer spill (April through September), the spill trajectory extends inshore of the continental slope. Marine mammals that occur within or transit through the point of entry and within the trajectory swath between southern Mauritania to Dakar, Senegal would encounter the highest surface hydrocarbon concentrations. It is not expected that the fuel and lubricating oil spill would result in the mortality of individual mammals on the continental slope. However, it is likely that individuals exposed to the spill in these waters may suffer sublethal effects. Although it is not possible to quantify the extent of sublethal impacts, these effects are not expected to significantly affect regional populations or species.

The modeled boreal Summer spill would have less than 25% probability that spilled fuel and lubricating oil would travel through outer and mid-continental shelf waters. During boreal Winter, this probability increases to 25 to 50% in waters south of the point of release, and extends south into Senegal waters. The maximum surface thickness of fuel and oil within outer and mid-continental shelf waters would be greater than 200 µm (Appendix N-1). Marine mammals that may occur in shelf waters (groups and species listed under the wellhead failure event, above) may be impacted by the pipelaying vessel collision spill. The extent and severity of impact would be based on the size of the spill, the relatively short duration of the spill, and the relatively high surface thickness of surface fuel and oil within the spill trajectory.

From the modeled results, it would be possible but not likely that individual cetaceans in regional shelf waters would perish from direct effects of oiling. Similar to the FPSO failure event, a Mediterranean monk seal exposed to these surface oil and fuel concentrations may perish, although this is a very unlikely occurrence based on the distribution and rarity of this species. It is expected that impacts to a number of marine mammals that come into contact with surface oil in sheen concentrations would be limited to sublethal effects. It is not possible to quantify the extent of the sublethal impacts; however, it is expected that these effects would not significantly affect regional populations or species.

7.5.9.3 Impact Ratings

Well Blowout

The consequence of impacts to marine mammals from a well blowout event include acute effects from both direct and indirect exposure to released condensate hydrocarbons. As modeled, the fate of a well failure, as manifested by the spatial trajectory of released condensate, depends upon the seasonal wind and current conditions.

Assuming the worst case scenario between seasonal modeling results, the impact intensity of the well blowout would be moderate, based on few if any mortalities of cetaceans and numerous individual cetaceans with sublethal impacts. It would be very unlikely that individual Mediterranean monk seals would be impacted, based on their rarity within the project area. It is likely that this species would most likely occur within inner shelf waters, although sightings in other areas have occurred in outer shelf and oceanic waters. However, impacts to monk seals from a blowout spill resulting in the mortality of an individual seal or seals are expected to be high. The numbers of cetaceans impacted by the well blowout and released condensate would be a function of the relative sea surface thickness or shoreline thickness of condensate and associated hydrocarbons and other toxins (e.g., metals). The extent of these impacts would be regional, although the duration of impacts from a well blowout would be short term. Impact consequence would be minor. Given the remote likelihood of a well blowout, overall impact significance is 1 – Negligible (see Table 7-167 below for details on selected criteria).

Failure of FPSO Due to a Ship Collision

The failure of FPSO event with sea surface release of condensate and MDO would have the potential for detectable impacts to regional marine mammals, particularly within inner shelf waters off Senegal. Within waters of the outer continental shelf and slope, and inner shelf waters of Mauritania, released condensate and MDO concentrations are relatively low and classified as a sheen. There would be a significant probability that condensate and MDO would reach shoreline habitats of southern Mauritania and especially Senegal, where the emulsion thickness in areas are expected to be moderate. Cetaceans within slope waters may experience spill concentrations of only rainbow sheen and impacts are not likely. However, cetaceans on the continental shelf may experience much higher concentrations in some areas, resulting in potential mortalities (expected to be low) but more numerous sublethal impacts. Within nearshore environments, primarily in Senegal, the spill thickness would be rated as moderate in several areas; it is expected that cetaceans (bottlenose dolphin and Atlantic humpbacked dolphin) may experience numbers of mortalities from direct and indirect exposures and numerous sublethal impacts.

Due to the expected numbers of cetacean mortalities associated with the spill in select areas of the continental shelf and shoreline, the intensity of the impact from the FPSO failure event would be moderate. Duration and spatial extent are short term and regional, resulting in a minor impact consequence. Given the remote likelihood of this event, overall impact significance is 1 – Negligible (see Table 7-167 below for details on selected criteria).

As discussed above, the occurrence of the Mediterranean monk seal within project waters is considered rare or unlikely. However, exposure of individual seals to surface oil concentrations projected in seasonal spill modeling runs would likely result in the mortality of these individuals. Due to the protected status of the Mediterranean monk seal (IUCN Endangered), the intensity of an impact resulting in the mortality of individual seals would be high. Duration and spatial extent are long term and regional based on the low population size of the species. Therefore, the consequence of the impact would be severe. Given the remote likelihood of this event, overall impact significance is 3 – Medium (see Table 7-167 below for details on selected criteria).

Pipelaying Vessel Collision

A vessel collision resulting in a sea surface rapid release of MDO, HFO and lubricating oil is likely to affect regional marine mammals as spilled fuel would be carried across the continental shelf and inner shelf, based on the trajectories and weathering characteristics. Similar to the FPSO failure event, the mid- to inner shelf waters of northern Senegal and southern Mauritania are at most risk, with areas of moderate oiling and some discrete areas with heavy oiling. Marine mammals within slope waters may experience spill concentrations of only rainbow sheen in for a boreal Winter spill, and impacts are not likely. However, cetaceans (and possibly the Mediterranean monk seal) on the continental shelf may experience much higher concentrations in some area, resulting in few potential mortalities and more numerous sublethal impacts.

Due to the expected low numbers of mortalities associated with the spill in select areas of the continental shelf, the intensity of the impact to cetaceans from the pipelaying vessel collision would be moderate. Duration and spatial extent are short term and regional in extent, resulting in a minor impact consequence. Given the remote nature of this spill, overall impact significance is 1 – Negligible (see Table 7-167 below for details on selected criteria).

As discussed in the FPSO failure event, the occurrence of the Mediterranean monk seal within project waters would be considered rare or unlikely, but exposure of individual seals to surface oil concentrations projected in seasonal spill modeling runs would likely result in the mortality of these individuals. The intensity of an impact resulting in the mortality of individual seals would be high. This impact would be regional but long term, based on the low population size of the species. Therefore, the consequence of the impact would be severe. Given the remote likelihood of this accidental event, overall impact significance is 3 – Medium (see Table 7-167 below for details on selected criteria).

Summary

A summary of impacts to marine mammals from accidental events is presented in Table 7-167.

Table 7-167. Impacts to Marine Mammals from Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout					
Mauritania Senegal	Exposure of marine mammals to elevated hydrocarbons within a regional area; some lethal impacts to cetaceans and numerous sublethal impacts to cetaceans from direct and indirect effects from exposure to oil from a blowout.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 – Negligible
Mauritania Senegal	Exposure of Mediterranean monk seals to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from the blowout spill.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Long term	Severe	Remote	3 – Medium
Failure of FPSO Due to a Ship Collision					
Mauritania Senegal	Exposure of marine mammals to elevated hydrocarbons within a regional area; some lethal impacts to cetaceans and numerous sublethal impacts to cetaceans, from exposure to oil from FPSO failure due to a ship collision.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 – Negligible
Mauritania Senegal	Exposure of Mediterranean monk seals to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Long term	Severe	Remote	3 – Medium
Pipelaying Vessel Collision					
Mauritania Senegal	Exposure of marine mammals to elevated hydrocarbons within a regional area; some lethal impacts to cetaceans and numerous sublethal impacts to cetaceans, from direct and indirect effects from exposure to oil from pipelaying vessel collision.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 – Negligible

Country	Impact	Criteria	Consequence	Likelihood	Significance
Mauritania Senegal	Exposure of Mediterranean monk seals to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from pipelaying vessel collision.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Long term	Severe	Remote	3 – Medium

7.5.9.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-168) and available mitigation measures recommended to reduce impact significance associated with accident-related impacts to marine mammals are identified. While these measures may further reduce accident likelihood, they would not alter overall impact significance. These mitigation measures are in addition to the measures and controls already planned in the project design, summarized as follows:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea X-mas trees), other well control barriers and isolation of any permeable zone.
- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.
- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.
- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.
- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.

- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.
- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.
- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.
- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Table 7-168. Mitigation Measures to Avoid or Reduce Impacts to Marine Mammals from Accidental Events.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Exposure of Mediterranean monk seals to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from the blowout spill.	3 – Medium	M101, M102, M103, M104, M105, M112	3 – Medium
Exposure of Mediterranean monk seals to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.	3 – Medium	M101, M102, M103, M104, M105, M112	3 – Medium
Exposure of Mediterranean monk seals to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from pipelaying vessel collision.	3 – Medium	M101, M102, M103, M104, M105, M112	3 – Medium

Notes:

M101: In the unlikely event of a spill, tactical response methods that may be considered under the OSCP include: surveillance and monitoring, offshore containment and recovery; subsea and at surface dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.

M102: All response measures will be continuously monitored to ensure that they remain effective. The response team will maintain situational awareness of the event and response effort.

M103: In the unlikely event of a spill reaching the shoreline, a Shoreline Clean-up and Assessment Technique (SCAT) program will be implemented to inform shoreline clean-up and remediation as applicable.

M104: In the unlikely event of a spill reaching the shoreline, a shoreline clean-up and remediation team will be mobilized to the affected areas. BP will also engage specialized expertise to mitigate impacts to sensitive areas and wildlife species as needed.

M105: In the unlikely event of a spill, follow national regulatory requirements for reporting and notification, using established protocols, which extends to all relevant external stakeholders.

M112: In the unlikely event of a spill of high intensity, specific monitoring (e.g., environmental effects monitoring) may be required and developed in consultation with applicable national authorities.

7.5.10 Sea Turtles

High Level Summary

In this section on Sea Turtles, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. The residual impacts on Sea Turtles from Accidental Events were assessed as of medium significance when mitigation measures are applied.

7.5.10.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.10.2 Impact Description

Accidental events as described in Section 7.5.1 would introduce large volumes of contaminant materials into the receiving environment of the project areas. The following subsections explain how these accidental event IPFs would produce impacts to sea turtles, including a summary of modeled environmental impacts from each accidental event in offshore and shoreline environments (from Appendix N-1) and a brief assessment of potential impacts from each event to regional sea turtles within oceanic (continental slope) waters, outer and middle continental shelf waters, and inner shelf waters.

Effects of spilled oil on sea turtles are discussed by Geraci and St. Aubin (1987), Lutcavage et al. (1995, 1996), and Milton et al. (2003). Because sea turtles are highly migratory – spending different life-history stages in different habitats – they are vulnerable to oil spills at all life stages: eggs on nesting beaches, post-hatchlings and juveniles in the open ocean gyres, subadults in nearshore habitats, and adults migrating between nesting and foraging grounds, and adult females on nesting beaches.

As in the case of birds and marine mammals, the effects of spilled oil on sea turtles may be direct and indirect. Direct contact of sea turtles with oil may impact them through four primary pathways (from Day et al., 1997; Geraci and St. Aubin, 1987).

- Physical contact with skin;
- Ingestion – when animals swallow oil particles directly or consume prey items that have been exposed to oil;
- Absorption – when animal skin or mucous membranes come into direct contact with oil; and
- Inhalation – when animals breathe volatile organics released from oil.

Several aspects of sea turtle biology and behavior place them at risk, including lack of avoidance behavior, indiscriminate feeding in convergence zones, and inhalation of large volumes of air before dives (Milton et al., 2003).

Sea turtles can become directly contaminated by spilled oil when they rise to the surface to breathe in the midst of an oil slick. During the breeding season, adult females and males may become oiled when they arrive in contaminated areas or when gravid females go ashore to lay eggs. Hatchlings may become trapped in oil when they head to sea after leaving nests. Offshore, sea turtles often spend time in areas of water mass convergence which provides food and sheltering habitat (flotsam) for post hatchlings and juveniles. Unfortunately, spilled oil also collects within these areas of convergence, putting them at greater risk of direct contact with oil (Oiledwildlife, 2018).

Although there are little statistical data on the effects of oil pollution on sea turtles, they are subject to the following impacts:

- Poisoning by absorption of toxic components through the skin or ingestion of contaminated food, leading to damage to the digestive tract and other organs;
- Damage or irritation to airways, lungs, and eyes; and

- Contamination of eggs, which may inhibit their development.

Studies have shown that direct exposure of sensitive tissues (e.g., eyes, nares, other mucous membranes) and soft tissues to diesel fuel or volatile hydrocarbons may produce irritation and inflammation (Geraci and St. Aubin, 1987). Diesel fuel can adhere to turtle skin or shells. Turtles surfacing within or near a diesel release would be expected to inhale petroleum vapors, causing respiratory stress. Ingested diesel fuel, particularly the lighter fractions, can be acutely toxic to sea turtles (Lutcavage et al., 1996).

Sea turtles are also very vulnerable to direct effects from oil spills at beach nesting sites during the breeding season. The Sea Turtle Conservancy (2017) lists the following potential impacts from spilled oil on nesting beaches:

- Digestion/absorption of oil through food contamination or direct physical contact, leading to damage to the digestive tract and other organs.
- Females may refuse to nest on an oiled beach, and crossing it could cause external oiling of the skin and carapace.
- Eggs may be contaminated, either because there is oil in the sand high up on the beach at the nesting site, or because the adult turtles are oiled as they make their way across the oiled beach to the nesting site. Oiling of eggs may inhibit their development.
- Newly hatched turtles, after emerging from the nests, make their way over the beach to the water and may become oiled.
- If eggs are exposed to fresh oil during the last half to last quarter of the incubation period, there is a significant decrease in hatchling survival. If hatchlings do survive to emerge from the nest, they tend to have developmental deformities.
- Oil could prevent oxygen from getting through the sand to the eggs.
- Several potential indirect impacts may be attributed to unique biological attributes or behaviors of sea turtles. Frazier (1980) suggested that olfactory impairment from chemical contamination may cause substantial indirect effects to sea turtles, since their well-developed olfactory system may play an important role in impairing their ability to properly navigate, and so may result in a population-level impact. A related problem is the possibility that an oil spill impacting nesting beaches may affect the locational imprinting of hatchlings, and thus impair their ability to return to their natal beaches to breed and nest (Milton et al., 2010).
- Reduced food availability following exposure to oil would be an indirect exposure route. For example, an oil spill off Panama in 1986 trapped oil in sediments of intertidal beds of turtle grass (*Thalassia testudinum*), killing the seagrass, and invertebrate and sponge populations, which are important food sources for green, hawksbill, loggerhead, and ridley turtles (National Research Council, 2003).
- The temperature of beach sand on nesting beaches during incubation influences sea turtle development and behavior, and subtle differences in sand color or albedo can significantly affect underlying temperatures (Hays et al., 2001). Sex determination in turtles is temperature-dependent, and changes in temperature could potentially change the sex ratio of hatchlings. Therefore, light surface oiling that does not penetrate directly to the eggs could possibly affect gender distribution in a population.
- This analysis of impacts is based on a worst case scenario with respect to the areal spread and thickness of spilled oil and/or condensate, and a conservative approach to impact ratings due to the status of sea turtle species (IUCN, 2017).

Well Blowout

Discharge trajectories and probabilities, and sea surface effects of the proposed wellhead failure blowout are discussed in Section 7.5.3 and are presented in Appendix N-1. In this event, the water column would be exposed to elevated hydrocarbon concentrations for approximately 40 days. The shape of the sea surface spill trajectory varies for each modeled season (boreal Summer [April through September] and boreal Winter [October through March]). However, the thickness of the modeled sea surface condensate spill would be limited to mostly sheen concentrations that would readily disperse. The modeled trajectories of water column condensate concentrations are similar for both boreal Summer and boreal Winter, showing a broad northeast-southwest trajectory of mostly low (<50 ppb) concentrations and a relatively small circular pattern of higher concentrations (>400 ppb) around the wellsite.

Impacts to Sea Turtles

Based on the modeled trajectories for a boreal Summer and boreal Winter spill (Appendix N-1), it is likely that sea turtles within regional oceanic waters (i.e., waters of the continental slope) would encounter and may make physical contact with surface oil over the 60-day release period. Both seasonal spill scenarios carry surface oil (in light sheen thicknesses) as far west as the Cape Verde archipelago, north to Morocco, and south as far as Guinea. Animals that may occur near the affected well and within the trajectory swath between southern Mauritania to Dakar, Senegal would encounter the highest surface hydrocarbon concentrations.

In the region, sea turtle species within oceanic waters include the leatherback turtle; however, adults of all other species in the region may use regional offshore waters during seasonal migrations between nesting and feeding habitats, and post hatchlings and juveniles may travel through the area in mesoscale currents. The degree of potential impact to sea turtles that may make direct contact with surface oil in these waters depends upon the concentration of petroleum hydrocarbons within a specific area, their length of exposure to the oil, and the persistence and bioavailability of specific hydrocarbons (i.e., the state of surface oil toxicity based on weathering processes). Because of the size of the spill trajectory, it would be possible that individual turtles may be directly exposed to surface oil more than once while breathing and feeding. Because of the time that they spend on or near the sea surface, post hatchling and juvenile sea turtles within the spill trajectory are expected to potentially be subject to much longer exposures to direct oiling than adults.

Leatherback turtles may also ingest prey that may be contaminated from areas of elevated water column hydrocarbons. Based on the size of the spill, the relatively short duration of the spill, the overall low surface thickness of surface oil within the spill trajectory, and time that adult turtles spend below the sea surface, it is not likely that adult sea turtles in regional oceanic waters would perish from direct effects of oiling; however, it is expected that impacts to a number of individuals of several species that come into contact with surface oil in sheen concentrations would be limited to sublethal effects. It is, however, possible that few post hatchling and juvenile turtles may perish if exposed to the spill trajectory, due to their exposure time to the surface spill. It is not possible to quantify the extent of lethal and sublethal impacts; however, based on the low number of sea turtles of all age groups expected to occur within oceanic waters, lethal and sublethal effects are not expected to substantially affect regional populations.

On continental shelf waters, there would be a 50 to 75% probability that surface condensate from a boreal Summer spill would extend as far north as Nouakchott, Mauritania and south to Dakar, Senegal, but in boreal Winter, the trajectory extends mostly to the south as far as southern Senegal. The surface thickness of condensate within these areas, as predicted by the model, would largely be sheens that would readily disperse, as described in Appendix N-1. All sea turtle species that occur within the region may be found within shelf waters. The distributions of these species are likely most concentrated within inner shelf and nearshore waters (unless animals are migrating between nesting and feeding habitats).

Based on modeling results, the middle shelf, including the area around the Nearshore Hub/Terminal, would likely receive the highest concentrations of condensate during both boreal Winter and boreal Summer spill scenarios. The loggerhead turtle is the most likely species to occur within middle shelf waters in the project area; however, the physical structure of the Nearshore Hub/Terminal may attract juvenile turtles, and adult hawksbill and ridley turtles that are likely to be attracted to the Hub/Terminal due to the presence of macroalgal and invertebrate fouling communities and motile invertebrate communities on and around fixed structures.

Overall, based on the size of the spill, the relatively short duration of the spill, and the overall relatively low surface thickness of surface oil within the spill trajectory, it is possible though unlikely that sea turtles in regional shelf waters may perish from direct effects of oiling; however, it is expected that a number of individuals that come into contact with surface oil in sheen concentrations may suffer sublethal effects. It is not possible to quantify the extent of lethal and sublethal impacts; however, it is expected that these effects would not significantly affect regional populations or species.

Failure of FPSO Due to a Ship Collision

Oil spill modeling for FPSO tank failure discharge trajectories and probabilities, and sea surface and water column effects of the proposed FPSO storage tank and diesel tank failure are discussed in Section 7.5.3 and detailed in Appendix N-1. During both modeled seasons, Senegal waters are most likely to be impacted by these spills, primarily as a result of a southerly flowing. However, waters of southern Mauritania, Cape Verde, Guinea-Bissau and The Gambia are also at risk in both boreal Summer and boreal Winter scenarios. During boreal Summer, the modeled spill may reach a surface thickness ranging from a sheen between 5 to 50 μm layer thickness to thicknesses between 50 and greater than 200 μm in some areas. During boreal Winter, the southerly currents move the majority of the spill trajectory into Senegal waters, with similar concentrations of hydrocarbons within inner shelf waters to those modeled during the boreal Summer.

Impacts to Sea Turtles

Based on the modeled trajectories for a boreal Summer and boreal Winter spill (discussed in Section 7.5.3 and Appendix N-1), it is likely that individual sea turtles within oceanic waters of the continental slope (for those groups and species listed above) would encounter and may make physical contact with surface oil over the 160-hour release period only if the spill were to occur in boreal Winter (October through March). During a boreal Summer spill (April through September), the spill trajectory extends inshore along the continental shelf. The spread of surface oil trends mostly southward from the source during boreal Winter. Species and groups that may be present in oceanic waters are listed above for the well blowout event.

The surface thickness of spilled condensate and MDO in this area is listed as rainbow sheen (0.3 μm to 5 μm layer thickness) that would readily disperse. Based on the size of the spill, the relatively short duration of the spill, and the overall low surface thickness of surface oil within the spill trajectory, no mortalities of adult sea turtles in regional oceanic waters are expected to perish from direct effects of oiling. However, it is expected that some juveniles and post-hatchlings may perish from direct exposure to the spilled oil. Further, it is expected that several individuals of all age groups that may come into contact with surface oil in sheen concentrations may suffer sublethal effects. Based on the low numbers of turtles expected in oceanic waters, it is expected that lethal and sublethal effects are not expected to substantially affect these populations.

Sea turtles that may occur along the continental shelf (listed above), and especially those in waters near the FPSO and within the trajectory swath between southern Mauritania to Dakar, Senegal would encounter the highest surface hydrocarbon concentrations from this event, ranging from a surface thickness ranging from a metallic sheen (5 to 50 μm layer thickness) to a discontinuous true color (50 to 200 μm layer thickness), and a continuous true color (>200 μm layer thickness) in some areas. Overall, based on the size of the spill, the relatively short duration of the spill, and the distribution of modeled surface oil thicknesses within the spill trajectory, it would be possible that within these areas of higher concentration, the condensate and MDO spill from the FPSO may result in the mortality of individual sea turtles of all age groups. It would be also expected that numbers of turtles would suffer sublethal effects from direct and indirect exposures. It is not possible to quantify the extent of lethal and sublethal impacts; however, it is expected that these effects would substantially affect regional populations.

Pipelaying Vessel Collision

Oil spill modeling for a pipelaying vessel collision resulting in release of fuel and lubricating oil was performed using two seasonal scenarios: boreal Summer (April through September) and boreal Winter (October through March) (Appendix N-1). As in the case of the FPSO failure event discussed above, Senegal waters are more likely to be impacted by this spill scenario during both seasons than Mauritania, due to a southerly flowing current. Inner shelf waters of northern Senegal and southern Mauritania are at risk in the boreal Summer, and probabilities of spread drop off significantly to the north and south of this swath. The maximum thickness of surface oil within surface waters in this area is greater than 200 µm. To the north and south of this area, the oil thickness drops to a sheen category that would readily disperse. During boreal Winter, the spill trajectory extends much further offshore of southern Mauritania and south to Dakar, Senegal. During a boreal Winter spill in shelf waters, emulsion thicknesses between 50 to greater than 200 µm are modeled, although extend much further offshore and south to the Dakar Peninsula. Sheen level concentrations (<3 µm) extend offshore into slope waters.

Impacts to Sea Turtles

The modeled trajectories suggest that some individual sea turtles within oceanic waters of the continental slope would encounter and may make physical contact with surface oil only if the spill were to occur in boreal Winter (October through March). During a boreal Summer spill (April through September), the spill trajectory extends inshore of the continental slope. Turtles that occur within or transit through the point of entry and within the trajectory swath between southern Mauritania to Dakar, Senegal would encounter the highest surface hydrocarbon concentrations. It is possible that exposure of sea turtles on the continental slope to a boreal Winter fuel and lubricating oil spill may result in the mortality of few individual turtles of all age groups. It is likely that individuals exposed to the spill in these waters may suffer some sublethal effects. Although it is not possible to quantify the extent of lethal and sublethal impacts, based on the trajectory and duration of the spill and the expected low numbers of turtles within continental slope waters, these effects are not expected to significantly affect regional populations or species.

The modeled boreal Summer spill would have less than 25% probability that spilled fuel and lubricating oil would travel through outer and mid-continental shelf waters. During boreal Winter, this probability increases to 25 to 50% in waters south of the point of impact, and extends south into Senegal waters. The maximum surface thickness of fuel and oil within outer and mid-continental shelf waters would be greater than 200 µm (Appendix N-1). Sea turtles that may occur in shelf waters (groups and species listed above) may be affected by the vessel collision spill. The extent of these effects would be based on the size of the spill, the relatively short duration of the spill, and relatively high surface thickness of surface fuel and oil within the spill trajectory. From the modeled results, it would be possible that individual sea turtles of all age groups within regional shelf waters may perish from direct effects of oiling. It would also be expected that impacts to numbers of sea turtles that come into contact with surface oil in sheen concentrations may be limited to sublethal effects. It is not possible to quantify the extent of the lethal and sublethal impacts; however, it is expected that these lethal effects would substantially affect regional populations.

7.5.10.3 Impact Ratings

Well Blowout

The consequence of impacts to sea turtles from a well blowout event include acute effects from both direct and indirect exposure to released condensate hydrocarbons. As modeled, the fate of a well failure, as manifested by the spatial trajectory of released condensate, depends upon the seasonal wind and current conditions.

Assuming the worst case scenario between seasonal modeling results, the impact intensity of the well blowout would be moderate, based on few if any mortalities of sea turtles but more numerous individual turtles with sublethal impacts. The numbers of sea turtles impacted by the well blowout and released condensate would be a function of the relative sea surface thickness or shoreline thickness of condensate and associated hydrocarbons and other toxins (e.g., metals), and the expected densities of turtles within the spill trajectory. The extent of these impacts would be regional and, based on the expected loss of few if any post hatchling or juvenile turtles, the duration of impacts to the resource from a wellhead failure blowout would be short term. This results in a minor impact consequence. Given the remote likelihood of a blowout, the overall Impact Significance is 1 – Negligible (see Table 7-169 below for details on selected criteria).

Failure of FPSO Due to a Ship Collision

The failure of FPSO event with sea surface release of condensate and MDO would have the potential for detectable impacts to regional sea turtles, particularly within inner shelf waters off Senegal. Within waters of the outer continental shelf and slope, and inner shelf waters of other countries, including southern Mauritania, Cape Verde, Guinea-Bissau, and The Gambia, released condensate and MDO concentrations are relatively low and classified as a sheen. There is a significant probability that condensate and MDO would reach shoreline habitats of southern Mauritania and especially Senegal, where the emulsion thickness in areas are modeled as moderate. Sea turtles within slope waters may experience spill concentrations of only rainbow sheen, and impacts are not likely. However, turtles on the continental shelf may experience much higher concentrations in some areas, resulting in potential mortalities (assumed to be low) of all age groups but numerous sublethal impacts. Within nearshore environments, primarily in Senegal, the spill thickness would be rated as moderate; it is expected that turtles may experience several mortalities from direct and indirect exposures, along with numerous sublethal impacts.

Due to the expected numbers of sea turtle mortalities associated with the spill in select areas of the continental shelf and shoreline, the intensity of the impact from the FPSO failure event would be high and regional in extent. The duration of these impacts would be long term, based on the loss of these endangered animals and the length of time for recruits to attain sexual maturity (ranging from 11 to 35 years, depending on the species [Chaloupka and Musick, 1997]); therefore, the impact consequence would be severe. Given the remote nature of this accidental event, the overall impact significance is 3 – Medium (see Table 7-169 below for details on selected criteria).

Pipelaying Vessel Collision

A vessel collision resulting in a sea surface rapid release of MDO, HFO and lubricating oil would likely affect regional sea turtles as spilled fuel would be carried across the continental shelf and inner shelf, based on the trajectories and weathering characteristics. Similar to the FPSO failure event, the mid- to inner shelf waters of northern Senegal and southern Mauritania are at most risk, with areas of moderate oiling and some discrete areas with heavy oiling. Sea turtles within slope waters may experience spill concentrations of only rainbow sheen for a boreal Winter spill, and impacts are not likely. However, turtles on the continental shelf may experience much higher concentrations in some areas, resulting in few potential mortalities of all age groups and more numerous sublethal impacts.

Due to the expected mortalities associated with the spill in select areas of the continental shelf, the intensity of the impact to sea turtles from the pipelaying vessel collision would be high and regional in extent. The duration of these impacts would be long term to the resource, based on the loss of breeding adults; therefore, the impact consequence would be severe. Given the remove likelihood of this accidental event, the overall impact significance is 3 – Medium (see Table 7-169 below for details on selected criteria).

Summary

A summary of impact to sea turtles from accidental events is presented in Table 7-169.

Table 7-169. Impacts to Sea Turtles from Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout					
Mauritania Senegal	Exposure of sea turtles to elevated hydrocarbons within a regional area; few, if any lethal impacts to turtles of all age groups but possibly some sublethal impacts to turtles from direct and indirect effects from exposure to oil from a blowout.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 – Negligible
Failure of FPSO Due to a Ship Collision					
Mauritania Senegal	Exposure of sea turtles to elevated hydrocarbons within a regional area; some lethal impacts to turtles of all age groups and numerous sublethal impacts to turtles from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Long term	Severe	Remote	3 – Medium
Pipelaying Vessel Collision					
Mauritania Senegal	Exposure of sea turtles to elevated hydrocarbons within a regional area; some lethal impacts to turtles of all age groups and numerous sublethal impacts to turtles from direct and indirect effects from exposure to oil from pipelaying vessel collision.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Long term	Severe	Remote	3 – Medium

7.5.10.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-170) and available mitigation measures recommended to reduce impact significance associated with accident-related impacts to turtles are identified. While these measures may further reduce accident likelihood, they would not alter overall impact significance. These mitigation measures are in addition to the measures and controls already planned in the project design, summarized as follows:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea X-mas trees), other well control barriers and isolation of any permeable zone.

- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.
- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.
- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.
- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.
- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.
- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.

- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.
- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Table 7-170. Mitigation Measures to Avoid or Reduce Impacts to Sea Turtles from Accidental Events.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Exposure of sea turtles to elevated hydrocarbons within a regional area; some lethal impacts to turtles of all age groups and numerous sublethal impacts to turtles from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.	3 – Medium	M101, M102, M103, M104, M105, M112	3 – Medium
Exposure of sea turtles to elevated hydrocarbons within a regional area; some lethal impacts to turtles of all age groups and numerous sublethal impacts to turtles from direct and indirect effects from exposure to oil from pipelaying vessel collision.	3 – Medium	M101, M102, M103, M104, M105, M112	3 – Medium

Notes:

M101: In the unlikely event of a spill, tactical response methods that may be considered under the OSCP include: surveillance and monitoring, offshore containment and recovery; subsea and at surface dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.

M102: All response measures will be continuously monitored to ensure that they remain effective. The response team will maintain situational awareness of the event and response effort.

M103: In the unlikely event of a spill reaching the shoreline, a Shoreline Clean-up and Assessment Technique (SCAT) program will be implemented to inform shoreline clean-up and remediation as applicable.

M104: In the unlikely event of a spill reaching the shoreline, a shoreline clean-up and remediation team will be mobilized to the affected areas. BP will also engage specialized expertise to mitigate impacts to sensitive areas and wildlife species as needed.

M105: In the unlikely event of a spill, follow national regulatory requirements for reporting and notification, using established protocols, which extends to all relevant external stakeholders.

M112: In the unlikely event of a spill of high intensity, specific monitoring (e.g., environmental effects monitoring) may be required and developed in consultation with applicable national authorities.

7.5.11 Threatened Species and Protected Areas

High Level Summary

In this section on Threatened Species and Protected Areas, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. The residual impacts on Threatened Species and Protected Areas from Accidental Events were assessed as of negligible to medium significance when mitigation measures are applied.

7.5.11.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.11.2 Impact Description

As indicated in Chapter 4, there are no protected areas located within the Offshore Area, Pipeline Area, or Support Operations Areas. One EBSA, the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal overlaps with the Nearshore Hub/Terminal Area.

As noted in Chapter 4 (Tables 4-26 and 4-27), there are a total of 10 Critically Endangered species and 18 Endangered species identified on the IUCN Red List which may be present in the coastal zone or nearshore and offshore waters of the core and extended study areas. Critically Endangered species include two marine and coastal bird species, two sea turtle species, and six demersal soft bottom and hard bottom fish species. Endangered species include four marine mammal species, one sea turtle species, nine demersal soft and hard bottom fish species, and four pelagic fish species (see Table 7-33 in Section 7.2.11).

The accidental events, as described in Section 7.5.1, would introduce large volumes of hydrocarbon contaminant materials into the receiving environment of the project areas. The spread of these contaminants by wind, waves, and currents would result in the potential for impacts to threatened species and offshore and coastal protected areas. The following subsections describe how the accidental events could impact threatened species and protected areas in the vicinity of the three project areas.

Well Blowout

If a well blowout event were to occur, it would be assumed to occur during the Construction and/or Operation Phases, in the Offshore Area. There are no protected areas located in the Offshore Area, Pipeline Area, or Support Operations Areas. The Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal EBSA, overlaps with the Nearshore Hub/Terminal Area. As described in Section 4.5.9, this EBSA is a highly productive area that serves as a nursery area for numerous fish species. The coastal area is also home to monk seals, numerous species of marine mammals, and sea turtles (Convention on Biological Diversity, 2016a). This coastal area either includes or is adjacent to several officially designated protected areas, including Guembeul Natural Reserve and Saint-Louis MPA (Senegal) and Chatt Tboul Reserve and Diawling National Park (Mauritania).

A hydrocarbons release arising from a well blowout would be expected to rise through the water column and be transported by winds and currents once it reaches the surface. The potential for impacts to coastal or offshore protected areas would depend on the size of a spill, the meteorological conditions at the time of the accidental release, the speed with which cleanup equipment could be employed, and the efficacy of spill countermeasures (e.g., mechanical cleanup; dispersant use; protection of coastal resources).

As described in the well blowout scenario (see Section 7.5.1), both Mauritanian and Senegalese surface waters and shorelines could be affected by hydrocarbons in both boreal Summer and boreal Winter in the event of a well blowout. Based on spill modeling, protected areas within the core and extended study areas that could be contacted in the event of a well blowout include: Chatt Tboul Reserve, Diawling National Park, and Aftout Es Sahli IBA in Mauritania, Langue-de-Barbarie National Park, Saint-Louis Marine Protected Area, and the Cayar Marine Protected Area in Senegal. Additionally, the coastal portion of the UNESCO Senegal River Delta Transboundary Biosphere Reserve located along the Mauritania/Senegal border could be contacted in the event of a well blowout. Summarized results of the stochastic modeling (Appendix N-1), including overall percentage chance of contact and the estimated time interval between a well blowout and contact for certain protected areas and other areas of conservation interest are presented in Table 7-171.

Table 7-171. Summarized Results of Stochastic Spill Modeling Estimating Percentage Chance of Contact and Interval between a Well Blowout and Contact for Protected Areas and Other Areas of Conservation Interest.

Protected Area / Area of Conservation Interest	Boreal Summer		Boreal Winter	
	Percent Chance of Contact	Shortest Time Interval between Spill and Contact	Percent Chance of Contact	Shortest Time Interval between Spill and Contact
Aftout Es Sahli IBA [1]	76%	6 days, 3 hours	-	-
Cayar Canyon	77%	3 days	100%	3 days
Cayar Marine Protected Area	34%	7 days	18%	9 days, 3 hours
Cayar Seamount Complex	98%	1 day	100%	1 day, 3 hours
Chatt Tboul Reserve	76%	6 days, 3 hours	-	-
Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal EBSA	95%	3 days, 12 hours	3%	61 days, 18 hours
Diawling National Park	69%	5 days, 1 hour	<1%	73 days, 12 hours
Guembeul Natural Reserve [2]	98%	3 days, 9 hours	7%	7 days
Langue-de-Barbarie National Park [2]	98%	3 days, 9 hours	7%	7 days
Northern Senegal Shelf Break IBA	99%	2 days	66%	3 days
Saint-Louis Marine Protected Area	98%	3 days, 9 hours	7%	7 days
Timiris Canyon	31%	21 days, 3 hours	-	-
UNESCO Senegal River Delta Transboundary Biosphere Reserve[3]	69%	5 days, 1 hour	<1%	73 days, 12 hours

1 Not included in stochastic modeling. Estimated to be similar to Chatt Tboul Reserve due to geographic proximity.
2 Not included in stochastic modeling. Estimated to be similar to Saint-Louis Marine Protected Area due to geographic proximity.
3 Not included in stochastic modeling. Estimated to be similar to Diawling National Park due to geographic proximity.

Based on the stochastic modeling summary results as presented in Table 7-172, the probability for condensate from an unplanned well blowout scenario to contact protected areas or other areas of conservation interest are generally higher in boreal Summer, with every area having a 31% or higher chance of contact. In boreal Summer, most of the protected areas or other areas of conservation interest are estimated to be contacted fairly quickly following a spill, with all but one area (Timiris Canyon) expected to be contacted in seven days or less. Conversely, in winter, only three areas (Northern Senegal Shelf Break IBA, Cayar Seamount Complex, and Cayar Canyon) have greater than 18% chance of contact, and contact times are estimated to be generally greater than seven days from the time of a spill.

Based on the modeling results in Table 7-172, potential impacts to protected areas or other areas of conservation interest would be highly dependent on the season which the spill occurred due to the differences in probabilities of contact and interval between spill and contact. Impacts to most protected areas or other areas of conservation interest (with Cayar Canyon and Cayar Seamount Complex as exceptions) would be expected to be lower in boreal Winter as compared to boreal Summer due to increased time for the condensate to weather before making contact as well as increased time for the deployment of spill containment equipment. All protected areas with the exception of Timiris Canyon and Cayar Marine Protected Area have a 66% chance or greater of condensate contact in either boreal Summer or Winter or Summer.

If a spill were to occur, any spilled condensate would be expected to float, with only a small percentage potentially adhering to waterborne particulates and sinking, water column, pelagic, and benthic species within offshore protected areas such as the Saint-Louis Marine Protected Area and Cayar Marine Protected Area would be at minimal risk of exposure when present. Surface oiling could impact threatened air-breathing marine fauna such the northern blue whale, northern fin whale, or green sea turtle, all of which are possibly or likely found in the Offshore Area.

Model results for a scenario of this magnitude (summarized in Section 7.5.1 and Appendix N-1) predict that in the event of a well blowout in the Offshore Area, marine protected areas including the Saint-Louis Marine Protected Area, the Cayar Marine Protected Area, or offshore EBSAs such as the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal, Cayar Seamount Complex EBSA, or the Cayar Canyon EBSA have a 25 to 50% probability of surface oiling in boreal Summer and a 5 to 25% chance of surface oiling in boreal Winter. Endangered and critically endangered species may be contacted by oil as a slick approaches the shore. The only critically endangered species that would likely be present in the Pipeline or Nearshore Hub/Terminal Areas is the Atlantic goliath grouper. Endangered species that are likely to be present in the Pipeline or Nearshore Hub/Terminal Areas include the dusky grouper, blackchin guitarfish, Senegalese hake, cassava croaker, common guitarfish, whale shark, scalloped hammerhead, and great hammerhead. Impacts specific to each faunal group (i.e. sea turtles, marine mammals, fish, birds) are presented in their respective subsection in Section 7.5. See Table 7-33 in Section 7.2.11 for a complete list of Critically Endangered or Endangered species that could be present in the project areas.

Modeling predicted that the maximum surface emulsion thickness in these marine protected areas would likely be between 3 and 50 µm, with the thickest oiling located in the immediate vicinity and east of the well head in boreal Summer and south of the wellhead in boreal Winter. These results suggest that the Saint-Louis Marine Protected Area would likely be subjected to heavier oiling if a spill occurred in boreal Summer, while EBSAs to the south the wellhead including Cayar Seamount Complex EBSA, or the Cayar Canyon EBSA would be subjected to heavier oiling if a spill occurred in boreal Winter.

As the slick approaches shore, adsorption to suspended sediments and particulates in shallow water would increase, providing a mechanism for oil to sink into shallow sediments. Once condensate reaches the shoreline, wave action and sediment movement would combine to introduce oil into shallow sediments. The coastlines of Mauritania and Senegal are predominantly high energy sandy beaches. Oil coming ashore along a sandy beach would be worked into sediments between high and low tide levels, and may be buried in sediments over time.

Once oil reaches the shore, a shift in the natural bacterial community to favor hydrocarbon degraders would likely occur, a process that can happen within days (Horel et al., 2012). It is possible that spilled hydrocarbons may be transported into sensitive coastal habitats (e.g., Chatt Tboul Reserve, Diawling National Park, Aftout Es Sahli IBA) via tidal action. This may only occur when an open exchange exists between coastal waters and the inland coastal habitat, or when subterranean marine-brackish water exchange occurs. Oil transported via tidal transport would likely be deposited on the shoreline within the brackish waterways of the affected protected area as tidal flow reverses. The extent of oil contamination within these waterways would be limited to the extent of tidal flow (i.e., only within the bounds of tidal influence). Weathered oil reaching these waterways would not realize the tidal action of the open coast and would remain in place with limited movement, being affected only by tidal flow.

Condensate reaching shore and any sensitive coastal habitats (e.g., coastal wetlands, submerged seagrass beds) may arrive in sufficient concentrations to produce impacts. Volatile components of would undergo weathering (i.e., volatilization, evaporation, dissolution, dispersion); the longer the condensate remains offshore, the more likely the volatile, toxic components would be removed via weathering processes.

According to the project-specific stochastic spill modeling results (Appendix N-1), under the worse-case spill scenario condensate from a well blowout in the Offshore Area could reach the shoreline in 27.6 days (boreal Summer) or 41.9 days (boreal Winter). The maximum amount of material onshore was estimated to be substantially less in boreal Winter (2,341 metric tonnes; approximately 1.23% of total spilled volume) as compared with boreal Summer (11,091 metric tonnes; approximately 5.86% of total spilled volume). Under both seasonal scenarios, the maximum volume of onshore hydrocarbons would occur between 68 and 70 days post-spill and would result in light to moderate oiling.

Spill trajectories summarized in Section 7.5.1 indicate potential landfall in or near sensitive wetlands (e.g., Diawling National Park). The impact of hydrocarbons on wetland vegetation is complex. It can be acute and chronic, ranging from short-term disruption of plant functioning to mortality. Numerous variables such as oil concentration and chemical composition, vegetation type and density, season or weather, preexisting stress levels, soil types, and water levels may influence the impacts of oil exposure on wetlands. The primary acute damage is to plants (e.g., mangrove *Rhizophora racemosa* and *Avicennia germinans*), which hold the soil in place and stabilize shoreline. Light oiling could cause plant die-back, followed by recovery in a fairly short time. Vegetation exposed to oil that persists in wetlands could take years to recover.

Vegetation also provides foraging and nursery habitat for larval and juvenile fish and crustaceans, and foraging habitat for wading birds. Once vegetation dies, the soil collapses and becomes flooded, and plants cannot re-grow. If plants cannot re-establish, soil erosion is accelerated, giving rise to even more flooding and wetland loss. If oil penetrates into the sediments, roots are continuously exposed to oil, with chronic toxicity making production of new shoots problematic. This feedback loop was observed following the *Deepwater Horizon* spill, where oiled marshes that had prior accelerated rates of erosion experienced a bio-geomorphological feedback that increased marsh loss to erosion and did not allow marsh regrowth (Silliman et al., 2012). However, Silliman et al. (2012) also reported that marshes that were generally healthy prior to oiling experiences regrowth to a pre-oiling state in approximately 18 months.

In addition to the direct impacts of oil, cleanup activities in marshes may accelerate rates of erosion and retard recovery rates (Lin et al., 2016; Turner et al., 2016). A recent review of the literature and new studies indicated that oil spill impacts to seagrass beds are often limited and may be limited to when oil is in direct contact with these plants (Fonseca et al., 2017). This conclusion is supported by the findings of Kenworthy et al. (2017) who reported that oil exposure following the *Deepwater Horizon* spill in the U.S. Gulf of Mexico did not result in shelf-wide seagrass declines in the Chandeleur Islands, Louisiana.

Failure of FPSO Due to a Ship Collision

If an FPSO failure due to a ship collision occurred, it would happen during the Operations Phase. As described in Section 7.5.1, the FPSO failure accidental event scenario includes the catastrophic sea surface release of condensate and MDO from the FPSO in the Pipeline Area. As previously mentioned, there are no protected areas located in the Offshore Area, Pipeline Area, or Support Operations Areas. One protected area, the Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal EBSA overlaps with the Nearshore Hub/Terminal Area. However, based on the spill trajectories as summarized in Section 7.5.1 and presented in Appendix N-1, this type of accidental event could result in offshore water column and shoreline oiling in areas where sensitive habitats, several Critically Endangered or Endangered and protected areas exist both offshore and along the Mauritanian and Senegalese coastlines. Summarized results of the stochastic modeling (Appendix N-1), including overall percentage chance of contact and the estimated time interval between an FPSO failure due to a ship collision and contact for certain protected areas and other areas of conservation interest are presented in Table 7-172.

Table 7-172. Summarized Results of Stochastic Spill Modeling Estimating Percentage Chance of Contact and Interval between an FPSO Failure Due to a Ship Collision and Contact for Protected Areas and Other Areas of Conservation Interest.

Protected Area / Area of Conservation Interest	Boreal Summer		Boreal Winter	
	Percent Chance of Contact	Shortest Time Interval between Spill and Contact	Percent Chance of Contact	Shortest Time Interval between Spill and Contact
Aftout Es Sahli IBA [1]	14%	4 days, 6 hours	-	-
Cayar Canyon	34%	2 days, 21 hours	98%	2 days, 12 hours
Cayar Marine Protected Area	33%	2 days, 21 hours	76%	3 days
Cayar Seamount Complex	9%	10 days	79%	3 days, 3 hours
Chatt Tboul Reserve	14%	4 days, 6 hours	-	-
Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal EBSA	70%	1 day, 9 hours	5%	2 days, 0 hours
Diawling National Park[1]	14%	4 days, 6 hours	-	-
Guembeul Natural Reserve [2]	88%	12 hours	33%	18 hours
Langue-de-Barbarie National Park [2]	88%	12 hours	33%	18 hours
Northern Senegal Shelf Break IBA	100%	3 hours	100%	3 hours
Saint-Louis Marine Protected Area	88%	12 hours	33%	18 hours
Timiris Canyon	-	-	<1%	35 days, 12 hours
UNESCO Senegal River Delta Transboundary Biosphere Reserve[3]	14%	4 days, 6 hours	-	-

[1] Not included in stochastic modeling. Estimated to be similar to Chatt Tboul Reserve due to geographic proximity.
[2] Not included in stochastic modeling. Estimated to be similar to Saint-Louis Marine Protected Area due to geographic proximity.
[3] Not included in stochastic modeling. Estimated to be similar to Chatt Tboul Reserve due to geographic proximity.

Based on the stochastic modeling summary results as presented in Table 7-173, the probability of condensate and MDO to contact protected areas or other areas of conservation interest are higher in boreal Summer in nearshore areas in the vicinity of Saint-Louis and N'Diago (e.g., Saint-Louis Protected Area, Chatt Tboul Reserve, Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal EBSA). In areas further south, stronger currents in boreal Winter would result in protected areas such as the Cayar Canyon and Cayar Marine Protected Area to have a higher chance of contact in boreal Winter. Due to the location of the FPSO relatively close to shore, all time intervals between an FPSO failure event and contact with protected areas or other areas of conservation interest are relatively brief (<5 days), with the exception of the Timiris Canyon area which is located far to the north of the location of the FPSO and would have a <1% chance of contact.

Due to the relatively brief time period between an FPSO failure event and contact with protected areas or other areas of conservation interest, weathering of spilled hydrocarbons would be minimized and complete deployment of spill containment equipment could be difficult. Most protected areas or other areas of conservation interest have a greater than 33% chance of contact probability in either boreal Summer or Winter (with Timiris Canyon, Chatt Tboul Reserve and associated estimates for Diawling National Park, Aftout Es Sahli IBA, and UNESCO Senegal River Delta Transboundary Biosphere Reserve as exceptions).

If an FPSO failure due to a ship collision were to occur, under the modeled worst-case scenario for this accidental event, greater than 20,000 metric tonnes of condensate and MDO could contact the shoreline. The only Critically Endangered species that is likely to be present in the Pipeline or Nearshore Hub/Terminal Areas is the Atlantic goliath grouper. Endangered species that are likely to be present in the Pipeline or Nearshore Hub/Terminal Areas include the dusky grouper, blackchin guitarfish, Senegalese hake, cassava croaker, common guitarfish, whale shark, scalloped hammerhead, and great hammerhead. Impacts specific to each faunal group (i.e. sea turtles, marine mammals, fish, birds) are presented in their respective subsection in Section 7.5. See Table 7-32 in Section 7.2.11 for a complete list of Critically Endangered or Endangered species that could be present in the project areas.

In boreal Summer, the worst case (maximum) emulsion thickness in offshore waters as a result of an FPSO failure due to a ship collision is estimated to be greater than 200 µm in some areas in the vicinity of and generally to the east of the FPSO location (near the Saint-Louis Marine Protected Area), with significant oiling thickness of between 5 and 200 µm for much of the offshore area between Nouakchott and Dakar. In boreal Winter, the area of heaviest offshore oiling would be further south, with oil thickness between 5 and 200 µm between areas just north of N'Diago/Saint-Louis south to Dakar.

In the event of an FPSO failure due to a ship collision, modeling predicts a 50 to 75% probability of surface oiling for northern Senegal/southern Mauritania nearshore protected areas (such as the Saint-Louis Marine Protected Area, and the Coastal Habitat of the Neritic Zone of Mauritania and Extreme North of Senegal EBSA) in boreal Summer. In boreal Winter, currents are expected to push any surface slick to the south, resulting in a lower risk for the Mauritania/Senegal area but a higher risk for areas near Dakar such as the Cayar Marine Protected Area, or the Cayar Seamount Complex or Cayar Canyon EBSAs.

Onshore protected areas that could be contacted by oil in the event of a failure of the FPSO due to a ship collision include Chatt Tboul Reserve and Diawling National Park (as well as the Aftout Es Sahli IBA) in Mauritania (light to moderate oiling in boreal Summer and moderate oiling in boreal Winter), and Langue-de-Barbarie National Park, Saint-Louis Marine Protected Area, and the Cayar Marine Protected Area in Senegal (moderate oiling in boreal Summer and boreal Winter). Additionally, the coastal portion of the UNESCO Senegal River Delta Transboundary Biosphere Reserve located along the Mauritania/Senegal border would be projected to have moderate oiling in both boreal Summer and boreal Winter seasons. The areas of greatest probability of shoreline oiling in the boreal Summer include the area just onshore of the Saint-Louis Marine Protected Area (50% to 75% probability). In boreal Winter, the area of greatest probability of shoreline contact would be further south. In the areas north of Dakar, in the vicinity of the Cayar Marine Protected Area, shoreline oiling probability ranges from 25 to 50%.

Any area that did come into contact with condensate or MDO from an FPSO failure due to a ship collision could result in detrimental impacts to threatened species, protected area wetlands, or other flora or fauna due to direct or indirect oiling or habitat contamination. Impacts would be similar to those described previously for a well blowout.

Pipelaying Vessel Collision

If a pipelaying vessel collision occurred, it would happen during the Construction Phase. As described in Section 7.5.1, this scenario would result in the rapid release of relatively large quantities of MDO, HFO, and lubricating oil at the Nearshore Hub/Terminal Area.

In the event of pipelaying vessel collision, spill trajectory modeling (Appendix N-1) estimates that oiling of offshore waters would be much more extensive during boreal Winter. During boreal Summer, oiling would be limited to areas near the coast, although emulsion thickness could exceed 200 µm in some areas offshore of N'Diago/Saint-Louis. In boreal Winter, currents are expected to result in a more widespread slick that carries the slick offshore and generally south of the spill location. Substantial oiling thickness greater than 5 µm would be projected to extend in offshore waters from areas offshore of N'Diago/Saint-Louis southwest to the area north and east of Dakar. Summarized results of the stochastic modeling (Appendix N-1), including overall percentage chance of contact and the estimated time interval between a pipelaying vessel collision and contact for certain protected areas and other areas of conservation interest are presented in Table 7-173.

Table 7-173. Summarized Results of Stochastic Spill Modeling Estimating Percentage Chance of Contact and Interval between a Pipelaying Vessel Collision and Contact for Protected Areas and Other Areas of Conservation Interest.

Protected Area / Area of Conservation Interest	Boreal Summer		Boreal Winter	
	Percent Chance of Contact	Shortest Time Interval between Spill and Contact	Percent Chance of Contact	Shortest Time Interval between Spill and Contact
Aftout Es Sahli IBA [1]	<1%	4 days, 12 hours	-	-
Cayar Canyon	-	-	42%	2 days, 18 hours
Cayar Marine Protected Area	-	-	28%	3 days, 6 hours
Cayar Seamount Complex	-	-	11%	4 days, 21 hours
Chatt Tboul Reserve	<1%	4 days, 12 hours	-	-
Coastal Habitat of the Neritic Zone of Mauritania and the Extreme North of Senegal EBSA	87%	6 hours	20%	6 hours
Diawling National Park[1]	<1%	4 days, 12 hours	-	-
Guembeul Natural Reserve [2]	99%	6 hours	100%	6 hours
Langue-de-Barbarie National Park [2]	99%	6 hours	100%	6 hours
Northern Senegal Shelf Break IBA	2%	1 day, 9 hours	58%	3 hours
Saint-Louis Marine Protected Area	99%	6 hours	100%	6 hours
UNESCO Senegal River Delta Transboundary Biosphere Reserve[3]	<1%	4 days, 12 hours	-	-

1 Not included in stochastic modeling. Estimated to be similar to Chatt Tboul Reserve due to geographic proximity.
2 Not included in stochastic modeling. Estimated to be similar to Saint-Louis Marine Protected Area due to geographic proximity.
3 Not included in stochastic modeling. Estimated to be similar to Chatt Tboul Reserve due to geographic proximity.

Based on the stochastic modeling summary results as presented in Table 7-174, most of the impacts from contact to protected areas or other areas of conservation interest by MDO, HFO, and lubricating oil are expected to occur to the south and east of the Nearshore Hub/Terminal Area where a spill would originate. Saint-Louis Marine Protected Area, Guembeul Natural Reserve, and Langue-de-Barbarie National Park are located in this area and are estimated (Based on Saint-Louis Marine Protected Area) to have a 99% chance of contact within 6 hours in the boreal Summer and 100% chance of contact within 6 hours in the boreal Winter. Dispersion of spilled hydrocarbons would be expected to be more extensive in the boreal Winter. Several protected areas or other areas of conservation interest such as Cayar Canyon, Cayar Marine Protected Area, and Cayar Seamount Complex, all of which are located to the southwest of the Nearshore Hub/Terminal Area, are predicted to be contacted in the boreal Winter but not during the boreal Summer. Similarly, the Northern Senegal Shelf Break IBA is estimated to have a 58% chance of contact within 3 hours in boreal Winter, but only a 2% chance of contact within 1 day, 9 hours in boreal Summer. All of the predicted time intervals between a spill and contact are less than 6 hours, which would limit environmental weathering.

Protected areas and other areas of conservation interest are at a higher risk of contact from a pipelaying vessel collision during boreal Winter than boreal Summer, but several protected areas with critical bird habitat, wetlands, and marine areas (i.e., Saint-Louis Marine Protected Area, Langue-de-Barbarie National Park) are highly likely to be affected, regardless of season.

If a pipelaying vessel collision occurred, shoreline oiling could occur within 1 to 2 days of a spill, depending on season. In both boreal Summer and boreal Winter seasons, the modelled worst-case scenario includes more than 4,500 metric tonnes of oil mass onshore. Shoreline oiling would be expected to occur in both boreal Summer and boreal Winter, with oiling in boreal Winter limited to areas south of N'Diago/Saint-Louis. In boreal Summer, probabilities for shoreline oiling would be highest, with the maximum probability of coastal oiling (50 to 75% probability) in the areas south N'Diago/Saint-Louis. In both seasons, oiling would be expected to be light to moderate.

Any marine or terrestrial protected area that did come into contact with MDO, HFO, or lubricating oil from a pipelaying vessel collision could result in detrimental impacts to protected area wetlands, Critically Endangered or Endangered species, or other flora, or fauna due to direct or indirect oiling or habitat contamination. Impacts from HFO or lubricating oil would be similar to those described above for a well blowout. MDO is highly volatile and it is unlikely that extensive impacts to coastal protected areas would occur as much of the MDO would be expected to evaporate before the slick could reach shore.

7.5.11.3 Impact Rating

Well Blowout

A well blowout in the Offshore Area could occur during the Construction or Operations Phase and could directly affect protected areas by introducing hydrocarbons into the environment, potentially fouling coastal areas that are part of protected areas, and indirectly or directly affecting flora and fauna. The spill trajectory modeling estimates that under a worst-case scenario, a well blowout in the Offshore Area could result in 11,091 metric tonnes of oil onshore (boreal Summer) or 2,341 metric tonnes of oil onshore (boreal Winter). The geographic extent of this oiling includes up to 479 km of coastline (see Section 7.5.1), including numerous coastal protected areas between Nouakchott and Dakar. Impact intensity would be high, spatial extent would be regional, and duration would be short term. Despite the potential for widespread light and moderate shoreline oiling and potential for water column contamination with hydrocarbons that could affect offshore protected areas, the remote likelihood of a well blowout results in the overall impact significance of 2 – Low (see Table 7-174 below for details on selected criteria).

As noted previously, there are several marine mammal, sea turtle, fish, and bird species which are listed as Critically Endangered or Endangered. Exposure to surface or water column hydrocarbon concentrations from a well blowout may result in one or more individual mortalities. For Critically Endangered or Endangered, the intensity of an impact which results in mortality ranges from moderate to high. When duration and spatial extent are either short term or long term and regional, respectively, the consequence of the impact ranges from minor to severe. Given the remote likelihood of this event, overall impact significance ranges from 1 – Negligible to 3 – Medium.

Failure of FPSO Due to a Ship Collision

An FPSO failure due to a ship collision during the Operations Phase could result in directly affect protected areas by introducing hydrocarbons into the environment, potentially fouling coastal areas that are part of protected areas, and indirectly or directly affecting flora and fauna. The spill trajectory modeling estimates that under a worst-case scenario, an FPSO failure located in the Pipeline Area could result in a maximum of 20,121 metric tonnes of oil onshore (boreal Summer) or 21,536 metric tonnes of oil onshore (boreal Winter) along a broad geographic extent of up to 435 km. Impact intensity would be high, spatial extent would be regional, and duration would be short term. Despite the potential for widespread moderate to heavy shoreline oiling and potential for water column contamination with hydrocarbons that could affect offshore protected areas, the remote likelihood an FPSO failure event results in the overall impact significance of 2 – Low (see Table 7-174 below for details on selected criteria).

As noted previously, there are several marine mammal, sea turtle, fish, and bird species which are listed as Critically Endangered or Endangered. Exposure to surface or water column hydrocarbon concentrations from an FPSO failure event may result in one or more individual mortalities. For Critically Endangered or Endangered, the intensity of an impact which results in mortality ranges from moderate to high. When duration and spatial extent are either short term or long term and regional, respectively, the consequence of the impact ranges from minor to severe. Given the remote likelihood of this event, overall impact significance ranges from 1 – Negligible to 3 – Medium.

Pipelaying Vessel Collision

A pipelaying vessel collision during the Construction Phase could result in directly affect protected areas by introducing hydrocarbons into the environment, potentially fouling coastal areas that are part of protected areas, and indirectly or directly affecting flora and fauna. The spill trajectory modeling estimates that under a worst-case scenario, a pipelaying vessel collision occurring in the Nearshore Hub/Terminal Area could result in a maximum of 4,610 metric tonnes of oil onshore (boreal Summer) or 4,523 metric tonnes of oil onshore (boreal Winter). The geographic extent of the projected oiling encompasses up to 98 km of shoreline. Impact intensity would be high, spatial extent would be regional, and duration would be short term. Despite the potential for widespread light to heavy shoreline oiling and potential for water column contamination with hydrocarbons that could affect offshore protected areas, the remote likelihood of a pipelaying vessel collision results in the overall impact significance of 2 – Low (see Table 7-174 below for details on selected criteria).

As noted above, several marine mammal, sea turtle, fish, and bird species which are listed as Critically Endangered or Endangered may occur in nearshore or offshore waters of the project area. Exposure to surface or water column hydrocarbon concentrations from a pipelaying vessel collision may result in one or more individual mortalities. For Critically Endangered or Endangered species, the intensity of an impact which results in mortality ranges from moderate to high. When duration and spatial extent are either short term or long term and regional, respectively, the consequence of the impact ranges from minor to severe. Given the remote likelihood of this event, overall impact significance ranges from 1 – Negligible to 3 – Medium.

Summary

A summary of impacts to threatened species and protected areas from accidental events is presented in Table 7-174. Separate impact significances have not been calculated for individual protected area or other area of conservation interest. Based on stochastic modeling results, the criteria for determining impact significance (i.e. Nature, Intensity, Spatial Extent, Duration, Consequence and Likelihood) would be similar for each protected area and result in identical impact significances. To reduce redundancy, a single impact significance was calculated for protected areas or other areas of conservation interest as a whole.

It should be noted that impact significance ratings for individual threatened species groups (e.g. sea turtles, marine mammals) are presented in their respective sections in Section 7.5. For threatened species, impact consequence determinations were variable, including minor for fish, minor or severe for turtles and marine mammals (i.e., Mediterranean monk seals noted as particularly vulnerable), and severe for birds. Due to the remote nature of all three accident scenarios, overall impact significance ranged from 1 – Negligible to 3 – Medium.

Table 7-174. Impacts to Threatened Species and Protected Areas from Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout					
Mauritania Senegal	Oiling of water column or coastline including impacts to areas designated as marine or onshore protected areas. Impacts could include loss of vegetation, habitat destruction, and injury or death to marine or terrestrial fauna from a blowout.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term	Moderate	Remote	2 – Low
Mauritania Senegal	Oiling of threatened species resulting in mortality from a blowout.	Nature: Negative Intensity: Moderate to High Spatial Extent: Regional Duration: Short term to Long term	Minor to Severe	Remote	1 – Negligible to 3 – Medium
Failure of FPSO Due to a Ship Collision					
Mauritania Senegal	Oiling of water column or coastline including impacts to areas designated as marine or onshore protected areas. Impacts could include loss of vegetation, habitat destruction, and injury or death to marine or terrestrial fauna from FPSO failure due to a ship collision.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term	Moderate	Remote	2 – Low
Mauritania Senegal	Oiling of threatened species resulting in mortality from FPSO failure due to a ship collision.	Nature: Negative Intensity: Moderate to High Spatial Extent: Regional Duration: Short term to Long term	Minor to Severe	Remote	1 – Negligible to 3 – Medium
Pipelaying Vessel Collision					
Mauritania Senegal	Oiling of water column or coastline including impacts to areas designated as marine or onshore protected areas. Impacts could include loss of vegetation, habitat destruction, and injury or death to marine or terrestrial fauna from pipelaying vessel collision.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term	Moderate	Remote	2 – Low

Country	Impact	Criteria	Consequence	Likelihood	Significance
Mauritania Senegal	Oiling of threatened species resulting in mortality from pipelaying vessel collision.	Nature: Negative Intensity: Moderate to High Spatial Extent: Regional Duration: Short term to Long term	Minor to Severe	Remote	1 – Negligible to 3 – Medium

7.5.11.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-175) and available mitigation measures recommended to reduce impact significance associated with accident-related impacts to these resources are identified. While these measures may further reduce accident likelihood, they would not alter overall impact significance. These mitigation measures are in addition to the measures and controls already planned in the project design, summarized as follows:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea X-mas trees), other well control barriers and isolation of any permeable zone.
- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.
- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.
- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.
- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.

- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.
- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.
- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.
- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Table 7-175. Mitigation Measures to Avoid or Reduce Impacts to Threatened Species and Protected Areas from Accidental Events.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Oiling of water column or coastline including impacts to areas designated as marine or onshore protected areas. Impacts could include, loss of vegetation, habitat destruction, and injury or death to marine or terrestrial fauna from a blowout.	2 – Low	M101, M102, M103, M104, M105, M112, M113	2 – Low
Oiling of threatened species resulting in mortality from a blowout.	1 – Negligible to 3 – Medium	M101, M102, M103, M104, M105, M112, M113	1 – Negligible to 3 – Medium
Oiling of water column or coastline including impacts to areas designated as marine or onshore protected areas. Impacts could include, loss of vegetation, habitat destruction, and injury or death to marine or terrestrial fauna from FPSO failure due to a ship collision.	2 – Low	M101, M102, M103, M104, M105, M112, M113	2 – Low
Oiling of threatened species resulting in mortality from FPSO failure due to a ship collision.	1 – Negligible to 3 – Medium	M101, M102, M103, M104, M105, M112, M113	1 – Negligible to 3 – Medium
Oiling of water column or coastline including impacts to areas designated as marine or onshore protected areas. Impacts could include, loss of vegetation, habitat destruction, and injury or death to marine or terrestrial fauna from pipelaying vessel collision.	2 – Low	M101, M102, M103, M104, M105, M112, M113	2 – Low
Oiling of threatened species resulting in mortality from pipelaying vessel collision.	1 – Negligible to 3 – Medium	M101, M102, M103, M104, M105, M112, M113	1 – Negligible to 3 – Medium

Notes:

M101: In the unlikely event of a spill, tactical response methods that may be considered under the OSCP include: surveillance and monitoring, offshore containment and recovery; subsea and at surface dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.

M102: All response measures will be continuously monitored to ensure that they remain effective. The response team will maintain situational awareness of the event and response effort.

M103: In the unlikely event of a spill reaching the shoreline, a Shoreline Clean-up and Assessment Technique (SCAT) program will be implemented to inform shoreline clean-up and remediation as applicable.

M104: In the unlikely event of a spill reaching the shoreline, a shoreline clean-up and remediation team will be mobilized to the affected areas. BP will also engage specialized expertise to mitigate impacts to sensitive areas and wildlife species as needed.

M105: In the unlikely event of a spill, follow national regulatory requirements for reporting and notification, using established protocols, which extends to all relevant external stakeholders.

M112: In the unlikely event of a spill of high intensity, specific monitoring (e.g., environmental effects monitoring) may be required and developed in consultation with applicable national authorities.

M113: Provide training in oil spill response planning and techniques to management staff of the designated National Parks and Marine Protected Areas that based on the ESIA spill modelling results could potentially be affected.

7.5.12 Biodiversity

High Level Summary

In this section on Biodiversity, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. The residual impacts on Biodiversity from Accidental Events were assessed as of negligible to medium significance when mitigation measures are applied.

7.5.12.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.12.2 Impact Description

As discussed in Chapter 4, the characteristics for biodiversity represent a suite of previously identified resources – i.e., fish and other fishery resources, marine mammals, sea turtles, birds, threatened species – and protected areas and areas of conservation interest. Impacts to biodiversity are represented by the composite of individual, accident-related impacts for each of these resources and protected areas and areas of conservation interest. Refer to Sections 7.5.6 and Sections 7.5.8 through 7.5.11 for detailed discussion of accident-related impact determinations for these resources and protected areas and areas of conservation interest.

The accidental release of hydrocarbons into the marine environment produces a multitude of impact pathways, depending upon the resource or protected area or area of conservation interest. For fish and other fishery resources, including sensitive egg and larval stages, direct effects include smothering of gills, feeding appendages, and swimming appendages via direct contact. Indirect effects occur when spilled dissolved, bioavailable hydrocarbons become incorporated into food webs or when structural habitats (e.g., reefs, mangrove shoreline, seagrass meadows) become covered in thick, emulsified material. Levels of direct or indirect effects would vary depending on seasonal or environmental context (e.g., boreal Winter vs. boreal Summer; shelf, slope, coast, or estuary). These effects may be lethal or sub-lethal (i.e., delayed development of eggs or embryos, developmental malformations, or genetic defects).

For marine mammals, impacts from hydrocarbon exposure would vary, depending on the species, but may include hypothermia in pinnipeds (e.g., Mediterranean monk seal), particularly pups; skin lesions in cetaceans; eye irritation; loss of body weight (due to prey contamination; reduced ability to forage (due to fouling of the baleen of surface feeding whale species); congestion of lungs and damaged airways from inhalation of oil vapors and droplets; emphysema and pneumonia (possible in most marine mammal species where volatile chemicals are strongest; cetaceans may be affected when they come to the surface to breathe; kidney, liver and brain damage, as well as anemia and immune suppression from ingestion and inhalation of oil; gastrointestinal ulceration and hemorrhage; anemia from damaged red blood cells; and damage to mucous membranes.

For sea turtles, direct impacts may arise from physical contact with skin; ingestion – when animals swallow oil particles directly or consume prey items that have been exposed to oil; absorption – when animal skin or mucous membranes come into direct contact with oil; or inhalation – when animals breathe volatile organics released from oil.

For birds, the mechanisms for accident-related impacts are similar to those noted previously for turtles. Impacts to birds from accident events may arise from physical contact with plumage – when oil contacts and matts or fouls plumage; ingestion – when animals swallow oil particles directly or consume prey items that have been exposed to oil; absorption – when animal skin or mucous membranes come into direct contact with oil; and inhalation – when animals breathe volatile organics released from oil.

For threatened species, encompassing those listed as Critically Endangered or Endangered, potential impacts are the same as noted for each resource, following the same mechanisms as noted above. Finally, for protected areas, impacts may occur from accidental events via the increase in water column concentrations of hydrocarbons in the water column, or the deposition of hydrocarbons on the shoreline. The mechanisms may affect either local species (including threatened species) or areas designated as marine or onshore protected areas. Impacts could include loss of vegetation, habitat destruction, and injury or death to marine or terrestrial fauna.

The impact analysis, as presented for both routine and accident-related scenarios, utilizes a risk based approach, integrating impact consequence and impact likelihood to determine overall impact significance. One of the artifacts of a risk-based approach, particularly as it relates to assessing accident-related impacts, is often the minimization of the impact consequence of the accidental events to the resource or protected area or area of conservation interest. Table 7-176 outlines the **impact consequence** to biodiversity resources and protected areas or areas of conservation interest, to be followed by a summarization of overall impact significance.

Table 7-176. Summary of Accidental Event-Related Impact Consequence for Various Components of Biodiversity.

IPF	Fish and Other Fishery Resources	Marine Mammals	Sea Turtles	Birds	Threatened Species	Protected Areas
Well blowout	Negligible	Minor to Severe	Minor	Severe	Minor to Severe	Moderate
Failure of FPSO due to a ship collision	Negligible	Minor to Severe	Severe	Severe	Minor to Severe	Moderate
Pipelaying vessel collision	Negligible	Minor to Severe	Severe	Severe	Minor to Severe	Moderate

Impact consequence, as noted above, is quite variable and covers the entire spectrum of negative impacts, ranging from negligible to severe. The potential for impacts to these resources and protected areas/areas of conservation interest depends on several factors – the size, location, and duration of the spill, the presence and distribution of the resource or location of the protected area/area of conservation interest, the sensitivity of the resource or protected area or area of conservation interest to spilled hydrocarbons, and meteorological conditions at the time of the spill. Hydrocarbons may affect biodiversity resources or protected area or area of conservation interest either via the presence of the spill material on the surface in open ocean or at the shoreline, or as dissolved or dispersed material in the water column.

Given the remote likelihood of each of the three accidental event scenarios, the subsequent overall impact consequence ranges from 1 – Negligible to 3 – Medium (Table 7-177).

Table 7-177. Summary of Accidental Event-Related Impact Significance for Various Components of Biodiversity.

IPF	Fish and Other Fishery Resources	Marine Mammals	Sea Turtles	Birds	Threatened Species	Protected Areas
Well blowout	1 – Negligible	1 – Negligible to 3 – Medium	1 – Negligible	3 – Medium	1 – Negligible to 3 – Medium	2 – Low
Failure of FPSO due to a ship collision	1 – Negligible	1 – Negligible to 3 – Medium	3 – Medium	3 – Medium	1 – Negligible to 3 – Medium	2 – Low
Pipelaying vessel collision	1 – Negligible	1 – Negligible to 3 – Medium	3 – Medium	3 – Medium	1 – Negligible to 3 – Medium	2 – Low

7.5.12.3 Mitigation Measures and Residual Impacts

Impacts to biodiversity resources resulting from accidental events were rated 1 – Negligible to 3 – Medium. Summary information on these mitigation measures is presented in Table 7-178.

It is noteworthy that each of three accidental event scenarios has a likelihood of remote – the lowest likelihood category. As a consequence, mitigation measures may further reduce the likelihood that a specific accidental event may occur, but the likelihood classification for that impact cannot be reduced. Consequently, overall impact significance remains the same.

As previously indicated, these mitigation measures are in addition to measures and controls already planned in the scope of the project.

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea X-mas trees), other well control barriers and isolation of any permeable zone.
- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.
- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.
- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.

- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.
- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.
- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.
- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.
- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Table 7-178. Mitigation Measures to Avoid or Reduce Impacts to Biodiversity from Accidental Events.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Fish and Other Fishery Resources			
No mitigation measures noted.			
Marine Mammals			
Exposure of Mediterranean monk seals to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from the blowout spill.	3 – Medium	M101, M102, M103, M104, M105, M112, M113	3 – Medium
Exposure of Mediterranean monk seals to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.	3 – Medium	M101, M102, M103, M104, M105, M112, M113	3 – Medium
Exposure of Mediterranean monk seals to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from pipelaying vessel collision.	3 – Medium	M101, M102, M103, M104, M105, M112, M113	3 – Medium
Sea Turtles			
Exposure of sea turtles to elevated hydrocarbons within a regional area; some lethal impacts to turtles of all age groups and numerous sublethal impacts to turtles from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.	3 – Medium	M101, M102, M103, M104, M105, M112, M113	3 – Medium
Exposure of sea turtles to elevated hydrocarbons within a regional area; some lethal impacts to turtles of all age groups and numerous sublethal impacts to turtles from direct and indirect effects from exposure to oil from pipelaying vessel collision.	3 – Medium	M101, M102, M103, M104, M105, M112, M113	3 – Medium
Birds			
Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from a blowout.	3 – Medium	M101, M102, M103, M104, M105, M112, M113	3 – Medium
Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.	3 – Medium	M101, M102, M103, M104, M105, M112, M113	3 – Medium

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from pipelaying vessel collision.	3 – Medium	M101, M102, M103, M104, M105, M112, M113	3 – Medium
Threatened Species and Protected Areas			
Oiling of water column or coastline including impacts to threatened species or areas designated as marine or onshore protected areas. Impacts could include, loss of vegetation, habitat destruction, and injury or death to marine or terrestrial fauna from a blowout.	2 – Low	M101, M102, M103, M104, M105, M112, M113	2 – Low
Oiling of threatened species resulting in mortality from a blowout.	1 – Negligible to 3 – Medium	M101, M102, M103, M104, M105, M112, M113	1 – Negligible to 3 – Medium
Oiling of water column or coastline including impacts to areas designated as marine or onshore protected areas. Impacts could include, loss of vegetation, habitat destruction, and injury or death to marine or terrestrial fauna from FPSO failure due to a ship collision.	2 – Low	M101, M102, M103, M104, M105, M112, M113	2 – Low
Oiling of threatened species resulting in mortality from FPSO failure due to a ship collision.	2 – Low to 3 – Medium	M101, M102, M103, M104, M105, M112, M113	2 – Low to 3 – Medium
Oiling of water column or coastline including impacts to areas designated as marine or onshore protected areas. Impacts could include, loss of vegetation, habitat destruction, and injury or death to marine or terrestrial fauna from pipelaying vessel collision.	2 – Low	M101, M102, M103, M104, M105, M112, M113	2 – Low
Oiling of threatened species resulting in mortality from pipelaying vessel collision.	2 – Low to 3 – Medium	M101, M102, M103, M104, M105, M112, M113	2 – Low to 3 – Medium

Notes:

M101: In the unlikely event of a spill, tactical response methods that may be considered under the OSCP include: surveillance and monitoring, offshore containment and recovery; subsea and at surface dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.

M102: All response measures will be continuously monitored to ensure that they remain effective. The response team will maintain situational awareness of the event and response effort.

M103: In the unlikely event of a spill reaching the shoreline, a Shoreline Clean-up and Assessment Technique (SCAT) program will be implemented to inform shoreline clean-up and remediation as applicable.

M104: In the unlikely event of a spill reaching the shoreline, a shoreline clean-up and remediation team will be mobilized to the affected areas. BP will also engage specialized expertise to mitigate impacts to sensitive areas and wildlife species as needed.

M105: In the unlikely event of a spill, follow national regulatory requirements for reporting and notification, using established protocols, which extends to all relevant external stakeholders.

M112: In the unlikely event of a spill of high intensity, specific monitoring (e.g., environmental effects monitoring) may be required and developed in consultation with applicable national authorities.

M113: Provide training in oil spill response planning and techniques to management staff of the designated National Parks and Marine Protected Areas that based on the ESIA spill modelling results could potentially be affected.

7.5.13 Land & Seabed Occupation and Use

High Level Summary

In this section on Land & Seabed Occupation and Use, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. The residual impacts on Land & Seabed Occupation and Use were assessed as of low significance when mitigation measures are applied.

7.5.13.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.13.2 Impact Description

This section addresses the impacts of a potential spill resulting from these three accidental events on the coastline and the seabed. The assessment of potentially affected human settlements on the coastline is based on the current situation. Of course, the current situation will not remain static over the >20-year project. The situation will change over the lifetime of the project as a result of several factors including population increase. In 20 years from now, there could be more settlements on the coast and the existing ones are likely to include a larger number of inhabitants.

Spill modeling results show that a well blowout, a failure of FPSO due to a ship collision and a pipelaying vessel collision could all three see Mauritania and Senegal maritime waters and coastlines affected. Depending on the type of accidental event and the season, the length of the coastline affected would vary. For the purpose of this assessment, the season with the worst-case scenario is considered. The impact description is a conservative assessment. It is based on worst case scenarios with no intervention to contain a spill.

Well Blowout

In case of a well blowout, close to 400 km of coastline could be affected by a spill. It could affect the coastline from about 100 km south of Nouakchott to Dakar. These 400 km of the coast include, from North to South, the following main human settlements:

- In Mauritania:
  - Legweichich, also called PK 93 (600 inhabitants);
  - PK 144 (100 inhabitants);
  - Mouly (30 inhabitants);
  - the *commune* of N'Diago (6,137 inhabitants).
- In Senegal:
  - the *commune* of Saint-Louis (230,801 inhabitants);
  - Niayam (1,500 inhabitants);

  - Lompoul-sur-Mer (10,000 inhabitants);
  - Fass Boye (15,000 inhabitants);
  - Mboro Ndeundekat (2,000 inhabitants);
  - Cayar (29,810 inhabitants);
  - Dakar (3,137,196 inhabitants).

If a spill landfall reached the shore, the coastline of all human settlements listed above could be affected; a temporary oiling of the shore could result of the landfall. However, the use of the beach would not be compromised except, potentially and temporarily, for tourism and recreational activities if any. Sections 4.6 and 4.7 have shown that there is a limited use of the beach by the inhabitants of the coastal settlements. Potential impacts of a well blowout and other accidental events on tourism and recreational activities are discussed in Section 7.5.17.

In addition to the coastline, a well blowout could affect the seabed around the well were the incident occurred. The only anthropogenic activities on the seabed in the Offshore Area are:

- the project infrastructures, i.e., the wells and the SPS, and;
- one submarine telecommunication cables, MainOne, which is located a few kilometers to the west of all project infrastructures.

A spill would not affect a submarine telecommunication cable and any effect of a well blowout on the project infrastructures would be handled by the project proponent; no other parties would be affected. Therefore, the impacts of a well blowout on the seabed are not further discussed in this section.

Failure of FPSO Due to a Ship Collision

In case of a failure of FPSO due to a ship collision, close to 400 km of coastline could be affected by a spill. It could affect the same coastline as the well blowout from about 100 km south of Nouakchott to Dakar. Therefore, the human settlement that could be affected are the same as those identified for the well blowout.

As indicated previously, all three accidental events could involve a spill in the Senegal River estuary, but the worst-case scenario would be in case of failure of FPSO due to a ship collision.

In case of the spill reaching the river estuary, the coastline of the human settlements located between the river mouth and about 20 km upstream of the island of Saint-Louis could be affected. A temporary oiling of the shore could result of the landfall. However, there is a limited use of the shore by the inhabitants of these settlements.

These settlements along the river estuary include:

- In Mauritania:
  - Villages in the hinterland of the *commune* of N'Diago which are part of the Diawling National Park (already accounted for in the 6,137 inhabitants of the *commune*).
- In Senegal:
  - Neighborhoods in the outskirts of the *commune* of Saint-Louis (already accounted for in the 230,801 inhabitants of the *commune*);
  - Villages of the *commune* of Ndiébène Gandiole established along the mouth of the Senegal River downstream of Saint-Louis (Ndiébène Gandiole *commune* has an estimated population of 17,737 inhabitants for the year 2015);

   - Villages of the *commune* of Gandon established along the Senegal River upstream of Saint-Louis (the Gandon *commune* has an estimated population of 38,637 inhabitants for the year 2015).

Additionally, an FPSO failure due to a ship collision could result in debris landing on the seabed. However, beside the project infrastructure, there is no anthropogenic activity on the seabed near the FPSO. Therefore, the impacts of the FPSO failure event scenario on the seabed is not further discussed.

Pipelaying Vessel Collision

In case of a pipelaying vessel collision, the spill on the coastline could extend about 100 km north and south of N'Diago/Saint-Louis for a total of about 200 km of coastline.

These 200 km of the coast include, from North to South, the following main human settlements whose coastline could be affected:

- In Mauritania:
   - PK 144 (100 inhabitants);
   - Mouly (30 inhabitants);
   - the *commune* of N'Diago (6,137 inhabitants).
- In Senegal:
   - the *commune* of Saint-Louis (230,801 inhabitants);
   - Niayam (1,500 inhabitants);
   - Lompoul-sur-Mer (10,000 inhabitants);
   - Fass Boye (15,000 inhabitants).

Additionally, a pipelaying vessel collision could result in debris landing on the seabed, along to the pipeline route where the incident occurred. Beside the project's infrastructure, the only anthropogenic activity on the seabed, along the Pipeline Area, is located in the Offshore Area and consist of the MainOne submarine telecommunication cable. Although shipwreck debris would have the potential to affect submarines cables if they landed on them[157], MainOne is a few kilometers away from the pipeline route (as illustrated in Chapter 4, Figures 4-30 and 4-38) thus, in the case in the proposed project, no submarine telecommunication cable is at risk from a pipelaying vessel collision. As for the project infrastructures, any effect of a pipelaying vessel collision on them would be handled by the project proponent; no other parties would be affected. Therefore, the impacts of a pipelaying vessel collision on seabed is not further discussed.

7.5.13.3 Impact Rating

Well Blowout

A well blowout could affect the coastline of several human settlements on about 400 km, from approximately Legweichich in Mauritania to Dakar in Senegal. Since the inhabitants of these settlements have a limited use of the beach and a temporary oiling of the shore would not compromise their use of the beach, the intensity of the impact would be moderate. The extent would be regional. The adverse effects of the spill on the beach would be reversible, but the duration of the

[157] Submarine telecommunication cables can be rendered temporarily inoperable if a hard object in contact with them penetrates their armor and insulation, or if the object severs them. According to a joint report of United Nations Environmental Program (UNEP) and the International Cable Protection Committee (ICPC), "*the breaking strength of such cables ranges from a few tonnes to more than 40 tonnes for the double-armoured types. However, a cable may be rendered inoperable by forces smaller than those needed to sever it".* (UNEP-ICPC, 2009)

recovery period could vary from one location to the other. The duration is considered short to long term. Based on the combination of these criteria, the consequence of the impact would be minor to moderate. Given that the probability of a well blowout is remote, its overall significance is rated 1 – Negligible to 2 – Low (details are provided in Table 7-179).

Failure of FPSO Due to a Ship Collision

A failure of FPSO due to a ship collision could affect the same coastline as a well blowout. However, it has a greater potential to also affect additional human settlements along the Senegal River estuary. Since the inhabitants of these settlements have a limited use of the beach and a temporary oiling of the shore would not compromise their use of the beach, the intensity of the impact would be moderate. The extent would be regional. The adverse effects of the spill on the beach would be reversible, but the duration of the recovery period could vary from one location to the other. The duration is considered short to long term. Based on the combination of these criteria, the consequence of the impact would be minor to moderate. Given that the probability of a failure of FPSO due to a ship collision is remote, its overall significance is rated 1 – Negligible to 2 – Low (details are provided in Table 7-179).

Pipelaying Vessel Collision

A pipelaying vessel collision could affect about 200 km of coastline, from approximately PK 144 in Mauritania to Fass Boye in Senegal. Unlike a well blowout or a failure of FPSO due to a ship collision, the spill from pipelaying vessel collision would not reach Dakar.

Since the inhabitants of these settlements have a limited use of the beach and a temporary oiling of the shore would not compromise their use of the beach, the intensity of the impact would be moderate. The extent would be regional. The adverse effects of the spill on the beach would be reversible, but the duration of the recovery period could vary from one location to the other. The duration is considered short to long term. Based on the combination of these criteria, the consequence of the impact would be minor to moderate. Given that the probability of a pipelaying vessel collision is remote, its overall significance is rated 1 – Negligible to 2 – Low (details are provided in Table 7-179).

Table 7-179. Impacts to Land & Seabed Occupation and Use in Case of Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout					
Mauritania Senegal	Oil spill of coastline on close to 400 km, from approximately Legweichich in Mauritania to Dakar in Senegal due to a well blowout.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term to Long term	Minor to Moderate	Remote	1 – Negligible to 2 – Low
Failure of FPSO Due to a Ship Collision					
Mauritania Senegal	Oil spill of coastline on close to 400 km, from approximately Legweichich in Mauritania to Dakar in Senegal, and on the shore of <20 km along the Senegal River estuary, due to a failure of FPSO caused by a ship collision.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term to Long term	Minor to Moderate	Remote	1 – Negligible to 2 – Low
Pipelaying Vessel Collision					
Mauritania Senegal	Oil spill of coastline on about 200 km, from approximately PK 144 in Mauritania to Fass Boye in Senegal due to a pipelaying vessel collision.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term to Long term	Minor to Moderate	Remote	1 – Negligible to 2 – Low

7.5.13.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 and the identified potential applicable mitigation measures are reported below (Table 7-180). These mitigation measures are in addition to the measures and controls already planned in the project design and operational controls in place, notably:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea X-mas trees), other well control barriers and isolation of any permeable zone.
- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.
- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.

- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.
- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.
- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.
- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.
- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.
- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Table 7-180. Mitigation Measures to Avoid or Reduce Impacts to Land & Seabed Occupation and Use in Case of Accidental Events.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Oil spill of coastline on close to 400 km, from approximately Legweichich in Mauritania to Dakar in Senegal due to a well blowout.	1 – Negligible to 2 – Low	M101, M102, M103, M104, M105, M106, M107, M108	1 – Negligible
Oil spill of coastline on close to 400 km, from approximately Legweichich in Mauritania to Dakar in Senegal, and on the shore of <20 km along the Senegal River estuary, due to a failure of FPSO caused by a ship collision.	1 – Negligible to 2 – Low	M101, M102, M103, M104, M105, M106, M107, M108	1 – Negligible
Oil spill of coastline on about 200 km, from approximately PK 144 in Mauritania to Fass Boye in Senegal due to a pipelaying vessel collision.	1 – Negligible to 2 – Low	M101, M102, M103, M104, M105, M106, M107, M108	1 – Negligible

Notes:

M101: In the unlikely event of a spill, tactical response methods that may be considered under the OSCP include: surveillance and monitoring, offshore containment and recovery; subsea and at surface dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.

M102: All response measures will be continuously monitored to ensure that they remain effective. The response team will maintain situational awareness of the event and response effort.

M103: In the unlikely event of a spill reaching the shoreline, a Shoreline Clean-up and Assessment Technique (SCAT) program will be implemented to inform shoreline clean-up and remediation as applicable.

M104: In the unlikely event of a spill reaching the shoreline, a shoreline clean-up and remediation team will be mobilized to the affected areas. BP will also engage specialized expertise to mitigate impacts to sensitive areas and wildlife species as needed.

M105: In the unlikely event of a spill, follow national regulatory requirements for reporting and notification, using established protocols, which extends to all relevant external stakeholders.

M106: In the unlikely event of a spill, establish a grievance mechanism easily accessible to affected stakeholders that includes monitoring of claims and the resolution thereof.

M107: In the unlikely event of a spill, work with national authorities as requested, to inform relevant stakeholders (including artisanal fishermen) on: 1) the location of the spill; 2) cleanup operations; 3) applicability of temporary exclusion zones; and 4) grievance mechanism, as applicable. In relation to fishermen, this will include providing timely communication, offering them the opportunity to remove gear from affected areas, reducing impact on fishing gear.

M108: In the unlikely event of a spill, in coordination with national authorities if requested, monitor and support ways to address the concerns of stakeholders regarding potential impacts of the spill.

7.5.14 Maritime Navigation

High Level Summary

In this section on Maritime Navigation, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. The impacts on Maritime Navigation from Accidental Events were assessed as of negligible significance. No mitigation measures were required but some have been suggested despite the impacts being ranked as negligible.

7.5.14.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.14.2 Impact Description

This section addresses the impacts of a potential spill resulting from the above-mentioned accidental events on maritime navigation. The oil spill modeling results in Appendix N-1 show that the direction of the spills could vary according to the type of accidental events and the seasons of the year. However, the spills resulting from the three types of accidental events could affect both offshore and nearshore waters. As a result, the three accidental events would have similar impacts on maritime navigation. Therefore, they are discussed together in this section.

An oil spill could interfere with maritime navigation. Maritime navigation would be excluded from the spill response and cleanup area, initially at the release location, with expanded operations as the oil spill spreads. The temporary exclusion area would move according to the direction of the spill and the area targeted by the spill containment and cleanup activities.

The size of the exclusion area would depend on the size of the spill response and clean-up area. However, vessels would be able to pass with a detour around the spill response and clean-up area.

As indicated previously, there is a maritime traffic corridor offshore the Mauritanian and Senegalese coasts used mostly for shipping activities between Africa and Europe. Figures 4-29 and 4-37 in Chapter 4 show the location of this corridor and the importance of the traffic. Additionally, Figures 4-28 and 4-34 in Chapter 4 show that a large number of industrial fishing boats navigate in Mauritania and Senegal maritime waters. Finally, Figure 4-34 illustrates the importance of the traffic of pirogues.

In case of a well blowout, a failure of FPSO due to a ship collision or a pipelaying vessel collision, maritime shipping and navigation of industrial and artisanal fishing boats would be precluded in the spill response and clean-up area. Most commercial vessels would be able to pass their way unabated by the detour. However, the detour could be a more significant disturbance for small artisanal fishing boats.

7.5.14.3 Impact Rating

Since most commercial vessels would be able to pass their way from the spill response and clean-up area unabated by the detour but this disturbance could be more significant for artisanal fishing boats, the intensity of the impact is considered low to moderate. The extent would be regional. The duration of the impact would be short term; it would be limited to the period of the spill response and clean-up. Based on the combination of these criteria, the consequence of the impact would be negligible to moderate. Given that the probability of a well blowout, an FPSO failure due to a ship collision or a pipelaying vessel collision is remote, the overall significance of the impact is rated 1 – Negligible (details are provided in Table 7-181).

Table 7-181. Impacts to Maritime Navigation in Case of Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout, Failure of FPSO Due to a Ship Collision and Pipelaying Vessel Collision					
Mauritania Senegal	Preclusion of maritime navigation in the spill response area in offshore and nearshore waters.	Nature: Negative Intensity: Low to Moderate Spatial Extent: Regional Duration: Short term	Negligible to Minor	Remote	1 – Negligible

7.5.14.4 Mitigation Measures and Residual Impacts

Impacts being rated 1 - Negligible, no mitigation measures are required.

Despite the impact being ranked as negligible the following mitigation measures will be undertaken:

- M101: In the unlikely event of a spill, tactical response methods that may be considered under the OSCP include: surveillance and monitoring, offshore containment and recovery; subsea and at surface dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.
- M102: All response measures will be continuously monitored to ensure that they remain effective. The response team will maintain situational awareness of the event and response effort.
- M105: In the unlikely event of a spill, follow national regulatory requirements for reporting and notification, using established protocols, which extends to all relevant external stakeholders.
- M107: In the unlikely event of a spill, work with national authorities as requested, to inform relevant stakeholders (including artisanal fishermen) on: 1) the location of the spill; 2) cleanup operations; 3) applicability of temporary exclusion zones; and 4) grievance mechanism, as applicable. In relation to fishermen, this will include providing timely communication, offering them the opportunity to remove gear from affected areas, reducing impact on fishing gear.

7.5.15 Industrial Fisheries

High Level Summary

In this section on Industrial Fisheries, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. The residual impacts on Industrial Fisheries from Accidental Events were assessed as of low significance when mitigation measures are applied.

7.5.15.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.15.2 Impact Description

This section addresses the impacts of a potential spill resulting from the above-mentioned three accidental events on industrial fisheries. As indicated in Section 7.5.14, the oil spill modeling results in Appendix N-1 show that the direction of the spills could vary according to the type of accidental events and the seasons of the year. However, the modeling results show that spills could extend on several hundred km^2 of maritime waters. The three accidental events would have similar impacts on industrial fisheries. Therefore, they are discussed together in this section.

An oil spill could interfere with industrial fisheries in several ways:

- As indicated in Section 7.5.6, an accidental event could have impacts on plankton, fish and other fishery resources. The consequences of a spill have been deemed moderate on these resources. However, given the remote likelihood of the three discussed accidental events, the overall impact significance of the accidental events on plankton, fish and other fishery resources has been rated 1 – Negligible.
- In case of an oil spill, there would be a temporary preclusion of industrial fishing in the spill response area. As a result, industrial fishing activities in a part of the Mauritanian and Senegalese waters could be temporarily shut down.
- A temporary disruption of industrial fisheries would entail direct loss of revenues for industrial fishing operators. It would also have ramifications to the economies of Mauritania and Senegal since part of the catches are landed in these countries.
- As indicated in Section 7.5.6, other potential effects involve tainting of the flesh of fishes and other fishery resources. Tainting may affect the consumer perception of seafood products and greatly reduce marketability both locally and regionally. Tainting of living tissue is reversible but, whereas the uptake of oil taint is frequently rapid, the depuration process whereby contaminants are metabolized and eliminated from the organisms is slower. The presence and persistence of taint will depend on type and fate of oil, species, extent of exposure, hydrographic conditions, and temperate.

Industrial fisheries in Mauritania and Senegal are characterized in Sections 4.6.6 and 4.7.6 with details provided in Appendices E-1 and E-2. There are very little data on the revenues that industrial fisheries provide to the operators. Data on revenues generated on national economies by industrial fisheries are also limited. Additionally, existing data only consider legal fishing and reported data while illegal fishing and unreported fishing is an issue in Mauritania and Senegal.

Industrial fisheries statistics are generally presented in number of boats and in tonnages of catches reported and/or in tonnage of catches landed in-country.

The assessment of potentially affected industrial fishing boats and catches is based on the current situation. Of course, the current situation will not remain static over the >20-year project. The situation will change over the lifetime of the project as a result of several factors. In 20 years from now, there could a different number of industrial fishing boats in the maritime waters of Mauritania and Senegal.

In Mauritania, the industrial fleet counted about 300 vessels in 2017: about 100 nationals and 200 foreign. While industrial fishing covers the whole EEZ, it is practiced more in the country's North zone. It is also important in the Central zone but diminishes in the southern part of the country's maritime waters.

In Senegal, the industrial fleet counted 161 vessels in 2017: 128 nationals and 33 foreign. Notwithstanding the areas prohibited by the Fishing Code, industrial fishing boats go where the resource is, and can thus be found throughout the entire zone authorized by the type of license obtained.

Based on the above data, >450 industrial vessels operate in the maritime waters of Mauritania and Senegal. Since this number varies throughout time, there are a lot of uncertainties on the number of industrial fishing vessels that could be operating in the area over the next 20 years. While a spill would not cover all Mauritania and Senegalese maritime waters, it is not possible to determine the portion of the >450 vessels that could be affected. Therefore, a very conservative estimation takes all of them into account in the impact assessment. The actual impact on the sector may be less given that the industrial fishing fleet may actively avoid the area affected and target fish stocks in unaffected waters, with much of the Mauritanian fleet already predominantly operating in waters not likely affected by a spill event. Of course, this estimated number would also change over the 20-year project, but no available data allows any projection on its variations in the future.

Existing data on in-country landings show very important variations from one year to another. For instance, reported catches by small pelagic by the industrial fleet in Mauritania accounted for about 1 million tonnes in 2011. A record drop was recorded in 2013 when catches did not exceed 300,000 tonnes. Several factors explain these variations including changes in bilateral fishing agreements. While a spill could affect catches, it is not possible to estimate the tonnages that would be affected if a spill occurs now. There are even more uncertainties around any projection on potential losses if the spill occurred several years from now.

Existing industrial fisheries statistics do not provide the information required to estimate the current revenues from industrial fisheries in Mauritania and Senegal and to make any projections on these revenues in the future. Additionally, uncertainties around the portion of the maritime waters where industrial fisheries would be precluded in case of a spill and the duration of this preclusion add to the uncertainties around any fishing catches losses and revenues losses. Therefore, spill-related loss of catches and loss of revenues for the industrial fisheries cannot be quantified, let alone projected if a spill occurred several years from now.

However, high-level data indicate that the fisheries sector, as a whole, is important to both Mauritania and Senegal national economies. Available indicators, while different for each country, show the importance of fisheries in both countries. In Mauritania, the fisheries sector currently accounts for about 18% of the national budget, 40% of foreign exchanges earnings, and about 4-5% of Gross Domestic product. In Senegal, the fisheries sector generated approximately 278 billion FCFA (US$ 488 million) in 2014. Fisheries and related activities employed more than 600,000 people and accounted for approximately 15% of the country's labor force in 2017. These figures include both industrial and artisanal fisheries. While data is lacking to assess the weight of industrial fisheries against artisanal fisheries in the national economies, temporary catch losses in the industrial fisheries could have an indirect impact on the national economies.

7.5.15.3 Impact Rating

The impacts of the accidental events on plankton, fish and other fishery resources have been rated 1 – Negligible (See section 7.5.6). There are a lot of uncertainties on the species that would be affected and on the time that would be required for their recovery. Depending on the species that would be affected, the impact on plankton, fish and other fishery resources could entail a disruption of industrial fisheries. Very conservatively, the intensity of the indirect impact on industrial fisheries is deemed high. The extent of the impact would be regional. However, the impact would be reversible and its duration would be short term; it would be limited to the period of recovery of the fishery resources. Based on the combination of these criteria, the consequence of the impact would be moderate. Given that the probability of a well blowout, a failure of FPSO due to a ship collision or a pipelaying vessel collision is remote, the overall significance of the impact is rated 2 – Low (details are provided in Table 7-182).

Additionally, industrial fisheries would be disrupted in the spill response area. Due to the size of the maritime waters that could be affected by a spill and the size of the industrial fisheries fleet, the intensity of the preclusion of industrial fishing activities is considered high. The extent of the impact would be regional. However, the duration of the impact would be short term; it would be limited to the period of the spill response. Based on the combination of these criteria, the consequence of the impact would be moderate. Given that the probability of a well blowout, a failure of FPSO due to a ship collision or a pipelaying vessel collision is remote, its overall significance is rated 2 – Low (details are provided in Table 7-182).

Other potential effects involve tainting of the flesh of fishes and other fishery resources which may greatly reduce marketability both locally and regionally. This could involve losses of industrial fishing revenues. In relation with this specific impact and the above ones, the intensity of the loss of industrial fishing revenues is considered high. The extent of the impact would be regional. However, the duration of the impact would be short term; it would be limited to the period of the spill response and/or the period of recovery of the fishery resources. Based on the combination of these criteria, the consequence of the impact would be moderate. Given that the probability of a well blowout, a failure of FPSO due to a ship collision or a pipelaying vessel collision is remote, its overall significance is rated 2 – Low (details are provided in Table 7-182).

Finally, any losses in industrial fishing catches and revenues could have indirect impacts on the national economies. Due to the importance of fisheries to the economies, the intensity of the impact would be high. The extent of the impact would be regional. However, the duration of the impact would be short term; it would be limited to the period of the industrial fisheries disruption. Based on the combination of these criteria, the consequence of the impact would be moderate. Given that the probability of a well blowout, a failure of FPSO due to a ship collision or a pipelaying vessel collision is remote, its overall significance is rated 2 – Low (details are provided in Table 7-182).

Table 7-182. Impacts to Industrial Fisheries in Case of Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout, Failure of FPSO Due to a Ship Collision and Pipelaying Vessel Collision					
Mauritania Senegal	Temporary loss of industrial fishing catches due to spill impacts on plankton, fish and other fishery resources.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term	Moderate	Remote	2 – Low
Mauritania Senegal	Temporary preclusion of industrial fishing in the spill response area for up to >450 industrial vessels (2017 numbers).	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term	Moderate	Remote	2 – Low
Mauritania Senegal	Temporary loss of catches and revenues for industrial fishing operators.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term	Moderate	Remote	2 – Low
Mauritania Senegal	Temporary loss of revenues for national economies due to the temporary disruption of industrial fisheries.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term	Moderate	Remote	2 – Low

7.5.15.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 and the identified potential applicable mitigation measures are reported below (Table 7-183). These mitigation measures are in addition to the measures and controls already planned in the project design and operational controls in place, notably:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea X-mas trees), other well control barriers and isolation of any permeable zone.
- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.
- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.
- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.

- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.
- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.
- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.
- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.
- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.
- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Table 7-183. Mitigation Measures to Avoid or Reduce Impacts to Industrial Fisheries in Case of Accidental Events.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Temporary loss of industrial fishing catches due to spill impacts on plankton, fish and other fishery resources.	2 – Low	M101, M102, M105, M106, M107, M108	2 – Low
Temporary preclusion of industrial fishing in the spill response area for up to >450 industrial vessels (2017 numbers).	2 – Low	M101, M102, M105, M106, M107, M108	2 – Low
Temporary loss of catches and revenues for industrial fishing operators.	2 – Low	M101, M102, M105, M106, M107, M108	2 – Low
Temporary loss of revenues for national economies due to the temporary disruption of industrial fisheries.	2 – Low	M101, M102, M105, M106, M107, M108	2 – Low

Notes:

M101: In the unlikely event of a spill, tactical response methods that may be considered under the OSCP include: surveillance and monitoring, offshore containment and recovery; subsea and at surface dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.

M102: All response measures will be continuously monitored to ensure that they remain effective. The response team will maintain situational awareness of the event and response effort.

M105: In the unlikely event of a spill, follow national regulatory requirements for reporting and notification, using established protocols, which extends to all relevant external stakeholders.

M106: In the unlikely event of a spill, establish a grievance mechanism easily accessible to affected stakeholders that includes monitoring of claims and the resolution thereof.

M107: In the unlikely event of a spill, work with national authorities as requested, to inform relevant stakeholders (including artisanal fishermen) on: 1) the location of the spill; 2) cleanup operations; 3) applicability of temporary exclusion zones; and 4) grievance mechanism, as applicable. In relation to fishermen, this will include providing timely communication, offering them the opportunity to remove gear from affected areas, reducing impact on fishing gear.

M108: In the unlikely event of a spill, in coordination with national authorities if requested, monitor and support ways to address the concerns of stakeholders regarding potential impacts of the spill.

7.5.16 Artisanal Fisheries and Related Activities

High Level Summary

In this section on Artisanal Fisheries and Related Activities, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. The residual impacts on Artisanal Fisheries and Related Activities were assessed as of low significance when mitigation measures are applied.

7.5.16.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.16.2 Impact Description

This section addresses the impacts of a potential spill resulting from the above-mentioned accidental events on artisanal fisheries and related activities. As indicated in Section 7.5.14, the oil spill modeling results in Appendix N-1 show that the direction of the spills could vary according to the type of accidental events and the seasons of the year. However, the modeling results show that spills could extend on several hundred km^2 of maritime waters and they could all affect nearshore waters where artisanal fisheries are concentrated. The three accidental events would have similar impacts on artisanal fisheries. Therefore, they are discussed together in this section.

An oil spill could interfere with artisanal fisheries in several ways. Interference would be similar to those identified for industrial fisheries:

- As indicated in Section 7.5.6, an accidental event could have impacts on plankton, fish and other fishery resources. The consequences of a spill have been deemed moderate for these resources. However, given the remote likelihood of the three discussed accidental events, the overall impact significance of the accidental events on plankton, fish and other fishery resources has been rated 1 – Negligible.
- In case of an oil spill, there would be a temporary preclusion of artisanal fishing in the spill response area. As a result, part of the artisanal fishing activities in Mauritanian and Senegalese waters could be temporarily shut down.
- As indicated in Section 7.5.6, other potential effects involve tainting of the flesh of fishes and other fishery resources. Tainting may affect the consumer perception of seafood products and greatly reduce marketability both locally and regionally. Tainting of living tissue is reversible but, whereas the uptake of oil taint is frequently rapid, the depuration process whereby contaminants are metabolized and eliminated from the organisms is slower. The presence and persistence of taint will depend on type and fate of oil, species, extent of exposure, hydrographic conditions, and temperate.
- A temporary disruption of artisanal fisheries would entail direct loss of catches and revenues for fishermen.
- It would also have ramifications on the revenues of other people involved in economic activities related to artisanal fisheries.
- A temporary disruption of artisanal fisheries would have ramifications on the national economies of Mauritania and Senegal.
- Additionally, disruption of artisanal fisheries would have ramifications on communities livelihood, but this is discussed separately in Section 7.5.20.
- Artisanal fisheries in Mauritania and Senegal are characterized in Sections 4.6.6 and 4.7.6 with details provided in Appendices E-1 and E-2.

Artisanal fisheries statistics are generally presented in number of boats and tonnages of catches landed. The assessment of potentially affected artisanal fishing boats and catches is based on the current situation. Of course, the current situation will not remain static over the >20-year project. The situation will change over the lifetime of the project as a result of several factors. In 20 years from now, there could be a different number of artisanal fishing boats in the waters of Mauritania and Senegal and the tonnages of catches could also be different. Similarly, the number of fishermen could change as well as the number of people involved in activities related to artisanal fisheries.

In Mauritania, the artisanal fleet counted 6,244 units in 2017, with more than 53% of the units concentrated in the Nouadhibou area. Annual catches generated by artisanal fisheries and landed in Mauritania between 2012 and 2015 average approximately 300,000 tonnes. Statistics show important variations in the tonnage over the years. Additionally, and as indicated previously, the different artisanal fishing zones of the Mauritanian EEZ have very different contributions to the national catches. The South zone's contribution to this tonnage accounted for only 2.1% of the catches during the 2012-2015 period. Most of the contributions came from the North zone.

As indicated in Table 4-33 in Section 4.6.6, the estimations of the monetary value of artisanal fisheries show large variations according to the different zones. For the period 2012-2015, the total monetary value of the artisanal catches, all zones included, is estimated at over 210 billion MRO (i.e., about US$ 585,000,000[158]). The North zone accounted for over 175 billion of this value while the South zone accounted for less than 1.9 billion.

In Senegal, the artisanal fleet counted 19,009 units in 2015 and the sector employed approximately 63,000 fishermen. Annual catches generated by artisanal fisheries were estimated to 350,000 tonnes in 2017. The total monetary value of the artisanal catches at a national level was estimated at over 93,574,514,000 FCFA (i.e., about US$ 165,000,000[159]) for the year 2014, with variations in the average value from one location to another. There are a lot of uncertainties around the temporary loss of revenues in case of a spill since the annual monetary value varies a lot from one year to another. Additionally, the value of the losses would depend on several factors, for instance the location of the spill, its size, the season during which it would occur, the duration of the recovery time for the fishery resources, etc. As a result, any estimation of the value of the losses would be imprudent, let alone projections of the value of these losses over a 20-year period.

Based on the above data, over 25,000 artisanal boats operate in the maritime waters of Mauritania and Senegal. There are a lot of uncertainties on the number of units that could be operating in these waters over the next 20 years. Even if a spill was to happen in the next coming years, there would still be a lot of uncertainties around the number of artisanal fishing units that would be affected since it would depend of the area covered by the spill. Considering that a spill would not cover all Mauritania and Senegalese maritime waters, it is not possible to determine the portion of the >25,000 artisanal fishing units that could be affected. Therefore, a conservative estimation takes all of them into account in the impact assessment.

There are also uncertainties on the number of fishermen that would be affected. While available data suggest that there are approximately 63,000 fishermen in Senegal, no such data is available for Mauritania. Based on the number of units in Mauritania, which is roughly 1/3 of the units in Senegal, an assumption is made that there could be around 20,000 fishermen in Mauritania. As a result, the two countries together would count over 80,000 fishermen. While a spill would not cover all Mauritania and Senegalese maritime waters and not all fishermen would be affected, it is not possible to determine the portion of the >80,000 artisanal fishermen that could be affected. Therefore, a very conservative estimation takes all of them into account in the impact assessment. The actual impact on the sector may be less given that the artisanal fishing fleet may actively avoid the area affected and target fish stocks in unaffected waters, with much of the Mauritanian artisanal fishing fleet already predominantly operating in waters not likely affected by a spill event. Of course, this estimated number could also change over a 20-year period, notably because the number of artisanal fishermen in Mauritania and Senegal will change over time.

Existing data on the value of the landings show very important variations in time, and from one area to the other. While a spill could affect catches, it is not possible to estimate the tonnages that would be affected if a spill occurred. There are even more uncertainties around any projection on potential losses if the spill occurred several years from now.

There are important annual variations in annual value of artisanal fisheries in Mauritania and Senegal. Any projections on the future monetary value of the catches would be imprudent. Additionally, uncertainties around the portion of the maritime waters where artisanal fisheries would be precluded in case of a spill and the duration of this preclusion add to the uncertainties around any fishing catches losses and revenues losses. Therefore, spill-related loss of catches and loss of revenues for the artisanal fisheries cannot be quantified, let alone projected if a spill occurred in several years from now.

[158] As of July 16, 2017, US$ 1 = MRO 359.05

[159] Senegal National Agency of Statistics and Demography published in August 2017 the data on monetary value of artisanal catches for the year 2014 (ANSD, 2017)

As indicated in Sections 4.6.6 and 4.7.6, a number of economic activities related to artisanal fisheries are carried out in Mauritania and Senegal: ice production and transportation, fishmonging, road transportation, fish processing, sales, etc. Some of the activities are conducted in the fishing communities, but some have a much larger geographical extent. While data provided in Sections 4.6.6. and 4.7.6 and their related appendices provide some indications on the number of people involved in these activities in the communities neighboring the Nearshore Hub/Terminal Area, there are no available data on their revenues or their number at a national level. As a result, the indirect impact of temporary disruption of artisanal fisheries on related activities and revenues of people involved in these activities cannot be estimated. As a conservative approach, it is assumed that the impacts of the disruption would be similar for artisanal fishermen and other people involved in related activities.

There are a lot of uncertainties around the number of people involved in activities related to artisanal fisheries that could potentially be affected in case of a disruption of artisanal fisheries. It is roughly estimated that about 700,000 people[160] are involved in activities related to artisanal fisheries in the two countries together. These people could be affected in case of a disruption of artisanal fisheries. A very conservative estimation takes all of them into account in the impact assessment. Of course, this estimated number could also change over a 20-year period, notably because the number of artisanal fishermen in Mauritania and Senegal will change over time.

Finally, a temporary disruption of artisanal fisheries would have ramifications on the national economies of Mauritania and Senegal. Again, it is difficult to do a quantitative assessment of this impact with available data. However, stakeholders in Mauritania and Senegal recognize the importance of artisanal fisheries in the national economies and food security of both countries. This is specifically discussed under communities livelihood in Section 7.5.20.

7.5.16.3 Impact Rating

The impacts of the accidental events on plankton, fish and other fishery resources have been rated 1 – Negligible. There are a lot of uncertainties on the species that would be affected and on the time that would be required for their recovery. Depending on the species that would be affected, the impact on plankton, fish and other fishery resources could entail a disruption of artisanal fisheries. Very conservatively, the intensity of the indirect impact on artisanal fisheries is deemed high. The extent of the impact would be regional. The impact would be reversible. Its duration would be short term: it would be limited to the period of recovery of the fishery resources. However, if a disruption of artisanal fisheries lasted several months, some fishermen might have difficulties to recover from the disruption and their activity could be compromised. As a result, the duration of the impact is considered short to long term. Based on the combination of these criteria, the consequence of the impact would be moderate to severe. Given that the probability of a well blowout, a failure of FPSO due to a ship collision or a pipelaying vessel collision is remote, the overall significance of the impact is rated 2 – Low to 3 – Medium (details are provided in Table 7-184).

Additionally, artisanal fisheries would be disrupted in the spill response area. Due to the size of the maritime waters that could be affected by a spill and the size of the artisanal fisheries fleet, the intensity of the preclusion of artisanal fishing activities is considered high. The extent of the impact would be regional. The preclusion would be temporary. However, depending on the duration of the disruption of artisanal fisheries, some fishermen might have difficulties to recover from it and their activity could be compromised. As a result, the duration of the impact is considered short to long term. Based on the combination of these criteria, the consequence of the impact would be moderate to severe. Given that the probability of a well blowout, a failure of FPSO due to a ship collision or a pipelaying vessel collision is remote, the overall significance of the impact is rated 2 – Low to 3 – Medium (details are provided in Table 7-184).

[160] A rough estimation of the number of people can be made based on several assumptions. Fisheries and related activities employ more than 600,000 people in Senegal, most of them in the artisanal sector. This number includes 63,000 artisanal fishermen. This suggests that there are 9 people involved in related activities for every fisherman. Based on this ratio and the previous assumption on the number of fishermen in Mauritania, there would be about 190,000 people involved in activities related to artisanal fisheries in Mauritania.

Other potential effects involve tainting of the flesh of fishes and other fishery resources which may greatly reduce marketability both locally and regionally. This could involve losses of artisanal fishing revenues. In relation with this specific impact and the above ones, the intensity of the loss of artisanal fishing revenues is considered high. The extent of the impact would be regional. Depending on the duration of the loss and the capacity of fishermen to recover from the loss, the impact could be short term to long term. Based on the combination of these criteria, the consequence of the impact would be moderate to severe. Given that the probability of a well blowout, a failure of FPSO due to a ship collision or a pipelaying vessel collision is remote, the overall significance of the impact is rated 2 – Low to 3 – Medium (details are provided in Table 7-184).

Any disruption of artisanal fisheries could have indirect impact on related activities. It is assumed that the intensity would be similar for artisanal fisheries and for related activities. Therefore, the intensity is considered high. The extent of the impact would be regional. Depending on the duration of the disruption of artisanal fisheries and related activities, and the capacity of people to recover from the loss, the impact could be short term to long term. Based on the combination of these criteria, the consequence of the impact would be moderate to severe. Given that the probability of a well blowout, a failure of FPSO due to a ship collision or a pipelaying vessel collision is remote, the overall significance of the impact is rated 2 – Low to 3 – Medium (details are provided in Table 7-184).

Finally, any losses in artisanal fishing catches and revenues could have indirect impacts on the national economies. Because of the large number of people that could be affected, the intensity of the impact would be high. The extent of the impact would be regional. Depending on the duration of the disruption of artisanal fisheries and related activities, the duration of the impact could be short to long term. Based on the combination of these criteria, the consequence of the impact would be moderate to severe. Given that the probability of a well blowout, a failure of FPSO due to a ship collision or a pipelaying vessel collision is remote, the overall significance of the impact is rated 2 – Low to 3 – Medium (details are provided in Table 7-184).

Table 7-184. Impacts to Artisanal Fisheries and Related Activities in Case of Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout, Failure of FPSO Due to a Ship Collision and Pipelaying Vessel Collision					
Mauritania Senegal	Temporary loss of artisanal fishing catches due to spill impacts on plankton, fish and other fishery resources.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term to Long term	Moderate to Severe	Remote	2 – Low to 3 – Medium
Mauritania Senegal	Temporary preclusion of artisanal fishing in the spill response area for up to over 25,000 artisanal fishing units (2017 numbers).	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term to Long term	Moderate to Severe	Remote	2 – Low to 3 – Medium
Mauritania Senegal	Temporary loss of revenues for up to about 80,000 artisanal fishermen (2017 numbers).	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term to Long term	Moderate to Severe	Remote	2 – Low to 3 – Medium
Mauritania Senegal	Temporary loss of revenues for up to about 700,000 people involved in activities related to artisanal fisheries (2017 numbers).	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term to Long term	Moderate to Severe	Remote	2 – Low to 3 – Medium
Mauritania Senegal	Temporary loss of revenues for national economies due to the temporary disruption of artisanal fisheries.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term to Long term	Moderate to Severe	Remote	2 – Low to 3 – Medium

7.5.16.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-185) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the measures and controls already planned in the project design and operational controls in place, notably:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea Xmas trees), other well control barriers and isolation of any permeable zone.
- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.

- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.
- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.
- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.
- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.
- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.
- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.

- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Table 7-185. Mitigation Measures to Avoid or Reduce Impacts to Artisanal Fisheries and Related Activities in Case of Accidental Events.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Temporary loss of artisanal fishing catches due to spill impacts on plankton, fish and other fishery resources.	2 – Low to 3 – Medium	M101, M102, M105, M106, M107, M108, M112	2 – Low
Temporary preclusion of artisanal fishing in the spill response area for up to over 25,000 artisanal fishing units (2017 numbers).	2 – Low to 3 – Medium	M101, M102, M105, M106, M107, M108, M112	2 – Low
Temporary loss of revenues for up to about 80,000 artisanal fishermen (2017 numbers).	2 – Low to 3 – Medium	M101, M102, M105, M106, M107, M108, M109, M110, M111	2 – Low
Temporary loss of revenues for up to about 700,000 people involved in activities related to artisanal fisheries (2017 numbers).	2 – Low to 3 – Medium	M106, M107, M108, M109, M110, M111	2 – Low
Temporary loss of revenues for national economies due to the temporary disruption of artisanal fisheries.	2 – Low to 3 – Medium	M106, M108, M109, M110, M111	2 – Low

Notes:

M101: In the unlikely event of a spill, tactical response methods that may be considered under the OSCP include: surveillance and monitoring, offshore containment and recovery; subsea and at surface dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.

M102: All response measures will be continuously monitored to ensure that they remain effective. The response team will maintain situational awareness of the event and response effort.

M105: In the unlikely event of a spill, follow national regulatory requirements for reporting and notification, using established protocols, which extends to all relevant external stakeholders.

M106: In the unlikely event of a spill, establish a grievance mechanism easily accessible to affected stakeholders that includes monitoring of claims and the resolution thereof.

M107: In the unlikely event of a spill, work with national authorities as requested, to inform relevant stakeholders (including artisanal fishermen) on: 1) the location of the spill; 2) cleanup operations; 3) applicability of temporary exclusion zones; and 4) grievance mechanism, as applicable. In relation to fishermen, this will include providing timely communication, offering them the opportunity to remove gear from affected areas, reducing impact on fishing gear.

M108: In the unlikely event of a spill, in coordination with national authorities if requested, monitor and support ways to address the concerns of stakeholders regarding potential impacts of the spill.M109: In the unlikely event of a spill, implement, in coordination with national authorities if requested, an emergency fund to assist affected vulnerable households in artisanal fishing communities if needed.

M109: In the unlikely event of a spill, implement, in coordination with national authorities if requested, an emergency fund to assist affected vulnerable households in artisanal fishing communities if needed.

M110: In the unlikely event of a spill, prepare and implement, in coordination with national authorities if requested, a Livelihood Restoration Plan for affected communities.

M111: In the unlikely event of a spill, implement, in coordination with national authorities if requested, an emergency plan to ensure food security of affected vulnerable households and groups if needed.

M112: In the unlikely event of a spill of high intensity, specific monitoring (e.g., environmental effects monitoring) may be required and developed in consultation with applicable national authorities.

7.5.17 Other Coastal & Sea-Based Activities

High Level Summary

In this section on Other Coastal & Sea-Based Activities, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. All impacts on Other Coastal & Sea-Based Activities were assessed as of negligible significance. No mitigation measures were required but some have been suggested despite the impacts being ranked as negligible.

7.5.17.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.17.2 Impact Description

This section addresses the impacts of a potential spill resulting from these three accidental events on other coastal and sea-based activities. As indicated in Section 7.5.14, the oil spill modeling results in Appendix N-1 show that the direction of the spills could vary according to the type of accidental events and the seasons of the year. However, the modeling results show that spills could extend on several hundred km^2 of maritime waters and they could also affect the coastline. The three accidental events would have similar impacts on coastal and sea-based activities. Therefore, they are discussed together in this section.

An oil spill could interfere with the two following coastal and sea-based activities: 1) tourism and recreation; 2) other offshore oil and gas activities.

The assessment of potentially affected coastal and sea-based activities is based on the current situation. Of course, the current situation will not remain static over the >20-year project. The situation will change over the lifetime of the project as a result of several factors. In 20 years from now, tourism and recreation could increase as well as offshore oil and gas activities. Additionally, other coastal and sea-based activities could develop.

The assessment of tourism and recreation in Mauritania (Section 4.6.7) and in Senegal (Section 4.7.7) shows that there is currently some beach tourism and recreational activities conducted in Saint-Louis. Recreational activities are also conducted on the beaches of Dakar and Nouakchott.

As indicated in Section 7.5.13, close to 400 km of coastline could be touched by a spill. The potentially affected coastline extends from approximately Legweichich in Mauritania to Dakar in Senegal. In this 400 km coastline, beach tourism is currently concentrated in Saint-Louis. In addition to attracting tourists, the beaches of Dakar and Saint-Louis are used for recreational activities by local population. While beach tourism is currently underdeveloped, there is a potential for its development throughout the Mauritanian and Senegalese coasts due to the access to the ocean, the sandy beaches, and the natural landscape.

Other tourism points in the area could be affected by an oil spill: the Island of Saint-Louis, the Gandiole area and the Diawling National Park. The island of Saint-Louis is a designated UNESCO world heritage site since 2000. Its historical heritage makes it an important tourism area in Senegal. Additionally, a small tourism area is located downstream the Senegal River in the Gandiole area in Senegal. A few tourism camps are located in this area where tourists are attracted by the presence of the Senegal River mouth, its sandy beaches and the natural environment. Tourism at the Diawling National Park, visited notably for its birds, could also be affected.

A spill along the coastline and into the Senegal River estuary could affect the current tourism activities and those that could develop on the Mauritanian and Senegalese coasts and along the Senegal River in both countries over the course of the >20-year project. During the spill and the clean-up operations, there could be a disruption of tourism and recreational activities on the beach and the shores of the river.

A spill on the coastline could also have indirect impacts on businesses and jobs in the tourism sector. Although a temporary disruption of beach tourism would be short term, limited to the period of the spill and the clean-up operations, some workers could be temporarily laid off.

There are no available data on the number of people working in the tourism sector in the coastal area that could potentially be affected by a spill on the coastline. Additionally, there are a lot of uncertainties around the development of beach tourism in Mauritania and Senegal in a 20-year timeframe. Therefore, the indirect impact of a spill on jobs and businesses cannot be quantified.

The other coastal and sea-based activities that could be affected by a spill are offshore oil and gas activities. These include oil and gas exploration/production conducted by other operators in offshore blocks in Mauritania and Senegal. They also include, in Mauritania, hydrocarbon bunkering. The response effort would not interfere with the hydrocarbon bunkering activity and it would not affect directly the oil and gas exploration/production activities. However, water intake for desalination on the offshore platforms and FPSOs may be temporarily affected. There are a lot of uncertainties around the development of oil and gas exploration/production activities in Mauritania and Senegal in a 20-year timeframe, and around desalination processes used for these activities. Therefore, the indirect impact of a spill on water intake for offshore oil and gas exploration/production activities cannot be quantified.

7.5.17.3 Impact Rating

A spill could affect tourism and recreational activities conducted along the coastline from approximately Legweichich in Mauritania to Dakar in Senegal, and along the Senegal River estuary downstream of the Diama dam. There is currently little tourism or recreational activities conducted in these areas. In consideration of the potential for the development of these activities, the intensity of the impact is considered moderate. The extend would be regional. The adverse effects of the spill on tourism and recreational activities would be short term. Their duration would be limited to the period of the spill and the clean-up operations. Based on the combination of these criteria, the consequence of the impact would be minor. Given that the probability of a well blowout, an FPSO failure due to a ship collision or a pipelaying vessel collision is remote, the overall significance of the impact is rated 1 – Negligible (details are provided in Table 7-186).

A spill could affect water intake for offshore oil and gas exploration/production. These activities could be disrupted during the spill response and clean-up operations. In consideration of the potential for the development of these activities offshore Mauritania and Senegal, the intensity of the impact is considered moderate. The extent would be regional. The adverse effects of the disruption of activities would be short term. Their duration would be limited to the period of the spill response and the clean-up operations. Based on the combination of these criteria, the consequence of the impact would be minor. Given that the probability of a well blowout, an FPSO failure due to a ship collision or a pipelaying vessel collision is remote, the overall significance of the impact is rated 1 – Negligible (details are provided in Table 7-186).

Table 7-186. Impacts to Other Coastal & Sea-Based Activities in Case of Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout, Failure of FPSO Due to a Ship Collision and Pipelaying Vessel Collision					
Mauritania Senegal	Temporary disruption of tourism and recreational activities (including the disruption of business and jobs in the sector) on the coastline between Legweichich in Mauritania and Dakar in Senegal, and along the Senegal River estuary downstream of the Diama dam.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 - Negligible
Mauritania Senegal	Temporary disruption of water intake for desalination conducted for offshore oil and gas exploration/production.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 - Negligible

7.5.17.4 Mitigation Measures and Residual Impacts

Impacts being rated 1 – Negligible, no mitigation measures are required, over and above the following design and operational control measures in place:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea X-mas trees), other well control barriers and isolation of any permeable zone.
- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.
- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.
- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.

- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.
- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.
- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.
- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.
- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Furthermore, despite the impact being ranked as negligible the following measures will be implemented

- M101: In the unlikely event of a spill, tactical response methods that may be considered under the OSCP include: surveillance and monitoring, offshore containment and recovery; subsea and at surface dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.
- M102: All response measures will be continuously monitored to ensure that they remain effective. The response team will maintain situational awareness of the event and response effort.

- M103: In the unlikely event of a spill reaching the shoreline, a Shoreline Clean-up and Assessment Technique (SCAT) program will be implemented to inform shoreline clean-up and remediation as applicable.
- M104: In the unlikely event of a spill reaching the shoreline, a shoreline clean-up and remediation team will be mobilized to the affected areas. BP will also engage specialized expertise to mitigate impacts to sensitive areas and wildlife species as needed.
- M105: In the unlikely event of a spill, follow national regulatory requirements for reporting and notification, using established protocols, which extends to all relevant external stakeholders.
- M106: In the unlikely event of a spill, establish a grievance mechanism easily accessible to affected stakeholders that includes monitoring of claims and the resolution thereof.
- M107: In the unlikely event of a spill, work with national authorities as requested, to inform relevant stakeholders (including artisanal fishermen) on: 1) the location of the spill; 2) cleanup operations; 3) applicability of temporary exclusion zones; and 4) grievance mechanism, as applicable. In relation to fishermen, this will include providing timely communication, offering them the opportunity to remove gear from affected areas, reducing impact on fishing gear.
- M108: In the unlikely event of a spill, in coordination with national authorities if requested, monitor and support ways to address the concerns of stakeholders regarding potential impacts of the spill.
- M112: In the unlikely event of a spill of high intensity, specific monitoring (e.g., environmental effects monitoring) may be required and developed in consultation with applicable national authorities.

7.5.18 Employment and Business Opportunities

High Level Summary

In this section on Employment and Business Opportunities, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision was evaluated. All impacts have already been discussed through the impacts on Industrial Fisheries, Artisanal Fisheries and Related Activities and, Other Coastal & Sea-Based Activities. No additional impacts were identified. Therefore, they are not further discussed in this section.

Coastal and sea-based employment and business opportunities[161] would be at risk in case of accidental events at sea. Therefore, the economic sectors that are relevant to this section are the following: industrial and artisanal fisheries, tourism, offshore oil and gas exploration/production and hydrocarbon bunkering. Considering that impacts on these sectors have already been examined in Sections 7.5.15, 7.5.16 and 7.5.17, they are not further discussed in this section.

[161] For standardization with other sections of the report, the term “opportunities” is used even though an accidental event’s impacts would be around existing jobs and businesses.

7.5.19 Population and Demography

High Level Summary

In this section on Population and Demography, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision was evaluated. No impacts were identified. Consequently, no mitigation measures were required.

As indicated in Table 7-7, a well blowout, a failure of FPSO due to a ship collision or a pipelaying vessel collision would have no potential interference with population and demography.

In case of a spill, followed by oil washing up on the shore, communities on the coast would have to temporarily avoid going in the water and/or on parts of the beach. Nevertheless, their housing would remain unaffected and they would not have to move. Therefore, a spill resulting from these offshore accidental events would not entail any population movements. Consequently, the impact of accidental events on population and demography is not further discussed in this section.

7.5.20 Community Livelihoods

High Level Summary

In this section on Community Livelihoods, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. The residual impacts on Community Livelihoods were assessed as of low significance when mitigation measures are applied.

7.5.20.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.20.2 Impact Description

This section addresses the impacts of a potential spill resulting from the above-mentioned accidental events on community livelihoods. As previously mentioned, the coastal communities livelihoods of Mauritania and Senegal are largely based on artisanal fisheries except for those living in Dakar or Nouakchott.

The assessment of potentially affected community livelihoods is based on the current situation. Of course, the current situation will not remain static over the >20-year project. The situation will change over the lifetime of the project as a result of several factors. In 20 years from now, community livelihoods situation could be different than it currently is.

In the coastal communities, artisanal fisheries revenues are currently either the only or the main source of income. These revenues are generated daily and no data indicate that the community members have savings for times of scarcity. Additionally, fish catches are the main staple of these communities.

As a result, any disruption of artisanal fisheries could quickly impact the livelihoods of the coastal communities in several ways. For instance:

- A short disruption of the revenues of the members of these communities could impact their capacity to cover day-to-day needs such as food, rent, health care expenditures, schooling for the children, etc.
- A longer disruption could put the communities at risk of sliding into poverty and becoming vulnerable.
- A disruption of artisanal fisheries, even short, could compromise the food supply for these communities. With the disruption in their revenues, the lack of fish could hardly be compensated by other food products.
- The disruption of artisanal catches could have ramifications on households at a national level. Fish is the main staple in Senegal and it is also very important in Mauritania. A shortage in fish supply could entail inflation. The longer the shortage would last, the higher the risk would be for effects on the diet of households.

There are a lot of uncertainties around which coastal communities would be affected. It would depend of the location and the size of the spill, and consequently the area where artisanal fisheries would be disrupted. With these uncertainties, the assumption is made that the fishing communities whose shoreline would be affected could also see their livelihood affected. Consequently, this would include the coastal communities identified in Section 7.5.13.

The following coastal communities from Legweichich to Cayar could see their livelihood affected in case of a spill:

- In Mauritania:
  - Legweichich, also called PK 93 (600 inhabitants);
  - PK 144 (100 inhabitants);
  - Mouly (30 inhabitants);
  - The *commune* of N'Diago (6,137 inhabitants).
- In Senegal:
  - The *commune* of Saint-Louis (230,801 inhabitants);
  - Niayam (1,500 inhabitants);
  - Lompoul-sur-Mer (10,000 inhabitants);
  - Fass Boye (15,000 inhabitants);
  - Mboro Ndeundekat (2,000 inhabitants);
  - Cayar (29,810 inhabitants).

Dakar would be excluded from this list since its economy is not mainly based on artisanal fisheries. Communities located along the Senegal River are also excluded. River fishing is not the sole or main source of revenues of these communities. The communities listed above count about 300,000 people whose livelihood would be at risk. This rough estimation does not take into account the coastal fishing communities living North of Nouakchott or South of Dakar, whose livelihood could also be affected. Finally, this rough estimation is based on current number of inhabitants.

In addition to the uncertainties around the size and the trajectory of an oil spill, there are a lot of uncertainties around the evolution of artisanal fisheries in Mauritania and Senegal over the next 20 years, on the weight of artisanal fisheries in the revenues of local communities over these years, on the size of the fishing communities themselves, and on the development of the economy of the two countries. As a result, any quantification of the impacts of an accidental event on the community livelihoods would be imprudent.

7.5.20.3 Impact Rating

A temporary disruption of artisanal fisheries resulting from a spill could affect the livelihood of several communities in Mauritania and Senegal. Disruption of revenues would affect their capacity to cover day-to-day needs with the risk for them to sliding into poverty and vulnerability. The intensity of the impact is considered high. The extent of the impact would be regional. Depending on the duration of the disruption of artisanal fisheries, the ripple effects on the community livelihoods could be short to long term. As a result, the duration of the impact is considered short to long term. Based on the combination of these criteria, the consequence of the impact would be moderate to severe. Given that the probability of a well blowout, a failure of FPSO due to a ship collision or a pipelaying vessel collision is remote, the overall significance of the impact is rated 2 – Low to 3-Medium. Details are provided in Table 7-187.

A temporary disruption of artisanal fisheries resulting from a spill could also compromise the food supply for these communities and affect their diet. This impact would go beyond the local communities and it would affect the food supply of the two countries, resulting in inflation and risk for household diet at a national level. The intensity of the impact on food supply and household diet is considered high. The extent of the impact would be regional. Depending on the duration of artisanal fisheries disruption and the ripple effects, the impact could be short term to long term. Based on the combination of these criteria, the consequence of the impact would be moderate to severe. Given that the probability of a well blowout, a failure of FPSO due to a ship collision or a pipelaying vessel collision is remote, the overall significance of the impact is rated 2 – Low to 3 – Medium (details are provided in Table 7-187).

Table 7-187. Impacts to Community Livelihoods in Case of Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout, Failure of FPSO Due to a Ship Collision and Pipelaying Vessel Collision					
Mauritania Senegal	Temporary decrease of the capacity of the coastal communities to cover day-to-day needs due to the disruption of their revenues, with a risk of sliding into poverty and vulnerability.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term to Long term	Moderate to Severe	Remote	2 – Low to 3 – Medium
Mauritania Senegal	Temporary shortage of the main staple of coastal communities due to the disruption of artisanal fish catches, with potential ramifications on the diet of the households at a national level.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Short term to Long term	Moderate to Severe	Remote	2 – Low to 3 – Medium

7.5.20.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-188) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the measures and controls already planned in the project design and operational controls in place, notably:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea X-mas trees), other well control barriers and isolation of any permeable zone.
- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.
- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.
- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.
- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.
- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.

- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.
- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.
- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Table 7-188. Mitigation Measures to Avoid or Reduce Impacts to Community Livelihoods in Case of Accidental Events.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Temporary decrease of the capacity of the coastal communities to cover day to day needs due to the disruption of their revenues, with a risk of sliding into poverty and vulnerability.	2 – Low to 3 – Medium	M101, M102, M103, M104, M105, M106, M107, M108, M109, M110, M111, M112	2 – Low
Temporary shortage of the main staple of coastal communities due to the disruption of artisanal fish catches, with potential ramifications on the diet of the households at a national level.	2 – Low to 3 – Medium	M101, M102, M103, M104, M105, M106, M107, M108, M109, M110, M111, M112	2 – Low

Notes:

M101: In the unlikely event of a spill, tactical response methods that may be considered under the OSCP include: surveillance and monitoring, offshore containment and recovery; subsea and at surface dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.

M102: All response measures will be continuously monitored to ensure that they remain effective. The response team will maintain situational awareness of the event and response effort.

M103: In the unlikely event of a spill reaching the shoreline, a Shoreline Clean-up and Assessment Technique (SCAT) program will be implemented to inform shoreline clean-up and remediation as applicable.

M104: In the unlikely event of a spill reaching the shoreline, a shoreline clean-up and remediation team will be mobilized to the affected areas. BP will also engage specialized expertise to mitigate impacts to sensitive areas and wildlife species as needed.

M105: In the unlikely event of a spill, follow national regulatory requirements for reporting and notification, using established protocols, which extends to all relevant external stakeholders.

M106: In the unlikely event of a spill, establish a grievance mechanism easily accessible to affected stakeholders that includes monitoring of claims and the resolution thereof.

M107: In the unlikely event of a spill, work with national authorities as requested, to inform relevant stakeholders (including artisanal fishermen) on: 1) the location of the spill; 2) cleanup operations; 3) applicability of temporary exclusion zones; and 4) grievance mechanism, as applicable. In relation to fishermen, this will include providing timely communication, offering them the opportunity to remove gear from affected areas, reducing impact on fishing gear.

M108: In the unlikely event of a spill, in coordination with national authorities if requested, monitor and support ways to address the concerns of stakeholders regarding potential impacts of the spill.

M109: In the unlikely event of a spill, implement, in coordination with national authorities if requested, an emergency fund to assist affected vulnerable households in artisanal fishing communities if needed.

M110: In the unlikely event of a spill, prepare and implement, in coordination with national authorities if requested, a Livelihood Restoration Plan for affected communities.

M111: In the unlikely event of a spill, implement, in coordination with national authorities if requested, an emergency plan to ensure food security of affected vulnerable households and groups if needed.

M112: In the unlikely event of a spill of high intensity, specific monitoring (e.g., environmental effects monitoring) may be required and developed in consultation with applicable national authorities.

7.5.21 Community Health, Safety and Security

High Level Summary

In this section on Community Health, Safety and Security, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. They could have an indirect impact on the health of communities through impacts on air quality. However, all impacts on Air Quality from accidental events were assessed as of negligible significance. Therefore, they are not further discussed in this section.

7.5.21.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.21.2 Impact Description

The above-mentioned three IPFs could have an indirect impact on the health of communities through impacts on air quality. However, no interference is expected between a spill and the safety and the security of the coastal communities.

Section 7.5.2 assesses the impacts of accidental events on air quality. The results show that a well blowout, a failure of FPSO due to a ship collision and a pipelaying vessel collision could entail a decrease of onshore air quality due to introduction of VOC in the atmosphere during the spill. However, the impacts on onshore air quality would be negligible. As a result, the accidental events would not impact the health of the coastal communities.

Consequently, the impact of accidental events on community health, safety and security is not further discussed in this section.

Despite the anticipated impacts being negligible, the project will carry out the following mitigation measure:

- M112: In the unlikely event of a spill of high intensity, specific monitoring (e.g., environmental effects monitoring) may be required and developed in consultation with applicable national authorities.

7.5.22 Public Infrastructure and Services

High Level Summary

In this section on Public Infrastructure and Services, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. All impacts on Public Infrastructure and Services from Accidental Events were assessed as of negligible significance. No mitigation measures were required.

7.5.22.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.22.2 Impact Description

This section addresses the impacts of a potential spill resulting from the above-mentioned three accidental events on public infrastructure and services.

The assessment of potentially affected public infrastructure and services is based on the current situation. Of course, the current situation will not remain static over the >20-year project. The situation will change over the lifetime of the project as a result of several factors. In 20 years from now, the capacity of these public services could be different from what they currently are.

The public services in charge of addressing emergencies at sea in Mauritania and Senegal, currently have limited resources. An accidental event resulting in a spill has the potential to add a strain to these limited resources.

As indicated in Section 7.5.1.5, if a spill occurred, BP would take charge of all emergency response and clean-up operations through the implementation of a SCERP and an OSCP. While Mauritanian and Senegalese authorities would be informed of the accidental event and the spill through agreed information channels, their assistance with the emergency response and clean-up operations would be limited.

It is also assumed that the chain of command and communication in case of a spill will be agreed between BP and the relevant Mauritanian and Senegalese authorities, before the project starts. Consequently, if BP was to activate the SCERP and/or the OSCP, the chain of command and communication would already be clear.

7.5.22.3 Impact Rating

An accidental event at sea could temporarily disrupt normal activities of the Mauritanian and Senegalese authorities and public services in charge of addressing emergencies at sea. However, their assistance with the emergency response and clean-up operations would be limited. Since the attention of a large number of public services would be focused on the accidental event and this could disrupt their normal activities, the intensity of the impact would be moderate. The extent would be regional but the duration short term. Based on the combination of these criteria, the consequence of the impact would be minor. Given that the probability of a well blowout, a failure of FPSO due to a ship collision or a pipelaying vessel collision is remote, the overall significance of the impact is rated 1 – Negligible (details are provided in Table 7-189).

Table 7-189. Impacts to Public Infrastructure and Services in Case of Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout, Failure of FPSO Due to a Ship Collision and Pipelaying Vessel Collision					
Mauritania Senegal	Temporary disruption of normal activities of authorities and public services in charge of addressing emergencies at sea.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 – Negligible

7.5.22.4 Mitigation Measures and Residual Impacts

Impacts being rated 1 – Negligible, no mitigation measures are required.

7.5.23 Women and Vulnerable Groups

High Level Summary

In this section on Women and Vulnerable Groups, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. The residual impacts on Women and Vulnerable Groups from Accidental Events were assessed as of low significance when mitigation measures are applied.

7.5.23.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.23.2 Impact Description

This section addresses the impacts of a potential spill resulting from the three above-mentioned accidental events on women and vulnerable groups. Impacts on women and vulnerable groups would be indirect. They would result mainly from the impacts on artisanal fisheries and community livelihoods described in Sections 7.5.16 and 7.5.20.

Sections 4.6.11 and 4.7.11 have provided a description of the situation of women and vulnerable groups in Mauritania and Senegal with more specific information on those living in the coastal fishing communities. The following groups have been identified as vulnerable in the two countries: women, youth, the disabled, HIV-positive people/households. Specific vulnerable groups included for Mauritania, descendants of former slaves and refugees who returned from Senegal in 1989, and for Senegal, the communities living on the Langue de Barbarie due to the erosion process that threatens the physical integrity of the dwellings on this narrow strip of land. Women and vulnerable groups generally rely on their families who provide the only significant social support in these communities.

The results of the impact assessment of accidental events on artisanal fisheries show that the disruption of artisanal fisheries could have ripple effects that would result notably in a temporary decrease of the capacity of the coastal communities to cover day-to-day needs due to the disruption of their revenues, with a risk of sliding into poverty and vulnerability.

Generally speaking, women and vulnerable groups are more dependent, and therefore at risk in case of any loss of livelihood of those upon which they rely. As a result, women and vulnerable groups of the coastal communities of Mauritania and Senegal would be more at risk in case of the temporary decrease of the capacity of these communities to cover their day-to-day needs.

In case of a disruption of artisanal fishing activities, the families could not play their usual role of social safety net for women and vulnerable groups in these communities. The social organization in the fishing communities is based on the family unit. For instance, the crew of a given fishing unit is generally composed of members of the same family. Since the fishing communities would be at risk of sliding into poverty and vulnerability in case of a disruption of fishing activities, their vulnerable members would become even more vulnerable. Without the social net provided by their family support, these vulnerable members would be at risk of being further marginalized.

The fishing communities living on the Langue de Barbarie having been identified as a vulnerable group as a whole, they could be particularly at risk. While the other vulnerable groups could be at risk in all fishing communities of Mauritania and Senegal, the fishing communities of the Langue de

Barbarie, as a whole, could be at risk of rapidly sliding into increased vulnerability since all the members of the communities would be affected, with no or little social safety nets. In 2017, the communities of the Langue de Barbarie accounted for over 70,000 people. Of course, this number could change over a 20-year period as well as the composition of the vulnerable groups in the fishing communities of Mauritania and Senegal. As a result, there are a lot of uncertainties on who will be the vulnerable groups in the future, how many people they could count, the social organization of communities and their social safety nets.

7.5.23.3 Impact Rating

A temporary disruption of artisanal fisheries resulting from a spill could affect the livelihood of several coastal communities in Mauritania and Senegal, with ripple effects on women and vulnerable groups since family is their main social safety net. Additionally, the fishing communities of the Langue de Barbarie as a whole would be at risk of increased vulnerability. Due to the number of people that could be affected, the intensity of the impact would be high. The extent would be regional. Once people fall into poverty and great vulnerability, the recovery can take a lot of time. As a result, the duration of the impact is considered long-term. Based on the combination of these criteria, the consequence of the impact would be severe. Given that the probability of a well blowout, a failure of FPSO due to a ship collision or a pipelaying vessel collision is remote, the overall significance of the impact is rated 3 – Medium (details are provided in Table 7-190).

Table 7-190. Impacts to Women and Vulnerable Groups in Case of Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout, Failure of FPSO Due to a Ship Collision and Pipelaying Vessel Collision					
Mauritania Senegal	Increased vulnerability of women and vulnerable groups of fishing communities and, in particular, those of the Langue de Barbarie.	Nature: Negative Intensity: High Spatial Extent: Regional Duration: Long term	Severe	Remote	3 – Medium

7.5.23.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 and the identified potential applicable mitigation measures are reported below (Table 7-191). These mitigation measures are in addition to the measures and controls already planned in the project design and operational controls in place, notably:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea X-mas trees), other well control barriers and isolation of any permeable zone.
- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.
- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.

- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.
- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.
- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.
- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.
- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.
- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Table 7-191. Mitigation Measures to Avoid or Reduce Impacts to Women and Vulnerable Groups in Case of Accidental Events.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Increased vulnerability of women and vulnerable groups of fishing communities, and, in particular, those of the Langue de Barbarie.	3 – Medium	M101, M102, M103, M104, M108, M109, M111	2 – Low

Notes:

M101: In the unlikely event of a spill, tactical response methods that may be considered under the OSCP include: surveillance and monitoring, offshore containment and recovery; subsea and at surface dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.

M102: All response measures will be continuously monitored to ensure that they remain effective. The response team will maintain situational awareness of the event and response effort.

M103: In the unlikely event of a spill reaching the shoreline, a Shoreline Clean-up and Assessment Technique (SCAT) program will be implemented to inform shoreline clean-up and remediation as applicable.

M104: In the unlikely event of a spill reaching the shoreline, a shoreline clean-up and remediation team will be mobilized to the affected areas. BP will also engage specialized expertise to mitigate impacts to sensitive areas and wildlife species as needed.

M108: In the unlikely event of a spill, in coordination with national authorities if requested, monitor and support ways to address the concerns of stakeholders regarding potential impacts of the spill.

M109: In the unlikely event of a spill, implement, in coordination with national authorities if requested, an emergency fund to assist affected vulnerable households in artisanal fishing communities if needed.

M111: In the unlikely event of a spill, implement, in coordination with national authorities if requested, an emergency plan to ensure food security of affected vulnerable households and groups if needed.

7.5.24 Cultural and Archaeological Heritage

High Level Summary

In this section on Cultural and Archaeological Heritage, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. All impacts have already been discussed through the impacts on Sediment Quality. Therefore, they are not further discussed in this Section.

This section addresses the impacts of a potential spill on cultural and archaeological heritage, more specifically underwater artifacts.

Seabed-disturbing accidental events can lead to damage to resources located on the seabed, particularly archaeological resources such as historic shipwrecks. As indicated in Chapter 4, both Mauritania and Senegal may potentially have, in some areas along their coasts, shipwrecks of pre-colonial and colonial times with archaeological and cultural value.

However, Section 7.5.4 has demonstrated that a spill resulting from an accidental event would have negligible impacts on the quality of sediments on the seabed. Consequently, the impacts of a spill on potential artifacts on the seabed are expected to be similar.

Consequently, the impact of accidental events on cultural and archaeological heritage is not further discussed in this section.

7.5.25 Landscape and Seascape

High Level Summary

In this section on Landscape and Seascape, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. All impacts on Landscape and Seascape from Accidental Events were assessed as of negligible significance. No mitigation measures were required.

7.5.25.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.25.2 Impact Description

This section addresses the impacts of a potential spill resulting from the three accidental events on landscape and seascape. Spill modeling results show that a well blowout, a failure of FPSO due to a ship collision and a pipelaying vessel collision could all three see Mauritania and Senegal maritime coastlines affected, and thus have impacts on coastal landscape and seascape.

As indicated in Chapter 4, both in Mauritania and Senegal the coastal landscape and seascape consist of alternating uninhabited coastline and populated areas. Considering that landscape and seascape characteristics are based on human sight, the impacts on visual features would essentially only be felt in the inhabited portions of the coastline. Consequently, the current section will focus on impacts on the visual receptors that are in the human settlements.

The assessment of potentially affected receptors in the human settlements on the coastline is based on the current situation. Of course, the current situation will not remain static over the >20-year project. The situation will change over the lifetime of the project as a result of several factors including population increase. In 20 years from now, there could be more settlements on the coast and the existing ones are likely to include a larger number of inhabitants.

Well Blowout

In case of a well blowout, close to 400 km of coastline could be touched by a spill. It could affect the coastline from about 100 km south of Nouakchott to Dakar. These 400 km of the coast include, from North to South, the following main human settlements:

- In Mauritania:
    - Legweichich, also called PK 93 (600 inhabitants);
    - PK 144 (100 inhabitants);
    - Mouly (30 inhabitants); and
    - The *commune* of N'Diago (6,137 inhabitants).

The landscape and seascape in this section of the coast are characterized by a sandy and rectilinear beach and their main markers of human presence are fishing camps on land and fishing boats near shore. The occasional cargo ship can be spotted in the distant offshore waters.

- In Senegal:
  - The *commune* of Saint-Louis (230,801 inhabitants);
  - Niayam (1,500 inhabitants);
  - Lompoul-sur-Mer (10,000 inhabitants);
  - Fass Boye (15,000 inhabitants);
  - Mboro Ndeundekat (2,000 inhabitants);
  - Cayar (29,810 inhabitants); and
  - Dakar (3,137,196 inhabitants).

The landscape and seascape in this section are also characterized by a sandy and rectilinear beach, which alternates between areas mostly devoid of human activities and populated fishing villages and towns. In these fishing communities the beach's landscape and seascape are occupied by artisanal fishing boats and occasional cargo ships. Its esthetics are affected by beach dumping (see Chapter 4).

Failure of FPSO Due to a Ship Collision

In case of a failure of FPSO due to a ship collision, close to 400 km of coastline could be affected by a spill. It could affect the same coastline as the well blowout from about 100 km south of Nouakchott to Dakar. Therefore, the human settlements and visual features that could be affected are the same as those identified for the well blowout. No visual pollution is expected for the inhabitants of the settlements on the Senegal River estuarine shore because there is not much chance of an oil slick stranding on the estuarine shore. The impact will be limited to some hydrocarbon dissolved or entrained in the water column.

Pipelaying Vessel Collision

In case of a pipelaying vessel collision, the spill on the coastline could extend about 100 km north and south of N'Diago/Saint-Louis for a total of about 200 km of coastline.

These 200 km of the coast include, from North to South, the following main human settlements whose coastline could be affected:

- In Mauritania:
  - PK 144 (100 inhabitants);
  - Mouly (30 inhabitants); and
  - The *commune* of N'Diago (6,137 inhabitants).
- In Senegal:
  - The *commune* of Saint-Louis (230,801 inhabitants);
  - Niayam (1,500 inhabitants);
  - Lompoul-sur-Mer (10,000 inhabitants); and
  - Fass Boye (15,000 inhabitants).

The visual features of these villages are presented in the Well Blowout section above.

7.5.25.3 Impact Rating

Well Blowout

Considering the localized portion of the coast that is inhabited, and the fact that the inhabited areas are currently not pristine (see Sections 4.6.14 and 4.7.14), the intensity of the impact would be moderate. The extent of the adverse effects would be regional, but reversible. As for the impact duration, corresponding to the clean-up period, it is considered short term. Based on the combination of these criteria, the consequence of the impact would be minor. Given that the probability of a well blowout is remote, its overall significance is 1 – Negligible (details are provided in Table 7-192).

Failure of FPSO Due to a Ship Collision

A failure of FPSO due to a ship collision could affect the same coastline as a well blowout. As a result, the intensity, the extent and the duration of the impact would be identical. The consequence of the impact would be minor. Given that the probability of an FPSO failure due to a ship collision is remote, its overall significance is rated 1 – Negligible ow (details are provided in Table 7-192).

Pipelaying Vessel Collision

A pipelaying vessel collision could affect about 200 km of coastline, from approximately PK 144 in Mauritania to Fass Boye in Senegal. Unlike a well blowout or a failure of FPSO due to a ship collision, the spill from pipelaying vessel collision would not reach Dakar. Due to the limited number of human settlements and their visual features that would be affected, the intensity of the impact would be moderate and the extent would be regional. The adverse effects of the spill on the beach would be reversible with a short-term duration corresponding to the clean-up period. Based on the combination of these criteria, the consequence of the impact would be minor. Given that the probability of a pipelaying vessel collision is remote, its overall significance is rated 1 – Negligible (details are provided in Table 7-192).

Table 7-192. Impacts to Landscape and Seascape in Case of Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Well Blowout					
Mauritania Senegal	Oil spill on visual features of human settlements from approximately Legweichich in Mauritania to Dakar in Senegal due to a well blowout.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 – Negligible
Failure of FPSO Due to a Ship Collision					
Mauritania Senegal	Oil spill on visual features of human settlements from approximately Legweichich in Mauritania to Dakar in Senegal due to a failure of FPSO caused by a ship collision.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 – Negligible
Pipelaying Vessel Collision					
Mauritania Senegal	Oil spill on visual features of human settlements from approximately PK 144 in Mauritania to Fass Boye in Senegal due to a pipelaying vessel collision.	Nature: Negative Intensity: Moderate Spatial Extent: Regional Duration: Short term	Minor	Remote	1 – Negligible

7.5.25.4 Mitigation Measures and Residual Impacts

Impacts being rated 1 – Negligible, no mitigation measures are required. Despite the anticipated impacts on landscape and seascape being negligible, the project will carry out some mitigation measures, in addition to the measures and controls already planned in the project design and operational controls in place, notably:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea X-mas trees), other well control barriers and isolation of any permeable zone.
- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.
- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.

- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.
- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.
- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.
- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.
- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.
- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

- M101: In the unlikely event of a spill, tactical response methods that may be considered under the OSCP include: surveillance and monitoring, offshore containment and recovery; subsea and at surface dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.
- M102: All response measures will be continuously monitored to ensure that they remain effective. The response team will maintain situational awareness of the event and response effort.
- M103: In the unlikely event of a spill reaching the shoreline, a Shoreline Clean-up and Assessment Technique (SCAT) program will be implemented to inform shoreline clean-up and remediation as applicable.
- M104: In the unlikely event of a spill reaching the shoreline, a shoreline clean-up and remediation team will be mobilized to the affected areas. BP will also engage specialized expertise to mitigate impacts to sensitive areas and wildlife species as needed.
- M108: In the unlikely event of a spill, in coordination with national authorities if requested, monitor and support ways to address the concerns of stakeholders regarding potential impacts of the spill.
- M112: In the unlikely event of a spill of high intensity, specific monitoring (e.g., environmental effects monitoring) may be required and developed in consultation with applicable national authorities.

7.5.26 Social Climate

High Level Summary

In this section on Social Climate, the impact of three impact producing factors, these being Well blowout, Failure of FPSO due to a ship collision and Pipelaying vessel collision, was evaluated. The residual impacts on Social Climate from Accidental Events were assessed as of negligible significance when mitigation measures are applied.

7.5.26.1 Impact Producing Factors

The IPFs for accidental events identified for this resource in Table 7-7 are:

- Well blowout;
- Failure of FPSO due to a ship collision; and
- Pipelaying vessel collision.

7.5.26.2 Impact Description

This section addresses the impacts of a potential spill resulting from these three accidental events on the social climate in Mauritania and Senegal. The oil spill modeling results in Appendix N-1 show that the spills resulting from the three types of accidental events could affect both Mauritania and Senegal offshore and nearshore waters. As a result, the three accidental events would all trigger indistinctly social reactions and therefore they are presented together in this section. However, since the two countries have different social contexts, the impacts are discussed separately by country.

The current assessment is based on the current social context in Mauritania and Senegal, notably in their coastal communities. Of course, the current context will not remain static over the >20-year project. The situation will change over the lifetime of the project as a result of several factors including population increase. Consequently, there are a lot of uncertainties on the reactions that would be triggered by an oil spill.

In Mauritania, the communities that could be directly affected by an oil spill are the fishing villages and camps located on the coast, with currently relatively few inhabitants. Their current social climate is generally calm (see Section 4.6.15) and it is assumed that in case of a spill their reactions would be limited to grievances being addressed to the State officials and BP. However, it should be expected that communities that are not directly affected, but have larger populations and many stakeholders, will also be triggered by the situation. And for instance, there could be social unrest in Nouakchott for the whole duration of clean-up operations.

In Senegal, the communities that could be directly affected by an oil spill include large fishing neighborhoods and villages, and Dakar. Currently, their social climate can occasionally be tense, notably in the fishing neighborhoods of Saint-Louis (see Section 4.7.15), especially when fishery resources are at stake. In case of a spill, there would be social discontent and, in some cases, a certain degree of despair (for instance in communities already experiencing adverse situations). These populations usually express their dissatisfaction in a non-violent manner through administrative and political authorities, however, at times they have been known for social unrest escalation with violence and riots, notably the fishing neighborhoods of Saint-Louis. Similarly to what could be expected in Mauritania, social discontent could be expected in communities not directly affected for the whole duration of clean-up operations.

In both countries, an oil spill could lead to high level of nationwide opposition to oil and gas activities, and eventually mobilize international attention and fuel an international debate until the end of clean-up operations and potentially beyond.

7.5.26.3 Impact Rating

In Mauritania, due to the limited size of potentially affected human settlements and their general calm social climate, the intensity of the impact would be moderate and the extent would be regional. In Senegal, due to the large population of the potentially affected human settlements and their sometimes tense social climate, the intensity of the impact would be high. In both countries, the adverse effects of the spill on the social climate would be reversible, with a short-term duration corresponding to the clean-up period. Based on the combination of these criteria, the consequence of the impact would be minor to moderate. Given that the probability of a spill is remote, its overall significance is rated 1 – Negligible to 2 – Low (details are provided in Table 7-193).

Table 7-193. Impacts to Social Climate in Case of Accidental Events.

Country	Impact	Criteria	Consequence	Likelihood	Significance
Mauritania Senegal	Risks of social unrest in coastal communities and escalating opposition to oil and gas activities nationwide, with a risk of violence in fishing communities in Senegal.	Nature: Negative Intensity: Moderate to High Spatial Extent: Regional Duration: Short term	Minor to Moderate	Remote	1 – Negligible to 2 – Low

7.5.26.4 Mitigation Measures and Residual Impacts

Impacts with a significance rating over 1 are reported below (Table 7-194) and potential applicable mitigation measures are identified. These mitigation measures are in addition to the measures and controls already planned in the project design and operational controls in place, notably:

- D101: Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea X-mas trees), other well control barriers and isolation of any permeable zone.
- D102: BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.
- D103: Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.
- D104: Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
- D105: Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.
- D106: Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
- D107: Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
- D108: Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.
- D109: An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
- D110: Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
- D111: Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
- D112: Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.

- D113: Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
- D114: Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
- D115: Conduct routine spill response drills and training.
- D116: Development of an oil spill sensitivity map highlighting resources at risk
- D117: BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.
- D118: BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.
- D119: Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Table 7-194. Mitigation Measures to Avoid or Reduce Impacts to Social Climate in Case of Accidental Events.

Impact	Significance	Mitigation Measures	Significance of Residual Impact
Risks of social unrest in coastal communities and escalating opposition to oil and gas activities nationwide, with a risk of violence in fishing communities in Senegal.	1 – Negligible to 2 – Low	M101, M102, M103, M104, M106, M107, M108	1 – Negligible

Notes:

M101: In the unlikely event of a spill, tactical response methods that may be considered under the OSCP include: surveillance and monitoring, offshore containment and recovery; subsea and at surface dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.

M102: All response measures will be continuously monitored to ensure that they remain effective. The response team will maintain situational awareness of the event and response effort.

M103: In the unlikely event of a spill reaching the shoreline, a Shoreline Clean-up and Assessment Technique (SCAT) program will be implemented to inform shoreline clean-up and remediation as applicable.

M104: In the unlikely event of a spill reaching the shoreline, a shoreline clean-up and remediation team will be mobilized to the affected areas. BP will also engage specialized expertise to mitigate impacts to sensitive areas and wildlife species as needed.

M106: In the unlikely event of a spill, establish a grievance mechanism easily accessible to affected stakeholders that includes monitoring of claims and the resolution thereof.

M107: In the unlikely event of a spill, work with national authorities as requested, to inform relevant stakeholders (including artisanal fishermen) on: 1) the location of the spill; 2) cleanup operations; 3) applicability of temporary exclusion zones; and 4) grievance mechanism, as applicable. In relation to fishermen, this will include providing timely communication, offering them the opportunity to remove gear from affected areas, reducing impact on fishing gear.

M108: In the unlikely event of a spill, in coordination with national authorities if requested, monitor and support ways to address the concerns of stakeholders regarding potential impacts of the spill.

7.6 Summary of Impacts

This section summarizes the non-negligible negative impacts identified for all phases of the project, including routine activities and accidental events.

7.6.1 Impacts of Routine Activities

Table 7-195 compiles all non-negligible negative impacts of routine activities. Tables 7-196 and 7-197 list design & operation controls measures (“D” measures) and recommended mitigation measures (“M” measures) for the project’s routine activities impacts respectively. As shown in Table 7-195, all impacts, after application of D and M measures, are deemed negligible or low.

Table 7-195. Summary Table of Non-Negligible Negative Impacts of Routine Activities.

Project Areas:
O: Offshore Area
P: Pipeline Area
N: Nearshore Hub/Terminal Area
S: Support Operations Areas

Project Phase:
Co: Construction Phase
Op: Operations Phase
De: Decommissioning Phase

D&OC: Design & Operation Controls Measures

No.	Impact	Project Phase	Project Area	Mauritania	Senegal	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
Air Quality and Greenhouse Gases								
IMP01	Reduction in ambient air quality (NOx and SOx only).	Co	O, P, N	•	•	3 – Medium	D01, D02, D03, D04, M01, M02	2 – Low
IMP02	Reduction in ambient air quality.	Op	P, N	•	•	3 – Medium	D01, D02, D04, D15, D29, D30, D31, D32, D33, M01, M02, M29, M30, M31	2 – Low
Water Quality								
IMP03	Reduction in ambient water quality from FPSO produced water and FLNG cooling water discharges and associated chemicals.	Op	P, N	•	•	2 – Low	D01, D05, D06, D07, D11, D34, D35, D36, D37, D38, M32, M33, M35, M36, M37, M38, M39	2 – Low
IMP04	Changes in water quality from accidental loss of trash and debris.	Op	O, P, N, S	•	•	2 – Low	D01, D05, D06, D07, D11, D34, D35, D36, D37, D38, M34	1 – Negligible

No.	Impact	Project Phase	Project Area	Mauritania	Senegal	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
Coastal Erosion								
IMP05	Accretion or reduction in natural erosion of the Langue de Barbarie (relative to the case without the breakwater) of up to 13 m over 10 years near the Mauritania-Senegal border and extending southward approximately 8 km, accompanied by a maximum increase in coastal erosion rate (relative to the case without the breakwater) of approximately 6 m over 10 years further south, along approximately 2 km of coast, starting from the south end of the Hydrobase neighborhood.	Op, De	N		•	2 – Low	D39, D42, M40, M41, M45	2 – Low
Sediment Quality								
IMP06	Changes in bottom contours, grain size, and some chemical parameters from dredging activities and discharge of drilling muds and cuttings discharges.	Co	O	•	•	2 – Low	D01, D05, D06, D09, D10, D13, M03	2 – Low
IMP07	Potential chemical leaching of solid waste materials and localized organic loading from epibiota.	Op	O, P, N	•	•	2 – Low	D01, D05, D06, D38, M34	1 – Negligible
Benthic Communities								
IMP08	Disturbance to benthic communities from resuspension and deposition of sediments in close proximity to dredging activities.	Co	N	•	•	2 – Low	D01, D05, D06, D08, D09, D10, D13, M03	1 – Negligible
IMP09	Introduction of aquatic invasive species.	Co	O, P, N	•	•	2 – Low	D01, D05, D06, D08, D09, D10, D13	2 – Low

No.	Impact	Project Phase	Project Area	Mauritania	Senegal	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
Plankton & Fish and Other Fishery Resources								
IMP10	Entrainment and impingement of plankton and adult fish in FLNG cooling water at Nearshore Hub/Terminal. Entrainment and impingement of plankton and adult fish by FPSO.	Op	P, N	•	•	2 – Low	D01, D05, D06, D34, M42	1 – Negligible
Birds								
IMP11	Incineration of individual birds from well stem test flaring at the drillship.	Co	O	•	•	2 – Low	D01, D05, D06, D15, D16, D17, D29	2 – Low
IMP12	Incineration of birds during flaring from the FPSO and FLNG during non-routine conditions.	Op	P, N	•	•	2 – Low	D01, D05, D06, D15, D16, D17, D29	2 – Low
IMP13	Potential vessel strike resulting in bird injury or mortality.	Op	P, N, S	•	•	2 – Low	D01, D05, D06, D15, D16, D17, D29	2 – Low
IMP14	Effects of routine vessel and facility discharges during operations impacting birds directly or indirectly.	Op	P, N, S	•	•	2 – Low	D01, D05, D06, D15, D16, D17, D29, M33, M35, M36, M37, M38, M39	1 – Negligible
Marine Mammals								
IMP15	Auditory impairment due to sound from construction activities, particularly pile driving and VSP survey.	Co	O, P, N, S	•	•	2 – Low	M04, M05, M07	1 – Negligible
IMP16	Potential vessel strike resulting in marine mammal injury or mortality.	Co, Op, De	O, P, N, S	•	•	2 – Low	D41, D42, D43, M06	1 – Negligible
IMP17	Avoidance or displacement from vessel traffic or the FPSO; Noise disturbances from operations (liquefaction of LNG and transfer operations).	Op	P, N	•	•	2 – Low	None	2 – Low

No.	Impact	Project Phase	Project Area	Mauritania	Senegal	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
Sea Turtles								
IMP18	Avoidance or displacement from areas under construction for some species; attraction to other species as a foraging strategy; Noise disturbances from construction activities, particularly pile driving and VSP surveys; loss of foraging habitats from proposed construction.	Co	O, P, N	•	•	2 – Low	M04, M05, M07	1 – Negligible
IMP19	Potential vessel strike resulting in sea turtle injury or mortality.	Co, Op, De	O, P, N, S	•	•	2 – Low	D41, D42, D43, M06	1 – Negligible
IMP20	Avoidance or displacement from vessel traffic or the FPSO; Noise disturbances from operations (liquefaction of LNG and transfer operations).	Op	O, P, N, S	•	•	2 – Low	None	2 – Low
IMP21	Direct and indirect effects of routine vessel discharges during operations.	Op	O, P, N, S	•	•	2 – Low	M33, M35, M36, M37, M38, M39	1 – Negligible
Threatened Species and Protected Areas								
IMP22	Physical injuries and disturbances to threatened species.	Co	O, N	•	•	2 – Low	M04, M05, M07	2 – Low
IMP23	Disturbance, possible auditory injury, vessel strike to threatened species from vessels, operations.	Co, Op De	O, P, N	•	•	1 – Negligible to 2 – Low	D01, D02, D15, D29, D30, D31, D32, D33, D40, M06	1 – Negligible (Op, De) to 2 – Low (Co)
IMP24	Introduction of non-native or invasive species.	Co, Op, De	O, P, N, S	•	•	2 – Low	None	2 – Low
IMP25	Behavioral disturbances to fauna within protected areas or other areas of conservation interest.	Op, De	N	•	•	2 – Low	D01, D02, D15, D29, D30, D31, D32, D33, D40, D41, D42, D43, M43	2 – Low

No.	Impact	Project Phase	Project Area	Mauritania	Senegal	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
IMP26	Behavioral disturbances to threatened species.	Op, De	O, N	●	●	2 – Low	D01, D02, D15, D29, D30, D31, D32, D33, D40, D41, D42, D43	2 – Low
IMP27	Increase in airborne contaminants in protected areas or other areas of conservation interest.	Op	P, N, S	●	●	2 – Low	D01, D02, D15, D29, D30, D31, D32, D33, D40, M01, M02	1 – Negligible
Biodiversity								
Plankton and Fish and Other Fishery Resources								
IMP10	Entrainment and impingement of plankton and adult fish in FLNG cooling water at Nearshore Hub/Terminal. Entrainment and impingement of plankton and adult fish by FPSO.	Op	P, N	●	●	2 – Low	D01, D05, D06, D34, M42	1 – Negligible
Marine Mammals								
IMP15	Auditory impairment due to sound from construction activities, particularly pile driving and VSP survey.	Co	O, P, N, S	●	●	2 – Low	M04, M05, M07	1 – Negligible
IMP16	Potential vessel strike resulting in marine mammal injury or mortality.	Co, Op, De	O, P, N, S	●	●	2 – Low	D41, D42, D43, M06	1 – Negligible
IMP17	Avoidance or displacement from vessel traffic or the FPSO; Noise disturbances from operations (liquefaction of LNG and transfer operations).	Op	P, N	●	●	2 – Low	None	2 – Low

No.	Impact	Project Phase	Project Area	Mauritania	Senegal	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
Sea Turtles								
IMP18	Avoidance or displacement from areas under construction for some species; attraction to other species as a foraging strategy; Sound disturbances from construction activities, particularly pile driving and VSP surveys; loss of foraging habitats from proposed construction.	Co	O, P, N	●	●	2 – Low	M04, M05, M07	1 – Negligible
IMP19	Potential vessel strike resulting in sea turtle injury or mortality.	Co, Op, De	O, P, N, S	●	●	2 – Low	D41, D42, D43, M06	1 – Negligible
IMP20	Avoidance or displacement from vessel traffic or the FPSO; Noise disturbances from operations (liquefaction of LNG and transfer operations).	Op	O, P, N, S	●	●	2 – Low	None	2 – Low
IMP21	Direct and indirect effects of routine vessel discharges during operations.	Op	O, P, N, S	●	●	2 – Low	M33, M35, M36, M37, M38, M39	1 – Negligible
Birds								
IMP11	Incineration of individual birds from well stem test flaring at the drillship.	Co	O	●	●	2 – Low	D01, D05, D06, D15, D16, D17, D29	2 – Low
IMP12	Incineration of birds during flaring from the FPSO and FLNG during non-routine conditions.	Op	P, N	●	●	2 – Low	D01, D05, D06, D15, D16, D17, D29	2 – Low
IMP13	Potential vessel strike resulting in bird injury or mortality.	Op	P, N, S	●	●	2 – Low	D01, D05, D06, D15, D16, D17, D29	2 – Low
IMP14	Effects of routine vessel and facility discharges during operations impacting birds directly or indirectly.	Op	P, N, S	●	●	2 – Low	D01, D05, D06, D15, D16, D17, D29, M33, M35, M36, M37, M38, M39	1 – Negligible

No.	Impact	Project Phase	Project Area	Mauritania	Senegal	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
Threatened Species and Protected Areas								
IMP22	Physical injuries and disturbances to threatened species.	Co	O, N	●	●	2 – Low	M04, M05, M07	2 – Low
IMP23	Disturbance, possible auditory injury, vessel strike to threatened species from vessels, operations.	Co, Op De	O, P, N	●	●	2 – Low	D01, D02, D15, D29, D30, D31, D32, D33, D40, M06	1 – Negligible (Op, De) to 2 – Low (Co)
IMP24	Introduction of non-native or invasive species.	Co, Op, De	O, P, N, S	●	●	2 – Low	None	2 – Low
IMP25	Behavioral disturbances to fauna within protected areas or other areas of conservation interest.	Op, De	N	●	●	2 – Low	D01, D02, D15, D29, D30, D31, D32, D33, D40, D41, D42, D43, M43	2 – Low
IMP26	Behavioral disturbances to threatened species.	Op, De	O, N	●	●	2 – Low	D01, D02, D15, D29, D30, D31, D32, D33, D40, D41, D42, D43	2 – Low
IMP27	Increase in airborne contaminants in protected areas or other areas of conservation interest.	Op	P, N, S	●	●	2 – Low	D01, D02, D15, D29, D30, D31, D32, D33, D40, M01, M02	1 – Negligible
Maritime Navigation								
IMP28	Risk of collision between project vessels and pirogues due to project vessels movements.	Co, Op, De	P, N	●	●	2 – Low (De) to 3 – Medium (Co, Op)	D19, D20, D21, D22, D23, D43, M08, M09, M10, M11, M12, M13, M14, M15, M16, M17, M18, M19	1 – Negligible (De) to 2 – Low (Co, Op)

No.	Impact	Project Phase	Project Area	Mauritania	Senegal	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
Artisanal Fisheries and Related Activities								
IMP29	Potential loss of artisanal fishing gears (nets and buoys) due to project vessels movements in artisanal fishing areas.	Co, Op	P, N	•	•	2 – Low	D19, D23, D24, M09, M12, M13, M17, M18, M19, M20, M21, M22, M23, M24, M27	2 – Low
Community Health, Safety and Security								
IMP30	Risk of conflicts between artisanal fishermen and public security forces if some fishermen need to be escorted out of the exclusion safety zones.	Co, Op, De	P, N	•	•	2 – Low (De) to 3 – Medium to 4 – High (Co, Op)	D23, D26, D43, M08, M17, M19, M25, M26	1 – Negligible (De) to 2 – Low (Co, Op)
IMP31	Risk of terrorism act targeting the gas production facilities which in turn will raise the level of terrorism risk at a national level.	Op, De	P, N	•	•	4 – High	D24, D26, D43, M25, M26	2 – Low
Public Infrastructure								
IMP32	Placing additional demands on the public security forces limited resources since they will be required to be available 24/7 to handle a safety incident with artisanal fishermen or a search and rescue operation if needed.	Co, Op	P, N	•	•	2 – Low (Co) to 3 – Medium (Op)	D24, D26, D27, D28, M08, M09, M10, M11, M12, M13, M14, M16, M25, M26,	1 – Negligible (Co) to 2 – Low (Op)
IMP33	Placing additional demands on National security authorities who will need to prevent and be available 24/7 to handle a national security incident at sea resulting from the presence of the project offshore gas production infrastructures.	Op	P, N	•	•	3 – Medium	D24, D26, D27, M25, M26	2 – Low

No.	Impact	Project Phase	Project Area	Mauritania	Senegal	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
Social Climate								
IMP34	Social discontent in N'Diago and Saint-Louis due to the potential perception of loss of fishing grounds and fishing catches combined with the limited employment opportunities, the perception of unsatisfied grievances and/or compensation claims (e.g., for lost gear), and elevated safety risk for fishermen at sea due to presence of project vessels.	Co, Op, De	P, N, S	•	•	2 – Low (De) to 4 – High (Co, Op)	D19, D24, D43, M09, M17, M18, M19, M20, M23, M24, M27, M28. M44, M46	1 – Negligible (De) to 2 – Low (Co, Op)

Notes:
[1] The significance presented is the maximum significance for any of the project areas noted, and therefore the impact may be less significant in other project areas.
[2] See Tables 7-196 and 7-197 for the detailed list of design & operation controls, and mitigation measures.

Table 7-196. Summary Table of Design & Operation Controls Measures that Will Avoid or Reduce Impacts from Routine Activities.

#	Measures
D01	Contractors will be expected to comply with the contract terms that have been established, including HSSE standards and performance requirements.
D02	Compliance with applicable national and international regulations (MARPOL 73/78 Annex VI) and guidelines regarding emissions of nitrogen oxides (NOx) and sulphur oxides (SOx) from main project vessels.
D03	An efficient flare burner head equipped with an appropriate combustion enhancement system will be selected with the intent of minimizing incomplete combustion, black smoke, and hydrocarbon fallout to the sea.
D04	Volumes of hydrocarbons flared will be recorded.
D05	Compliance with applicable national and international regulations (MARPOL 73/78, Annex IV and V) for waste and wastewater discharges from offshore project vessels.
D06	A waste management plan will be developed and implemented to avoid unauthorized waste discharges and transfers, with written procedures for collection, segregation, storage, processing and disposal of waste, including use of equipment and record keeping.
D07	Waste not permitted to be discharged at sea (such as waste chemicals, cooking oils or lubricating oils, biomedical waste) will be transported onshore for transfer to an approved disposal facility[162] (in-country or an international provider).
D08	Ballast water will be discharged according to IMO International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM), where applicable.
D09	Discharges of SBDF[163] mud and cuttings will be managed. SBDF cuttings will only be discharged once the performance targets of 6.9 g/100 g retained "synthetic on cuttings" on wet solids averaged over the whole well discharge can be satisfied. The concentration of SBDF on cuttings will be monitored on the drillship. No excess or spent SBDF will be discharged to the sea. Spent or excess SBDF that cannot be re-used during drilling operations will be brought back to shore for disposal. If mineral oil base drilling fluid (OPDF[164]) were to be selected, cuttings contaminated with mineral oil base drilling fluid at a concentration greater than 1% by weight mineral oil on dry cuttings will not be discharged. No OPDF will be discharged as whole fluid.
D10	Selection of drilling chemicals will be in accordance with the BP chemical selection and waste management standards to reduce potential for environmental effect. Where feasible, lower toxicity drilling muds and biodegradable and environmentally friendly additives within muds, cements and completion fluids will be preferentially used. If barite is used as weighting agent, it will not contain more than: – Hg: max 1 mg/kg dry weight in stock barite and – Cd: max 3 mg/kg dry weight in stock barite.
D11	Completion and well workover fluids to be discharged overboard will be tested to confirm the fluids are suitable for discharge as required by applicable national and international regulations. Fluids that do not meet the specification would either be treated offshore or transported onshore for transfer to an approved disposal facility[165] (in-country or an international provider).
D12	A pipeline and FLNG hydrotesting plan will be developed and implemented, detailing hydrotesting requirements, and demonstrating, based on an environmental risk assessment approach, the chemical additives to be selected as well as likely concentrations, volumes and frequencies of discharges. The plan will include a strategy to minimize environmental impact.
D13	A dredging management plan will be developed for large dredging works (breakwater, disposal areas, potential sand borrow areas offshore) and implemented that defines the dredging methodology, identifies and assesses dredged materials disposal options and sites, characterizes the composition and behavior of the sediment to be dredged, and defines the area of influence and the potential mitigation and monitoring measures. In addition, pre- and post-dredged survey will be performed.

162 In this document, a treatment center can mean either a center for waste treatment or for final disposal.
163 SBM: Synthetic Based Muds; SBDF: Synthetic Based Drilling Fluids.
164 OPDF: Organic-Phase Drilling Fluids.
165 In this document, a treatment center can mean either a center for waste treatment or for final disposal.

#	Measures
D14	Commitment to building Hub at approximately 10 to 11 km from shore with an intended benefit of limiting impact on the seagrass beds.
D15	The FLNG and FPSO will be designed, constructed, and operated to avoid routine flaring[166].
D16	Lighting will be reduced to the extent that worker safety and safe & secure operations is not compromised. Reduction of light may include avoiding use of unnecessary lighting, shading, and downward lighting where possible.
D17	Development and implementation of a wildlife handling and rescue protocol for the FLNG and FPSO vessels and project patrol boats.
D18	The seabed in the project areas has been mapped as part of an extensive geophysical and geotechnical survey carried out by the project. The survey has confirmed that the project seabed infrastructure does not pose a risk to the submarine telecommunication cables.
D19	The relevant maritime, port or shipping authorities will be notified of all permanent offshore facilities, as well as safety zones and routine shipping routes to be used by project-related vessels. Permanent facility locations will be demarcated on nautical charts.
D20	Project vessels will follow the Convention on International Regulations for Preventing Collisions at Sea (COLREGs) adopted by the IMO.
D21	Main project vessels will be equipped with Universal Shipborne Automatic Identification System (AIS), a system of transponders installed on vessels which transmit over two dedicated digital marine VHF channels.
D22	Where there is a risk of vessel interaction, standard communication procedures will be used in international maritime traffic and shipping, aided by project patrol boats or standby vessels near the drilling, pipelay and Nearshore Hub/Terminal Area to prevent collision with larger vessels.
D23	Information will be provided to the national industrial fishing fleet of both Mauritania and Senegal to communicate and record the exclusion safety zones and applicable navigational charts.
D24	Exclusion safety zones will be demarcated on applicable navigational charts, and a communication procedure will be developed to communicate the location of the exclusion safety zones to the local fishing communities. This is intended to allow pirogues avoid the exclusion safety zones.
D25	The seabed has been mapped as part of an extensive geophysical and geotechnical survey carried out by the project. The survey has not identified any shipwrecks or other maritime heritage on the seabed. Further seabed surveys are foreseen prior to dredging taking place.
D26	A site security plan will be developed that considers the security arrangements for each of the facilities including the modalities of support provided by government.
D27	Expat workers and national workers will undergo a briefing to raise awareness on health risks, prevention and available treatment and their responsibilities. There will be an active screening and medical treatment program for workers.
D28	The nature of the drilling, pipelay, FPSO and FLNG Construction Phase activities will reduce the need for onshore stay-overs of personnel.
D29	Develop and implement a flaring protocol with the intention to meet defined operational combustion performance.
D30	Implementation of leak detection and repair programs for fugitive emissions.
D31	Implementation of technically feasible and cost-effective measures to optimize energy efficiency and air emissions on the FPSO and FLNG. This could include where feasible waste heat recovery, flare gas recovery, vapor recovery and selected method of export compression on the FPSO, and boil-off gas recovery and control of fugitive emissions through design of the FPSO and FLNG.
D32	Use of project-produced gas as preferred fuel for FLNG, FPSO and QU processes instead of diesel or crude oil.

166 Routine flaring is defined in Section 7.3.1.

#	Measures
D33	Aggregate greenhouse gas emissions from all offshore project facilities will be quantified annually in accordance with internationally recognized methodologies. The FPSO and FLNG will have fuel flow or emissions metering systems installed for equipment rated at 10 MW thermal or above. A predictive emission monitoring system (PEMS) will be used on equipment rated 10 MW thermal or above for the calculation of emissions of GHG, SOx and NOx.
D34	LNG and condensate carriers are expected to discharge ballast water according to the IMO International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM).
D35	FPSO and FLNG vessel will be certified according to Class and Flag requirements before leaving the shipyard. The vessels will be double-hulled.
D36	An inspection and maintenance program will be developed and implemented with the intent of maintaining mechanical integrity of equipment, piping, relief and vent systems and devices, emergency shutdown systems, controls, pumps and instrumentation, and prevent uncontrolled releases of hazardous or polluting materials from the project.
D37	Chemicals used in the production process, flow assurance, maintenance, well intervention and management, desalination and fire management systems will be selected and managed with the intent to reduce the potential for environmental effects.
D38	If dredging activities are required for maintenance during the Operations Phase, a dredging management plan will be developed and implemented that defines the maintenance dredging methodology, identifies and assesses dredged materials disposal options and sites, characterized the chemical and physical composition and behavior of the sediment to be dredged, and defines the area of influence and the potential mitigation and monitoring measures.
D39	Given the principle of the need for parity either side of the border, the project has selected a location and design for the Nearshore/Hub terminal that has both the most beneficial and least potential adverse effect on the shoreline morphology of the options reviewed, while meeting the required conditions for safe approach of LNG carriers, subsequent mooring and operation of the facility (see Section 5.2.6).
D40	The location of project facilities at some distance offshore from the protected areas avoids most direct and indirect impacts from routine activities.
D41	Contractors will be expected to comply with the applicable legal requirements and standards at the time of decommissioning, including HSSE standards and performance requirements.
D42	A preliminary decommissioning plan will be developed for the offshore project facilities, which considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[167] for equipment and materials.
D43	A final detailed decommissioning plan will be developed closer to the Decommissioning Phase for the offshore project facilities, which considers well abandonment, removal of hydrocarbons from flowlines, facility and subsea decommissioning along with disposal options[168] for equipment and materials.
D44	Well abandonment will be carried out in line with applicable good industrial practice and applicable legislation. A seabed survey will be conducted at the end of the well abandonment program to survey the seabed for debris.
D45	The relevant maritime, port or shipping authorities will be notified of all offshore facilities that remain in situ following decommissioning, as well as corresponding safety zones. The presence of these permanent facility locations will be demarcated on nautical charts.

[167] In this case, disposal includes treatment, reuse, recycling and final disposal practices.
[168] In this case, disposal includes treatment, reuse, recycling and final disposal practices.

Table 7-197. Summary Table of Mitigation Measures that Will Avoid or Reduce Impacts from Routine Activities.

#	Measures
M01	Maintaining routine maintenance procedures to help ensure that engines are operating at defined operational performance and specified emissions levels.
M02	Monitoring fuel consumption as a proxy for measuring performance and emissions. When practical, or as required by applicable regulations, vessel operators will be expected to utilize low-sulfur fuels to limit SOx production.
M03	Dredged material and drill cuttings will not be disposed on or near carbonate mounds and away from coastal areas. The proposed pipeline route will avoid sensitive carbonate mounds.
M04	Seismic survey mitigation measures to be implemented during VSP survey(s) with the aim of minimizing the acoustic exposures to marine mammals (e.g. gradually increasing seismic source elements over a period of approximately 30 minutes until the operating level is achieved before any VSP activity begins).
M05	Sound mitigation measures will be implemented during pile driving (e.g. soft-starting [gradually increasing hammer power]).
M06	Vessel operators will implement vessel strike avoidance protocols to reduce the potential for vessel strike with marine mammals and sea turtles (including injured/dead protected species reporting).
M07	Collection and analysis of acoustic data from the area to determine background sound levels and marine mammal presence/absence, and underwater sound modeling to determine distances to various thresholds.
M08	Develop and implement a training and awareness program targeting local fishing communities on the specific maritime safety rules associated with the project.
M09	Provide regular notices to mariners in the appropriate form and language to artisanal fishermen on project infrastructure, associated exclusion safety zones, travel and approach plans and the approximate timing of project activities.
M10	Equip the support vessels and other project vessels that regularly move outside the construction or operational exclusion safety zones with radar or infrared systems that can detect small fishing vessels during poor visibility/night time.
M11	Provide adequate lighting aboard the support vessels and other project vessels that regularly move outside the construction or operational exclusion safety zones with the intent of maintaining high visibility during poor visibility/night time. These vessels will also feature searchlights that can be used to shine on or signal approaching pirogues and foghorns for audible signaling.
M12	Having a project patrol boat to monitor the exclusion safety zones, including patrolling ahead of the approach or exiting of larger project vessels into or out of the exclusion safety zones.
M13	Where there is a risk of vessel interaction, using the services of local fishermen liaison officers (FLOs) aboard the project patrol boats in the areas of artisanal fishing.
M14	Equipping the support vessels and the project patrol boat with lifesaving appliances approved by the Convention for Safety of Life at Sea (SOLAS) and IMO, which can be used to assist in rescuing fishermen in the water in line with international maritime protocols or in the event of an accident involving a pirogue with a project vessel. Assist with the rescue of any fishermen involved in a collision with a project vessel or following the capsizing of their vessel due to ship wake associated with project vessels.
M15	In case of a collision, BP will inform as soon as possible the relevant national authorities: the Mauritanian Coast Guard (Garde Côte Mauritanienne) in Mauritania and HASSMAR in Senegal.
M16	Ensuring that each project vessel keeps records of maritime safety incidents with pirogues and other vessels, including near misses, and that these are subsequently shared with the project. BP will monitor maritime safety incidents and adjust, if required, project specific maritime safety rules, security and search & rescue arrangements in place.
M17	Establishing a grievance mechanism easily accessible to fishing communities members that includes monitoring of claims and the resolution thereof.
M18	Maintaining a community liaison officer (CLO) for N'Diago and Saint-Louis to provide a direct link with the fishing communities in all matters related to the project.

#	Measures
M19	Collaboration with a community council of formally nominated representatives of local key stakeholders from N'Diago and Saint-Louis set up to review local fishing communities' concerns and grievances related to the project.
M20	Develop and implement a framework for interaction with artisanal fisheries, with provisions covering engagement with local communities on access to fishing grounds, grievance and recourse mechanism for damage to fishing gear, environmental awareness building, livelihood enhancement and the role of community liaison officers.
M21	Project vessels to record incidents with fishing gears and report them to the project.
M22	To the extent feasible, establish a maritime corridor or speed restrictions for project vessels within artisanal fishing areas.
M23	Implement an environmental awareness building program in association with local schools and community groups.
M24	Provide technical assistance to mutually agreed marine resource research programs notably the national oceanographic research centers of both countries (CRODT and IMROP).
M25	The project will seek to work with the public security forces to establish an appropriate response and security framework which may include resource, equipment, training and response protocols.
M26	Include in the security stakeholder engagement plan, provisions around response, management and interface with Public security forces for security incidents scenario such as act of terrorism and unlawful entry in the exclusion safety zones.
M27	Developing a social investment program to enhance project benefits for the directly affected N'Diago and Saint-Louis communities, including livelihood enhancement activities.
M28	Engaging in an on-going dialogue with national, regional and local authorities to monitor the social climate in the local communities in order to help identify and support, if needed, ad hoc measures to prevent social discontent linked to project activities and its escalation into conflicts.
M29	Use of dry low emissions (DLE) gas turbine drivers for the main refrigeration compressors on the FLNG.
M30	Conduct monitoring of baseline air quality prior to the Construction Phase at receptor level to establish ground-level ambient air concentrations. Update air dispersion modelling if necessary when equipment specifications from vendors are available in detailed design phase.
M31	Tug boats and other project support vessels not in operational use and moored at the Hub facility will be connected to electrical power provided by the Hub to the extent practical.
M32	The seawater intake depth at the FLNG will be optimized to reduce the heated water plume. Cooling water effluent will not result in a temperature change of more than 3°C at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use, potential receptors, and assimilative capacity.
M33	Monitoring use of added chemicals to produced water stream (corrosion inhibitors, scale inhibitors, coagulants/flocculants).
M34	Verifying compliance with MARPOL Convention and implementation of a waste management plan, with the intent of reducing the likelihood of accidental loss.
M35	The seawater intake depth at the FPSO will be designed with the intent to reduce the need for use of antifoulant chemicals.
M36	Free chlorine in FLNG cooling water discharges to be sampled at point of discharge will be maintained below 0.2 parts per million (ppm).
M37	Produced water will be treated prior to discharge with sufficient treatment. Oil and grease content of the produced water effluent discharge at sea will be compliant with applicable regulation and not exceed 42 mg/L daily maximum; 29 mg/L monthly average.
M38	Produced water effluent quality will be monitored. The first 18 months of monitoring data will be used to assess the potential impacts of the effluent upon the receiving water body using an Environmental Risk Assessment approach, which is to be repeated following a material change in effluent composition or volume.
M39	The discharge of cooling water will be designed to reduce recirculation.

#	Measures
M40	a) To improve understanding of the long-term coastal dynamic equilibrium, the project will develop and implement a coastline monitoring plan during the project life cycle. Coastline monitoring will commence prior to breakwater construction, i.e. before 2020. This will include the collection of further bathymetric data along the Saint-Louis shore, including the Senegal River mouth. The project will aim to involve local academics in the implementation of the coastline monitoring plan. The relevant authorities and local communities will be informed of the monitoring results. b) The data collected as part of the implementation of the coastline monitoring plan will be used to update the coastline modeling (in Appendix I-3) to be completed before the construction of the breakwater in 2020. Additional modeling updates will be conducted at key stages of the project life cycle when new information with the potential to have a significant impact on the modeling results will become available. c) BP will seek the necessary authorizations to share relevant data for government led morphological studies initiatives and local academics. d) a contingency plan for the coastline will be developed by the project in consultation with the relevant authorities if the results of the coastline monitoring and modeling clearly and systematically demonstrate, over the duration of the project, negative impacts related to the GTA Phase 1 project which exceeds those currently identified in the GTA Phase 1 project ESIA report (in particular Section 7.3.3).
M41	Provide specialist assistance to studies led by local or national authorities on Saint-Louis coastal management.
M42	The seawater intake of the cooling water systems will be positioned taking into account technical constraints and appropriate screens or velocity caps will be fitted, if safe and practical, with the intent of avoiding entrainment and impingement of marine flora and fauna. The intake velocity will be below 1.0 m/s.
M43	Implement a program of support to local protected area management initiatives through mutually agreed capacity building.
M44	Review the social climate in N'Diago and in Saint-Louis prior to the Operations Phase to adjust as needed the mitigation measures identified to avoid or reduce social discontent.
M45	A final decommissioning plan will be developed for approval by the authorities near the end of the operational lifetime, which takes into consideration further morphological studies and data collection as applicable.
M46	Review the social climate in N'Diago and in Saint-Louis prior to the Decommissioning Phase to adjust as needed the mitigation measures identified to avoid or reduce social discontent.

7.6.2 Impacts of Accidental Events

Table 7-198 presents all non-negligible negative impacts of accidental events. The three accidental event scenarios assessed are a well blowout, a failure of the FPSO due to a ship collision and a pipelaying vessel collision, which were chosen to represent the most challenging response conditions, due to either location, oil type or volume or highest environmental impact.

As previously explained, since these accidental event scenarios are highly unlikely to happen (remote likelihood), most impacts arising from these events are of low or negligible significance. In addition, there is often no apparent reduction in the impact with the application of mitigation measures because it is already in the lowest possible likelihood bracket before the application of mitigation measures. The significance of the residual impact should therefore not be interpreted as an attempt to downplay the consequence of the impact if a highly unlikely accident were to happen. In order to give an overview of the impact consequence should an accidental event scenario did happen, the impact consequences are included in Table 7-198.

Tables 7-199 and 7-200 list design & operation controls measures ("D" measures) as well as recommended mitigation measures ("M" measures) for the accidental event impacts respectively. Note that numbering of measures for accidental events begins at 101.

As shown in Table 7-198, the most important negative residual impacts from accidental events would be associated with birds, marine mammals, sea turtles, threatened species and protected areas, and biodiversity. They are rated medium after the application of D and M measures.

Table 7-198. Summary Table of Non-Negligible Negative Impacts of Accidental Events.

Accidental Event:

WB Well Blowout

FF Failure of FPSO Due to a Ship Collision

PC Pipelaying Vessel Collision

D&OC: Design & Operation Controls Measures

No.	Impact	Accidental Event	Consequence	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
Water Quality						
IMP101	Changes in water quality from elevated hydrocarbon concentrations in both water column and at the sea surface from a well blowout.	WB	Moderate	2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112	2 – Low
IMP102	Changes in water quality from elevated hydrocarbon concentrations in both water column and at the sea surface from FPSO failure due to a ship collision.	FF	Moderate	2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112	2 – Low
IMP103	Changes in water quality within the Senegal River estuary from elevated hydrocarbon concentrations in the water column from FPSO failure due to a ship collision.	FF	Moderate	2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112	2 – Low
IMP104	Changes in water quality from elevated hydrocarbon concentrations in both water column and at the sea surface from pipelaying vessel collision (Senegal waters).	PC	Moderate	2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112	2 – Low

No.	Impact	Accidental Event	Consequence	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
Birds						
IMP105	Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from a blowout.	WB	Severe	3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112	3 – Medium
IMP106	Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.	FF	Severe	3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112	3 – Medium
IMP107	Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from pipelaying vessel collision	PC	Severe	3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112	3 – Medium
Marine Mammals						
IMP108	Exposure of Mediterranean monk seals to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from the blowout spill.	WB	Severe	3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112	3 – Medium

No.	Impact	Accidental Event	Consequence	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
IMP109	Exposure of Mediterranean monk seals to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.	FF	Severe	3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112	3 – Medium
IMP110	Exposure of Mediterranean monk seals to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from pipelaying vessel collision.	PC	Severe	3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112	3 – Medium
Sea Turtles						
IMP111	Exposure of sea turtles to elevated hydrocarbons within a regional area; some lethal impacts to turtles of all age groups and numerous sublethal impacts to turtles from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.	FF	Severe	3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112	3 – Medium
IMP112	Exposure of sea turtles to elevated hydrocarbons within a regional area; some lethal impacts to turtles of all age groups and numerous sublethal impacts to turtles from direct and indirect effects from exposure to oil from pipelaying vessel collision.	PC	Severe	3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112	3 – Medium

No.	Impact	Accidental Event	Consequence	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
Threatened Species and Protected Areas						
IMP113	Oiling of water column or coastline including impacts to areas designated as marine or onshore protected areas. Impacts could include, loss of vegetation, habitat destruction, and injury or death to marine or terrestrial fauna from a blowout.	WB	Moderate	2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	2 – Low
IMP114	Oiling of threatened species resulting in mortality from a blowout.	WB	Minor to Severe	1 – Negligible to 3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	1 – Negligible to 3 – Medium
IMP115	Oiling of water column or coastline including impacts to areas designated as marine or onshore protected areas. Impacts could include, loss of vegetation, habitat destruction, and injury or death to marine or terrestrial fauna from FPSO failure due to a ship collision.	FF	Moderate	2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	2 – Low
IMP116	Oiling of threatened species resulting in mortality from FPSO failure due to a ship collision.	FF	Minor to Severe	1 – Negligible to 3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	1 – Negligible to 3 – Medium
IMP117	Oiling of water column or coastline including impacts to areas designated as marine or onshore protected areas. Impacts could include, loss of vegetation, habitat destruction, and injury or death to marine or terrestrial fauna from pipelaying vessel collision.	PC	Moderate	2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	2 – Low

No.	Impact	Accidental Event	Consequence	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
IMP118	Oiling of threatened species resulting in mortality from pipelaying vessel collision.	PC	Minor to Severe	1 – Negligible to 3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	1 – Negligible to 3 – Medium
Biodiversity						
Marine Mammals						
IMP108	Exposure of Mediterranean monk seals to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from the blowout spill.	WB	Severe	3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	3 – Medium
IMP109	Exposure of Mediterranean monk seals to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.	FF	Severe	3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	3 – Medium
IMP110	Exposure of Mediterranean monk seals to elevated hydrocarbons within a regional area; assuming lethal impact(s) from direct and indirect effects from exposure to oil from pipelaying vessel collision.	PC	Severe	3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	3 – Medium

No.	Impact	Accidental Event	Consequence	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
Sea Turtles						
IMP111	Exposure of sea turtles to elevated hydrocarbons within a regional area; some lethal impacts to turtles of all age groups and numerous sublethal impacts to turtles from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.	FF	Severe	3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	3 – Medium
IMP112	Exposure of sea turtles to elevated hydrocarbons within a regional area; some lethal impacts to turtles of all age groups and numerous sublethal impacts to turtles from direct and indirect effects from exposure to oil from pipelaying vessel collision.	PC	Severe	3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	3 – Medium
Birds						
IMP105	Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from a blowout.	WB	Severe	3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	3 – Medium
IMP106	Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from FPSO failure due to a ship collision.	FF	Severe	3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	3 – Medium

No.	Impact	Accidental Event	Consequence	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
IMP107	Exposure of birds to elevated hydrocarbons within a regional area; some lethal impacts and numerous sublethal impacts from direct and indirect effects from exposure to oil from pipelaying vessel collision.	PC	Severe	3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	3 – Medium
Threatened Species and Protected Areas						
IMP113	Oiling of water column or coastline including impacts to threatened species or areas designated as marine or onshore protected areas. Impacts could include, loss of vegetation, habitat destruction, and injury or death to marine or terrestrial fauna from a blowout.	WB	Moderate	2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	2 – Low
IMP114	Oiling of threatened species resulting in mortality from a blowout.	WB	Minor to Severe	1 – Negligible to 3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	1 – Negligible to 3 – Medium
IMP115	Oiling of water column or coastline including impacts to areas designated as marine or onshore protected areas. Impacts could include, loss of vegetation, habitat destruction, and injury or death to marine or terrestrial fauna from FPSO failure due to a ship collision.	FF	Moderate	2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	2 – Low

No.	Impact	Accidental Event	Consequence	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
IMP116	Oiling of threatened species resulting in mortality from FPSO failure due to a ship collision.	FF	Minor to Severe	2 – Low to 3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	2 – Low to 3 – Medium
IMP117	Oiling of water column or coastline including impacts to areas designated as marine or onshore protected areas. Impacts could include, loss of vegetation, habitat destruction, and injury or death to marine or terrestrial fauna from pipelaying vessel collision.	PC	Moderate	2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	2 – Low
IMP118	Oiling of threatened species resulting in mortality from pipelaying vessel collision.	PC	Minor to Severe	2 – Low to 3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M112, M113	2 – Low to 3 – Medium
Land & Seabed Occupation and Use						
IMP119	Oil spill of coastline on close to 400 km, from approximately Legweichich in Mauritania to Dakar in Senegal due to a well blowout.	WB	Minor to Moderate	1 – Negligible to 2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M106, M107, M108	1 – Negligible
IMP120	Oil spill of coastline on close to 400 km, from approximately Legweichich in Mauritania to Dakar in Senegal, and on the shore of <20 km along the Senegal River estuary, due to a failure of FPSO due to a ship collision.	FF	Minor to Moderate	1 – Negligible to 2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M106, M107, M108	1 – Negligible

No.	Impact	Accidental Event	Consequence	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
IMP121	Oil spill of coastline on about 200 km, from approximately PK 144 in Mauritania to Fass Boye in Senegal due to a pipelaying vessel collision.	PC	Minor to Moderate	1 – Negligible to 2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M106, M107, M108	1 – Negligible
Industrial Fisheries						
IMP122	Temporary loss of industrial fishing catches due to spill impacts on plankton, fish and other fishery resources.	WB, FF, PC	Moderate	2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M105, M106, M107, M108	2 – Low
IMP123	Temporary preclusion of industrial fishing in the spill response area for up to >450 industrial vessels (2017 numbers).	WB, FF, PC	Moderate	2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M105, M106, M107, M108	2 – Low
IMP124	Temporary loss of catches and revenues for industrial fishing operators.	WB, FF, PC	Moderate	2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M105, M106, M107, M108	2 – Low
IMP125	Temporary loss of revenues for national economies due to the temporary disruption of industrial fisheries.	WB, FF, PC	Moderate	2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M105, M106, M107, M108	2 – Low

No.	Impact	Accidental Event	Consequence	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
Artisanal Fisheries and Related Activities						
IMP126	Temporary loss of artisanal fishing catches due to spill impacts on plankton, fish and other fishery resources.	WB, FF, PC	Moderate to Severe	2 – Low to 3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M105, M106, M107, M108, M112	2 – Low
IMP127	Temporary preclusion of artisanal fishing in the spill response area for up to over 25,000 artisanal fishing units (2017 numbers).	WB, FF, PC	Moderate to Severe	2 – Low to 3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M105, M106, M107, M108, M112	2 – Low
IMP128	Temporary loss of revenues for up to about 80,000 artisanal fishermen (2017 numbers).	WB, FF, PC	Moderate to Severe	2 – Low to 3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M105, M106, M107, M108, M109, M110, M111	2 – Low
IMP129	Temporary loss of revenues for up to about 700,000 people involved in activities related to artisanal fisheries (2017 numbers).	WB, FF, PC	Moderate to Severe	2 – Low to 3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M106, M107, M108, M109, M110, M111	2 – Low
IMP130	Temporary loss of revenues for national economies due to the temporary disruption of artisanal fisheries.	WB, FF, PC	Moderate to Severe	2 – Low to 3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M106, M108, M109, M110, M111	2 – Low

No.	Impact	Accidental Event	Consequence	Significance[1]	D&OC and Mitigation Measures[2]	Residual Impact Significance[1]
Community Livelihoods						
IMP131	Temporary decrease of the capacity of the coastal communities to cover day to day needs due to the disruption of their revenues, with a risk of sliding into poverty and vulnerability.	WB, FF, PC	Moderate to Severe	2 – Low to 3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M106, M107, M108, M109, M110, M111, M112	2 – Low
IMP132	Temporary shortage of the main staple of coastal communities due to the disruption of artisanal fish catches, with potential ramifications on the diet of the households at a national level.	WB, FF, PC	Moderate to Severe	2 – Low to 3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M105, M106, M107, M108, M109, M110, M111, M112	2 – Low
Women and Vulnerable Groups						
IMP133	Increased vulnerability of women and vulnerable groups of fishing communities, and, in particular, those of the Langue de Barbarie.	WB, FF, PC	Severe	3 – Medium	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M108, M109, M111	2 – Low
Social Climate						
IMP134	Risks of social unrest in coastal communities and escalating opposition to oil and gas activities nationwide, with a risk of violence in fishing communities in Senegal.	WB, FF, PC	Minor to Moderate	1 – Negligible to 2 – Low	D101, D102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115, D116, D117, D118, D119, M101, M102, M103, M104, M106, M107, M108	1 – Negligible

Notes:
[1] The significance presented is the maximum significance for any of the project areas noted, and therefore the impact may be less significant in other project areas.
[2] See Tables 7-200 and 7-201 for the detailed list of design & operation controls, and mitigation measures.

Table 7-199. Summary Table of Design & Operation Controls Measures that Will Avoid or Reduce Impacts from Accidental Events.

No.	Measure
D101	Wells are designed to documented BP engineering practices and procedures related to well design and construction in line with recognized international standards. A number of these practices and procedures relate specifically to blowout preventers (BOPs and subsea X-mas trees), other well control barriers and isolation of any permeable zone.
D102	BP will perform assurance audits prior to drillship acceptance to confirm all critical systems such as subsea BOP and well control surface equipment are meeting performance standards.
D103	Design measures will be incorporated into the FPSO and FLNG to contain minor spills, e.g. bunded areas on the process decks to contain any small oil spills, spill containment connected to the drains and slop tanks, and minimization of potential spills or overflows from diesel storage and transfer systems through good tank design and metering. The FPSO and FLNG vessel will be double-hulled.
D104	Management and mitigation measures will be in place to prevent and/or minimize the likelihood of a spill from the installation and operation of the subsea facilities. This may include flowline design specification, use of appropriate design codes (e.g. for corrosion allowance), use of corrosion inhibitor. BP will also implement a risk-based proactive pipeline inspection and maintenance program.
D105	Reels and hoses used for hydrocarbon and chemical transfer will be designed, operated and maintained to prevent spills. Operational procedures will be put in place to prevent spill risk, including the use of drip trays and other measures to prevent spillages from, for instance valves, or lubricant changes.
D106	Fuels, chemicals and lubricating oil will be stored in designated containment areas/storage tanks on board project vessels.
D107	Conduct routine maintenance and inspection of safety critical equipment during construction and operation.
D108	Processes and procedures will be in place with the intent of maintaining navigational safety at all times during the project. Obstruction lights, navigation lights and foghorns will be kept in working condition on board the drillship, PSVs, FPSO and breakwater/hub. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.
D109	An exclusion safety zone (estimated to be a 500-m wide radius) will be established around the drillship, FPSO and hub/breakwater within which non-project related vessels are prohibited. Operational procedures will be put in place to further reduce vessel collision risk for instance by a restriction on visiting vessels in bad weather, defined vessel no-go areas within the exclusion safety zone, agreed approach procedures to drillship, FPSO and FLNG/breakwater.
D110	Measures will be implemented aimed at reducing the risk of oil spills from supply, patrol and installation vessels, including selection of vessels which comply with IMO codes for prevention of oil pollution; all vessels will have onboard Shipboard Oil Pollution Emergency Plans (SOPEPs), as required.
D111	Develop a Source Control Emergency Response Plan (SCERP), with provisions for well containment and capping and relief well planning.
D112	Develop an Oil Spill Contingency Plan (OSCP), which will cover a range of response strategies for different spill scenarios.
D113	Tier 1 spill response equipment will be available and maintained in conformance with internal procedures and good international industry practice throughout construction, operations and decommissioning.
D114	Contractual arrangements will be in place with specialist contractors who can support spill response. This includes procedures for verifying their availability and capability.
D115	Conduct routine spill response drills and training.
D116	Development of an oil spill sensitivity map highlighting resources at risk.
D117	BP will undertake an assessment (e.g. Spill Impact Mitigation Assessment (SIMA)) to evaluate the risks and benefits of different response tools or techniques before implementation.
D118	BP will seek regulatory approval for any use of dispersants or in-situ burning as required as per provisions in the OSCP.
D119	Contractor will be required to reports all incidents, including near-misses to BP using established protocols.

Table 7-200. Summary Table of Mitigation Measures that Will Avoid or Reduce Impacts from Accidental Events.

No.	Measure
M101	In the unlikely event of a spill, tactical response methods that may be considered under the OSCP include: surveillance and monitoring, offshore containment and recovery; subsea and at surface dispersant application; in-situ burning; shoreline protection; shoreline clean up; and oiled wildlife response.
M102	All response measures will be continuously monitored to ensure that they remain effective. The response team will maintain situational awareness of the event and response effort.
M103	In the unlikely event of a spill reaching the shoreline, a Shoreline Clean-up and Assessment Technique (SCAT) program will be implemented to inform shoreline clean-up and remediation as applicable.
M104	In the unlikely event of a spill reaching the shoreline, a shoreline clean-up and remediation team will be mobilized to the affected areas. BP will also engage specialized expertise to mitigate impacts to sensitive areas and wildlife species as needed.
M105	In the unlikely event of a spill, follow national regulatory requirements for reporting and notification, using established protocols, which extends to all relevant external stakeholders.
M106	In the unlikely event of a spill, establish a grievance mechanism easily accessible to affected stakeholders that includes monitoring of claims and the resolution thereof.
M107	In the unlikely event of a spill, work with national authorities as requested, to inform relevant stakeholders (including artisanal fishermen) on: 1) the location of the spill; 2) cleanup operations; 3) applicability of temporary exclusion zones; and 4) grievance mechanism, as applicable. In relation to fishermen, this will include providing timely communication, offering them the opportunity to remove gear from affected areas, reducing impact on fishing gear.
M108	In the unlikely event of a spill, in coordination with national authorities if requested, monitor and support ways to address the concerns of stakeholders regarding potential impacts of the spill.
M109	In the unlikely event of a spill, implement, in coordination with national authorities if requested, an emergency fund to assist affected vulnerable households in artisanal fishing communities if needed.
M110	In the unlikely event of a spill, prepare and implement, in coordination with national authorities if requested, a Livelihood Restoration Plan for affected communities.
M111	In the unlikely event of a spill, implement, in coordination with national authorities if requested, an emergency plan to ensure food security of affected vulnerable households and groups if needed.
M112	In the unlikely event of a spill of high intensity, specific monitoring (e.g., environmental effects monitoring) may be required and developed in consultation with applicable national authorities.
M113	Provide training in oil spill response planning and techniques to management staff of the designated National Parks and Marine Protected Areas that based on the ESIA spill modelling results could potentially be affected.

7.7 Cumulative Impacts

7.7.1 Scope and Limits of the Assessment

Cumulative impacts are those resulting from the incremental effects of the proposed project when added to other past, present, and reasonably foreseeable future actions, regardless of who undertakes them. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over time.

In addition to this project, other sources of impact that may contribute to cumulative impacts include on-going and future oil and gas exploratory (i.e., seismic surveys; exploratory drilling) and development activity in Mauritanian and Senegalese waters and other activities in the offshore and nearshore region, including maritime navigation and shipping, artisanal and industrial fishing, hydrocarbon bunkering, port development or modification, shoreline stabilization projects. Potential cumulative impacts with possible future phases of the GTA project will be addressed, in due time, in the ESIA reports for these phases.

Tables 7-201 and 7-202 list the ongoing activities and anticipated projects in the foreseeable future in the GTA project areas.

Table 7-201 summarizes recently completed and anticipated oil and gas-related operations offshore Mauritania and Senegal in a near future. In Mauritania waters, these activities are currently limited to exploration operations – seismic surveying and exploratory drilling, both of which generate local impacts (i.e., 5-20 km). In Senegal waters, exploration and development operations are expected.

Of course, the current situation of oil and gas-related operations will not remain static over the >20-year project. The situation will change over the lifetime of the project as a result of several factors including the results of on-going or planned exploration activities. In the coming years, there could be increased oil and gas exploration activities and also other production projects. As a result, there are important uncertainties around the cumulative impacts of the current project with future oil and gas projects. For the purpose of the current assessment, the cumulative impacts are assessed considering only the impacts of the projects identified on Table 7-201.

Table 7-202 provides a summary of other current marine uses and known marine-related development projects. The current situation of on-going marine uses will not remain static over the >20-year project. The situation of marine navigation and shipping, fisheries and hydrocarbon bunkering could change during this period. No data allows any projection on their evolution. For the purpose of this assessment, it is assumed that marine navigation and shipping, fisheries and hydrocarbon bunkering will not change.

While there are uncertainties around on-going marine activities, there are much bigger uncertainties around the planned multiservice maritime port about 30 km north of N'Diago and planned initiatives to control the coastal erosion of the Langue de Barbarie and to stabilize the shoreline. The on-going construction of a 3.5 km rock dike in the sea from Goxxu Mbacc to Guet Ndar is of limited concern since it is not an important infrastructure. However, the multiservice maritime port project and any initiative to control the coastal erosion could have significant impacts on the marine and coastal environments in the area. For the time being, the potential biophysical and social impacts of these projects are not known. As a result, there are important uncertainties around the cumulative impacts of the current project with these future projects.

The assessment of cumulative impacts is considered for each of the three project phases. Given that the Construction Phase should start in 2018, the level of incertitude revolving around the potential cumulative impacts during this phase is relatively limited. However, assessing the potential cumulative impacts of the project during the 20-year Operations Phase includes a much greater level of incertitude. Finally, assessing the potential cumulative impacts of the project during the Decommissioning Phase which is planned after approximately 20 years of operations includes an even larger level of uncertainties.

Table 7-201. Summary of Known Near Future Oil and Gas-Related Activities, Offshore Mauritania and Senegal.

Country	Block	Operator	Seismic	Exploratory Drilling	Development
Mauritania	C21	Open	-	-	
	C22	ExxonMobil	2019	2021	-
	C19	Open	-	-	-
	C23	Open	-	-	-
	C24	Open	-	-	-
	C20	Open	-	-	-
	C17	ExxonMobil	2019	2021	-
	C18	Total	2019	-	-
	C7	Total	-	-	-
	C16	Open	-	-	-
	C9	Total	-	-	-
	C12	BP/Kosmos	-	2020	-
	C6	BP/Kosmos	-	2019	-
	C28	Open	-	-	-
	C29	Open	-	-	-
	C3	Tullow	-	-	-
	C15	Open	-	-	-
	C31	Open	-	-	-
	C30	Open	-	-	-
	C13	BP/Kosmos	-	2020	-
	C8	BP/Kosmos	-	2019	2022
	C2	Open	-	-	-
	C14	ExxonMobil	2019	2021	-
	C1	Open	-	-	-
	C10	Tullow	-	-	-
	C32	Open	-	-	-

Country	Block	Operator	Seismic	Exploratory Drilling	Development
Senegal	Offshore North Ultra Profond	Open	-	-	-
	Saint-Louis Offshore Profond	BP/Kosmos	-	-	2022
	Saint-Louis Offshore	Oranto Petroleum Ltd.	-	-	-
	Cayar Offshore Profond	BP/Kosmos	-	2019	-
	Cayar Offshore	Oranto Petroleum Ltd.	-	-	-
	Rufisque Offshore Profond	Total	-	-	-
	Rufisque Offshore	Capricorn Senegal Ltd, First Australian Resources Ltd, Woodside Energy Senegal	-	-	-
	Sangomar & Sangomar Offshore Profond	Capricorn Senegal Ltd, First Australian Resources and Woodside Energy Senegal	-	2018	2020
	Djiffere Offshore	Trace Atlantic	-	2019	-
	Offshore South Ultra Profond	Open	-	-	-
	Senegal Offshore Sud Profond	African Petroleum Corp	-	-	-
	Senegal Offshore Sud	Open	-	-	-

References: Maps of blocks offshore Mauritania and Senegal (see Appendix H); projected timeframes for seismic, exploratory drilling, and development provided by Kosmos Energy LLC, March 2018.

Table 7-202. Summary of Other Marine Uses and Known Marine-Related Development.

Type	Country	Location	Month/Year	Available Information
New multipurpose maritime Port (military, industrial and artisanal fishing, commerce)	Mauritania	About 30 km north of N'Diago	Initiated Dec 2016/	Project managed at the Presidency level. Limited information available.
Maritime navigation and shipping	Mauritania	Maritime waters	On-going	As described in Section 4.6.7
Fisheries	Mauritania	Maritime waters	On-going	As described in Section 4.6.6.
Hydrocarbon bunkering	Mauritania	Maritime waters	On-going	As described in Section 4.6.7
New multipurpose river port (commerce, artisanal fishing, yachting)	Senegal	Senegal River and Saint-Louis, including infrastructures at Hydrobase (Langue de Barbarie)	Planned/Calendar unavailable	Multi-country project called "Système Intégré de Transport Multimodal" conducted by OMVS. Available information indicates that Feasibility Study and ESIA are under preparation
New river port (artisanal fishing)	Senegal	Senegal River and Saint-Louis, including infrastructures at Hydrobase (Langue de Barbarie)	Planned/Calendar unavailable	National project conducted by ANAM. Available information indicate that Feasibility Study is completed and ESIA is under preparation
Coastal erosion/shoreline armoring	Senegal	Langue de Barbarie in Saint-Louis	On-going	3.5 km rock dike in the sea from Goxxu Mbacc to Guet Ndar. Emergency project conducted by a national agency, APRHN. ESIA completed and provisional version available
Coastal erosion/shoreline armoring	Senegal	Saint-Louis and other locations of the country	Planned/Calendar unavailable	Several discussions going-on at a State level
Maritime navigation and shipping	Senegal	Maritime waters	On-going	As described in Section 4.7.7
Fisheries	Senegal	Maritime waters	On-going	As described in Section 4.7.6.

7.7.2 Potential Cumulative Impacts during the Construction Phase

As outlined in Chapter 2, construction will occur within all four areas – Offshore, Pipeline, Nearshore Hub/Terminal and Support Operations Areas, including the transit routes to shore for construction vessels and helicopters. Preparation, construction, and installation activities are slated to occur between 2018 and 2023.

In general, potential impacts to biophysical and social resources associated with routine activities from Construction Phase of the GTA project are expected to be short term in nature and concentrated mostly within a few hundred to several thousand meters of the activity within each of the four areas (see Section 7.2). Impacts to social resources occur within the communities along the southern Mauritania and northern Senegal coastline. As indicated in Section 7.2, residual impacts (i.e., overall impact significance after mitigation measures have been applied) for construction-related activities were either 1 – Negligible or 2 – Low. In several instances, beneficial impacts arising from construction-related activities were noted.

Cumulative impacts have been considered separately for: 1) cumulative impact with other oil and gas activities in the area; 2) cumulative impacts with other marine uses and known marine-related development projects, based on summary information provided in Tables 7-201 and 7-202, respectively.

Other oil and gas activities expected during the Construction Phase can be summarized as following:

- Mauritania waters: seismic operations are currently expected to be pursued by ExxonMobil (Blocks C14, C17, C22) and Tullow (Block C18) in 2019, to be followed by exploratory drilling operations by ExxonMobil in 2021. Exploratory drilling activities in Mauritania waters are also expected from BP/Kosmos in the 2019-2020 timeframe on Blocks C6, C8, C12, and C13.

- Senegal waters: no proposed seismic operations are known. Exploratory drilling activities in Senegal waters are currently expected from BP/Kosmos in 2019 on the Cayar Offshore Profond block. Capricorn Senegal Ltd/First Australian Resources/ Woodside Energy Senegal is also expected to initiate exploratory drilling in the Sangomar Offshore block in 2018, with FAR pursuing exploratory drilling on the Djiffere Offshore block in 2019. Development activities are expected in 2020 and 2021, to be initiated by BP/Kosmos (Saint-Louis Offshore Profond), FAR (Sangomar Offshore Profond), and Cairn/Woodside (Sangomar Offshore).

Due to the localized nature of the Construction Phase activities and associated impacts and the intermittent and short-term nature of other oil and gas activities in the area, there is little chance of cumulative impacts with other activities in the region for biophysical resources. Furthermore, given the 1 – Negligible to 2 – Low residual impact level (i.e., overall impact significance) for routine project-related impacts for the Construction Phase, overall cumulative impact significance with other oil and gas activities is expected to be similar ranging from 1 – Negligible to 2 – Low, depending upon the resource and specific IPF. There are no biophysical resources currently at risk from impacts arising from oil and gas activities conducted to date, or anticipated in the near future.

For social resources, the potential cumulative impacts with the planned oil and gas activities are very limited. Routine operations of seismic and exploratory drilling activities generally have negligible impacts on social resources due to the location of these projects offshore, the nature of the operations and their short duration. The only social impact deemed more significant is the risk of collision between the support vessels for the seismic or exploratory drilling operations and the artisanal fishing boats. Given that the identified seismic surveys and exploratory drilling activities will be conducted in other areas than the current project, the potential for cumulative risk of collision is limited. Finally, the risk for any cumulative social impacts with a development project in the Sangomar & Sangomar Offshore Profond blocks is limited due to the distance between the two project areas.

For the other marine uses and known marine-related development, potential cumulative impacts have been considered based on the nature of the activity (e.g., port construction, maritime navigation and shipping, fisheries, hydrocarbon bunkering, shoreline armoring), the level and timing of expected activity, and potential impacts to biophysical and social resources. In general, other marine uses and marine-related development activities will produce localized impacts which vary from short- to long-term. Construction-related impacts are normally short term in nature, where fisheries and bunkering operations are long term.

There are no biophysical resources currently at risk from impacts arising from cumulative impacts with other marine uses and known marine-related development, with the possible exception of the following:

- Marine Mammals and Sea Turtles: potential cumulative impacts could include vessel traffic and associated potential for vessel strike and injury or mortality. The Ports of Nouakchott and Dakar experience moderate to high levels of commercial vessel traffic, with annual visits of 400 and 2,705 vessels, respectively (Sections 4.6.7.1 and 4.7.7.1). Most of the commercial vessels utilizing these ports are container ships, tankers, tugs, flyboats, and ro-ro ships. Offshore, the maritime traffic is of moderate density (see Figures 4-29 and 4-37). Closer to the project area, maritime traffic has been characterized as moderate in the offshore area and light traffic near the coast. The susceptibility of marine mammals to vessel strike is relatively low over the shelf, increasing with increasing water depth and distance offshore. Predominant nearshore species (e.g., delphinids) actively recognize and engage transiting vessels; larger whales, especially deep diving species, are considered to be more susceptible to vessel strike. The susceptibility of sea turtles to vessel strike is not appreciably different across water depths. Sections 7.2.9 and 7.2.10 determined that the residual impact of a collision risk between GTA project vessels and marine mammals and/or sea turtles during the Construction Phase was 1 – Negligible. Cumulative impacts with other activities and projects could increase the frequency of this impact, potentially elevating overall cumulative impact significance to 2 – Low; and

- Threatened Species: potential cumulative impacts may include noise-related injuries and disturbances to threatened species (i.e., pile driving, VSP surveys); disturbance, possible auditory injury, and vessel strike to threatened species from vessels and operations; and introduction of non-native or invasive species. Residual impacts to threatened species for these IPFs were determined to be 2 – Low. Cumulative impacts with other activities and projects could increase the frequency of these impacts, although overall cumulative impact significance is expected to remain 2 – Low.

For social resources, the potential cumulative impacts with marine uses and known marine-related development during the Construction Phase include a lot of uncertainties including the timing of the planned projects. However, a few potential cumulative impacts on social resources can be identified:

- Maritime Navigation: potential cumulative impacts include increased traffic and risk of collision for artisanal fishing boats in the N'Diago and Saint-Louis area due to the potential increase of maritime navigation related to the planned multipurpose maritime port north of N'Diago and the two planned river ports in Saint-Louis. Even though the GTA project is located in maritime waters and the two river ports are located on the Senegal river, the Senegalese fishermen could potentially have to cross all three project areas when fishing at sea. Additionally, Mauritanian fishermen would see maritime traffic increased in the planned maritime port area located close to N'Diago. If the construction of the three new ports was initiated during the GTA project Construction Phase, the risk of collision between project construction vessels and artisanal fishing boats could increase due to the combination of project vessels movements. Section 7.2.14 has assessed that the residual impact of a collision risk between GTA project vessels and artisanal fishing boats during the Construction Phase was 2 – Low. Cumulative impacts with other projects could increase the significance of this impact to 3 – Medium.

- Artisanal Fisheries and Related Activities: potential cumulative impacts with the planned multipurpose maritime port north of N'Diago and the two planned river ports in Saint-Louis include: 1) an increased loss of potential artisanal fishing grounds due to project infrastructures and their exclusion safety zones; and 2) an increase of potential loss of artisanal fishing gears due to project vessels movements in artisanal fishing areas. With potentially four neighboring projects constructed simultaneously, the perception of the fishing ground losses and fishing catches decrease could be a significant issue for artisanal fishermen. Section 7.2.16 has assessed that the residual impacts of the GTA project on artisanal fisheries during the

Construction Phase were 2 – Low. Cumulative impacts with other projects could increase the significance of these impacts to 2 – Low.

- Population and Demography: Onshore logistic activities of large projects have the potential to change the demography of local communities with an influx of population: an influx of workers in the project area and an influx of jobseekers, some of them foreign workers. It has been demonstrated that it is unlikely that the GTA project will entail any population influx in N'Diago and Saint-Louis since no project support operations are planned in these locations, and limited employment or business opportunities will be created in N'Diago and Saint-Louis. Potential cumulative impacts with the planned multipurpose maritime port north of N'Diago and the two planned river ports in Saint-Louis include an influx of worker and job seekers if the construction of the three new ports is initiated during the GTA project Construction Phase. While this change in the local demography would not be due to the GTA project, the perception could be different. Identifying the responsibilities for population influx in the area, and its ripple effects on public infrastructures and services, inflation, community health, safety and security could be challenging. Section 7.2.19 has assessed that the GTA project will have no impacts on population and demography. Cumulative impacts with other projects could create the perception that the GTA project has some responsibilities for population influx and its ripple effects in the area but this is considered a negligible impact, and it is rated 1 – Negligible.

- Social Climate: potential cumulative impacts include increased social discontent in N'Diago and Saint-Louis, with a risk for social unrest in Saint-Louis, due to the potential perception of loss of fishing grounds and fishing catches combined with the perception of unsatisfied grievances and/or compensation claims (e.g. for lost gear), and elevated risk of injury/death of fishermen at sea due to presence of project vessels. While the mitigation measures planned for the GTA project will reduce this impact, social discontent could increase if the construction of the three new ports was initiated during the GTA project Construction Phase. Section 7.2.26 has assessed that the residual impact of the GTA project on social climate during the Construction Phase was 2 – Low. Cumulative impacts with other projects could increase the significance of this impact to 3 – Medium or 4 – High.

7.7.3 Potential Cumulative Impacts during the Operations Phase

As outlined in Chapter 2, activities during the Operations Phase will generally occur within three areas – Pipeline (FPSO), Nearshore Hub/Terminal (FLNG) and Support Operations Areas, including the transit routes to shore for vessels and helicopters (emergencies only). Limited activity may also occur in the Offshore Area (well maintenance, etc.). Operations are slated to begin in 2021 and will continue for 20 years.

During the Operations Phase, impacts will generally exhibit a similar spatial scale but will be long term in nature. Residual (post-mitigation) operations impacts, in general, range from 1 – Negligible to 2 – Low. Beneficial impacts arising from operations-related activities were also noted.

Given the 1 – Negligible to 2 – Low residual impact level (i.e., overall impact significance) for routine project-related impacts for all the activities slated to occur during the Operations Phase, overall cumulative impact significance with other oil and gas activities is expected to be similar ranging from 1 – Negligible to 2 – Low, depending upon the resource and specific IPF. There are no biophysical resources currently at risk from impacts arising from oil and gas activities conducted to date, or anticipated in the near future.

For social resources, the potential impacts of the planned oil and gas activities during the Operations Phase would be similar to those identified during the Construction Phase in Section 7.7.2. As a result, no cumulative impacts on social resources are expected.

For the other marine uses and known marine-related development, potential cumulative impacts have been considered based on the nature of the activity, as noted previously. Other factors considered in the cumulative impacts analysis included the level and timing of expected activity and potential impacts to biophysical and social resources. In general, other marine uses and marine-related development activities will produce localized impacts which vary from short- to long-term. Operation-related impacts (e.g., operations of a newly constructed port) are long term in nature, as are ongoing fisheries and bunkering operations.

For biophysical resources, there are few potential cumulative impacts of the GTA project with marine uses and known marine-related development during the Operations Phase. It is also difficult to assess cumulative impacts on these resources based on the limited available information of the future projects.

Several biophysical resources currently at risk from impacts arising from other marine uses and known marine-related development:

- Air Quality: potential cumulative impacts may result from emissions associated with operations in the Ports of Dakar and Nouakchott, where impacts are possible from the introduction of atmospheric contaminants. Although emissions from GTA project sources will be below WHO guidance levels, impact intensity for criteria contaminants are expected to be moderate, occurring on a local level, and of long-term duration, and producing a residual impact significance is 2 – Low. Although cumulative impacts with other activities and projects could increase the frequency or consequence of this impact, impacts are expected to be limited to port areas and cumulative impact significance is expected to remain 2 – Low;

- Water Quality: potential cumulative impacts could result from discharges associated with commercial vessel traffic, primarily associated with operations into and out of the Ports of Dakar and Nouakchott. Although discharges from GTA project vessels and infrastructure (i.e., produced water from the FPSO; thermal discharges from the FLNG) will be localized, impact intensity is expected to be moderate, occurring on a local level, and of long term duration, and producing a residual impact significance is 2 – Low. Although cumulative impacts with other activities and projects could increase the frequency or consequence of this impact, impacts are expected to be limited to port areas and vessel transit lanes; cumulative impact significance is expected to remain 2 – Low;

- Coastal Erosion: potential cumulative impacts to coastal erosion from other marine uses and known-marine related development are difficult to assess. It is likely that these other activities are producing very limited effects to coastal erosion, with the exception of shoreline armoring projects. By design, shoreline armoring projects are expected to reduce coastal erosion on a local level near Saint-Louis and the Langue de Barbarie – a beneficial impact, but occasionally these types of projects may interfere with the longshore sediment transport downdrift of where they are implemented. Alteration of erosional processes (slightly accelerated erosion) south of Saint-Louis resulting from the presence of the GTA project breakwater may be offset by the shoreline armoring projects. Cumulative impacts are expected to remain 2 – Low.

- Marine Mammals and Sea Turtles: potential cumulative impacts could include increased vessel traffic and a concomitant increase in the potential for vessel strike and injury or mortality to marine mammals and sea turtles. As noted previously, the Ports of Nouakchott and Dakar experience moderate to high levels of commercial vessel traffic, with most of the commercial vessels utilizing these ports being container ships, tankers, tugs, flyboats, and ro-ro ships. Offshore, the maritime traffic is of moderate density. The susceptibility of marine mammals to vessel strike is relatively low over the shelf, increasing with increasing water depth and distance offshore. The susceptibility of sea turtles to vessel strike is not appreciably different across water depths. Sections 7.3.9 and 7.3.10 determined that the residual impact of a collision risk between GTA project vessels and marine mammals and/or sea turtles during the Operations Phase was 1 – Negligible. Cumulative impacts with other activities and projects could increase the frequency of this impact, potentially elevating overall cumulative impact significance to 2 – Low. Avoidance or displacement of marine mammals and sea turtles from around GTA project infrastructure may also occur; cumulative impacts with other activities and projects associated with avoidance/displacement are expected to remain 2 – Low;

- Fish and Other Fishery Resources: potential stresses to local fish and fishery resources from fishing operations have been documented, based on a mix of artisanal and industrial fishing operations (Ba et al., 2016, 2017). The status of the fish and other fishery resources in Mauritania and Senegal is a complex determination, varying by location, season, and target species, including underexploited, fully exploited, and overexploited stocks. Potential cumulative impacts to fish and other fishery resources from these other marine uses are likely in the 2 – Low to 3 – Medium overall impact significance category. Cumulative residual impacts from GTA project operations, the latter of which is deemed 1 – Negligible, are not likely to increase these impact levels (i.e., impacts remain in the 2 – Low to 3 – Medium overall impact significance category); and

- Threatened Species and Protected Areas: potential cumulative impacts may include noise-related disturbances to threatened species or protected areas and emissions effects on protected areas from vessels and operations; and introduction of non-native or invasive species. Residual impacts to threatened species and protected areas for these IPFs were determined to be 2 – Low. Cumulative impacts with other activities and projects could increase the frequency of these impacts, although overall cumulative impact significance is expected to remain 2 – Low.

For social resources, the potential cumulative impacts of the GTA project with marine uses and known marine-related development during the Operations Phase include a lot of uncertainties including the timing of the planned projects. If the construction of the three new ports is initiated during the GTA project Operations Phase instead of its Construction Phase, the potential cumulative impacts identified in Section 7.7.2 could be a bit less intensive. However, this would not necessarily be reflected in the cumulative impact significance.

- Maritime Navigation: potential cumulative impacts could still include increased traffic and risk of collision for artisanal fishing boats in the N'Diago and Saint-Louis area due to the potential increase of maritime navigation related to the planned multipurpose maritime port north of N'Diago and the two planned river ports in Saint-Louis. However, there will be a smaller number of GTA project vessels during the Operations Phase than during the Construction Phase. As a result, the cumulative impacts due to the combination of all project vessels movements would not be as important. Section 7.3.14 has assessed that the residual impact of a collision risk between GTA project vessels and artisanal fishing boats during the Operations Phase was 2 – Low. Even if the number of GTA project vessels would decrease during the Operations Phase, cumulative impacts with other project vessels could still increase the significance of the impact to 3 – Medium.

- Artisanal Fisheries and Related Activities: potential cumulative impacts with the planned multipurpose maritime port north of N'Diago and the two planned river ports in Saint-Louis would still include: 1) an increased loss of potential artisanal fishing grounds due to project infrastructures and their exclusion safety zones; and 2) an increase of potential loss of artisanal fishing gears due to project vessels movements in artisanal fishing areas. However, if the four neighboring projects are not constructed simultaneously, the perception of the fishing ground losses and fishing catches decrease could be toned down. The risk for fishing gears losses would also decrease with the number of project vessels. Section 7.3.16 has assessed that the residual impacts of the GTA project on artisanal fisheries during the Operations Phase were 2 – Low. Even if the number of GTA project vessels would decrease during the Operations Phase and the loss of fishing gears could also decrease, cumulative impacts with other projects could still keep the significance of the impacts on artisanal fisheries to 2 – Low.

- Population and Demography: If the construction of the planned multipurpose maritime port north of N'Diago and the two planned river ports in Saint-Louis occurred after the GTA Construction Phase, any influx of worker and job seekers during the construction of the three new ports would unlikely be associated with the GTA project. As a result, identifying the responsibilities for population influx in the area, and its ripple effects on public infrastructures and services, inflation, community health, safety and security could be less challenging.

- Social Climate: potential cumulative impacts could still include increased social discontent in N'Diago and Saint-Louis, with a risk for social unrest in Saint-Louis. For instance, any important discontent of fishing communities around project benefits during the GTA Construction Phase could entail a tense climate in N'Diago and Saint-Louis when the Operations Phase will start. Conversely, satisfaction around projects benefits could result in a calm social climate at the beginning of the Operations Phase. Discontent or satisfaction around the construction of the three new ports could add to the social climate at the time of their initiation. Section 7.3.26 has assessed that the residual impact of the GTA project on social climate during the Operations Phase was 2 – Low. Cumulative impacts with other projects could increase the significance of this impact to 3 – Medium or 4 – High.

There are a lot of uncertainties around the potential impacts of the three new ports during their operation phases. Cumulative impacts on social resources of these projects with the GTA project could include those mentioned above and additional impacts on artisanal fisheries. The multipurpose maritime port north of N'Diago will include facilities for the landing of catches of industrial fishing boats and artisanal fishing boats. The river ports in Saint-Louis will also include facilities for the landing of catches of artisanal fishing boats. The new infrastructures are likely to increase the fishing activities offshore N'Diago and Saint-Louis with a concentration of fishing efforts and potential ripple effects on fishery resources. Potential increased demands on fishery resources from increased fishing operations could have a negative effect on the reproduction of fishery resources. The assessment in Section 7.3.16 has shown that the GTA project will have negligible impacts on artisanal fisheries during its Operations Phase. However, identifying the responsibilities for a decrease in fishing catches offshore N'Diago and Saint-Louis could be challenging with several projects being conducted in the same area.

7.7.4 Potential Cumulative Impacts during the Decommissioning Phase

Decommissioning activities, as detailed in Chapter 2, will include operations in the Offshore Area, Pipeline Area, and Nearshore Hub/Terminal Area, as well as support activities operating from the Support Operations Areas. Decommissioning activities will occur at the end of the project life, approximately 20 years from startup and commissioning. Decommissioning will be similar to construction operations, with exceptions – e.g., the breakwater will not be removed, FPSO anchors will not be removed, and pipelines and flowlines will be decommissioned and abandoned in place. It is expected that decommissioning activities will produce similar impacts to construction, aside from the noted exceptions.

Given the 1 – Negligible to 2 – Low residual impact level (i.e., overall impact significance) for routine project-related impacts for the Decommissioning Phase, overall cumulative impact significance with other oil and gas activities or with other marine uses and known marine-related development is expected to be similar ranging from 1 – Negligible to 2 – Low, depending upon the resource and specific IPF. Such determinations are necessarily preliminary, given the difficulty in predicting the status of biophysical and social resources more than 20 years into the future.

7.8 Transboundary Impacts

7.8.1 Routine Impacts

Impacts from routine activities associated with the GTA project are localized and transient for short term activities (i.e., Construction and Decommissioning Phases), and generally localized but long term for the Operations Phase. Construction and decommissioning will occur in all four project areas – Offshore, Pipeline, Nearshore Hub/Terminal, and Support Operations. Operations will occur in the Pipeline and Nearshore Hub/Terminal Areas, with support from the Support Operations Areas. The locations of three areas – Offshore, Pipeline, and Nearshore Hub/Terminal – straddle the Mauritania-Senegal maritime boundary, while the Support Operations Areas include the Ports of Nouakchott and Dakar and the transit routes for construction vessels and helicopters. Table 7-203 provides calculated distances to other countries in the region from the Mauritania-Senegal maritime boundary, where the majority of the activities will occur; distances range from <200 km to ~650 km.

Table 7-203. Distances of the Project Areas to other Countries in the Region.

Country	Nearest Distance of Infrastructure (km)		
	Offshore Area	Pipeline Area	Nearshore Hub/Terminal Area
Cape Verde Islands	195.8	203.7	323.8
Guinea	642.9	608.9	603.6
Guinea-Bissau	431.0	427.5	422.4
The Gambia	276.6	281.0	278.7
Western Sahara	404.1	408.9	457.8

Short-term activities completed under the Construction and Decommissioning Phases will not produce long-term impacts to resources. Routine operations under these phases will result in a variety of IPFs, some of which will be very localized around the project vessels (e.g., physical presence; routine discharges; solid waste); the extent of these impacts is expected to range from tens to several hundred meters from their source. Other IPFs, while still producing localized impacts, will extend many kilometers from their source (e.g., emissions, drilling discharges; floating solid waste; noise; vessel traffic). In addition, transitory impacts will occur along transit routes and flight paths from the supply bases or airports to the Offshore, Pipeline, and Nearshore Hub/Terminal Areas. In general, such routine, project-related impacts will diminish in intensity and severity with increasing distance from the source. Among these IPFs, only floating solid waste has the potential for long distance transport into transboundary waters. Consequently, the majority of routine, project-related activities are expected to result in 1 – Negligible or 2 – Low residual transboundary impacts.

Long-term activities to be conducted under the Operations Phase will also be localized around project infrastructure and vessel operations. As noted in Section 7.7, operations-related residual impacts for the GTA project have been categorized as 1 – Negligible or 2 – Low. The spatial extent of all operations-related residual impacts, regardless of impact significance level, does not extend beyond 100 to 150 km with the possible transport of floating solid waste out of the project area. In summary, there is no or very limited potential for routine, project-related impacts to result in transboundary impacts.

7.8.2 Accident Impacts

The potential for transboundary impacts from accidents is more extensive, and varies by accident scenario. Appendix N-1 summarizes the results of spill modeling conducted for the three accident scenarios, all of which originate along the Mauritania-Senegal maritime boundary. Section 7.5.1 provides a synopsis of each scenario. Table 7-204 provides a summary of the potential for transboundary impacts from accidents, by country.

Table 7-204. Summary of the Potential for Transboundary Impacts from Accidents.

Country	Impact Probability			
	Shoreline	Surface	Water Column Dissolved	Water Column Total (Entrained)
Well Blowout				
Cape Verde	None	High	None	Low
Guinea	None	Low	None	Low
Guinea-Bissau	None	Low	None	Low
The Gambia	None	High	None	Low
Western Sahara	None	Low	None	Low
Failure of FPSO Due to a Ship Collision				
Cape Verde	None	High in boreal Winter Low in boreal Summer	None	Low
Guinea	None	None	None	Low
Guinea-Bissau	None	Low	None	Low
The Gambia	None	High in boreal Winter Low in boreal Summer	None	Low
Western Sahara	None	None	None	Low
Pipelaying Vessel Collision				
Cape Verde	None	Low in boreal Winter None in boreal Summer	None	None
Guinea	None	None	None	None
Guinea-Bissau	None	None	None	None
The Gambia	None	Low in boreal Winter None in boreal Summer	None	None
Western Sahara	None	None	None	None

Key: High probability: >40%; Low probability: ≤40%

Key findings for these scenarios, based on modeling results for shoreline oiling, surface oiling, and water column contamination (i.e., dissolved hydrocarbons and total [entrained] hydrocarbons), are summarized below.

For the well blowout scenario:

- Shoreline impact: Only Mauritania and Senegal are at risk of shoreline impact; no transboundary impacts are expected due to shoreline oiling.
- Surface impact: More countries will be affected in the boreal Summer scenario. However, a boreal Winter spill is far more likely to reach the waters of the EEZ of Cape Verde Islands (51% in boreal Summer vs. 100% in boreal Winter) and of The Gambia (42% in boreal Summer vs. 92% in boreal Winter); Guinea, Guinea-Bissau, and the Western Sahara have a low probability of surface oiling in the EEZ, regardless of season. The thickness of the condensate spill is limited to mostly sheen and rainbow sheen that will more readily disperse.

- Water column contamination: Dissolved hydrocarbon concentrations will not reach the coastal waters of other countries. Total water column hydrocarbon concentrations may reach the EEZ of Cape Verde Islands, Guinea, Guinea-Bissau, The Gambia, and Western Sahara, although the probability of this occurring is predicted to be <1% or 1-5%, and few instances where the stochastic modeling results predicted 5-25% probabilities; total water column hydrocarbon concentrations for these transboundary impacts are predicted to be <150 ppb. Arrival time is predicted to >30 days and exposure time limited to <0.5 day.

For the FPSO failure due to a ship collision scenario:

- Shoreline impact: Only Mauritania and Senegal are at risk of shoreline impact; no transboundary impacts are expected due to shoreline oiling.
- Surface impact: The EEZ waters of Cape Verde Islands, Guinea-Bissau, and The Gambia are at risk in both boreal Summer and boreal Winter, although probabilities are extremely variable by season (e.g., Cape Verde: <1% in boreal Summer; 71% in boreal Winter; Guinea-Bissau: 6% and 8% in boreal Summer and boreal Winter, respectively; The Gambia: 12% in boreal Summer; 60% in boreal Winter). The thickness of the FPSO spill is limited to sheen and not within a thickness where effective containment and recovery is possible.
- Water column contamination: Dissolved concentrations will not reach the coastal waters of other countries. Total water column hydrocarbon concentrations may increase in the EEZ waters of Cape Verde Islands, Guinea, Guinea-Bissau, and The Gambia, particularly in boreal Winter; the probability of this occurring is predicted to be <1% or 1-5%; with the total water column hydrocarbon concentrations for these transboundary impacts being <150 ppb. Arrival time is predicted to be >21 days and exposure time limited to <0.25 day.

For the pipelaying vessel spill scenario:

- Shoreline impact: Only Mauritania and Senegal are at risk of shoreline impact; no transboundary impacts are expected due to shoreline oiling.
- Surface impact: The EEZ waters of Cape Verde Islands and The Gambia are predicted to surface oiling in boreal Winter (with a stochastic probability of 11% and 6%, respectively), but not in boreal Summer. The thickness of the pipelaying vessel spill is limited to sheen during boreal Winter only and not within a thickness where effective containment and recovery is possible.
- Water column contamination: Neither dissolved hydrocarbon concentrations or total water column hydrocarbon concentrations will reach the EEZ of other countries.

In summary, transboundary impacts from accidents are limited to surface oiling or water column total (entrained) under all three scenarios; no transboundary impacts are expected for shoreline oiling or water column dissolved.

For surface oiling, the potentially affected countries are limited to the Cape Verde Islands and The Gambia (under all three accident scenarios); impact potential ranges from high to low with one exception (i.e., no potential for impact from surface oiling in The Gambia in boreal Summer). Other countries, including Guinea, Guinea-Bissau, and Western Sahara, have no potential for transboundary impact from surface oiling except under the well blowout scenario; Guinea-Bissau may also be affected under the FPSO failure due to a ship collision scenario.

For water column total (entrained), all five countries have a low impact potential under the well blowout and FPSO failure due to a ship collision scenarios; no transboundary impacts from water column total are expected from under the pipelaying vessel collision scenario.

Impact intensity from transboundary impacts is moderate. This impact will be of short duration but regional extent, producing a minor impact consequence. Given the remote likelihood of any of the accident scenarios, overall impact consequence for transboundary impacts is 1 – Negligible.

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