



FINAL TERMS OF REFERENCE

ENVIRONMENTAL IMPACT ASSESSMENT

ESSO EXPLORATION AND PRODUCTION GUYANA LIMITED (EEPGL) –
LIZA PHASE I DEVELOPMENT PROJECT

Approved

February, 2017

PREAMBLE

The Final Terms of Reference (ToR) for EEPGL Liza Phase I Development Project was prepared in consultation with the Consultancy Firm, Environmental Resources Management (ERM), which has been approved by the Environmental Protection Agency (EPA) to undertake the Environmental Impact Assessment.

The ToR has been developed to guide the preparation of the Environmental Impact Assessment and outlines the requirements of same. Further, the ToR has incorporated the concerns/issues/suggestions garnered during the 28-day Public Notification Period and Public and Sector Scoping Meetings conducted for the Project.

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List of Acronyms

AOI	Area of Influence
AUV	Autonomous Underwater Vehicle
BFROC	Base Fluid Retained on Cuttings
BOP	Blowout Preventer
BOPD	Barrels of Oil Per Day
Bpd	Barrels per day
CO	Carbon Monoxide
CORMIX	Cornell Mixing Zone Expert System
DC	Drill Center
EBS	Environmental Baseline Survey

EEPGL	Esso Exploration and Production Guyana Limited
EIA	Environmental Impact Assessment
EPA	Guyana Environmental Protection Agency
ERM	Environmental Resources Management
ESMP	Environmental and Social Management Plan
FEED	Front-End Engineering and Design
FLET	Flowline End Termination
FPSO	Floating Production, Storage, and Offloading
FSV	Fast Supply Vessel
GEA	Guyana Energy Agency
GGMC	Guyana Geology and Mines Commission
GI	Gas Injection
GIFT	Generalized Integrated Fate and Transport
H ₂ S	Hydrogen Sulfide
ha	Hectares
HP	High Pressure
HVAC	Heating, Ventilating, and Air Conditioning
HYCOM	HYbrid Coordinate Ocean Model
ICSS	Integral Control and Safety System
ICZM	Integrated Coastal Zone Management
ILO	International Labor Organization
IMO	International Maritime Organization
IOGP	International Oil and Gas Producers Association

IP	Intermediate Pressure
Km	Kilometers
LP	Low Pressure
m	Meters
MARAD	Maritime Administration
mi	Miles
MoNRE	Ministry of Natural Resources and Environment
MPV	Multi-Purpose Vessel
MSCFD (or mscfd)	Million Standard Cubic Feet per Day
NABF	Non-Aqueous Base Fluid
NADF	Non-Aqueous Drilling Fluid
NDS	Guyana National Development Strategy
NEAP	Guyana National Environmental Action Plan
NOx	Nitrogen Oxide
OIMS	Operations Integrity Management System
OSRP	Oil Spill Response Plan
P&A	Plugging and Abandonment
PCS	Process Control System
PDA	Project Development Area
PM (2.5 or 10)	Particulate Matter
PSV	Platform Supply Vessel
ROV	Remotely Operated Vehicle
SCM	Subsea Control Module

SDU	Subsea Distribution Unit
SIS	Safety Instrumented System
SO ₂	Sulfur Dioxide
SSHE	Safety, Security, Health, and Environment
SRU	Sulfate Removal Unit
SURF	Subsea Umbilicals Risers and Flowlines
ToR	Terms of Reference
TSS	Total Suspended Solids
VLCC	Very Large Crude Carrier
VOC	Volatile Organic Compounds
VSP	Vertical Seismic Profile
WBDF	Water-based Drilling Fluids
WI	Water Injection

1.0 Introduction

The Environmental Protection Agency (EPA) received an application for Environmental Authorization from Esso Exploration and Production Guyana Limited (EEPGL) on July 5, 2016 for the first phase of development of the Liza Project in the eastern half of the Stabroek Block (hereafter referred to as the Liza Phase 1 Development Project, or the Project). This Application was made in accordance with Section 11 (1) of the Environmental Protection Act (hereafter EPAct Cap 20:05). The Project seeks to develop oil reserves from the Liza field located in the eastern portion of the Stabroek Block. Based on exploration and assessment activities in the Stabroek Block, including three exploration wells (Liza-1, Liza-2, and Liza-3 respectively), EEPGL believes these reservoirs¹ potentially contain a recoverable resource of between 0.8 and 1.4 billion oil equivalent barrels. The EPA has determined that there could be significant environmental impacts from Project activities. In this regard, an Environmental Impact Assessment (EIA) is required in accordance with Section 11 of the EP Act (Cap. 20:05) in order to inform a decision to approve or reject the Project. The EIA has to be prepared in compliance with an approved Terms of Reference (ToR).

2.0 Purpose of the Terms of Reference

The purpose of this ToR is to guide the scope, content, and process to understand the potential impacts and the measures that should be taken to mitigate the significant impacts and benefits associated with the proposed Project.

While every attempt has been made to ensure that this ToR addressed all of the major issues that can be associated with a development of this nature, it is not exhaustive and should not be interpreted as excluding matters which may be deemed significant and/or currently unforeseen that may emerge as significant during the course of preparation of the EIA.

3.0 Objectives of the Environmental Impact Assessment

The objectives of the EIA are to:

- Describe the components and activities of the Project including:
 - Development drilling, including well design and drill ships;

¹a subsurface pool of hydrocarbons contained in porous or fractured rock formations

- Subsea Umbilicals, Risers, and Flowlines (SURF);
 - Floating Production, Storage, and Offloading (FPSO) vessel, including topsides facilities and the vessel mooring system;
 - Installation, hookup, and commissioning;
 - Production operations, including offloading tankers;
 - Onshore support, including shorebases;
 - Marine and aviation support vessels and equipment; and
 - End of Phase 1 operations (decommissioning).
- Describe the existing conditions within the Project's Area of Influence (AOI). The EIA will be prepared based on the results of available research, studies, and data, as appropriate, with further studies being conducted where necessary and practicable (see Section 7 of this ToR). Limitations, if any, of available information that may influence the conclusions of the EIA should be identified. The AOI may vary by resource or by impact, and would not necessarily be limited to the Liza Project Development Area (PDA) or the Stabroek Block. More details on the extent of the AOI are presented in Section 6.1.
 - Identify and assess the potential direct and indirect environmental and socioeconomic impacts that could credibly result from the Project during the drilling, installation, production, and decommissioning stages using a risk-based assessment process described in Section 8.
 - Describe a strategy to manage those identified significant adverse impacts of the Project as defined using the Risk Matrix provided in Figure 8.1.
 - Characterize potential positive benefits of the Project.
 - Evaluate the cumulative impacts from this proposed development, other on-going developments (e.g., exploratory drilling) and further proposed activities within the AOI and surrounding environment.
 - Recommend monitoring to assess the effectiveness of the management strategy.
 - Provide the factual and analytical basis required by EPA and the Guyana Geology and Mines Commission (GGMC) to make an informed decision on EEPGL's Application for Environmental Authorisation to permit the Project.

Environmental Resources Management (ERM), which is an international environmental and social consulting firm, has been approved by the EPA to serve as the independent consultant to prepare the EIA.

4.0 Description of the Project and Alternatives

Phase 1 of the Project will consist of the drilling of approximately 17 development wells (including production, water injection, and gas re-injection wells) installation and operation of SURF equipment, and the installation and operation of a FPSO

facility in the eastern half of the Stabroek Block. The Project information presented in this section is based on conceptual design and will be further defined as the EIA progresses. The process of drilling the development wells will be similar to the drilling programs for the Liza-1, Liza-2, and Liza-3 exploration campaigns. The development wells, as depicted in Figures 4.5 and 4.7, and described in Section 4.5, will be drilled in a to-be-determined order, with time in between each well for any ancillary processes (see Section 4.5.4) and mobilization between well sites. The exact sequence of development well drilling has no environmental significance. The Project will involve onshore facilities and marine/aviation services to support development drilling, installation of the FPSO/SURF facilities, production operations, and decommissioning stages of the Project.

4.1 Project Area

Figure 4.1 illustrates the location of the Liza field within the Stabroek Block, which is located approximately 190 kilometers(km) (120 miles [mi]) northeast of Georgetown, Guyana.

Figure 4.2 illustrates the preliminary conceptual layout of the FPSO, the SURF equipment, and the drill centers within the PDA, as well as their proximity to the Liza-1, Liza-2, and Liza-3 exploration wells.

The exact locations of the future development wells have not yet been finalized, however, the wells will be drilled from two main drill centers². During drilling and installation of the FPSO/SURF facilities, work may be performed in a subsea area within the PDA that could potentially cover an estimated 4,500-5,000 hectares (ha). Much of this subsea area will not be physically disturbed, except where the SURF equipment and the FPSO mooring system are sited as shown in Figure 4.2.

During the FPSO production operations stage, work may be performed on the surface of the ocean within the PDA that could potentially cover an estimated 4,500-5,000 ha. As further described in subsequent sections and shown in Figure 4.3, some of the ocean surface may have operational constraints, which will restrict unauthorized vessels from entering a defined marine safety exclusion zone during drilling and production operations. While Figure 4.3 shows four marine safety exclusion zones around the drilling locations, only up to two drill ships would be potentially operating simultaneously. The safety exclusion zones for the large installation vessels are not

²For the purposes of this ToR, a drill center is defined as a group of wells (including production, water injection, and/or gas re-injection wells) clustered around one or more manifolds. Each drill center incorporates separate manifolds which are separated by several kilometers and are designed for production or injection. For example, Drill Center 1 will be separated into 1-P (production) and 1-I (injection) components.

specifically denoted on Figure 4.3; however, exclusion zones similar to those for the drill ships will be maintained for these vessels while working in the PDA.

Figure 4.1 Location of the Liza Project Development Area within the Stabroek Block

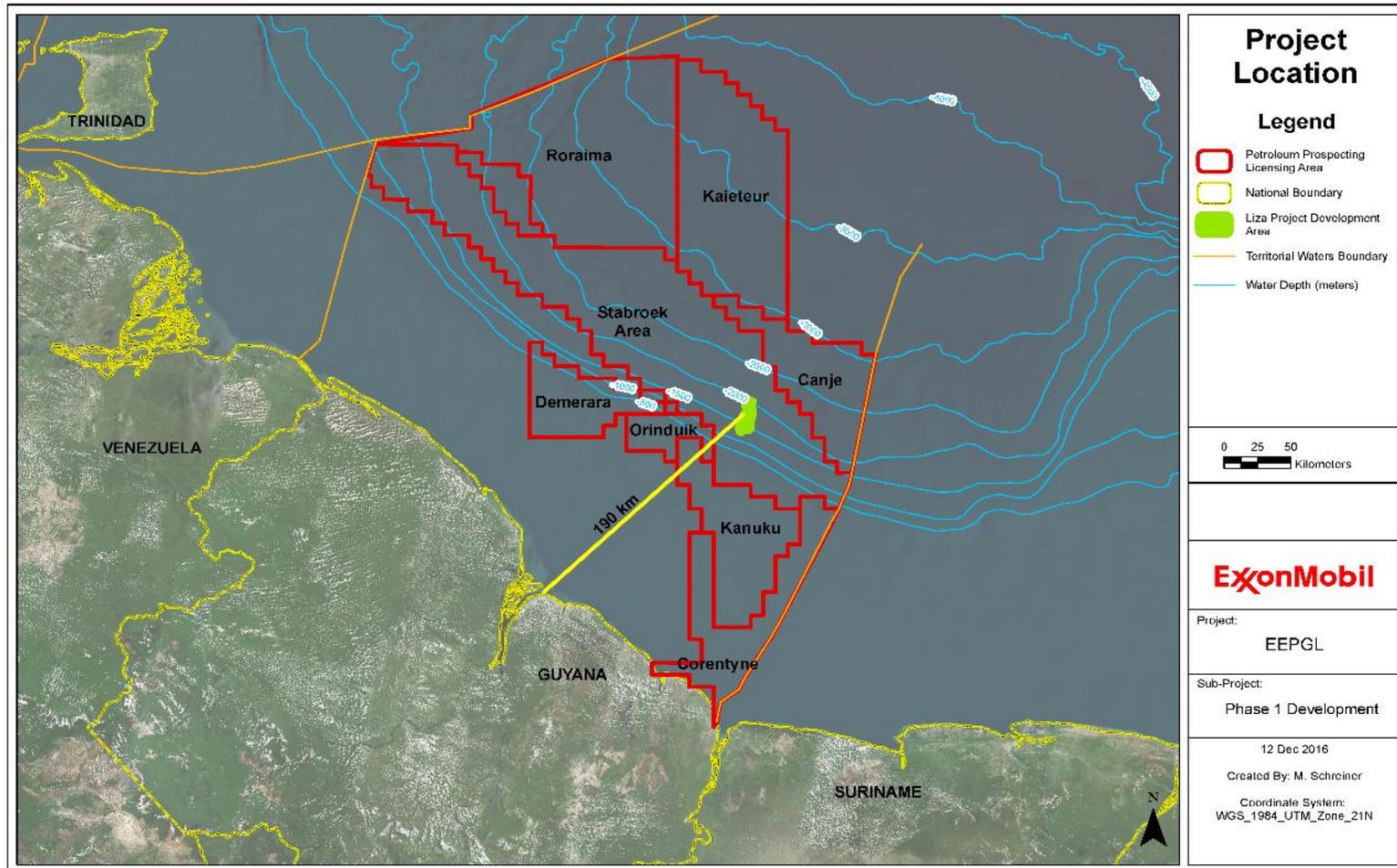
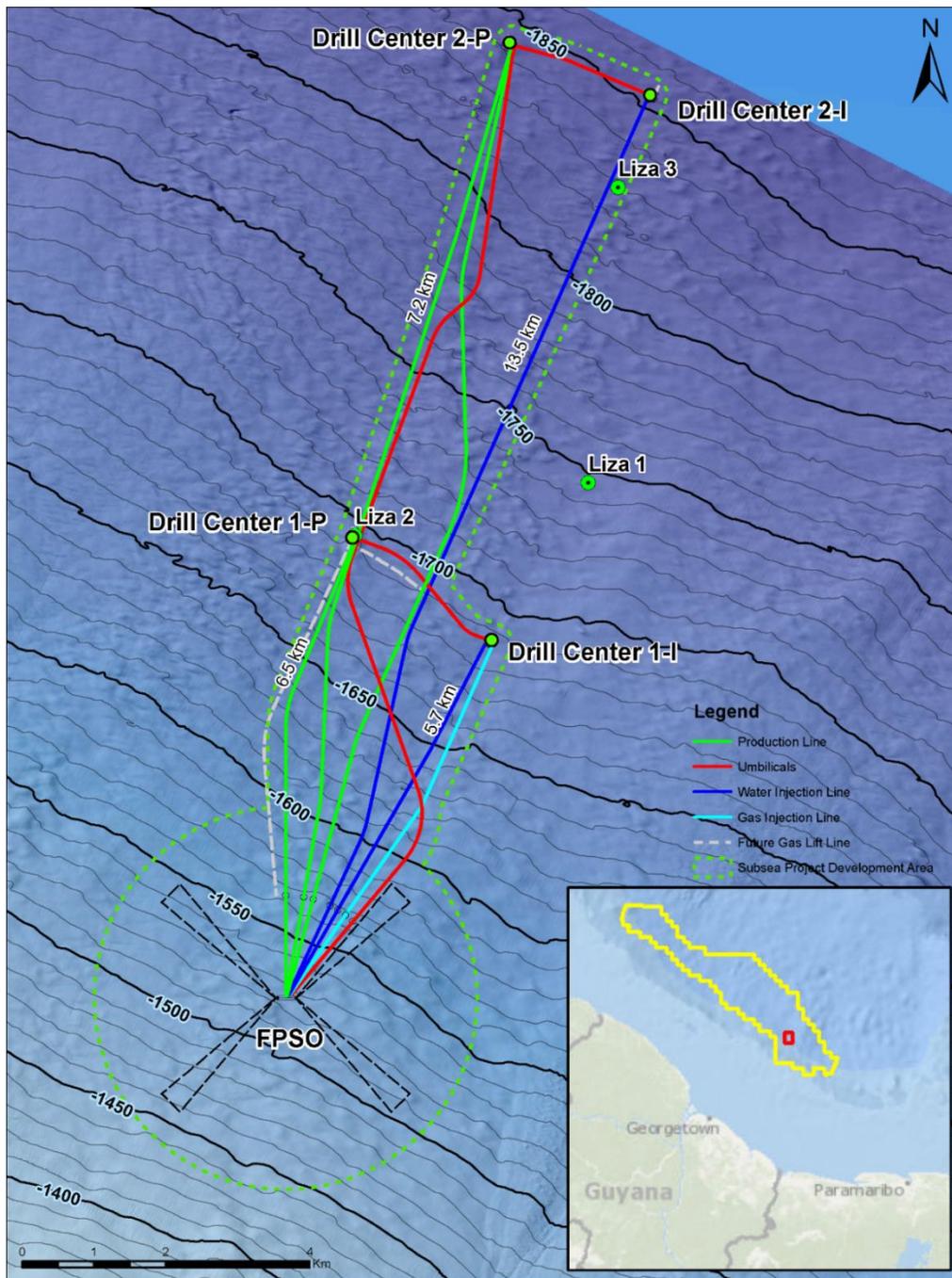
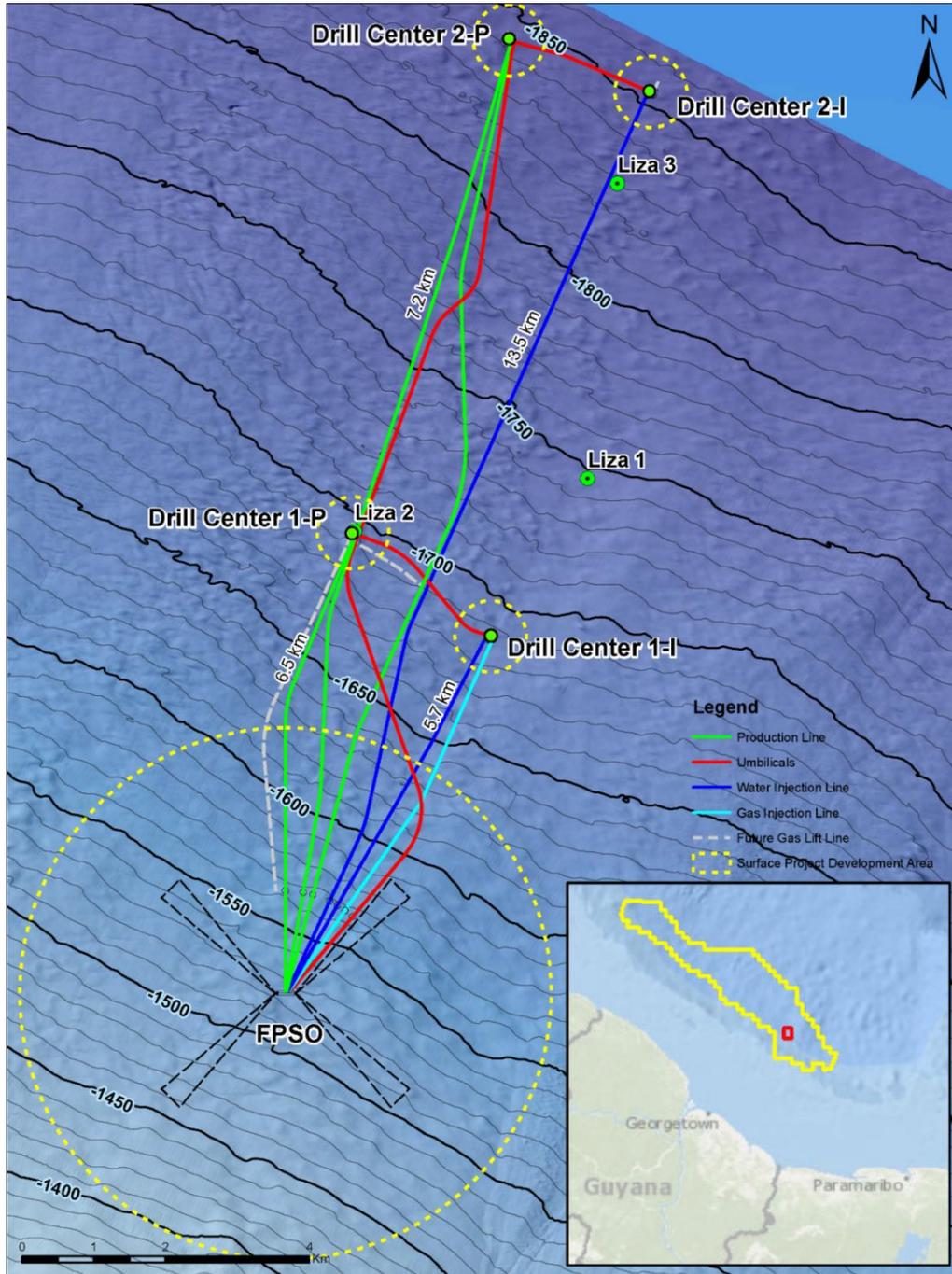


Figure 4.2 Subsea Project Development Area for FPSO Installation, SURF, and Drill Centers within Stabroek Block



NOTE: Locations in figure subject to change.

Figure 4.3 Surface Project Development Area for FPSO and Drill Centers within StabroekBlock



NOTE: Locations in figure subject to change.

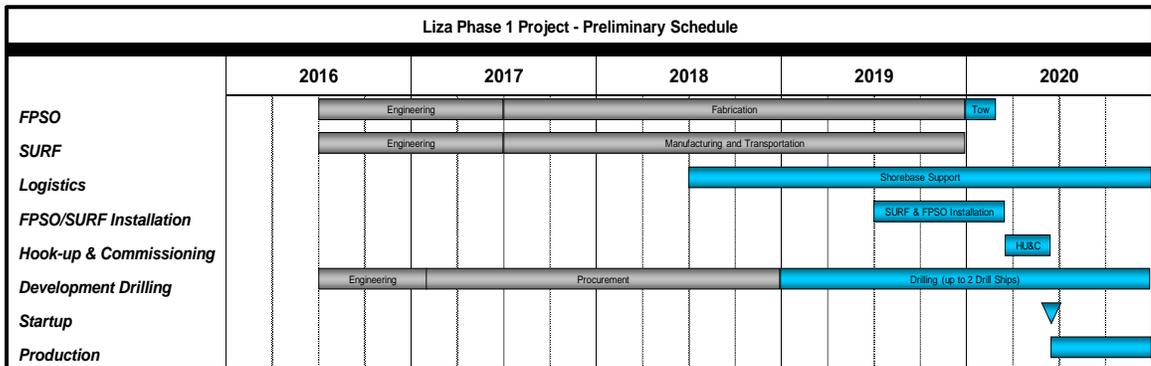
4.2 Project Schedule

At this time, the Project schedule for the proposed Project is still being developed. The Project life cycle for Phase 1 will include engineering, development drilling, installation, hook-up, commissioning, start-up, operations and maintenance, and decommissioning. The engineering stage will include design, Front-End Engineering and Design (FEED), and detailed engineering. The execution stage will include procurement, fabrication and construction, drilling, installation, hook-up, commissioning, and start-up. Operations and maintenance will follow start-up, and will be the longest stage of the Project.

Figure 4.4 provides a preliminary schedule for the major Project components and activities. As depicted in Figure 4.4, initial oil production is planned for mid-2020. To support this goal, development well drilling from up to two drill ships is planned to start in early 2019, with the potential for mobilization in 2018, and the installation of the subsea components and the FPSO to follow. Production will continue for at least 20 years. The milestones are still being refined and are subject to change.

This schedule provides for simultaneous development drilling and FPSO/SURF production operations, which will involve bringing the initial production wells online as subsequent development wells are being drilled.

Figure 4.4 Preliminary Project Schedule



4.3 Project Workforce

Preliminary workforce estimates are provided in Table 4.1. These estimates have been slightly revised (especially for Mobilization, Installation, and Hookup and Production Operations) since submittal of the Application for Environmental

Authorisation and will be further refined following selection and contracting for the drill ship, FPSO, SURF installation, support vessels, and shorebase support facilities. The current plan is to conduct primary support activities from shorebases in Guyana and Trinidad and Tobago.

Table 4.1 Workforce Estimates

Project Stage	Estimated Workforce
Development Well Drilling	Approximately 600 Persons at peak utilizing up to two Drill Ships. (Dependent upon final drill ships and support vessels selected)
FPSO and SURF Mobilization, Installation, and Hookup	Approximately 600 Persons at peak. (Dependent upon final construction/installation and support vessels selected)
Production Operations, including FPSO and conventional tanker	Approximately 100-140 Persons at peak (an additional 25-30 Persons would be onboard the tanker). (Dependent upon conventional tanker schedule)
Decommissioning	Approximately 60 Persons at peak

In addition to the offshore components, there will also be personnel providing shorebase and marine logistical support onshore (approximately 100-150), some of whom will be Project dedicated while others will be shared resources. The onshore logistical support staff will ramp up gradually through the mobilization and installation stage until reaching a peak during the development drilling campaign and FPSO/SURF installation activities, and then will diminish during FPSO/SURF production operations. The logistical support onshore staff is expected to increase again briefly during decommissioning.

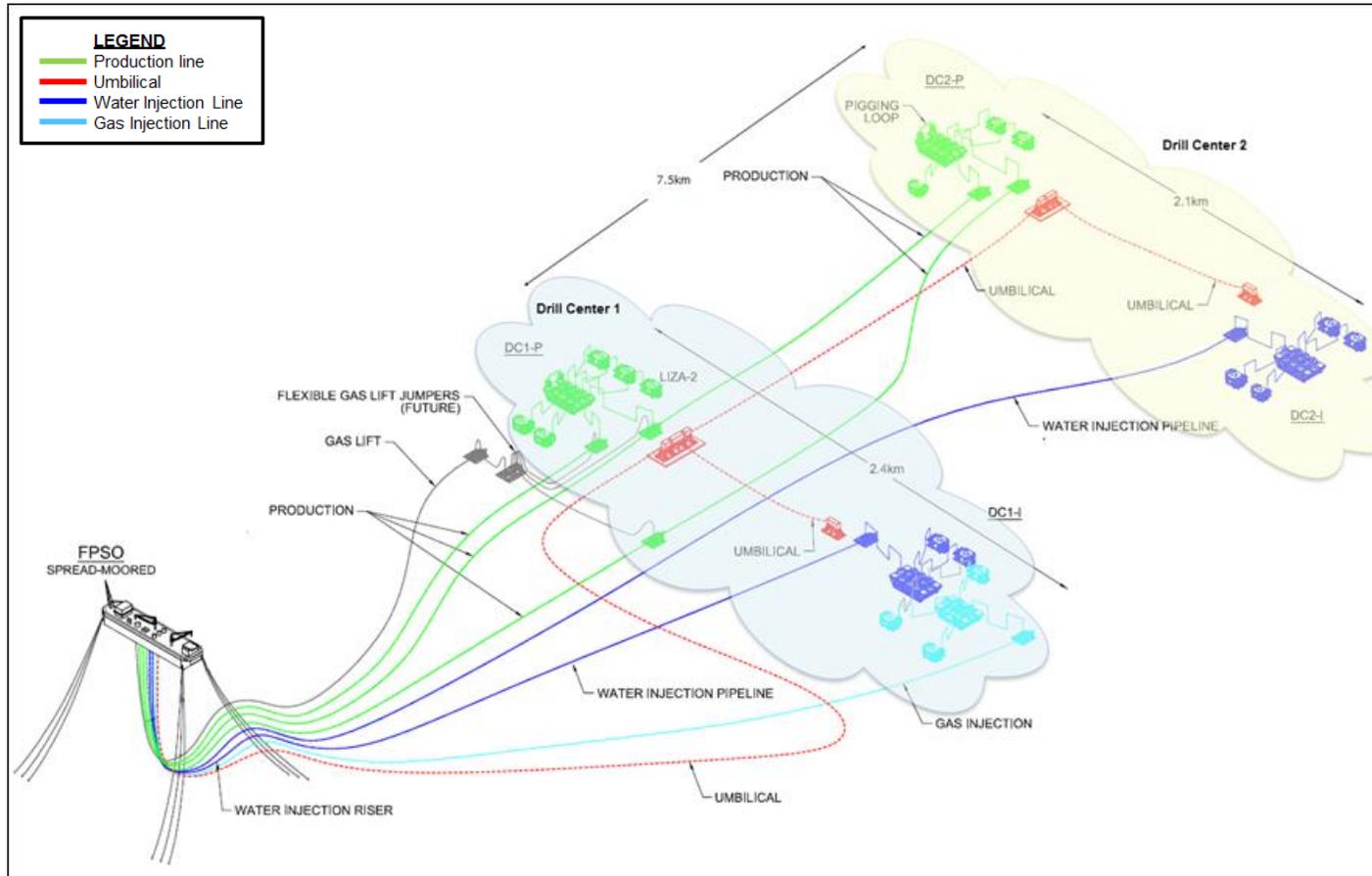
4.4 Overview of the Development Concept

4.4.1 Development Concept

The Liza field will be developed during Phase 1 with approximately 17 development wells drilled from two drill centers, each with separate production, gas, and water injection manifolds. Figure 4.5 represents the preliminary field

layout of the proposed Liza field development, which includes the development wells, SURF, and a spread-moored FPSO vessel. The facility layout will continue to evolve during the design development process. The various components included in Figure 4.5 are further described in the relevant Drilling, SURF, and FPSO sections.

Figure 4.5 Preliminary Liza Phase 1 Field Layout



The development wells include production wells, water injection wells, and gas re-injection wells. A portion of the associated gas produced from the reservoir will be used onboard the FPSO as fuel gas, and the remaining balance will be re-injected back into the reservoir via the gas re-injection wells during Phase 1. Alternative means of gas disposition for future phases are being studied and will be described in a separate environmental authorization. Water injection will be used as needed to maintain reservoir pressure for optimal production over the life cycle of the Project.

The Liza field will be developed using a spread-moored FPSO (see Section 4.7). The FPSO will be a converted double hull Very Large Crude Carrier (VLCC) that will support the topsides facilities, process the produced fluids from the production wells, and store the processed crude oil. Offloading of the processed crude oil for export will occur directly to conventional tankers in a tandem configuration. Subsea production, gas, and water injection wells and manifolds will be tied back directly to the FPSO via flowlines and risers (see Section 4.6).

4.4.2 *Applicable Codes, Standards, and Management Systems*

The various aspects of engineering design and operations will be carried out according to applicable Guyana statutory requirements, applicable international design codes and standards, applicable EEPGL and contractor design specifications, the EEPGL Operations Integrity Management System (OIMS)³, as well as the EEPGL Safety, Security, Health, and Environment (SSHE) policies⁴. EEPGL and its contractors will have a structured management system to verify the ongoing application of all necessary codes, standards, procedures, and management systems.

The EIA will describe how EEPGL intends to conduct business in a manner that is compatible with the environmental and economic needs of the communities in which it operates, and that protects the safety, security, and health of its employees, those involved with its operations, its customers, and the public. These commitments should be documented in its management systems, policies, and plans.

³<http://corporate.exxonmobil.com/company/about-us/safety-and-health/operations-integrity-management-system>

⁴ The SSHE policies are part of the overall Standards of Business Conduct policy:

<http://corporate.exxonmobil.com/en/company/about-us/guiding-principles/standards-of-business-conduct>

4.5 Drilling and Well Design

4.5.1 Drilling Program

The Project is considering an option to utilize up to two drill ships, similar to the drill ship shown in Figure 4.6, operating simultaneously during Phase 1 to drill the development wells. Drilling operations may occur prior to, during, and after the installation of the FPSO and SURF components.

Figure 4.6 Typical Drill Ship



During the drilling process, drill ships will require various tubulars, instruments, and devices (collectively referred to as the drill string) to conduct the well construction process: drilling the borehole, running and cementing casings, and installing the completion and production tubing. The drilling program will employ high-angle and extended reach drilling technologies. These technologies allow wells to reach targets up to 4 km from the drilling seabed location. The wells will be clustered around two drill centers rather than distributed over the producing reservoir. This approach reduces the number of drilling locations, thereby reducing the area potentially affected by drilling operations

including discharged drill cuttings⁵. The planned development drilling program and its cuttings management approach is consistent with industry practices, protective of the environment, and has previously been the basis for the Liza-1, Liza-2, and Liza-3 exploration wells.

4.5.2 Typical Well Design

Once the borehole is started for a well, pipe (also known as casing) must be run (inserted) into the borehole and cemented in place (to keep the well from collapsing and to seal the casing to the formation). Various sized casings will be progressively set as the wells are drilled deeper. The size and strength of the casings to be used in the design of the well takes into account the peak reservoir temperature and pressure conditions that may be encountered during drilling and during production operations when the wells are flowing reservoir fluids. After each casing (conductor and deeper strings) is installed, pressure and integrity testing will be performed according to standard industry practices. A provisional well program and design, including casing types and sizes, setting depths, drilling fluid types, and discharge locations for the development drilling program is shown in Figure 4.7.

The first (i.e., most shallow) section of each well, also known as the Structural casing section, will be jetted or drilled with seawater. Drilling fluids and cuttings from this section will be discharged to sea just above the seafloor per standard industry practice.

For each subsequent section of the well to be drilled, the drill string will be removed and the casing will be lowered into the hole to prevent its collapse. Wet cement will then be pumped down the casing and forced into the annular space between the hole and the outside of the casing, and into the annular space between the present and previously set casing. The casing will be pressure tested before drilling the next hole section.

The Conductor casing, which is designed to hold back seabed surface soils and support the weight of the entire well, is then set and cemented back to the seabed. Drilling fluids and cuttings from this section will be discharged to sea just above the seafloor per standard industry practice.

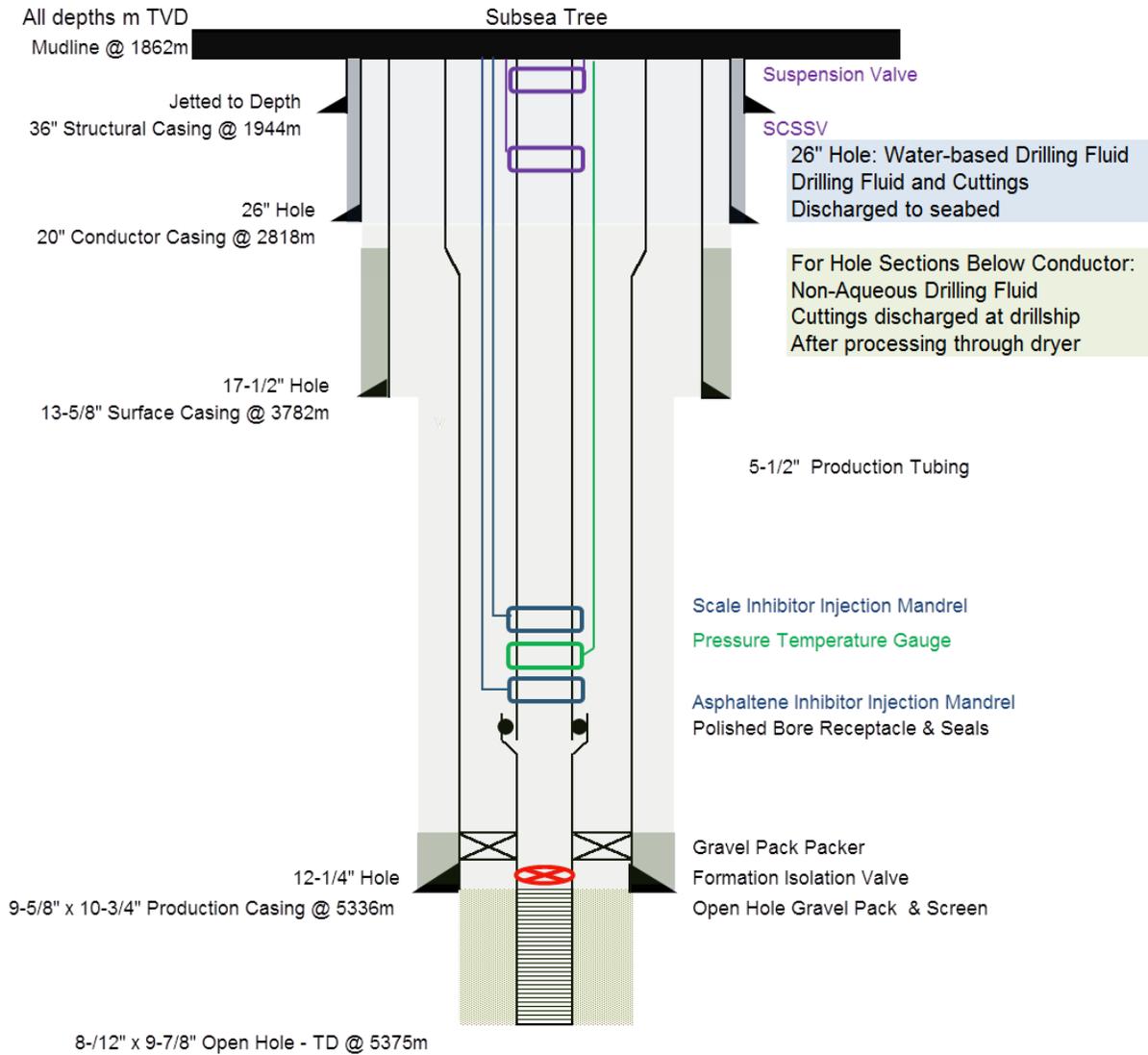
⁵Drill cuttings are the broken bits of solid material produced as the drill bit advances through the borehole in the rock or soil. The cuttings are usually carried to the surface by drilling fluid circulating up from the drill bit.

A drilling riser will be deployed to connect the Conductor casing and the drill ship, and the blowout preventer⁶ (BOP) will be installed. Marine drilling risers with buoyant joints and tension will be used to connect the wells via the BOP to the drill ship. BOPs will be periodically tested during the well construction process.

After this point, all returns of drilling fluids and cuttings will be directed to the drill ship for treatment (i.e., solids control and centrifugal cuttings dryer system) to recover, reuse and recycle the drilling fluids and reduce residual fluid on cuttings. After treatment, the cuttings from well sections below the Conductor casing will be discharged to the sea from the drill ship rather than at the seafloor. Based on prior analysis from the Liza-1 exploration program, cuttings disperse in the ocean current as they descend through the water column, which typically prevents significant accumulations of cuttings in any particular location on the seafloor.

⁶Blowout preventers are secondary safety devices that are installed at the top of a well to prevent the uncontrolled flow of liquids and gases in the event of a loss of well control during drilling operations.

Figure 4.7 Provisional Casing Program for Development Drilling Program



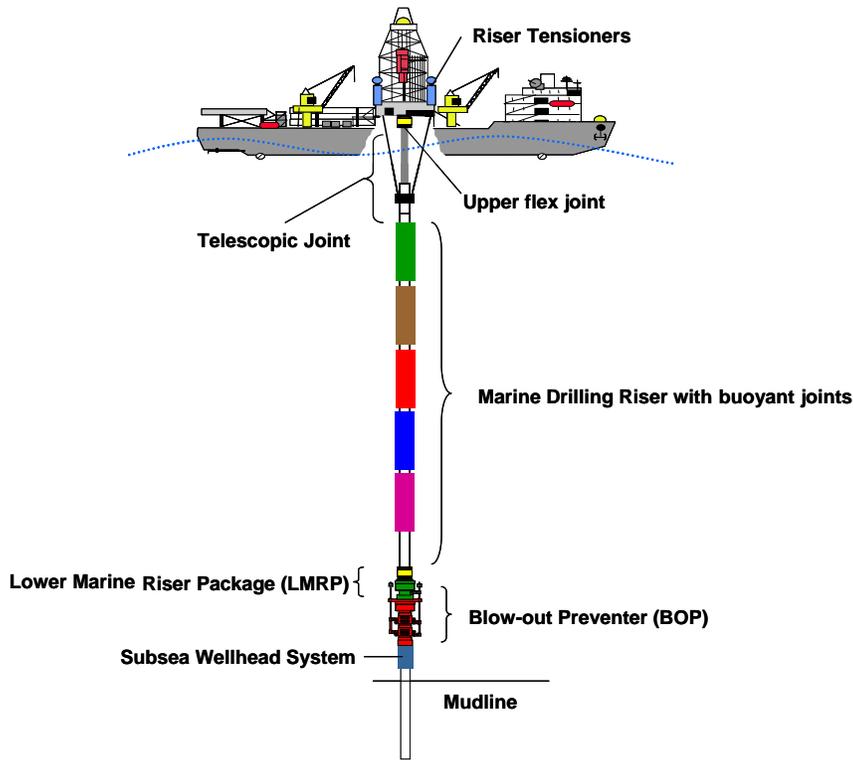
The Surface casing will then be set and cemented in competent rock at a depth below mudline to allow drilling to the top of reservoir. The Production casing will be set and cemented at the top of reservoir, which serves as the casing string in which the production tubing is run.

The production tubing carries the flowing reservoir fluids from the production zone to the wellhead. The production tubing includes the subsurface safety valve, which is designed to mitigate the uncontrolled release of fluids from the reservoir during the production process. The production tubing also protects the production casing from corrosion and deposition of by-products, such as sand, paraffins, and asphaltenes.

After the production tubing is run, the well will be suspended by installing barriers to flow; the riser and BOPs will be removed; and the subsea tree will be installed and tested. The well will be then handed over to the Project (SURF) for hook-up and commissioning.

Figure 4.8 shows the various components of a typical subsea drilling system.

Figure 4.8 Typical Subsea Drilling System



4.5.3 Drilling Fluids

The drilling process will require drilling fluid to remove cuttings and to control formation pressures. The choice of drilling fluids will be based on the challenges

associated with drilling in deep-water environments, which differ from shallow water drilling in the following areas:

- Colder temperature/higher seawater hydrostatic pressure at the mudline;
- More narrow window between pore pressure and fracture gradient; and
- Longer drilling risers requiring larger volumes of drilling fluid.

The colder temperature/higher pressure found at the mudline is more conducive to the formation of gas hydrates. A gas hydrate is a solid ice-like crystalline form of water that contains gas molecules (typically methane). Gas hydrates will be prevented by good drilling practices and by the use of properly inhibited fluid. For water-based fluids used in the upper sections, adding salt or organic inhibitors may be required.

4.5.3.1 Fluid Selection

Three categories of drilling fluids will be used: seawater, water-based drilling fluids (WBDF), and non-aqueous drilling fluids (NADF) in which the continuous phase is an International Oil and Gas Producers Association (IOGP) Group III low-toxicity non-aqueous base fluid (NABF) with low to negligible aromatic content. WBDF will be used when drilling the upper sections of the well. Fluid density will be maintained at sufficient levels to hold back shallow gas and shallow water flow potential, and these types of issues are further addressed in the geophysical and shallow geotechnical analysis. Based on wellbore stability analysis and experience gained from Liza-1, Liza-2, and Liza-3 drilling, NADF will be required to maintain borehole stability while drilling all well sections below the Conductor casing.

Cuttings drying equipment will be installed on the drill ships to process and reduce the percentage of NABF retained on cuttings (%BFROC). The cuttings will be discharged to the sea after treatment, in accordance with standard industry practice. The use of cuttings dryers on other similar projects has significantly reduced the %BFROC.

Higher fluid densities may be required in the more extended reach (i.e., longer horizontal) wells for wellbore stability. Additional information regarding the proposed drilling fluids will be provided in the EIA.

4.5.4 Well Cleanup and Ancillary Processes

4.5.4.1 Well Cleanup

Development wells will be drilled, completed and tied-back to the FPSO. Fluids left in the well bore will be flowed back to the FPSO. This process of well cleanup

includes the flowback of completion fluids and solids. The wells will not be cleaned up to the drill ship using temporary well test equipment; but rather, all wells will be cleaned up through the subsea tree/flowlines/production equipment on the FPSO. Such small quantities of fluids will be incorporated with the crude product from other wells. Resulting gas and water will be processed along with fluids from other wells. No well tests of the development wells are planned.

4.5.4.2 Vertical Seismic Profiling

Vertical Seismic Profile (VSP) data may be collected to improve velocity modeling and reduce uncertainty in reservoir mapping. VSP surveys can be used to correlate the surface-seismic data to the information on the physical properties and characteristics of the hydrocarbons gained from drilling the well. VSP data, along with check shots and well logs, provide further time/depth information from which to improve knowledge and understanding of the structure and stratigraphy of the reservoir.

A VSP survey, which can be conducted from a drill ship or other support vessel (not the FPSO), requires a sound source (commonly compressed air) and a receiver. Data is acquired by the receiver, which is installed within the wellbore. The source may be located with zero offset from the well (directly above the wellbore), at a fixed offset (a defined lateral distance from the well), walk away (at a range of offsets), or walk above (at zero offset to the down hole well location). The final scope of such a survey and specific geophysical tools to be used is still under review.

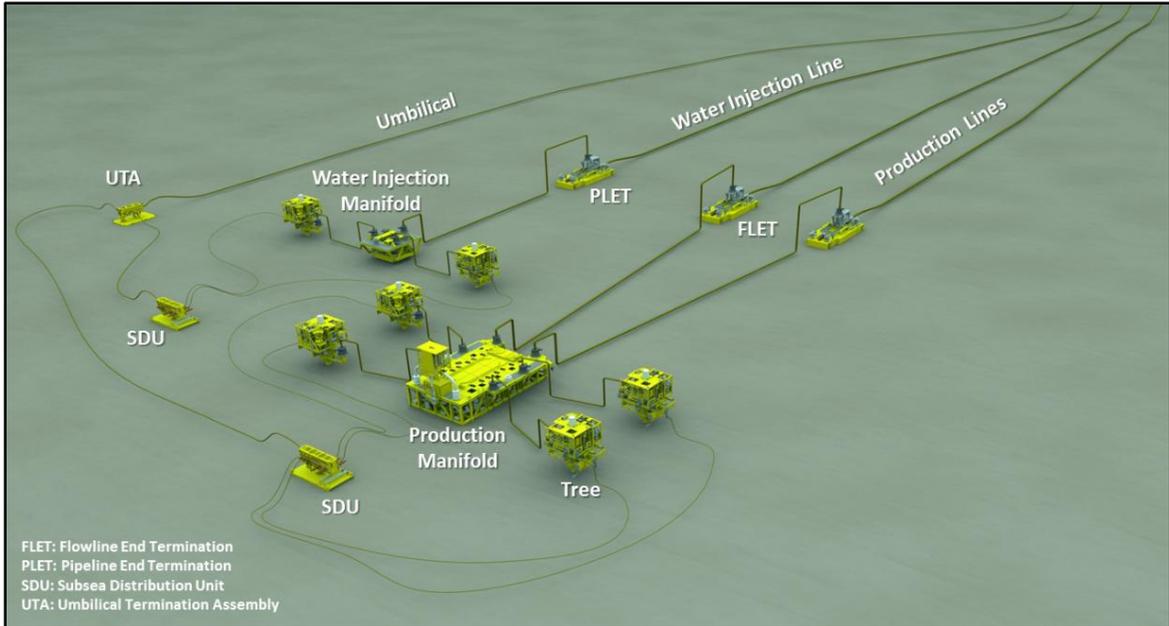
Although VSP operations produce lower acoustic output than 2D or 3D seismic surveys, they are still planned in a manner to mitigate any potential harm to marine mammals. VSPs commence during daylight hours after a suitable pre-watch by Marine Mammal Observers and begin with soft-start procedures that allow marine mammals to move away from the sound of the operation.

4.6 Subsea, Umbilicals, Risers, and Flowlines (SURF)

The SURF facilities concept for the Project is comprised of subsea production, gas, and water injection wells clustered around subsea manifolds, drilled from two subsea drill centers. This approach of clustering the wells around drill centers reduces the number of manifolds, flowlines and umbilicals⁷, as well as the size of equipment and marine vessels needed for installation. The risers and umbilical will connect the infrastructure on the seafloor to the FPSO. The manifolds will connect the individual development wells to the rest of the subsea system. The subsea system will be monitored and controlled from the FPSO using a control system connected to the FPSO through an umbilical that also supplies power, hydraulic fluid, and chemicals to the subsea manifolds and trees. The hydraulic fluid for operating the subsea control system will be a low-toxicity, water soluble hydraulic fluid. The SURF system will be designed to withstand the full shut in pressure from the production wells, and the gas/water injection components will be designed to withstand the highest required injection pressures. Overpressure protection will be provided on the FPSO, in accordance with industry standards, to protect the subsea systems. Figure 4.9 shows an illustration of a representative SURF system similar to what is currently being designed for the Project.

⁷A cable and/or hose that provides the electrical, hydraulic, chemical and communications connections needed to provide power and control between the FPSO and subsea equipment.

Figure 4.9 Representative SURF System



NOTE: Schematic is not necessarily representative of number of drill centers or wells.

The production drill centers also will be connected to the FPSO with round-trip piggable production flowlines. A pig is a specially designed device that is placed in the flowline at a launcher at one end and pushed by pressure until it reaches the receiving trap or catcher at the other end. Pigging is performed to aid and assist in the maintenance, operations, cleaning and inspection of flowlines. Figure 4.10 shows an example of a pig.

Figure 4.10 Example of Wire Brush Cleaning Pig

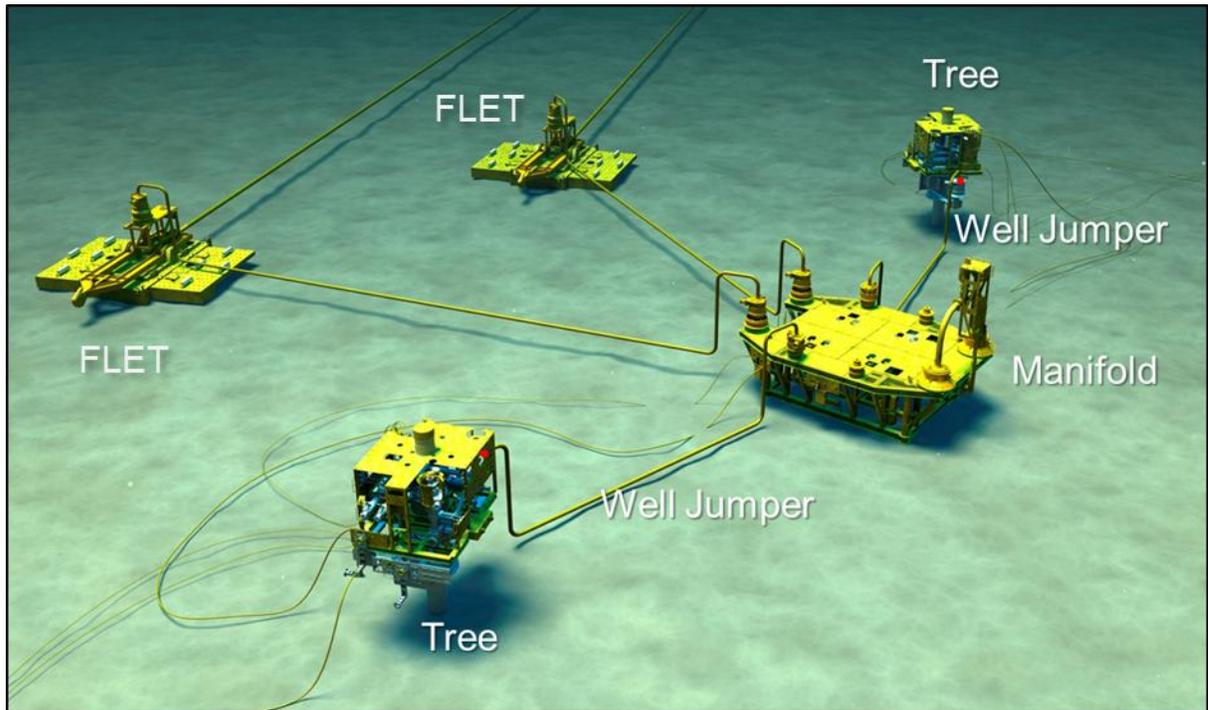


4.6.1 Well Flow Connections

Well flow connections between the subsea wells and the FPSO include several components. Each subsea development well is capped by a wellhead tree, which includes a choke valve to control production as well as water and gas injection. For a given set of wells tied to the same manifold, each wellhead tree is connected by jumpers to the well manifold, which is connected by a flowline jumper to a flowline end termination (FLET) located at the drill center end of the flowline.

A typical configuration of the subsea wells, flowlines, and manifolds expected at a drill center for the Project is indicated in Figure 4.11.

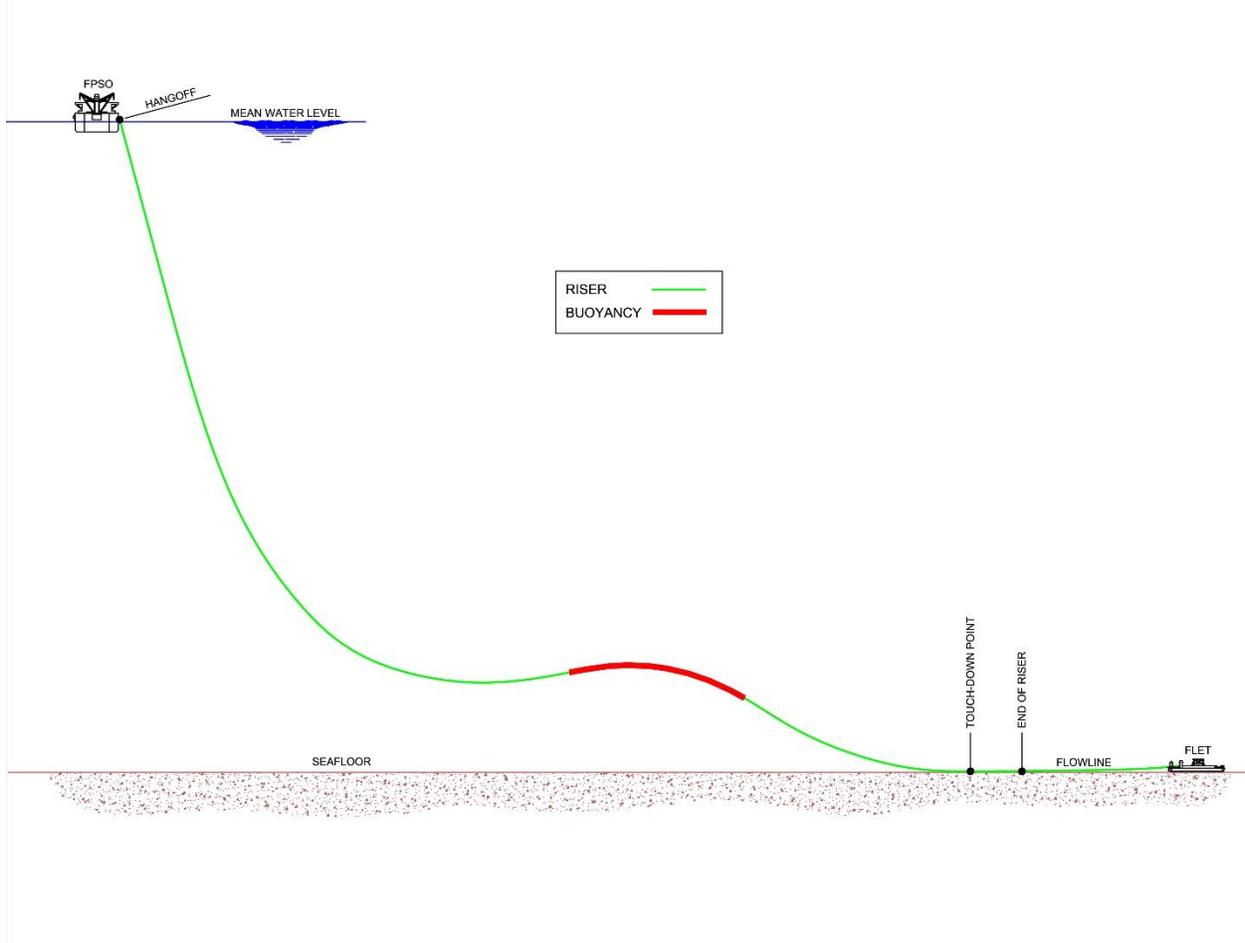
Figure 4.11 Representative Subsea Wellhead Tree, Jumper and Manifold



From the drill center, the rigid flowline travels on the seabed to the vicinity of the FPSO. At the FPSO end of the flowline, the flowline will transition to a riser, which carries the fluids between the seabed and the FPSO at the surface.

The risers transition from the seabed to the FPSO in a "lazy wave" steel catenary configuration as shown in Figure 4.12.

Figure 4.12 Representative Steel Catenary Riser



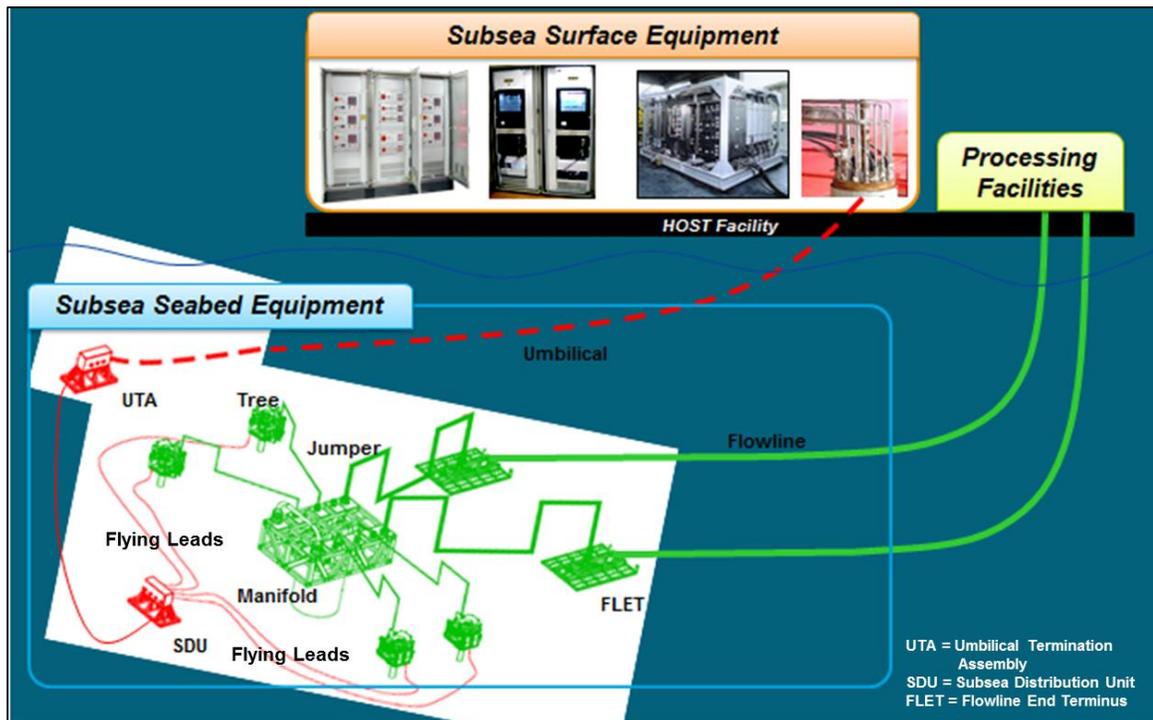
4.6.2 FPSO Subsea System Control

The FPSO will provide power, utilities, cabling, and tubing/piping tie-ins to equipment installed on its topsides to control the subsea equipment (see Figure 4.13). In the event primary power is lost, the FPSO will be configured with back-up power.

The subsea wells and manifolds will be monitored and controlled by a control system on the FPSO. Each tree has a subsea control module (SCM) mounted on it which controls and monitors the tree functions (e.g., choke valve position) and associated manifold functions. Subsea controls will accommodate typical monitoring requirements such as pressure and temperature measurement.

The control systems at each drill center will be supplied from the Process Control System (PCS) on the FPSO by one dynamic and static steel tube umbilical. The umbilical will supply control fluid to operate all hydraulically operated valves, chemicals as required to ensure flow to the FPSO, and low voltage power and communication to operate and monitor the SURF facilities. The umbilical will terminate in Subsea Distribution Units (SDU) which will have hydraulic and electrical outlets. Hydraulic and electrical leads (“flying leads”) will be used to connect the SDU outlets to the well-mounted SCMs and may be installed together to reduce congestion on the seabed.

Figure 4.13 Representative Subsea Control System



4.6.3 Risers, Flowlines, Umbilicals and Manifolds

4.6.3.1 Risers and Flowlines

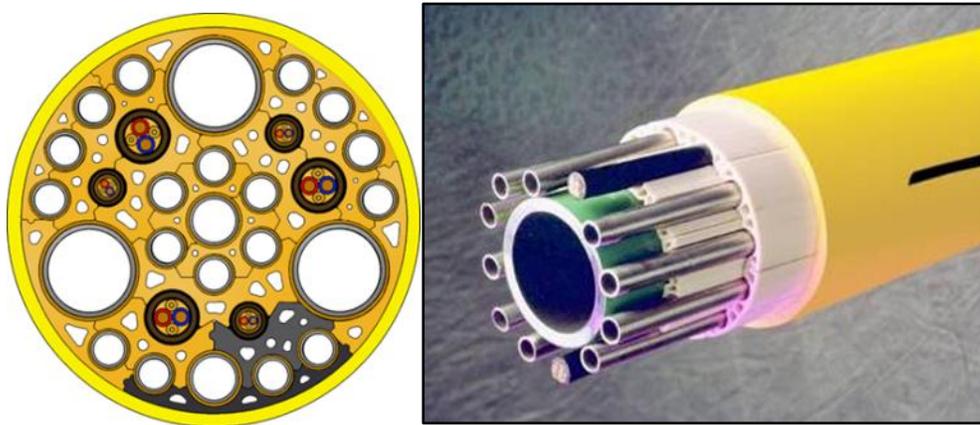
The Project will incorporate production, water and gas injection flowlines and risers, as shown in Figure 4.5. Flowline and umbilical lengths will range from 3.2 to 6.4 km (~2 to 4 mi), excluding risers, in water depths of approximately 1500-1900 meters (m). Lengths listed are subject to change. The current design

lengths are based on preliminary shallow hazard surveys and current field layout, which may be adjusted slightly during detailed design.

4.6.3.2 Umbilical

The umbilical will be designed as an integrated bundle of tubes and cables to serve all these functions (See Figure 4.14). A single dynamic umbilical, which will be connected to the FPSO and terminate subsea at Drill Center 1 (DC1), will service the entire Liza field during Phase 1. The remaining drill centers, composed of the subsea trees, manifolds, flying leads and jumpers, will be connected via the in-field umbilical.

Figure 4.14 Representative Integrated Dynamic Umbilical with Cross Section



4.6.3.3 Manifolds

Manifolds are gathering points, or central connections made up of valves, pumps, meters, hubs, piping, sensors and control modules. Manifolds include a protective structural framework that rests on a foundation on the seabed where multiple trees, jumpers, and flowlines gather to consolidate flows before they are either transported to the surface as part of production, or back downhole for final injection into the reservoir (See Figure 4.15).

Figure 4.15 Representative Subsea Manifold



4.6.3.4 Gas Lift System

The FPSO riser support system will be designed for gas lift capability. The gas lift system is not required for initial startup, and will be installed at some time during Phase 1 based on the production characteristics of the Liza field. This system will include a riser and flowline to DC1 with connections to the production flowlines.

4.7 Floating Production, Storage, and Offloading (FPSO) Vessel

4.7.1 General Description

The FPSO vessel to be utilized for the Project will be a VLCC tanker, which utilizes a spread moored configuration to maintain station continuously for at least twenty years. The FPSO will be designed to receive the full production wellstream from the development wells and will process crude oil at a design rate of 100,000 Barrels of Oil Per Day (BOPD), with potential to safely operate at sustained peaks of up to 120,000 BOPD. For the purposes of the EIA, potential impacts generated by the Project will be based on a conservative production volume of 144,000 BOPD. The FPSO will be capable of storing a minimum of 1.6 million barrels of stabilized crude oil. The FPSO will be able to offload approximately 1 million barrels to a tanker in a period of approximately twenty-

eight hours, although the exact offload rate will be driven by the throughput capacity of the pumping equipment on the FPSO.

The FPSO will also have the capability to process, dehydrate, compress, and re-inject the gas produced from the reservoir. The FPSO will be configured to treat seawater used for facility cooling purposes for injection into the reservoir, and to process produced water for disposal overboard. Living quarters and associated utilities will be provided in order to support the operations on the FPSO. The FPSO topsides equipment and design will have a design life of at least twenty years.

Table 4.2 provides an estimate of the design rates for the FPSO facility.

Table 4.2 FPSO Key Design Rates

Service	Design rate⁽¹⁾ (2)
Oil Production	100,000 barrels per day (bpd)
Produced Water	100,000 bpd
Total Liquids	150,000 bpd
Produced Gas	180 million standard cubic feet per day (Mscfd)
Gas Injection	160Mscfd (assumes 20 Mscfd of produced gas will be used as fuel gas for the FPSO)
Water Injection	190,000 bpd

¹: All design rates are presented as the peak annual average.

²: The facilities will have the potential to safely operate at sustained peaks of oil production up to approximately 120,000 bpd. For the purposes of the EIA, 144,000 bpd has been used as the basis to analyze potential impacts from the Project.

Key FPSO design features include the following:

- The FPSO will be designed to remain moored for at least 20 years without drydocking, and will include facilities to support in-water hull/structural surveys and repair and maintenance.
- The FPSO will be designed to operate in extreme (100 year return period) environmental conditions (associated wind, waves, and current).

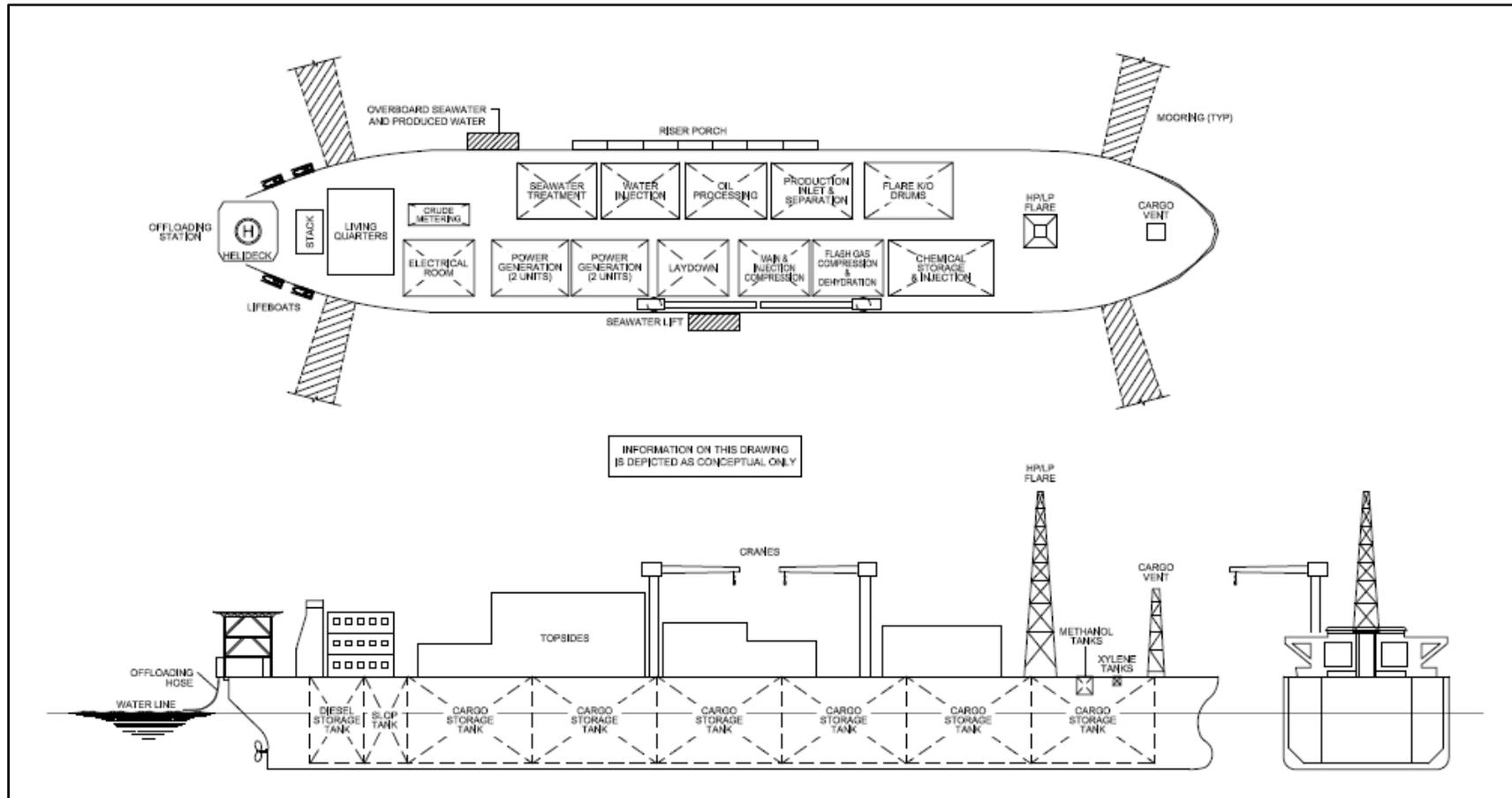
- The FPSO will be designed to re-inject the produced gas back into the reservoir, except during times of injection system unavailability, which will require temporary, non-routine flaring.

A computer simulated picture of the planned FPSO and a general schematic of a converted FPSO topsides and hull is provided in Figures 4.16 and 4.17, respectively.

Figure 4.16 Computer Simulated Picture of Planned Liza Phase 1 FPSO



Figure 4.17 General Schematic of a Converted FPSO Toppides and Hull



4.7.2 FPSO Topsides

The FPSO's topsides design utilizes an interconnected module concept where process equipment is packaged in modules. The design concept maximizes pre-commissioning and functional testing of the modules prior to arrival offshore Guyana. The FPSO will arrive for installation, hook-up, and commissioning in the Stabroek Block fully fabricated, pre-assembled and most facilities, modules, components and systems pre-tested.

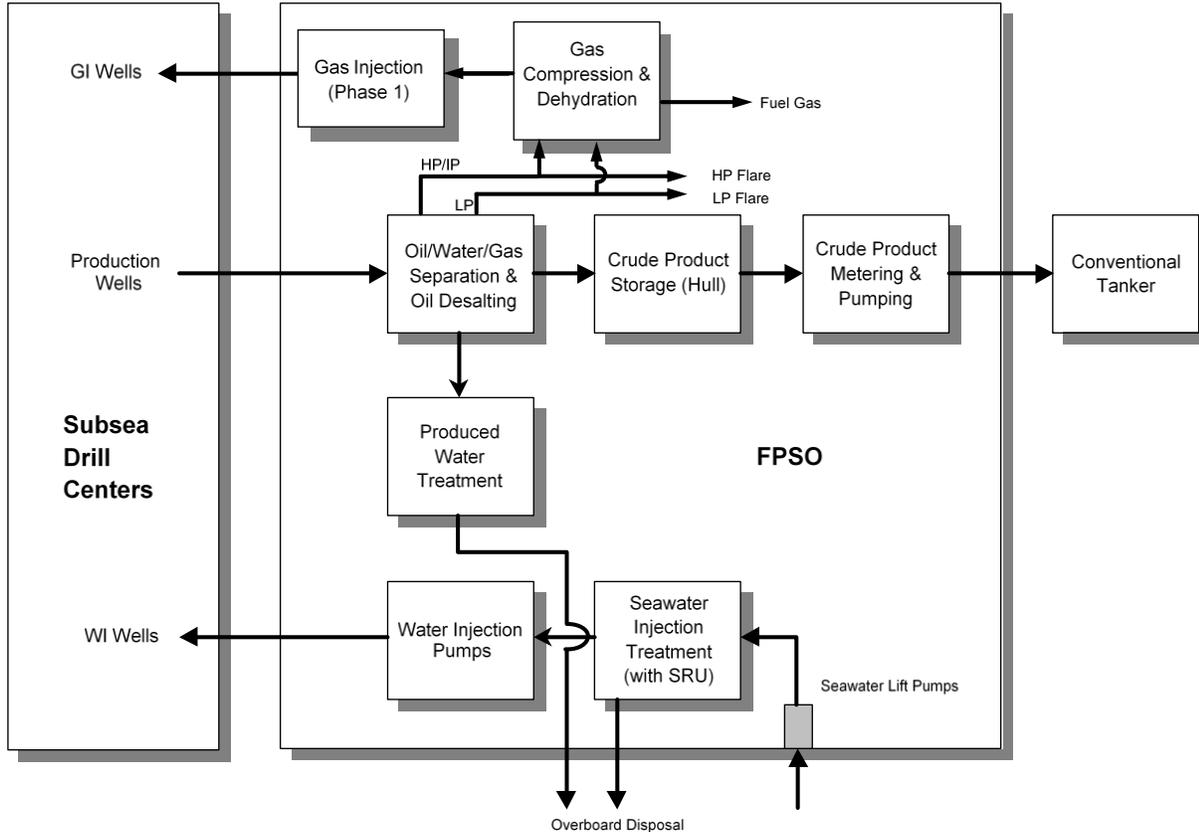
The principal functions of the topsides process facilities will be:

- To receive, separate, and process the produced reservoir fluids to provide:
 - a crude oil product for offloading onto conventional tankers;
 - produced water to be of sufficient quality for environmentally acceptable discharge to the sea; and
 - produced gas to meet requirements for FPSO turbine generator fuel gas and for reinjection into the reservoir;
- To treat seawater to provide a suitable supply of injection water to support the reservoir depletion plans; and
- To provide support systems for the safe accommodation of approximately 80-120 personnel involved in the operation of the production facilities and, on occasion, personnel involved with the drilling program.
- Temporary accommodations may also be utilized during key activities including hook-up, commissioning and maintenance operations to increase accommodations capacity to 100-140 personnel.

4.7.3 FPSO Process Systems

The process facilities on the FPSO topsides are shown schematically in Figure 4.18 and are described in the following sections.

Figure 4.18 Process Flow Diagram



Notes:

- GI = Gas [re]injection
- WI = Water injection
- HP = High pressure
- IP = Intermediate pressure
- LP = Low pressure
- SRU = Sulfate Removal Unit

4.7.3.1 Oil/Water/Gas Separation and Oil Desalting

An inlet manifold is required to receive full wellstream produced fluids from the reservoir (consisting of oil, gas, and water) from the production flowlines and to route the fluids to the FPSO processing facilities. The full wellstream produced fluids will be separated into oil, water, and gas phases in a single train of

separation. The separation train consists of three stages (high, intermediate, and low pressure) of flash separation to produce a stabilized crude product. Fresh water will then be added to the stabilized crude product to remove dissolved salts as part of oil desalting. The final crude oil product from the flash separation / stabilization process will be treated to meet the specifications for sale prior to being sent to the crude product storage tanks in the FPSO hull. Further processing of the water and gas streams from the separation process and the process for treating seawater for injection are described below.

4.7.3.2 Gas Processing

The purpose of the FPSO gas processing system is to condition the associated produced gas (which is not consumed as FPSO fuel gas) to the appropriate specification prior to re-injection into the reservoir.

The gas processing system consists of the following sub-systems:

- **Flash Gas Compression:** recovers and compresses flash gas from the IP and LP separators to mix with the gas from the HP separator.
- **Main Gas Compressor:** compresses gas from the HP separator and the flash gas compressor to an interstage pressure where it can be used as fuel gas with the remaining gas compressed up to an appropriate pressure for gas lift (when required). The main gas compressor provides gas to the injection compressor at an appropriate suction pressure to ensure stable operations of the gas injection compressor.
- **Gas Dehydration:** removes water vapor from gas to prevent hydrate formation in the gas lift and gas injection systems where high pressure gas will cool to seabed temperatures.
- **Fuel Gas:** provides fuel gas to all electrical power generation gas turbines and to all other low pressure users (marine boilers, pressure control of vessels, etc.).
- **Injection Gas Compression:** compresses discharge gas from the main gas compressor(s) to an appropriate pressure level where it can be re-injected into the reservoir. The high pressure re-injection gas is routed to the gas injection riser and then directed to the remote, subsea injection wells.

For Phase 1, the Project is planning to re-inject any produced gas (that will not be consumed as fuel gas on the FPSO) back into the reservoir.

During equipment maintenance and process upsets including startup and shutdown scenarios, part or all of the off-gas from the separation/stabilization process will be sent to the HP or LP Flare Systems. Flaring will be temporary and non-routine.

4.7.3.3 Produced Water Treatment

The produced water treating system will be designed to collect produced water from process facilities and treat the water for discharge overboard. The system will consist of two stages of treatment - primary treatment followed by secondary treatment. The primary treatment stage will consist of either a skim vessel or hydrocyclones for removal of large oil droplets from the produced water. The secondary treatment will consist of a gas flotation for removal of small oil droplets in order to meet the required discharge specification. Produced water that does not meet the overboard discharge specification will be routed to an appropriate tank in the hull and managed as described in Section 4.7.8.1.

4.7.3.4 Seawater Treatment and Water Injection System

Seawater will be used for injection water and will be treated prior to injection into the producing reservoirs. Water injection will be used for reservoir pressure maintenance to enhance oil production. The seawater treatment system will include sea lift pumping, filtration, deaeration, and sulfate removal. Seawater lift pumps on the FPSO will be used to pump seawater from depths up to 100 meters from the surface in order access colder seawater than what is available from the ocean surface. The filtration system will consist of both coarse filtration (strainers) and fine filtration (multi-media filtration) for removal of particulate from the incoming seawater. Following filtration, seawater will be vacuum deaerated for removal of oxygen. The deaerated seawater will then be pumped through a membrane system for removal of sulfate ions from the seawater as the final treatment step. The treated seawater will then be pumped to the necessary pressure for injection into the reservoir.

A portion of the treated seawater will be further treated through a reverse osmosis system to make fresh water. Fresh water is required both for potable water requirements as well as removal of salt from the crude product as part of oil desalting as described in Section 4.7.3.1.

4.7.4 FPSO Utility Systems

This section discusses the utility system requirements for the FPSO. For the most part, the utility systems designed to support the process facilities will be located above deck. Where appropriate, marine utility systems may be used to support topside systems.

4.7.4.1 Process Cooling

Cooling of process streams via a closed loop water-based cooling medium system is required to dissipate heat generated by the oil and water treating systems, the compression systems, and miscellaneous utility systems.

The seawater lifting system shall supply the required seawater for cooling (see Section 4.7.3.4). Process hydrocarbon fluids do not come into contact with this seawater. Seawater will be disposed of overboard at a suitable temperature so as not to adversely affect marine life.

4.7.4.2 Process Heating

A process heating system is required as part of the crude oil treatment process to achieve the required crude oil product specifications. A closed loop, water-based heating medium system will be used to add heat to the incoming production. Waste heat from the power generation system will be used as the source of heat.

4.7.4.3 Flaring System

EEPGL intends to re-inject produced gas under routine conditions, except that which will be utilized for FPSO operations (e.g., fuel gas). A flare system shall be provided for the collection and safe disposition of produced hydrocarbon gases resulting from unplanned, non-routine relief and blowdown events. Relief events occur to prevent overpressure scenarios in the process equipment. Blowdown events occur to depressure the facilities in a controlled manner as a result of emergency shutdown events. In addition, temporary, non-routine flaring will occur during equipment maintenance and process upsets including start-up. The flare system will include both a HP and LP flare sharing a common flare tower, as shown in Figure 4.17. The flare tower has elevated flare tips for both HP and LP flares which provides for the safe ignition of hydrocarbon gases. Both flares will support high efficiency combustion and will utilize pilots which have minimal emissions.

4.7.4.4 *Topsides and Subsea Chemical Injection*

The FPSO will have storage and injection facilities to inject the required amounts of chemicals and methanol into the production fluids to support production operations, both for subsea chemical injection requirements and for topsides chemical injection requirements.

Topsides chemicals may include: corrosion inhibitor, scale inhibitor, asphaltene inhibitor, emulsion breakers, anti-foam, demulsifier, oxygen scavenger, biocides, water treatment chemicals, and hydrogen sulfide scavenger.

Subsea chemicals may include: methanol, scale inhibitor, corrosion inhibitor, asphaltene inhibitor, and xylene. Methanol and xylene will be stored in tanks that are integrated into one of the FPSO hull cargo tanks, as shown in Figure 4.17.

4.7.4.5 *Air*

An air compression system will be provided to supply hull and topsides equipment. Compressed air is primarily required for the operation of control valves and other process instrumentation requirements.

4.7.4.6 *Nitrogen*

Instrument air shall feed the nitrogen generation system. Nitrogen shall be provided as required for purging (i.e., removing impurities), inerting (i.e., removing any flammable materials), and blanketing (i.e., using nitrogen as a buffer to protect sensitive equipment), and as required for miscellaneous utilities.

4.7.4.7 *Drains*

The topsides shall be equipped with the following drain systems:

- Non-hydrocarbon open drain. Used to collect drain fluids (e.g., rainwater) from non-hydrocarbon areas and to route them to the slop tank in the FPSO hull or directly overboard.
- Hydrocarbon open drain. Used to collect drain fluids (e.g. oil contaminated water) from hydrocarbon areas and to route them to the slop tank in the FPSO hull.

4.7.4.8 *Other*

Two deck cranes will be provided for supply boat offloading and materials handling and to support general maintenance activities. Workshops, a laboratory capable of checking the properties of the produced and injection fluids as well as

select discharges for compliance, medical facility, and storage facility for supplies and spare parts will also be provided. Heating, Ventilation, and Air Conditioning (HVAC) systems will be provided for buildings and enclosures.

4.7.5 Power Generation System

The required power for the FPSO will be generated by three systems as follows:

- The main power generation system shall be gas turbine driven generator sets with spares available in the case of unplanned downtime. All generator sets will be dual fuel (diesel, produced gas) capable to allow for restoring power to the facility ;
- The essential services power generation system will be a diesel driven generator set. Essential services include systems required for facility restart and for flow assurance hydrate mitigation activities after an unplanned shutdown; and
- The vessel emergency power generator set will be diesel driven and will provide power to both the hull and topsides emergency systems (e.g., safety systems including emergency lighting, telecommunication, etc.).

Additionally, for back-up power during emergency situations, the uninterruptible power supply system will be provided to power equipment such as the Integrated Control and Safety System, subsea controls, etc.

4.7.6 Integrated Control and Safety System (ICSS)

Monitoring and control of the FPSO production operations will be performed by an integrated control and safety system (ICSS). Located in the main control room of the FPSO, the ICSS will include process shutdown, emergency shutdown, and fire and gas systems to protect the facilities and personnel. These systems will interface to a public address and general alarm system to provide distinct audible and visual alarm notification.

The ICSS includes the following subsystems:

- Process Control System (PCS): The PCS shall perform primary process control, monitoring, and data acquisition functions;
- Safety Instrumented System (SIS): The SIS will implement functions for abandoning the host facility, emergency shutdown, fire and gas detection, and process shutdown. Also included in the SIS shall be a shutdown function to the subsea control / safety system. The SIS shall provide detection, logic sequencing, and actuation of devices to place the facility in a safe state;
- Fire and Gas system;

- Alarm Management System;
- Operator graphics / consoles; and
- Third-party interfaces to packaged systems (such as compressors, subsea, marine, etc.).

4.7.7 Communication Systems

Telecommunications equipment will be installed on the FPSO to enable safe operation of the facilities in normal and emergency conditions. This equipment will allow communication with the shorebase, support vessels, helicopters, and tankers as well as communication within the FPSO.

4.7.8 Additional Vessel Systems

4.7.8.1 FPSO Cargo Systems

The main purpose of the cargo system shall be:

- To receive, distribute, and store on-specification crude oil from the process facilities into the FPSO cargo tanks;
- To receive and store off-specification crude oil from the process facilities into a designated FPSO cargo tank; and
- To offload the crude oil stored in the FPSO cargo tanks into a conventional tanker at regular intervals.

In addition to the FPSO cargo tanks, there will be a slop tank to receive stripping water from the cargo tanks and discharge from the topsides non-hazardous and hazardous drain system. The oil and water will be gravity separated by a minimum residence and retention time. Once separated, the oil will be skimmed off the top and sent to the cargo tanks and the clean water will be discharged overboard to specification.

The FPSO cargo tanks will be blanketed with inert gas. As depicted in Figure 4.17, a tank vent system will be provided to release vapor and inert gas from the cargo tanks to a safe location, toward the bow of the FPSO, to prevent an overpressure event in the tanks.

The marine cargo system supports the following routine activities:

- Flushing of the crude oil offloading export hose;
- Emergency and temporary ballasting of FPSO cargo tanks with seawater; and

- Inspection and maintenance of FPSO cargo tanks and piping systems between offloading operations.

4.7.8.2 Custody Transfer Meter

For offloading, crude will be pumped from the FPSO hull storage tanks through a custody transfer metering package in the topsides and into the offloading system at a rate sufficient to achieve transfer of approximately 1 million barrels of oil in approximately 28 hours up to a VLCC class tanker size.

4.7.8.3 Crude Oil Offloading

Export of the crude oil from the FPSO will be via a floating hose to the midship manifold of a conventional tanker. The FPSO will be configured for tandem offloading to a conventional tanker. The separation distance between the stern of the FPSO and the conventional tanker will be approximately 120m (390 feet). The maximum conventional tanker size envisioned is a VLCC class. During offloading operations, the conventional tanker will maneuver and hold station relative to the FPSO with the assistance of up to three assistance tugs as shown in Figure 4.19. Crude will be transported to buyers' final location by the conventional tankers after each offloading operation.

Figure 4.19 General Offloading Configuration



4.7.8.4 Ballast System

Ballast water will be required during the transit from the shipyard to the site. Once on site, the un-needed ballast water from the FPSO may be discharged overboard in accordance with International Maritime Organization (IMO) standards.

4.7.9 Spread Mooring System

The FPSO will be permanently moored by fixed, spread mooring with up to a 20 point mooring line system each connected to their respective anchor pile embedded into the seafloor. The anchor piles will be either suction piles or driven piles. The mooring system will be designed to maintain the FPSO on station for a 100-year environmental condition.

4.7.10 Safety and Personnel Protection Systems

Safety systems will include:

- Firewater System – The firewater system will have one pump each located at the fore and aft ends of the FPSO, with one pump serving as a redundant backup.
- Fire and Gas Detection Systems – Fire and smoke detectors will be located throughout the topsides and living quarters and will be wired centrally with alarms sounding in the central control room, which will activate the general alarm system on the FPSO. Gas detectors will be placed in areas where gas might be released or could accumulate.
- Blanket Gas Generation – To prevent fires, the cargo tanks will be operated with an inert gas blanket at all times except during tank entry. The inert gas for cargo tanks will be supplied by an inert gas system utilizing flue gas from the marine boilers. To provide gas blanketing for other spaces, including the methanol and xylene tanks, inert gas will be provided by routing compressed air through the nitrogen membrane package.
- Lifeboats and Life Rafts – The FPSO will be provided with lifeboats on either side of the accommodation, having a capacity on each side for 100 percent of the personnel on board. A fast rescue boat will also be provided, complete with a davit launching and retrieving system.

4.8 Installation, Hookup, and Commissioning

Final development of the installation, hook-up, and commissioning activities for the SURF, FPSO, and associated moorings has not been completed, but will include the general elements listed below. The sequence and duration of each installation, hook-up, and commissioning activity will be further defined as part of ongoing Project planning and development. The final sequence and durations of activities will depend on a number of factors, including, but not limited to, final Project design, marine vessel and equipment availability, mobilization times, weather, etc. Key installation, hook-up, and commissioning activities will include:

- FPSO Mooring Installation – Installation of the FPSO’s anchor piles and mooring lines. Following installation, the mooring lines will be staged on the seafloor until arrival of the FPSO;
- Flowline/Riser Installation – Installation of the production, water injection, and gas injection flowlines and risers. These components will be cleaned, tested to verify and ensure integrity after installation, and then staged on the seafloor until arrival of the FPSO;
- FPSO Positioning and Mooring Connection – Positioning of the FPSO using support tugs followed by retrieval of the FPSO mooring lines from the seafloor and hook-up of the FPSO to its mooring system;
- Manifold/Drill Center Components – Installation of the manifold foundation piles and subsea components at the drill centers and tested to verify the integrity after installation;
- Umbilical Installation – Installation of the umbilical and SDU;
- Riser Connection – Retrieval from the seafloor, pull-in, and connection of the risers to the FPSO; and
- Testing and Commissioning – Testing and commissioning of the connected, integrated FPSO and SURF production systems, including testing and de-watering / displacing flowlines and umbilicals with commissioning fluids and testing SURF control and shutdown systems.

The above activities will be executed in an optimal sequence with activities completed in parallel where possible.

During the installation stage, a remotely operated vehicle (ROV) may be periodically utilized to support the above mentioned activities (e.g., underwater observations, connections, sampling, etc.).

4.9 Production Operations

The Project will include a leased FPSO, owned and operated by the FPSO contractor, and a subsea development, owned by EEPGL but operated by the FPSO contractor under the direction of EEPGL. Throughout production operations, EEPGL's personnel will perform oversight and monitoring of the FPSO contractor to ensure that management systems pertinent to safety, the environment, and operations integrity are properly implemented. To accomplish this, EEPGL plans to utilize an onboard representative supported by operational and technical specialists to monitor, and direct as necessary, operations of the FPSO and SURF facilities.

Operating processes will include flowing the hydrocarbon wellstream from the reservoir to the FPSO, where further fluid separation, stabilization, storage, and management will occur prior to offloading the crude oil to the conventional tankers. General maintenance of the FPSO and SURF components will also be performed. Some industry standard chemicals will be required as part of the processing of the oil on the FPSO. Both the FPSO and SURF facilities will also require the use of industry standard additives to provide flow assurance and prevent corrosion, scale, hydrate, and asphaltene formation as previously noted in Section 4.7.4.4 and described in Section 4.9.1.

The exact chemical requirements and quantities will be determined as part of the ongoing FPSO and SURF facilities design work, and will be addressed in the EIA process. Particular attention will be paid to scenarios that could result in flow instabilities, restrictions or blockages, or which could jeopardize the integrity of the fluid transfer systems or reduce overall system operability. The objective of the following sections is to provide a general overview of the flow assurance challenges and strategies.

4.9.1 Common Flow Assurance Additives

4.9.1.1 Hydrates

Ambient seafloor temperatures in the Liza PDA are sufficiently cold that hydrates could form. To prevent the formation of hydrates, a combination of inhibitor (methanol), thermal insulation, and operating practices will be utilized.

4.9.1.2 Paraffin and Asphaltenes

Paraffin (wax) inhibitors may be periodically injected downhole to manage any potential deposition in the production flowlines and risers. Asphaltene inhibitors may also be mixed with wax inhibitors for downhole injection. Xylene and/or

toluene may also be injected into the production wells for remediating any potential asphaltene deposition. Pigging operations with or without xylene may also be used for remediating any asphaltene deposition in the production flowline and riser.

4.9.1.3 Scale Control

Scaling potential for Liza wells is currently being investigated. Provisions to inject scale inhibitor downhole for production wells are in the current design.

4.9.1.4 Corrosion Control

Corrosion inhibitors will be used as needed and will be injected at wellheads and/or production manifolds to protect subsea equipment, flowlines, and risers.

4.9.2 Hydrogen Sulfide (H₂S) Management

The concentration of H₂S will be extremely low for the initial stage (i.e., 5-10 years) of FPSO/SURF production operations. There may be potential for the reservoir to sour over time, which influences material selection and corrosion inhibition for certain FPSO, SURF, and drilling systems. In the unlikely event that concentrations of H₂S increase to a level that could represent potential health or safety concerns for the Project's offshore workforce, additional management measures will be implemented as appropriate (e.g., training programs, personal protective equipment, response planning, and equipment for leak detection and alarms).

4.9.3 Marine Safety

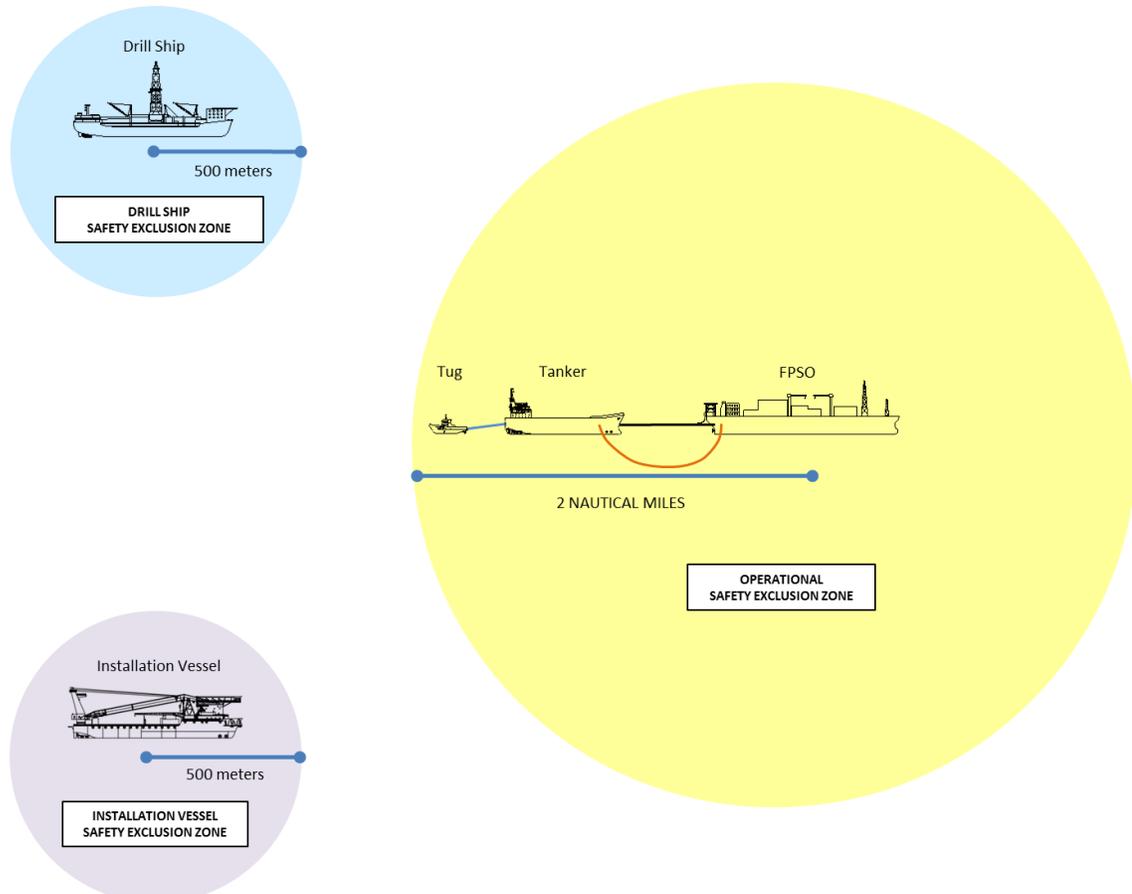
The Maritime Administration (MARAD) of the Ministry of Public Infrastructure is responsible for issuing notices to mariners concerning safety at sea.

MARAD will be advised of the location of drill ships during the drilling of the development wells and the performance of well workovers in the PDA, so that mariners are aware of these activities. Marine safety exclusion zones with a 500 meter radius will be established around drill ships during drilling operations and around drill centers during well workovers, as well as around major installation vessels in accordance with industry standards and practices.

Authorizations for in water activities will be obtained from MARAD and notices to mariners issued for all marine vessels including the FPSO, supply and support vessels, tugs and those vessels to be utilized during the installation, hook-up, and commissioning stage.

As shown in Figure 4.20, during the production operations stage the FPSO will have a 2 nautical mile radius encircling the vessel where marine support and tanker offloading will occur. No unauthorized vessels will be allowed to enter this approximately 4,000 ha operational marine safety exclusion zone.

Figure 4.20 *Preliminary Marine Safety Exclusion Zones During Drilling and Offloading Operations*



4.9.4 Offloading Tankers

Conventional tankers supporting offloading operations typically arrive anywhere from one day to several hours ahead of the scheduled loading time, as a function of weather and ocean conditions. To accommodate these vessels, an anchorage area will be established several kilometers away from the FPSO. When the tanker is ready to approach, a Mooring Master will board the conventional tanker

approximately 2km from the FPSO, in order to guide the conventional tanker to the FPSO and to support the offloading operation. The conventional tankers will export the crude oil for sale after offloading operations have been completed. Conventional tankers will be owned/operated by others and will not be dedicated to the Project.

4.9.5 Onshore Supply and Support Activities

Shorebases, laydown areas, pipe yards, warehouses, fuel supply, heliport, and waste management facilities are planned to be used to support development drilling, FPSO/SURF installation, production operations, and ultimately decommissioning. These onshore facilities will be owned/operated by others and will not be dedicated to the Project. The specific shorebase(s) and onshore support facilities (e.g., warehouses, laydown yards) to be utilized in Guyana have not yet been identified by EEPGL. A preliminary foot print estimate for onshore staging and storage is approximately 30,000-50,000 m². However, the final area required will be determined as the Project development plan progresses.

Accordingly, ERM will perform the impact assessment on the basis that the Project will utilize existing shorebase(s) located in Georgetown. Should any new or expanded shorebase(s) or onshore support facilities be utilized, the construction/expansion and any required dredging, as well as the associated environmental authorization, of such facilities would be the responsibility of the owner/operator and such work scope would not be included in the scope of the EIA.

A typical shorebase quay is shown in Figure 4.21, and a typical laydown yard is shown in Figure 4.22. Where existing Guyana shorebase(s) do not have the technical and/or capacity requirements to support Project activities, EEPGL will potentially consider the use of other onshore support facilities and services in Guyana, as identified and deemed necessary. Additional logistical support may be provided by other regional suppliers outside of Guyana, as informed by inputs from EEPGL contractors after contract award, to address Project needs (e.g., deepwater port access in Trinidad).

Onshore facilities to be utilized will include pier/port/quayside space with sufficient draft for receipt of cargo vessels bringing materials to and from the shorebase, and marine support vessels will be used to service the offshore activities and operations. A marine berth and secure warehousing space for indoor and outdoor storage of materials and goods, trucking, stevedoring, freight forwarding, customs logistics, receiving, inspection and associated container handling and storage operations will also be utilized.

Daily activities and operations to be performed at the shorebase will generally include:

- Storage of pipe, equipment, and spares;
- Loading and unloading cargo from trucks and marine vessels;
- Use of cranes and other lifting equipment;
- Bulk storage of chemicals, fuels, and industrial consumables;
- Potential operation of a cement and drilling fluids and mud plant to support offshore drilling operations; and
- Secure handling and storage of wastes pending final recycling, treatment, or disposal.

Most of the major SURF equipment will be shipped preassembled and pre-tested directly to the offshore Project site from their points of origin. Other minor equipment, supplies and materials may be temporarily staged at shorebases, laydown yards, and warehouses until transferred offshore for installation or use. The owners/operators of these contracted facilities will be required to seek environmental authorization for any changes to current operations (e.g., bulk storage of chemicals and fuels).

Figure 4.21 Typical Shorebase Quay



Figure 4.22 Typical Laydown Yard



Support and supply vessels will require sufficient water depths to transit between the Liza field and the shorebase. There is potential for some initial and periodic maintenance dredging to be performed by the shorebase owner/operator.

4.9.6 Logistical Support

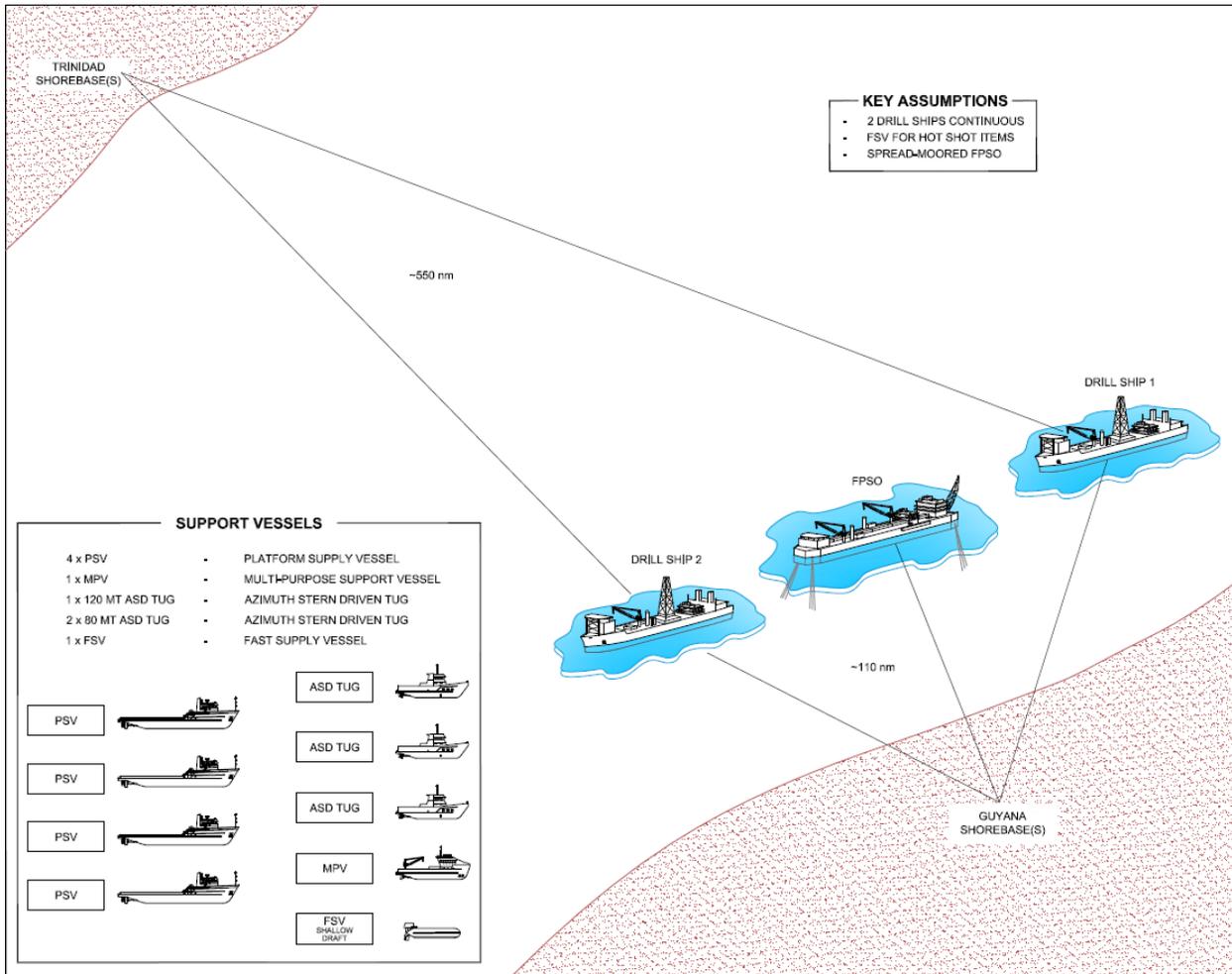
An average of 10 round-trip helicopter flights is currently being made per week to support ongoing exploration drilling activities. It is estimated that during development drilling and FPSO/SURF installation, an incremental 20-25 flights per week will be added, for a total of 30-35 round-trip flights per week. During FPSO/SURF production operations, an estimated 20-25 round-trip flights per week will be necessary to support FPSO/SURF production operations and development drilling activities.

There will be a variety of marine and aviation support equipment supporting the FPSO, installation vessels, and drill ship, as shown in Figure 4.23. The support vessels will consist of Platform Supply Vessels (PSV) and a Fast Supply Vessel (FSV) conducting re-supply trips to the FPSO and drill ships, tug vessels supporting tanker offloading activities, and Multi-Purpose Vessels (MPV) supporting subsea installation and maintenance activities. Based on current drilling activities and past experience with similar developments, it is estimated that during development drilling and FPSO/SURF installation, an average of 12 trips per week may be made to the PDA. During FPSO/SURF production operations, it is estimated that this number will be reduced to 7 trips per week. The vessels are planned to be loaded and offloaded at shorebase facilities in Guyana and/or Trinidad. Figure 4.24 depicts a conceptual diagram of the number and types of logistical support equipment that will be utilized to support the Project.

Figure 4.23 Typical Logistics Support Vessels



Figure 4.24 Potential Drilling and Operations Stage Peak Fleet Profile



4.9.7 Waste Management

Waste generated offshore will be reduced, recycled, and treated offshore where practicable, with the remainder directed for onshore treatment, recycling, reuse, or disposal. For the exploration drilling program, EEPGL is currently utilizing a regional supplier who is operating an existing waste management facility at a local shorebase in Georgetown, Guyana (See Figures 4.25 and 4.26). The Project is planning to utilize similar facilities in Guyana or the region during the development drilling and FPSO/SURF production operations stages. EEPGL would potentially consider the use of alternative Guyanese or regional waste management services according to Project needs, should they become available in the future. All waste streams will be managed in accordance with the Waste Management Plan that will be part of the Project Environmental and Socioeconomic Management Plan (ESMP).

Figure 4.25 Typical Waste Management Facilities at a Local Shorebase



Figure 4.26 Vertical Infrared Unit with Wet Scrubber and Oxidizer at Typical Waste Management Facilities



4.10 End of Phase 1 Operations (Decommissioning)

As part of the EIA, a conceptual End of Operations Decommissioning Plan will be provided. In advance of the completion of the Phase 1 production operations stage, EEPGL will prepare a decommissioning plan for the facility in compliance with the laws and regulations in effect at that time, while also considering the technology available at that time. The decommissioning plan and strategy will be based on a notice of the intent for decommissioning the production facilities and plugging and abandonment (P&A) of the development wells, which will be provided to the GGMC and EPA to obtain approval in accordance with the requirements of the Guyana Petroleum (Exploration and Production) Act (1998) and EP Act (Cap. 20:05).

EEPGL will be required to perform inspections, surveys and testing to assess and report to the EPA the conditions that will provide the basis and required information to prepare a plan for decommissioning. All risers, pipelines, umbilicals, subsea equipment, and topside equipment will be required to operate safely and properly isolated, de-energized, and cleaned to remove hydrocarbons and other hazardous materials to a suitable level prior to being taken out of service.

Near the time of decommissioning, EEPGL will work with the EPA and the GGMC to select the final decommissioning strategy based on a comparative assessment, which is designed to evaluate the potential safety, environmental, technical, and economic impacts and associated mitigation measures in order to finalize the decommissioning plan.

EEPGL will be required to describe how they will permanently plug and abandon wells by restoring suitable cap rock to prevent escape of hydrocarbons to the environment in the Final Decommissioning Plan. Plugging and abandoning (P&A) barriers will be installed in the wellbore, of adequate length to contain reservoir fluids and deep enough to resist being bypassed by fracturing. The number of barriers required will depend on the distribution of hydrocarbon-bearing permeable zones within the wellbore.

It is expected that the risers, pipelines, umbilicals, subsea equipment, FPSO mooring lines and anchor piles will be disconnected and abandoned in place on the seafloor, unless an alternative strategy is selected based on the results of the comparative assessments.

The FPSO will be disconnected from its mooring system, removed from the production location, and towed to a new location for re-use or decommissioning.

Selected waste streams associated with decommissioning activities, including hazardous and non-hazardous wastes, will be managed and disposed in accordance with standard industry practice and applicable regulations. Methods may include injection downhole into the reservoir, separation and incineration offshore, or transport to onshore waste management facilities for disposal in accordance with standard industry practice and applicable regulations.

4.11 Alternatives

The EIA will consider a range of potential Project alternatives, including:

- Location alternatives for the development wells;
- Development concept alternatives, including:

- Facility type (e.g., FPSO, FSO),
- Gas disposition (e.g., re-injection, flaring);
- Technology alternatives – use of industry-proven technology;
- No-go alternative – what would happen without the Project.

5.0 Administrative Framework

The Project will be regulated under several Guyanese statutes. These statutes contain requirements that must be implemented to ensure compliance with the applicable laws and regulations of Guyana. The EIA will include a summary of the relevant national legislation, regulations, policies, treaty obligations, and environmental, socioeconomic, and health standards in Guyana that would apply to the Project.

This section reviews the relevant laws and regulations in Guyana that are applicable to the Project and is divided into four subsections. The first subsection describes the national legal framework, consisting of laws and regulations which apply to environmental issues in a general context such as the Constitution of Guyana, as well as specific national laws that focus specifically on environmental issues such as the EP Act (Cap 20:05). This subsection also identifies several resource specific environmental laws that are more narrowly focused and have either direct or indirect relevance to the Project.

The second subsection describes the specific environmental and social laws in Guyana that apply to physical, biological, and socioeconomic resources, as well as how those laws may be relevant to the Project.

The third subsection describes the national policy framework, consisting of strategies and policies that apply to the Project. These strategies and policies articulate the government's management goals with respect to various environmental issues.

Additionally, Guyana is a signatory to a number of international and regional conventions and protocols aimed at addressing environmental concerns. The fourth subsection discusses the international conventions and protocols that are relevant to the Project.

5.1 National Legal Framework

This section provides an overview of the key legislation currently in force in Guyana that pertain to resources that could be affected by the Project.

5.1.1 National Constitution of Guyana

Guyana is governed according to the Constitution of the Co-operative Republic of Guyana, as amended. The constitution took effect in 1980 and expressly provides for protection of the environment. Article 25 establishes “improvement of the environment” as a general duty of the citizenry. In addition, Article 36 reads as follows:

"In the interests of the present and future generations, the State will protect and make rational use of its land, mineral and water resources, as well as its fauna and flora, and will take all appropriate measures to conserve and improve the environment."
(OAS, 2013).

5.1.2 The Environmental Protection Act

In 1996, the EP Act (Cap. 20:05) was enacted to implement the environmental provisions of the Constitution. The EP Act (Cap. 20:05) is Guyana’s single most significant piece of environmental legislation because it articulates national policy on important environmental topics such as pollution control, the requirements for environmental review of projects that could potentially impact the environment, and the penalties for environmental infractions. It also provides for the establishment of an environmental trust fund. Most importantly, the EP Act (Cap. 20:05) authorized the formation of the EPA, and establishes the EPA as the lead agency on environmental matters in Guyana (FAO, 2013). The EPA is one of the agencies included within the Ministry of Natural Resources. The EP Act (Cap. 20:05) further mandates the EPA to oversee the effective management, conservation, protection and improvement of the environment (EPA, 2012). It also requires the EPA to take the necessary measures to ensure the prevention and control of pollution, assessment of the impact of economic development on the environment, and the sustainable use of natural resources.

The EPA has issued an official guidance document entitled “Environmental Impact Assessment Guidelines” which describes the general components and content of a typical EIA. The EIA for the Project will be prepared consistent with the recommendations in this document.

5.1.3 The Guyana Geology and Mines Commission Act

The Guyana Geology and Mines Commission Act was enacted in 1979 and authorized the government to establish the GGMC, which is also within the Ministry of Natural Resources. The GGMC promotes and regulates the

exploration and development of the country's mineral resources. The GGMC has a dedicated Petroleum Unit charged specifically with regulatory supervision of the oil and gas sector; however petroleum related activities also occur in other divisions, such as the Geological Services division and the Environment Division.

5.1.4 *The Petroleum Act*

The Petroleum (Exploration and Production) Act was enacted in 1986 to regulate the prospecting for and production of petroleum in Guyana, including the territorial sea, continental shelf, and exclusive economic zone. This act identifies persons allowed to hold prospecting licenses, establishes the process for obtaining prospecting licenses, and specifies requirements for further resource development in the event petroleum resources are discovered.

The GGMC has a dedicated Petroleum Unit charged specifically with regulatory supervision of the oil and gas sector; however, petroleum-related activities also occur in other divisions, such as the Geological Services Division and the Environment Division. In 2012, the Commonwealth Secretariat was commissioned by the Government's then Ministry of Natural Resources and Environment, now the Ministry of Natural Resources, to prepare recommendations to reform Guyana's regulatory regime that governs the upstream petroleum sector. In September 2015, the Minister of Governance (via the GGMC's Petroleum Unit) announced plans to upgrade the country's upstream oil and gas policy, which was originally crafted in 2012 and finalized in 2014. In June 2016, the Ministry of Natural Resources completed a new national oil and gas policy and announced pending revisions to the Petroleum Act. These revisions were due for consideration by Guyana's National Assembly before the end of 2016 (Kaieteur News, 2016) but had not been presented for approval as of February 2017. In late January 2017, Guyana's Government Information Agency (GINA) announced the Ministry of Natural Resources' plan to conduct a national outreach program to provide information to the public and answer questions on the emerging oil and gas sector (GINA, 2017).

5.2 *Other Resource-Specific National Environmental and Social Laws*

Several Guyanese environmental laws with more narrowly defined scopes pertain to specific biological or physical natural resources. Other laws which primarily have a public health related focus are also indirectly related to the environment. Several of Guyana's environmental statutes were enacted prior to the 1980 Constitution and were subsequently incorporated into the newly formed national legal framework, but most were enacted after 1980. Table 5.1 identifies these laws and summarizes their relevance to the Project. The EIA/ESMP will describe in greater detail the Project's compliance with these laws and regulations.

Table 5.1 Resource-Specific Environmental and Social Laws

Title	Objective	Relevance to the Project
<i>Biological Resources</i>		
Fisheries Act, 2002	Regulates fishing and related activities in Guyana territorial waters.	Section 33(1) of the Fisheries Act authorizes the prohibition and/or regulation of deposition or discharge of substances harmful to fish.
Wild Birds Protection Act, 1987	Protects listed wild birds in Guyana.	Section 3 and 6 prohibit knowingly wounding or killing wild birds listed in the First and Second Schedule of the Act and establishes penalties.
Species Protection Regulations, 1999	Provides for the establishment of a Management Authority and a Scientific Authority in compliance with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).	Provides for wildlife protection, conservation, and management.
Wildlife Management and Conservation Regulations, 2013 (recently supplemented by passing of Wildlife Conservation and Management Bill, 2016)	Provides for the establishment of a Management Authority and the management of the country's flora and fauna.	Provides a supportive mechanism cognizant of the national goals for wildlife protection, conservation, management and sustainable use.
<i>Physical Resources</i>		
Environmental Protection Water Quality Regulations, 2000	Focused on setting effluent standards, reporting requirements, penalties for violations of standards, and permitting requirements for discharges.	Regulates discharges of listed substances, which could include substances used during the Project.
Environmental Protection Air Quality Regulations, 2000	Sets ambient air quality standards, reporting requirements, penalties for violations of standards, and permitting requirements for stationary and mobile sources.	Regulates discharges that could be emitted during the Project, including smoke, particulates, and carbon monoxide (CO).
Environmental Protection Hazardous Waste Regulations, 2000	Establishes requirements for generating, handling, and disposing of hazardous waste as well as penalties for violations of these requirements.	Identifies wastes subject to regulation, including several types of waste that could be produced by the Project.

Title	Objective	Relevance to the Project
Toxic Chemicals Control Act No. 13 of 2000, as amended in 2007	Provides for the formation of a Pesticides and Toxic Chemicals Control Board. Establishes requirements for registration, licensure, and trade in pesticides and toxic chemicals. Amended in 2007 to provide rules for the exportation of pesticides and toxic chemicals.	Establishes regulations pertaining to the use of toxic chemicals and pesticides. Pesticides will not be required for this Project, but small amounts of chemicals may be used.
Environmental Protection Noise Management Regulations, 2000	Establishes general provisions for noise avoidance and restrictions from multiple commercial and industrial sources including sound making devices, night clubs, equipment, tools, and construction activities.	Tools and equipment includes pile drivers, steam shovels, pneumatic hammers, pumps, vent or valve devices and any other similar equipment. A regulated facility includes any offshore installation and any other installation, whether floating or resting on the seabed.
Draft Guyana Standard, Requirements for Industrial Effluent Discharge into the Environment, 2015	Compulsory standard used for monitoring of effluents into freshwater, estuarine, and marine water resources.	Sets limits for key parameters in discharges of industrial effluent.
<i>Public Health</i>		
Occupational Safety and Health Act, 1997	Legally defines the responsibilities of workers and management with respect to keeping workplaces safe.	Would generally apply to workers and Project related activities on the Project site(s).
Food & Drug Regulations (Food and Drug Act)	Regulates the sale, advertisement, preparation, and handling of food products. Regulates the manufacture, advertisement, trade, and administration of pharmaceuticals. Provides the Ministry of Health authority to inspect facilities to establish compliance with sanitation standards.	Governs the preparation of food and provision of medications at Project facilities.
<i>Social / Cultural Resources</i>		

Title	Objective	Relevance to the Project
National Trust Act	Stewardship of historic resources and places of cultural significance	Governs the management of any building, structure, object, or other man-made or natural feature that is of historic or national cultural significance that could be impacted by the Project. Includes shipwrecks and other marine features.

Most recently, the Minister of Governance, who functions as the sponsoring Minister for the Oil and Gas industry, announced plans in September 2015 to upgrade the country’s upstream oil and gas policy, which was originally crafted in 2012 and finalized in 2014, indicating an evolving policy and regulatory framework surrounding the oil and gas industry in Guyana.

To date, there are 16 laws concerning oil and gas in Guyana. The majority of these laws are housed with the EPA, National Advisory Council on Occupational Safety and Health, Guyana Revenue Authority, or GGMC.

5.3 National Policy Framework

Guyana’s government has articulated national policies on several environmental and social topics that are relevant to the Project. This section provides an overview of the key government policies applicable to the Project.

5.3.1 National Development Strategy

The National Development Strategy (NDS) sets priorities for Guyana's economic and social development policies for the next decade. The draft document contains technical analysis of problems and future prospects in all sectors of the economy and in areas of social concern.

The NDS contains six volumes. Volumes 3 and 5 are the most relevant to the Project. Volume 3 of the NDS sets government policy with regard to the environment as well as social equality issues. It identifies 12 distinct “features” of Guyana’s natural resources and environment, and sets policies governing the management of each feature. Relevant features to this Project covered under Volume 3 include the coastal zone, fisheries, waste management, pollution control, and environmental impacts of private-sector activities (NDS, 1997).

Volume 5 relates in part to the energy sector. It describes the condition of the energy sector in Guyana, reviews past government policies related to the energy

sector, identifies challenges facing the energy sector in Guyana, and describes the government's vision for future development and regulation of the sector (NDS, 1997).

5.3.2 *National Environmental Action Plan*

Guyana's National Environmental Action Plan (NEAP) articulates the national government's approach to managing the environment from the perspective of economic development. The NEAP considers the issues of environmental management, economic development, social justice, and public health to be inextricably linked. It identifies deforestation, pollution, and unregulated gold mining as historically minor but with growing environmental problems, and identifies private sector investment as one of the primary opportunities to generate the necessary capacity within Guyana to 1) provide an appropriate level of public services to its citizens; 2) reduce and/or eliminate the avoidable environmental degradation that occurs when resource development occurs in a regulatory vacuum; and 3) reduce unsustainable uses of natural resources due to the socioeconomic pressures of widespread poverty.

The NEAP is directly relevant to the Project in several ways. It identifies the coastal zone, which will support Project activities, as an area in need of focused management action due to the concentrated human population along the coast and the susceptibility of the coastal environment to both natural and human-induced degradation. It identifies private sector-led development projects as a mechanism to build capacity and ultimately support more responsible environmental management. Finally, it identifies petroleum resources as a potential target for development.

5.3.3 *Integrated Coastal Zone Management Action Plan*

Guyana's Integrated Coastal Zone Management (ICZM) process is an ongoing initiative to: promote the wise use, development and protection of coastal and marine resources; enhance collaboration among sectorial agencies, and promote economic development. In 2000, after two years of study, the ICZM committee produced an ICZM Action Plan, which was approved by Cabinet in 2001.

The ICZM Action Plan addresses policy development, analysis and planning, coordination, public awareness building and education, control and compliance, monitoring and measurement and information management (GLSC, 2006). Other coastal-zone related tasks currently being undertaken by the Government include: strengthening the institutional setup for ICZM; conducting a public awareness campaign to increase public understanding of the vulnerability of the coastal zone to sea level rise and climate change; and creating a database of

coastal resources to facilitate improved ICZM. Currently, the EPA is mandated to coordinate the ICZM program and coordinate the development of the ICZM Action Plan through the ICZM Committee.

Under the Caribbean Planning for Adaptation to Climate Change project, Guyana has also conducted a socioeconomic assessment of sea-level rise as part of a wider vulnerability assessment and developed a Climate Change Adaptation Policy and Implementation Strategy for coastal and low-lying areas.

5.3.4 Protected Areas Act

The Protected Areas Act was enacted in 2011. It provides for protection and conservation of Guyana's natural heritage and natural capital through a national network of protected areas, and established a Protected Areas Commission to oversee the management of this network. It also highlights the importance of maintaining ecosystem services of national and global importance and public participation in protected areas and conservation, and it establishes a protected areas trust fund to ensure adequate financial support for maintenance of the network. Other functions of this Act include promoting national pride in and encouraging stewardship of Guyana's natural heritage, recognizing the conservation efforts and achievements of Amerindian Villages and Amerindian Communities, and promoting the recovery and rehabilitation of vulnerable, threatened, and endangered species.

5.3.5 Guyana's National Biodiversity Strategy and Action Plan (NBSAP)

Guyana's current National Biodiversity Strategy and Action Plan was formally adopted in 2015, and is the third iteration of the NBSAP. It establishes the national vision for biodiversity, which is to sustainably utilize, manage, and mainstream biodiversity by 2030, thereby contributing to the advancement of Guyana's bio-security, and socio-economic and low carbon development. It is intended to guide national policy with respect to biodiversity through 2020. It recognizes the importance of biodiversity to the growing ecotourism industry and other economic sectors. It also simultaneously recognized the importance of the mining industry to the national economy and the potential for conflicts between the mining industry and ecotourism if land degradation is associated with mining activity is not appropriately managed. The NBSAP set forth nine strategic objectives intended to promote conservation and sustainability on a national scale, improve biodiversity monitoring, harmonize legal and policy-based mechanisms across all levels of government to support biodiversity conservation, and prioritize funding to meet these objectives.

5.3.6 Low Carbon Development Strategy and the Green Economy

In June 2009, the Government of Guyana announced the Low Carbon Development Strategy (LCDS). The LCDS aims to protect and maintain the forests in an effort to reduce global carbon emissions and at the same time attract payments from developed countries for the climate services that the forests provide. In 2013 the LCDS was updated to focus on two main goals: (1) transforming the national economy to deliver greater economic and social development by following a low carbon development path while simultaneously combating climate change (2) providing a model for the world of how climate change can be addressed through low carbon development in developing countries. The LCDS identifies Reducing Deforestation and Forest Degradation Plus (REDD+) as a primary mechanism for achieving the goals of the strategy.

Although there is no formal government plan for achieving a “green economy”, the Government of Guyana has expressed interest in the concept. President David Granger has defined the “green economy” as consisting of the four “pillars” of energy, environmental security, ecological services, and enterprise and employment (Kaieteur News, 2016). The LCDS provides the conceptual framework for implementing the “green economy”.

5.3.7 Guyana Energy Agency’s Strategic Plan

The Guyana Energy Agency (GEA) was established by the Guyana Energy Agency Act of 1997 with a mandate to advise the Prime Minister on energy related issues, develop a national energy policy, improve energy efficiency, monitor the energy sector, and educate the public on energy efficiency and renewable energy (GEA, undated). The GEA’s Strategic Plan for 2014-2018 specifically charges the Agency with monitoring “the production, importation, distribution, and utilization of petroleum and petroleum products.”

5.4 International Conventions and Protocols

Guyana is signatory to a number of international agreements and conventions relating to environmental management and community rights, although not all of these agreements have been translated into national legislation. The key agreements relevant to the Project to which Guyana has acceded or is a signatory are listed in Table 5.2.

Guyana is a member state of two organizations that administer multiple international treaties and conventions: the International Labour Organization (ILO) and the International Maritime Organization (IMO). The ILO has established eight “fundamental” conventions which provide certain general

protections to workers in signatory states such as the right to organize, standards for remuneration, restrictions on child labor (including minimum ages to work), and protection from forced labor. In addition to these fundamental agreements, Guyana is signatory to several specific agreements that would govern certain specific aspects of the Project as they relate to labor.

The IMO is a similar organization whose member states have agreed to one or more conventions related to maritime activities. These include three “key” conventions (the International Convention for the Safety of Life at Sea, the International Convention for the Prevention of Pollution from Ships, and the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers) as well as several other agreements concerning more specific aspects of maritime activity such as safety and security at sea, maritime pollution, and liability for maritime casualties. Guyana’s Maritime Administration manages compliance with the requirements of the agreements Guyana is signatory to under the IMO, with technical assistance from the IMO’s Regional Maritime Advisory Office in Port of Spain, Trinidad.

The agreements to which Guyana is party through its membership in the ILO and IMO are identified in bold in Table 5.2.

Table 5.2 International Agreements Relevant to Environmental and Socioeconomic Issues in Guyana

Agreement/ Convention	Objective	Status	Relevance to Project
Climate Change/Air Quality			
United Nations Framework Convention on Climate Change	Promote international cooperation to limit average temperature increases and resulting changes in climate. Promote international cooperation to adapt to these impacts.	Acceded and ratified in 1994	Provides for controls on greenhouse gas emissions within Guyana's territory (maritime and land), and establishes national policy regarding adaptation to climate change. Guyana's Intended Nationally Determined Contributions under the convention are focused on preserving the country's forests as a carbon sink and include avoiding deforestation, minimizing emissions from forestry and mining operations, expansion of renewable energy sources, and integrated water resource management.
Kyoto Protocol	Extends the UNFCCC and commits countries to reduce greenhouse gas emissions.	Acceded in 2003	Establishes national emission reduction targets.
Vienna Convention on the Protection of the Ozone Layer	Provides a framework for the protection of the ozone layer.	Acceded in 1993	Establishes measures for protecting the ozone layer.

Agreement/ Convention	Objective	Status	Relevance to Project
Montreal Protocol on Substances that Deplete the Ozone Layer	Is a protocol to the Vienna Convention and is designed to protect the ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion.	Acceded in 1993	Prohibits the use of several groups of halogenated hydrocarbons that may deplete the ozone layer.
Pollution Prevention			
International Convention for the Prevention of Pollution from Ships	Regulates various forms of marine pollution, including oil and fuel, noxious liquid, hazardous substances, sewage, garbage, air emissions, and ballast water.	Acceded in 1997	Impacts the handling and disposition of controlled substances from the drill ships, FPSO, and support vessels.
International Convention for Safe Containers	Promote the safe transport and handling of containers through generally acceptable test procedures and related strength requirements, and facilitate the international transport of containers by providing uniform international safety regulations, equally applicable to all modes of surface transport.	Acceded in 1997	Regulates the manufacture, use, and integrity of containers used on board the drill ships, FPSO, and support vessels.
International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties	Confirms the right of coastal member states to take specific actions when necessary to prevent pollution from oil following a maritime casualty	Acceded in 1997	Would protect Guyana's rights to respond to an oil spill if such an event were to occur.

Agreement/ Convention	Objective	Status	Relevance to Project
International Convention on Civil Liability for Oil Pollution Damage	Establishes vessel owners' liability for damages caused by pollution from oil spills and provides for compensation would be available where oil pollution damage was caused by maritime casualties involving oil tankers	Acceded in 1997	Would not apply directly to EEPGL's activities, but would apply to potential spills from tankers that had received oil from the FPSO.
Basel Convention on the Transboundary Movement of Hazardous Wastes and Their Disposal	Reduce and control the movements of hazardous waste between nations and discourage transfer of hazardous waste from developed to less developed countries.	Acceded in 2001	Applies to the Project only if hazardous waste generated in Guyana were disposed outside Guyana, or if hazardous waste was brought into Guyana from a foreign state for disposal during execution of the Project.
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	Provides a mechanism for formally obtaining and disseminating decisions of party nations as to whether they wish to receive future shipments of listed chemicals, and for ensuring compliance with these decisions by exporting party nations.	Acceded June 2007	Applies to the Project only if chemicals and/or pesticides listed under the convention were shipped into or out of Guyana.
Stockholm Convention on Persistent Organic Pollutants, as amended	Requires party nations to take measures to eliminate or reduce the release of persistent organic pollutants.	Acceded September 2007	Applies to the Project only if POPs were released to the environment during the course of Project related activities in Guyana.

Agreement/ Convention	Objective	Status	Relevance to Project
International Convention on Oil Pollution Preparedness, Response and Cooperation	Establishes measures for dealing with marine oil pollution incidents	Ratified in 1997	Requires ships to have a shipboard oil pollution emergency plan.
Ecological/Environmental Quality			
The Cartagena Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region	Provide framework for international protection and development of the marine environment across the Caribbean region.	Acceded and Ratified in 2010	Sets general goals for protection for the marine environment, especially from pollution.
Protocol on Specially Protected Areas and Wildlife	Protocol supplementing and supporting the Cartagena Convention. Requires signatories to adopt an ecosystem approach to conservation. Provides mechanism for compliance with the Convention on Biological Diversity.	Acceded and Ratified in 2010	Elaborates on the wildlife goals established in the Cartagena Convention and Convention on Biological Diversity.
Convention on Biological Diversity	Promotes biological conservation within the framework of sustainable development and use of biological resources, and the fair and equitable sharing of benefits of genetic resources.	Signed in 1992, ratified in 1994	Discourages activities that would negatively impact biodiversity.

Agreement/ Convention	Objective	Status	Relevance to Project
United Nations Convention on the Law of the Sea	Defines nations' rights and responsibilities in terms of their use of oceans and provides guidance on environmental and natural resource management	Concluded in 1982 and ratified in 1994	Defines legal status of subsea mineral resources as the "common heritage of humankind," encourages resource development be done in a way that supports healthy global economic growth and trade balance, and mandates that states take measures to prevent, control and reduce pollution of the oceans.
Convention on International Trade in Endangered Species of Wild Flora and Fauna	Protects endangered plants and animals from international trade.	Acceded in 1977	Restricts collection and trade of endangered species.
UNESCO Convention on the Protection of the Underwater Cultural Heritage	Protects "all traces of human existence having a cultural, historical, or archaeological character" that have been under water for over 100 years.	Ratified in 2014	Applies to shipwrecks.
Labor/Health/Safety			
International Convention for the Safety of Life at Sea	Specifies minimum standards for the construction, equipment and operation of vessels, compatible with their safety. Allows governments of participating states to inspect vessels flagged in other participating states to ensure compliance.	Acceded in 1997	Affects construction, operation, and equipment onboard the drill ships, FPSO, installation vessels, and support vessels.

Agreement/ Convention	Objective	Status	Relevance to Project
Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation	Promotes safety at sea by criminalizing actions that would endanger a vessel or its cargo, or contributing to activities that would do so.	Acceded in 2003	Would apply to any activity intended to endanger vessels while at sea conducting permitted activities related the Project.
Dock Work Convention	Regulates activities associated with the loading and unloading of cargo onto/from oceangoing vessels when at port.	Acceded 1983	Would apply to loading and offloading activities at the shorebase.
Repatriation of Seafarers Convention (Revised)	Requires vessel owners/operators to repatriate (at the operator's expense) seafarers that have successfully concluded a minimum period of service onboard a vessel (minimum time to qualify for this benefit to be determined by the member state but not to exceed 12 months)	Acceded 1996	Would apply to workers onboard both EEPGL owned/operated vessels, their contractors, and tankers receiving oil from the FPSO.
Seafarer's Identify Documents Convention	Requires signatory states to issue identity cards to seafarers and for other signatory states to allow holders of these cards entry to their territories for the purposes of shore leave, joining a crew, or repatriation after completing a voyage.	Acceded 1966	Would apply to seafarers entering or egressing Guyana prior to or following employment on vessels operated by EEPGL or its contractors, and to seafarers on shore leave while employed by EEPGL or its contractors.

Agreement/ Convention	Objective	Status	Relevance to Project
Convention on the International Regulations for Preventing Collisions at Sea	Officially recognizes the importance of traffic separation in the marine environment and codifies basic measures to accommodate traffic separation, including safe speed, signalling conventions, and general vessel conduct.	Acceded in 1997	Governs operation of drill ships, FPSO, installation vessels, and support vessels.
International Convention on Standards of Training, Certification and Watchkeeping	Obligates crews operating vessels flagged in signatory states to adhere to minimum standards relating to training, certification and watchkeeping. Requires signatory states to submit detailed information to International Maritime Organization concerning administrative measures taken to ensure compliance with the convention.	Acceded in 1997	Impacts required capabilities of crew on board the drill ships, FPSO, installation vessels, and support vessels, and provides for inspection by authorities to ensure compliance.
Convention on Facilitation of International Maritime Traffic	Prevent unnecessary delays in maritime traffic arising from burdensome documentation requirements, and establish uniform formalities and other procedures to permit transboundary maritime commerce and travel.	Acceded in 1998	Facilitates entry of drill ships, FPSO, installation vessels, and support vessels into Guyana.

Guyana also belongs to other international organizations such as the Organization of American State, the International Monetary Fund, and the Caribbean Community.

To highlight Guyana's adherence to international standards and guidelines relevant to the oil and gas sector, in May 2010, the country announced its commitment to the implementation of the Extractive Industries Transparency Initiative and most recently, in September 2015, the country recommitted its support to the ILO.

6.0 *Scope of the Environmental Impact Assessment*⁸

The Environmental Impact Assessment will determine and address the types of activities and potential impacts associated with operations of the Project. These include, but are not limited to, development drilling operations, SURF and FPSO installation, oil and gas production operations, logistical support, and decommissioning.

In addition, the Project will include new activities associated with oil and gas production operations, relative to the current exploration program. Production-related components of the Project have required the collection of additional data and analysis to address their potential environmental and socioeconomic impacts.

The EIA will evaluate Project effects on potentially affected resources and receptors. Resources are defined as components of the physical (e.g., air quality, water quality, sound, marine sediments), biological (e.g., habitat, marine fish, mammals, turtles, benthos), and socioeconomic (e.g., employment, economy, infrastructure, health, wellbeing) environment. Those resources affected by the Project would be considered receptors of the impact.

6.1 *The Project Area of Influence*

The area potentially impacted by a project is referred to as its Area of Influence (AOI). The Project AOI can be divided into a direct and an indirect AOI, as described below:

- Direct AOI, within which the Project is expected to have direct impacts (Figure 6.1). This area includes: (1) the PDA (i.e., the Liza Phase 1 area including the subsea wells, SURF equipment, and the FPSO); (2) the marine transit corridors between the PDA and shore-based activity centers in Guyana and Trinidad; and (3) the City of Georgetown; and
- Indirect AOI, within which the Project is expected to have indirect impacts (Figure 6.2). This area includes: (1) coastal areas and marine waters within the territorial boundary of Guyana that could potentially be impacted by an unplanned event (i.e., an oil spill) and (2) coastal Regions 1 to 6 who could be impacted to a greater extent by the Project than the other regions because of their subsistence and commercial marine fisheries (e.g., potential impacts on

⁸Includes Environmental, Health, and Socioeconomics

fish and marine transport) and increased exposure to Project socioeconomic impacts.

The EIA will include a cumulative impact assessment, which will take into consideration incremental effects of the Project, when combined with other past, present, and reasonably foreseeable future projects/developments in the AOI, on all resources/receptors affected by the Project. Cumulative impacts can result from minor actions undertaken over a period of time that collectively represent a more substantial action. The geographical area of concern for the cumulative impacts analysis must be consistent with the Project AOI.

Figure 6.1 Direct Area of Influence

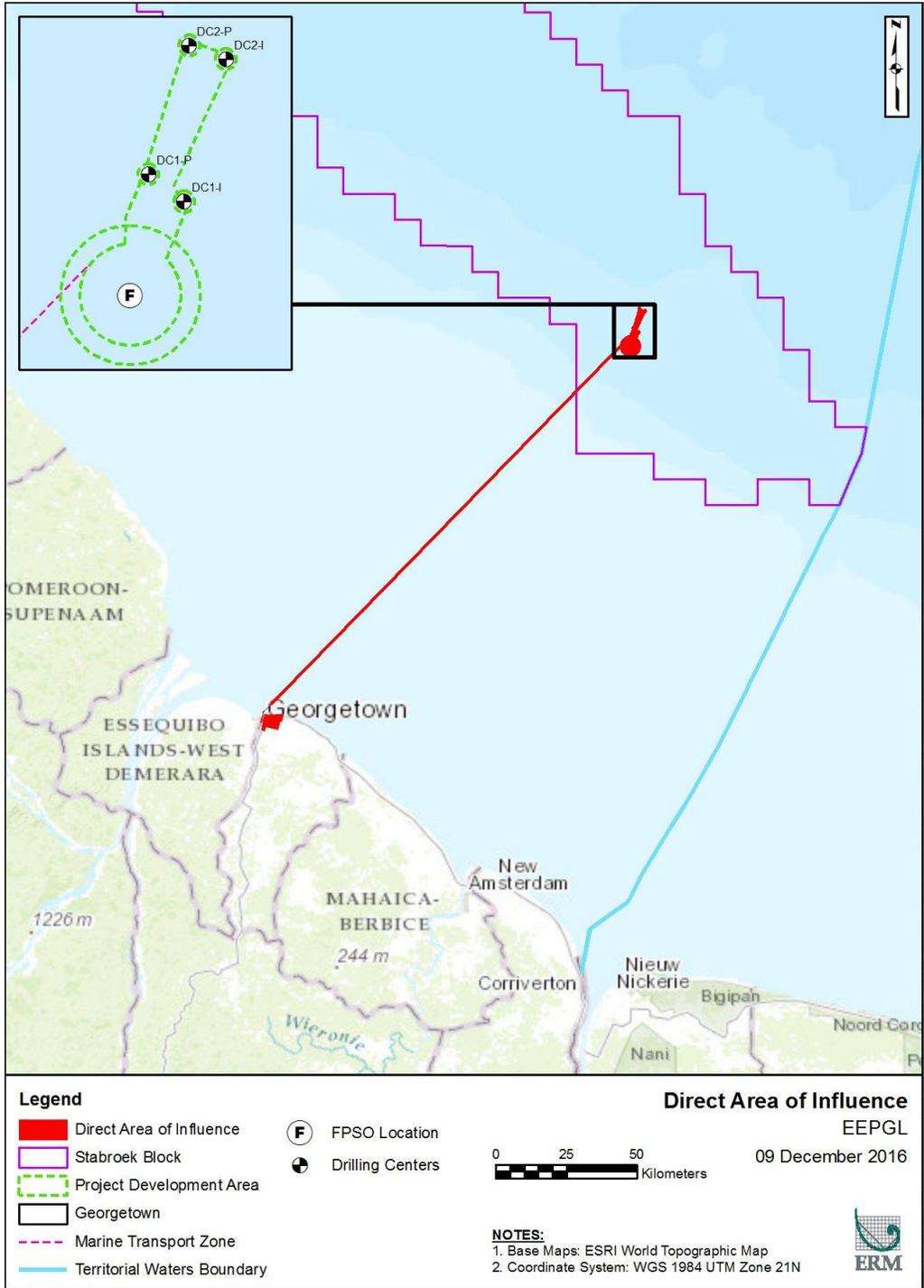
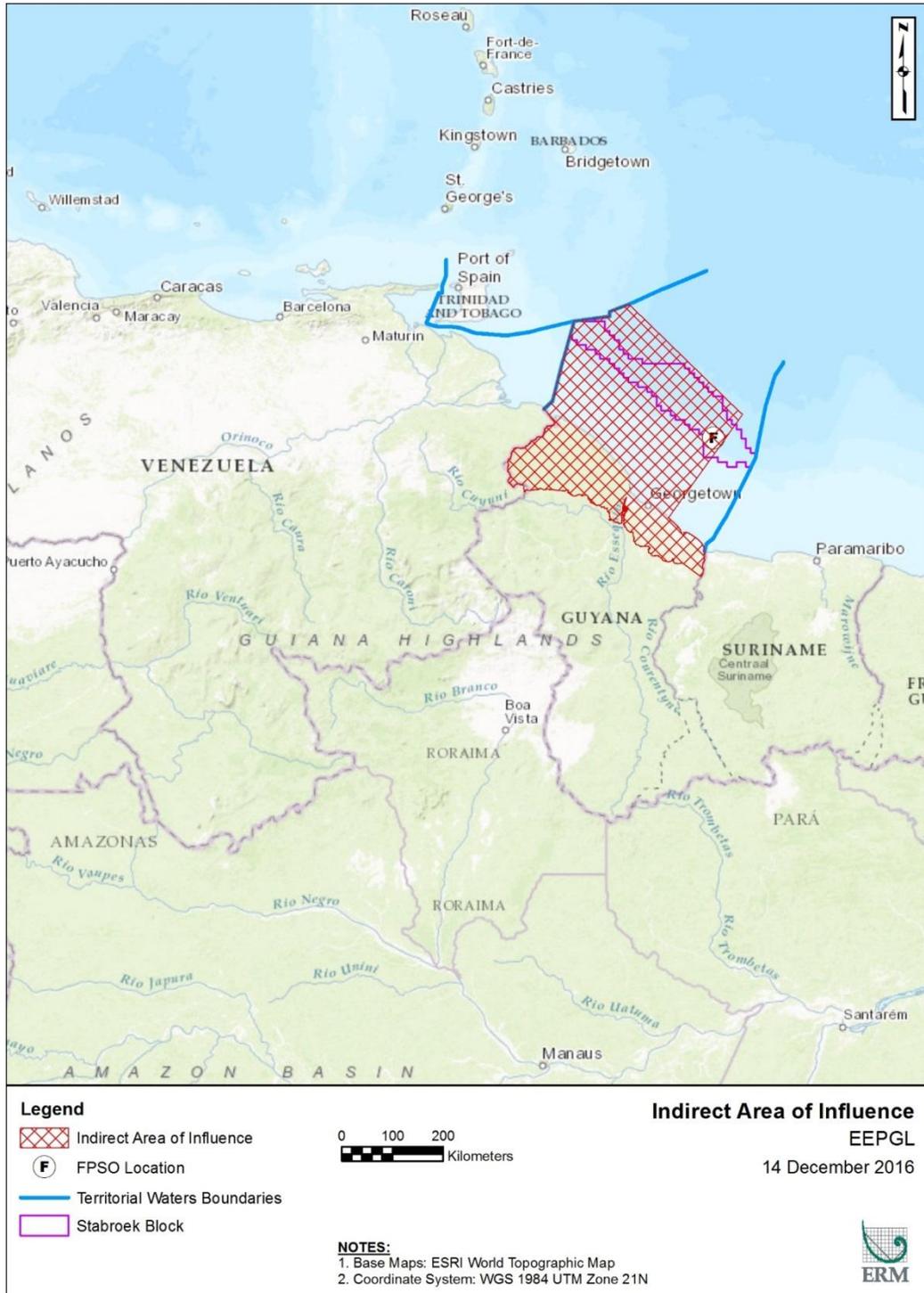


Figure 6.2 Indirect Area of Influence



6.2 Project Interactions with Environmental and Socioeconomic Receptors

In order to define the scope of the environmental and socioeconomic impact analysis, it is necessary to identify the potential interactions between the Project and the resources/receptors within the AOI. These interactions are the mechanisms that could trigger Project-related effects on resources/receptors.

Each of the Project stages and potential unplanned events listed below may have the potential to interact with existing resources/receptors, which could potentially create environmental or socioeconomic impacts.

- Development Drilling Stage:
 - Drill ship and drilling operations
 - Power generation
 - Drill cuttings discharges
 - Drilling fluids discharges
 - Wastewater discharges
 - Offshore waste treatment and disposal including incineration
 - Vertical seismic profiling
 - ROV operations
 - Onshore waste management, recycling, treatment, and disposal

- Installation of FPSO/SURF Components Stage:
 - Marine installation vessels and FPSO
 - Power generation
 - Install mooring system (e.g., driven or suction piles for FPSO and select SURF equipment)
 - Discharge of hydrostatic test water, hydrate inhibitor, ballast water
 - Wastewater discharges
 - Limited waste incineration
 - ROV operations and installation of SURF equipment
 - Hookup and commissioning of FPSO and SURF equipment
 - Onshore waste management, recycling, treatment, and disposal

- Production Operations Stage:
 - FPSO Vessel Operations
 - Power and heat generation
 - Non-routine, temporary flaring
 - Produced water discharge

- Brine discharges from sulfate removal and potable water processing
 - Sanitary wastewater discharge
 - Ballast water discharge (one time at mobilization)
 - Non-hydrocarbon contact cooling water discharge
 - Gas re-injection into reservoir
 - Seawater intake
 - Seawater injection into reservoir
 - Chemical use (topsides, subsea, downhole)
 - Oil Offloading to Conventional Tankers
 - Tanker power generation
 - Venting of cargo tanks during oil loading
 - Seawater intake for ballast operations
 - Tanker ballast water discharge on arrival
 - Tanker domestic wastewater discharge
 - Offshore waste treatment and disposal including waste incineration
 - Onshore waste management, recycling, treatment, and disposal
- Decommissioning Stage:
 - Marine decommissioning vessels and FPSO
 - Power generation
 - Disconnection of mooring system and SURF equipment
 - Wastewater discharges
 - Limited waste incineration
 - Onshore waste management, recycling, treatment, and disposal
- Logistical Support (across all Project stages):
 - Supply and support vessel/aircraft operations
 - Onshore fuel transfers from suppliers
 - Utilization of shorebases, including pipeyards and warehouses
 - Onshore waste management, recycling, treatment, and disposal
- Non-routine, Unplanned Events:
 - Oil spill or release – FPSO/SURF production operations
 - Oil spill or release – Well control event
 - Other oil spills or releases
 - Other unplanned events

6.3 Scope of the Environmental and Social Management and Monitoring Plan

The EIA will be required to include an Environmental and Socioeconomic Management and Monitoring Plan (ESMP), which will provide a management framework to address the identified significant adverse impacts of the Project, as well as a plan to monitor the effectiveness of the recommended management strategy. It will recommend specific management and monitoring strategies and will link these management measures to specific potential impacts from the Project. It will also include a schedule for implementing the recommended management measures, as well as auditing and reporting procedures that can be used to assess and communicate the effectiveness of such measures.

The management strategy will use an adaptive approach to ensure that recommended management measures were implemented as planned and producing the desired outcomes. This adaptive approach would provide the Project, in consultation with the EPA and other stakeholders, the opportunity to:

- Address unanticipated adverse impacts which are encountered;
- Adjust or replace existing management measures when appropriate during the Project life cycle to address evolving impacts;
- Retire existing management measures when no longer demonstrating value; and
- Add new management measures when required to address new impacts.

The Project will apply a hierarchy of controls when developing the management plans. The hierarchy is a series of sequential steps that emphasize proactive over reactive strategies to limit adverse impacts throughout a project's life cycle. The hierarchy consists of the following steps:

- **Avoid** risks related to environmental and socioeconomic impacts by employing alternative approaches to achieve objectives;
- **Reduce** the probability and/or consequence of impacts that cannot be avoided through mitigation measures; and
- **Remedy** impacts that occur despite avoidance and reduction actions, which may include rehabilitation, reclamation, restoration, and/or compensation.

At each step in the hierarchy, options for reducing the magnitude and sensitivity/vulnerability/importance that underpin the significance of each potentially adverse impact will be evaluated. EEPGL recognizes that

demonstrating capacity to manage non-routine, unplanned events such as emergencies or spills is an important and integral component of the permitting process. As such, the EIA will account for the possibility of non-routine, unplanned events as part of the environmental and socioeconomic management strategy.

In support of the EIA process, ERM will develop a Project Environmental and Social Management Plan (ESMP), which will include the identified management and mitigation measures and description of how they will be implemented and monitored to verify their effectiveness.

The ESMP will include the following:

- Environmental and Socioeconomic Management Plan Framework
- Environmental Management Plan, including:
 - Air Quality Management Procedures
 - Water Quality Management Procedures
 - Waste Management Plan
 - Marine Mammals Observation Procedures
- Socioeconomic Management Plan, including:
 - Road Safety Management Procedure
 - Cultural Resources Chance Finds Procedure
 - Stakeholder Engagement Plan
- Oil Spill Response Plan, including
 - Oil Spill Modeling and Coastal Sensitivity Mapping, including the results of the Net Environmental Benefit Assessment, and an evaluation of the environmental appropriateness of proposed dispersants
 - Emergency Preparedness and Response Procedures, including a detailed description of the Incident Command System
- Preliminary End of Operations Decommissioning Plan

7.0 Description of Existing Conditions

The EIA will provide a description of the existing physical, biological, and socioeconomic conditions within the AOI, including:

- Physical Conditions – including bathymetry, temperature, geology, stratigraphy, benthic sediments, oceanography, water quality, air quality, climate, meteorology, and applicable coastal processes (while recognizing that Project facilities would be located approximately 120 miles (190 km) offshore);
- Biological Conditions – including flora, fauna, and their conservation value/status; habitat and ecologically sensitive areas;
- Socioeconomic Conditions – including demographics, education, health, employment, land use, and cultural heritage.

Information on existing conditions and potential impacts, including potential cumulative effects, will be obtained using an appropriate method that integrates various sources of data. ERM will gather and consolidate available data on the existing conditions for the Project AOI.

Existing conditions may be evaluated based on remote-sensing imagery and data, available desktop studies, literature reviews, interviews and consultations with local stakeholders and communities, prior project-specific field studies, surveys and monitoring efforts conducted by EEGPL, and/or other planned studies as further described below. All applicable exploratory data, including the surveys described below from 2014 thru 2016 in the Stabroek Block, will be analyzed and used to inform the EIA.

7.1 2014 Geological, Geophysical and EBS Survey

Environmental Baseline Survey (EBS) was conducted within the Stabroek Block in 1Q2014 as part of a broader Geological and Geophysical Survey. The execution of the EBS survey allowed ERM to characterize the physical, chemical and biological properties of the marine environment in the Project AOI. The focus on water and sediment sampling and analysis is a reflection that these are the primary environmental receptors and repositories for introduced substances to be detected in the marine environment. Water quality and benthic infauna (macrofauna) community analysis are important indicators of environmental health and their relative sensitivity to changes in the physical, chemical and biological conditions of the water and sediments that could occur overtime. The study documented the current concentrations of hydrocarbons and metals as these are the main contaminants that could be potentially introduced from petroleum exploration and development operations.

7.2 2014 Geotechnical Site Investigation and EBS Surveys

A Geotechnical Site Investigation was conducted in 2014 to assist in the planning and preparation for drilling the first exploration well, Liza-1, offshore Guyana in the Stabroek Block, which allowed the Project to avoid areas of geological or geotechnical risk, and identify potential objects such as shipwrecks or other cultural/archaeological resources that could be present in the vicinity of the planned Project activities.

7.3 2016 Geophysical, Shallow Geotechnical, Deep Geotechnical (Phase I), and EBS Surveys

The purpose of these surveys was to assess the potential for seabed and shallow and deeper seafloor hazards throughout the Project AOI and in the surrounding portions of the Stabroek Block. It consisted of two primary sub-components: a deep water field autonomous underwater vehicle (AUV) survey and an EBS.

The scope of the EBS included building on the knowledge and understanding of the marine environment; covering a larger area of the block to obtain a diversity of water depths and regional distribution of potential habitat across the Stabroek Block; and providing a comparative analysis within the Project AOI. A total of 26 box core and water column locations were selected and 107 discrete water samples and 26 sediment samples were collected and are currently being analyzed. This EBS report will be further described in the EIA.

7.4 2016-2018 Metocean Survey

A metocean survey is being conducted to better define the design, operating, and installation conditions within the Stabroek Block. The metocean survey includes oceanographic and meteorological monitoring. Regular visits to maintain the moorings, collect data, and service the associated equipment and metocean instruments are currently being conducted and will continue over a period of approximately 27 months until mid-2018. The first preliminary data from this study will be available in September 2016 and will be incorporated into the EIA. Subsequent phases of the study will be undertaken concurrently with the EIA.

7.5 Coastal Sensitivity Mapping and Site Visits

ERM will revise the current EEPGL Oil Spill Response Plan (OSRP) that will support oil spill preparedness and response planning, coastal sensitivity mapping has been performed. The sensitivity of the coastline that could potentially be impacted from an oil spill or release in the Project AOI should include consideration of the following:

- Classification of the coastline by coastal index;
- Determination and mapping of biological resources;
- Determination and mapping of human resources.

The OSRP will describe how coastal sensitivity mapping will be considered for oil spill preparedness and response, including protection of sensitive areas, shoreline cleanup, wildlife care, etc. EEPGL will continue to hold OSR engagements with governmental authorities and key stakeholders. Training, exercises, and drills conducted as part of these engagements will include response activities associated with protecting sensitive and protected areas in the event of a spill.

Supplemental coastal mapping will be conducted by ERM to inform the EIA. As part of the EIA process, activities performed to support the update of the existing coastal maps will include literature reviews, surveys from roads where possible, as well as the assessment of GIS data and aerial imagery to supplement remotely-sensed data already collected. Stakeholder interviews and engagements will also be conducted to assess livelihoods, demographics, and other socioeconomic conditions within potentially impacted communities. These mapping exercises are intended to validate and supplement existing data on geographic, social, economic and environmental aspects of the Project AOI. Mapping activities will be conducted in the area between Georgetown and the Venezuelan border in Guyana, portions of Venezuela, Trinidad and Tobago and several islands in the Lesser Antilles (e.g., Grenada, St. Vincent, the Grenadines, and St. Lucia).

7.6 *Supporting Marine Mammal, Reptile and Wildlife Observations*

Visual and acoustic marine mammal surveys were conducted during two seismic surveys in the Stabroek Block, once in July 2015 and another in February 2016. These surveys combined produced more than 360 visual and acoustic detections, which constitutes the largest database of marine mammal detections in the immediate vicinity of the Project. The surveys have documented the presence of eight species of cetaceans and two species of marine turtle and further data continues to be gathered as part of a survey currently being performed in the adjacent block. These data will be used to inform the biological impact assessment.

8.0 Methodology for Preparing the EIA

The impact assessment process is a comparative process that identifies differences between existing physical, biological, and socioeconomic conditions and the projected conditions that could be potentially directly or indirectly attributable to the Project. For the purposes of the EIA, an “impact” will be defined as any alteration of existing conditions, adverse or beneficial, caused directly or indirectly by the Project. Under the provisions of the EP Act (Cap. 20:05), these could include:

- (i) impairment of the quality of the natural environment or any use that can be made of it;
- (ii) injury or damage to property or to plant or animal life;
- (iii) harm or material discomfort to any person;
- (iv) an adverse effect on the health of any person;
- (v) impairment of the safety of any person;
- (vi) rendering any property or plant or animal life unfit for use by human or unfit for its role in its ecosystem;
- (vii) loss of enjoyment of normal use of property; and
- (viii) Interference with the normal conduct of business.

Information on potential impacts, including potential cumulative effects generated from the activities required to develop the Project in Guyana, will be obtained by ERM from various sources including consultation with the EPA and GGMC as well as other stakeholders, environmental impact assessments for other similar projects worldwide; and scientific research and literature.

8.1 The EIA Process

The key stages for this EIA approach are:

- Screening;
- Scoping and Terms of Reference;
- Assessing Existing Conditions;
- Project Description and Interaction with Design and Decision-Making Process;
- Stakeholder Engagement;
- Assessment of Impacts and Identification of Mitigation;
- Mitigation, Management, and Monitoring; and
- Disclosure and Reporting.

It is standard impact assessment practice to “rate” potential impacts:

- Provides a basis for prioritization of impacts to be managed;
- Provides a method of assessing the effectiveness of proposed management measures; and
- Provides a scale which shows the level of impact both before and after proposed management measures have been applied.

Potential adverse impacts will be rated by ERM according to the magnitude of the potential impact, and the sensitivity/vulnerability/importance of a given impact or receptor. Risk factors will be evaluated by ERM using a range of quantitative and qualitative information sources.

The overall significance of potentially adverse impacts will be determined by ERM using the Impact Significance Rating Matrix shown in Figure 8.1. The primary purpose of the rating matrix is to identify those potentially adverse impacts which require further analysis and/or management.

8.2 *Criteria for Rating Impacts*

Impacts will be rated according to (1) the magnitude of the potential impact and (2) the sensitivity/vulnerability/importance of a given impact or receptor. These elements are described in greater detail below.

8.2.1 *Magnitude Element*

Magnitude essentially describes the degree of change that the identified impact is likely to impart upon the resource or receptor. Magnitude is a function of the following impact characteristics:

- Extent;
- Duration;
- Scale;
- Frequency;
- Reversible or irreversible; and
- Likelihood (for unplanned events only)

The magnitude of impacts will take into account all the various dimensions of a particular impact in order to determine where the impact falls on the spectrum (in the case of adverse impacts) from negligible to large. Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes will be regarded as

essentially having no impact, and will be characterized as having a negligible magnitude.

Taking into account the magnitude of impact characteristics identified above, the magnitude of each impact will be assigned one of the following five ratings in the EIA:

- Positive;
- Negligible;
- Small;
- Medium; or
- Large.

Not all resources/receptors or impacts can be assessed according to the same criteria, so the magnitude of specific impacts may be described differently according to the resource/receptor (or the type of impact) being assessed.

8.2.2 Sensitivity / Vulnerability / Importance Element

A range of factors will be taken into account by ERM when defining the sensitivity/vulnerability/importance of a resource/receptor, which may be physical, biological, or socioeconomic. For physical resources (e.g., marine water quality), its sensitivity to change and importance will be considered. For biological or cultural resources/receptors(e.g., a mangrove forest), its importance (e.g., its local, regional, national or international importance) and its sensitivity to the specific type of impact will be considered. For human receptors, the vulnerability of the individual, community or wider societal group will be considered. Other factors may also be considered when characterizing sensitivity/vulnerability/importance, such as legal protection, government policy, stakeholder views, and economic value.

As in the case of magnitude, the sensitivity/vulnerability/importance designations will be consistent, but the definitions of the designations will vary on a resource/receptor basis. The sensitivity/vulnerability/importance designations to be used in the EIA will be:

- Low;
- Medium; and
- High.

8.2.3 Determining Impact Significance

Once magnitude of impact and sensitivity/vulnerability/importance of resource/receptor have been characterized, the significance can be assigned for each impact. Impact significance is designated using the matrix shown in Figure 8.1. The significance categories provided in Figure 8.1 are standardized across all impacts and resource/receptor categories, and range from Negligible to Major.

Figure 8.1 Impact Significance Rating Matrix

		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	Medium	High
Magnitude of Impact	Negligible	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

Management measures will be developed by the Project to address potential adverse impacts which are deemed significant. Magnitudes are therefore generally not assigned in the case of positive impacts. It is usually sufficient to indicate that the Project will result in a positive impact, without characterizing the exact degree of positive change likely to occur.

ERM will perform a final impact assessment during the EIA which includes an assessment of the identified residual impacts (i.e., considering the implementation of the identified management measures). This involves re-evaluating the magnitude and the significance of the potential impact taking into consideration the implementation of proposed mitigation measures. If significant residual impacts remain, efforts will be made to identify additional or alternative cost-effective and practicable mitigation measures.

Where possible, the spatial and temporal extent of potential adverse impacts will be described, in order to provide context to the impacts assessment. Also, the concept of reversibility will be addressed, as appropriate.

9.0 *Scoping and Identification of Potential Sources of Project-generated Impacts*

This section of the ToR provides the scoping of the assessment by resource/receptor as well as the identification of the potential direct and indirect environmental and socioeconomic impacts that could credibly result from the Project.

Table 9.1 identifies the resources/receptors that could potentially be impacted, describes the potential impacts that could be encountered, describes the potential Project sources of the impacts, and summarizes the proposed analytical approach to be utilized in the EIA.

Table 9.1 Summary of Resources/Receptors, Potential Impacts, Sources of Potential Impacts, and Analytical Approach

Resource or Receptor	Potential Impact	Primary Sources of Potential Impacts	Proposed Analytical Approach
Physical Resources			
Air Quality and Climate	Air emissions resulting from the Project have the potential to change ambient air quality in the Project AOI on a localized basis. Air quality is important for health of humans and wildlife. Potential impact of greenhouse gas emissions from the Project on climate change.	<ul style="list-style-type: none"> • Power generation • Other combustion sources • Non-routine, temporary flaring • Fugitive emissions from storage and loading • Waste incineration • Helicopters and aircraft 	To describe actual air quality conditions in the vicinity of the Project, ambient air quality data were collected at the proposed Project site approximately 190 km (~120 mi) offshore of Guyana, including measurements of particulate matter (PM ₁₀), carbon monoxide (CO), sulfur dioxide (SO ₂), hydrogen sulfide (H ₂ S) nitrogen dioxide (NO ₂), and volatile organic compounds (VOC). Measurements will be taken on board a research vessel. Air emission inventories will be prepared for these pollutants and a screening level analysis will be conducted to identify potential air quality impacts associated with Project activities. Estimated greenhouse gas (GHG) emissions for the Project will be calculated. Potential impacts will be described.
Sound	Auditory impacts on project workers.	<ul style="list-style-type: none"> • Equipment/machinery operating onboard the FPSO or drill ships 	Managing occupational-related risks through appropriate PPE.
Marine Geology and Sediments	The Project will disturb marine geology and sediments on a localized basis in the PDA and could impact sediment quality from non-aqueous base fluid (NABF) on drill cuttings discharges.	<ul style="list-style-type: none"> • Drilling of development wells • Installation of FPSO and SURF components 	A fate and transport model (GIFT) will be used to evaluate cuttings and drilling fluid deposition surrounding the development wells. The physical differences between the native seafloor and the accumulated drill cuttings, as well as the distribution of residual NABF on drill cuttings, will be described based on the results of the modeling analysis.
Marine Water Quality	The Project could have localized impacts to marine water quality in the PDA from discharge of drill cuttings and from routine operational and hydrotesting discharges. The Project could potentially impact marine water quality in the Project AOI as a result of non-routine, unplanned events.	<ul style="list-style-type: none"> • Drilling of development wells (cuttings and fluid discharge) • Cooling water discharges • Installation of FPSO and SURF components • Wastewater discharges • Produced water discharges • Hydrotesting discharges • Non-routine, unplanned event (e.g., spill or release) 	A fate and transport model (GIFT) was used to evaluate total suspended solids (TSS) concentrations resulting from discharge of drilling fluid and cuttings based on global ocean currents data. USEPA's CORMIX model was used to simulate the mixing zone around the drill ships and FPSO, and to support an analysis of impacts on marine water quality from routine production operations discharges and one-time hydrotesting discharges. Oil spill modeling was used to estimate concentrations of dissolved hydrocarbons that might result from different unplanned event scenarios
Biological Resources			
Protected Areas and Special Status Species	The Project is not expected to impact Protected Areas during routine, planned operations and activities in the Project AOI. The Project could potentially impact Protected Areas in the Project AOI as a result of non-routine, unplanned events. The Project could potentially impact some special status species (e.g., endangered or listed species) in a localized manner in the PDA as a result of underwater	<ul style="list-style-type: none"> • Non-routine, unplanned event (e.g., spill or release) • Underwater sound generated by marine component operations and activities • Lighting on offshore facilities (e.g., FPSO, drill ships) • Seawater intake by FPSO • Wastewater discharges • Drilling of development wells (cuttings and fluid discharge) • Cooling water discharges 	<ul style="list-style-type: none"> • Oil spill modeling was used to simulate the trajectory of an oil spill and assess the risk of oiling impacting any designated Protected Areas. • Consistent with the approach taken for marine mammals, turtles, and fish without special status designation, the scientific literature was reviewed for information on the impacts of planned offshore activities on special status species, including marine turtles, fish, and marine mammals. Oil spill modeling was used to assess potential spill-related impacts. • Underwater sound was modeled to assess potential auditory impacts

Resource Receptor	or Potential Impact	Primary Sources of Potential Impacts	Proposed Analytical Approach
	sound, light, seawater withdrawal, and changes in marine water quality. The Project could potentially impact special status species in the Project AOI as a result of non-routine, unplanned events.	<ul style="list-style-type: none"> Produced water discharges Hydrotesting discharges Vessel movements 	<p>associated with marine activities.</p> <p>USEPA's CORMIX model was used to simulate the mixing zone around the drill ships and FPSO, and to support an analysis of impacts on marine water quality from routine operational discharges and one-time hydrotesting discharges. The GIFT model was used to evaluate TSS concentrations resulting from discharge of drilling fluid and cuttings based on global ocean currents.</p>
Coastal Habitats	The Project is not expected to impact beaches, mangroves, or wetlands in the Project AOI during routine, planned operations and activities. The Project could potentially impact beaches, mangroves, and wetland habitats in the Project AOI as a result of non-routine, unplanned events.	<ul style="list-style-type: none"> Non-routine, unplanned event (e.g., spill or release) 	Oil spill modeling will be used to simulate the trajectory of an oil spill and assess the risk of oiling beaches, mangroves, or wetlands.
Coastal Wildlife and Shore Birds	The Project is not expected to impact coastal wildlife or shore-birds during routine, planned operations and activities in the Project AOI. The Project could potentially impact coastal wildlife and shore-birds in the Project AOI as a result of non-routine, unplanned events.	<ul style="list-style-type: none"> Non-routine, unplanned event (e.g., spill or release) 	Oil spill modeling will be used to simulate the trajectory of an oil spill and assess the risk of impacting coastal wildlife and shore-birds.
Seabirds	The Project could potentially impact seabirds in a localized manner as a result of light (i.e., disorientation). The Project could potentially impact seabirds in the Project AOI as a result of non-routine, unplanned events.	<ul style="list-style-type: none"> Drill ship, FPSO, and support vessel operations Lighting on offshore facilities (e.g., FPSO, drill ships) Non-routine, temporary flaring Waste incineration Non-routine, unplanned event (e.g., spill or release) 	The scientific literature will be reviewed for information on the impacts of lighting from planned offshore activities on seabirds. Oil spill modeling will be used to assess potential spill-related impacts on seabirds.
Marine Mammals	The Project could potentially impact some marine mammals in a localized manner in the Project AOI as a result of underwater sound and ship strikes. The Project could potentially impact marine mammals in the Project AOI as a result of non-routine, unplanned events.	<ul style="list-style-type: none"> Underwater sound generated by marine component operations and activities Ship strikes Changes in forage availability Lighting on offshore facilities (e.g., FPSO, drill ships) Seawater intake by FPSO 	The scientific literature was reviewed for information on the impacts of planned offshore activities on marine mammals, turtles and fish. Analyses were performed based on expected marine mammal and turtle presence and Project vessel transits to assess likelihood of vessel strikes. Oil spill modeling was used to assess potential spill-related impacts. Underwater sound was modeled to assess potential auditory impacts associated with marine activities. USEPA's CORMIX model was used to simulate the mixing zone around the drill ships and FPSO, and to support an analysis of impacts on marine water quality from routine operational discharges and one-time hydrotesting discharges. A fate and transport model (GIFT) was used to evaluate total suspended solids (TSS) concentrations resulting from discharge of drilling fluid and cuttings based on global ocean currents.
Marine Turtles	The Project could potentially impact some marine turtles in a localized manner in the Project AOI as a result of underwater sound, ship strikes, and light. The Project could potentially impact marine turtles in the Project AOI as a result of non-routine, unplanned events.	<ul style="list-style-type: none"> Wastewater discharges Drilling of development wells (cuttings and fluid discharge) Cooling water discharges Produced water discharges Hydrotesting discharges 	

Resource or Receptor	Potential Impact	Primary Sources of Potential Impacts	Proposed Analytical Approach
Marine Fish	The Project could potentially impact some marine fish as a result of underwater sound, light, seawater withdrawal, and changes in marine water quality in the PDA. The Project could potentially impact marine fish in the Project AOI as a result of non-routine, unplanned events.		
Marine Benthos	The Project could potentially disturb some benthic habitat and organisms in a localized manner in the PDA.	<ul style="list-style-type: none"> • Drilling of development wells (cuttings discharge and deposition) • Installation of FPSO (mooring structures) and SURF components 	Fate and transport model (GIFT) will be used to predict the extent and thickness of cuttings discharged on the seafloor surrounding the development wells. The physical differences between the native seafloor and the accumulated drill cuttings, as well as the distribution of NABF containing cuttings and potential for toxicity impacts, will be described based on the results of the modeling analysis. Impacts from planned activities will be evaluated in terms of the percentage of benthic habitat impacted by disturbance.
Ecological Balance and Ecosystems	The Project could have indirect impacts on ecological functions in the Project AOI, particularly if special status species or trophic relationships are disturbed.	<ul style="list-style-type: none"> • Underwater sound generated by marine component operations and activities • Lighting on offshore facilities (e.g., FPSO, drill ships) • Seawater intake by FPSO • Installation of FPSO and SURF components • Installation-related disturbances to seafloor • Wastewater discharges • Ballast water discharges • Waste incineration • Non-routine, unplanned event (e.g., spill or release) 	The scientific literature was reviewed to determine the ecological relationships between major marine taxonomic groups. Oil spill modeling was used to assess potential spill-related impacts on marine organisms.
Socioeconomic Resources			
Economic Conditions	The Project is generally anticipated to have a positive impact on the economy of Guyana as a result of government revenue sharing from the Project, as well as employment and local procurement opportunities. Potential adverse impacts may include potential shorter term increases in the cost of living as a result of increased demand for specific goods and services. Potential adverse impacts to income from agriculture and fisheries could also occur as a result of non-routine, unplanned events.	<ul style="list-style-type: none"> • Government revenue sharing from Project • Local Project purchases of select materials, goods and services • Limited local Project employment (direct and indirect) • Increased spending on select materials, goods and services (indirect multiplier impacts for local/regional population) 	Government reports will be reviewed and key informant interviews will be conducted to identify key economic drivers in the national, regional, and local economies and determine the likely Project-related effects on these economic factors. A particular emphasis will be placed on industrial sectors that are important to coastal communities.

Resource or Receptor	Potential Impact	Primary Sources of Potential Impacts	Proposed Analytical Approach
Employment and Livelihoods	The Project is also expected to build capacity in the local labor force, increase demand for skilled labor, and increase demand for service industries. There is also the potential for limited adverse impacts to fishing activities as a result of marine safety exclusion zones or marine traffic, and non-routine, unplanned events.	<ul style="list-style-type: none"> • Local employment for <ul style="list-style-type: none"> ○ Drill ships ○ Installation vessels ○ FPSO topside equipment and operations ○ Marine support and supply vessels ○ Tankers ○ Tugs and support vessels ○ Aviation operations • Marine safety exclusion zones • Project-related marine traffic • Drilling; FPSO/SURF installation, hookup and commissioning; and FPSO and support vessel operations (aspects relating to occupational health and safety for Project workforce) <p>Non-routine, unplanned event (e.g., spill or release)</p>	Project workforce projections and types of labor requirements were assessed against data obtained through key informant interviews on the existing service industry within Guyana. The potential for adverse impacts to fishing activities was assessed by taking into consideration the distance from shore at which different fishery types typically operate, in comparison to the locations and durations of Project-related marine activity and marine safety exclusion zones. Potential occupational hazards to Project workforce working onshore and offshore were assessed.
Community Health and Wellbeing	Most Project activities will be located offshore in the PDA and would have no direct impacts on communities in Guyana. Introduction of limited levels of foreign labor could potentially have health and socioeconomic impacts. The Project could potentially impact community health and wellbeing in the Project AOI due to onshore traffic, social interaction, or as a result of non-routine, unplanned events.	<ul style="list-style-type: none"> • Increased traffic as a result of Project activities at the Guyana shorebase locations • Social interaction between Project workers and residents • Pressure on wages from introduction of foreign workers and increased competition for skilled labor • Noise and light near shore by Project marine and aviation operations • Non-routine, unplanned event (e.g. spill or release) 	Potential risks to safety and health of local communities posed by shorebase operations were assessed. Key informant interviews will be conducted to characterize existing road, marine and air traffic safety conditions, as well as coastal agriculture, aquaculture, and offshore/coastal fishing resources. Oil spill modeling will be used to simulate the trajectory of an oil spill and to assess potential spill-related impacts on community health and wellbeing.
Marine Use and Transportation	The Project may result in increased marine shipping and general marine-related traffic, which could potentially contribute to marine vessel congestion in port areas.	<ul style="list-style-type: none"> • Marine vessel operations • 	Key informant interviews will be conducted to characterize communities dependent on marine transportation for livelihoods (e.g., speedboat operators and fisherpersons), and to characterize existing marine vessel and safety conditions in the Project's AOI.
Social Infrastructure and Services	The Project will use public infrastructure and services and thus could potentially compete with other existing businesses and consumers across a range of services (e.g., roads, medical and emergency response, accommodation, and utilities). The Project may result in increased vehicular traffic in Georgetown, which could potentially contribute to vehicular congestion in certain areas..	<ul style="list-style-type: none"> • Project demand requirements for selected infrastructure and services which could overburden existing capacity and supply • Shorebase operations • Ground transportation operations 	Key informant interviews and review of government reports will be conducted to assess existing demand on public infrastructure, transportation networks, vehicular traffic, and public services and to determine the impact (access and safety) that any additional demand on these resources would have on impacted communities.

Resource or Receptor	Potential Impact	Primary Sources of Potential Impacts	Proposed Analytical Approach
Cultural Heritage	The Project has the potential to adversely affect cultural heritage through localized disturbance of archeological or historical sites related to Project development. These resources have conservation, cultural, and other values to stakeholders. The Project could potentially impact cultural heritage in the Project AOI as a result of non-routine, unplanned events.	<ul style="list-style-type: none"> • Drilling of development wells • Installation of FPSO and SURF components Non-routine, unplanned event (e.g. spill or release)	AUV and other geophysical surveys will be conducted to map seabed objects in the PDA. Oil spill modeling will be used to simulate the trajectory of an oil spill and to assess the potential for a release from an unplanned event to contact terrestrial archaeological sites.
Land Use	No new Project-dedicated land disturbance is planned. There is the potential that third-party onshore facilities may elect to expand or impact adjacent land as a result of supporting Project-related needs; however, these impacts are outside the scope of this EIA.	<ul style="list-style-type: none"> • Shorebase operations • Pipe yards • Warehouses • Bulk fuel storage and transfers • Onshore waste recycling, treatment and disposal facilities 	Land use in the area surrounding onshore facilities planned for Project use will be reviewed and assessed with respect to the potential for significance of land use changes as a result of the Project.
Ecosystem Services	Project-related impacts on natural resources could lead to shorter term direct or indirect impacts on the services and/or values derived from natural resources and ecosystems in the AOI.	<ul style="list-style-type: none"> • Direct or indirect impacts derived from one or more of the impacts on physical, biological, or socioeconomic resources described above 	The use of natural resources by local communities, including indigenous communities, was examined to identify specific dependencies on resources that could be impacted by the Project. Where dependencies on natural resources that would be impacted were identified, the direct and indirect impacts of Project activities on local communities' access to and use of impacted resources was assessed.
Indigenous Peoples	The Project is not expected to directly cause any changes to population and demographics in indigenous communities. The Project could potentially impact indigenous peoples in the Project AOI as a result of non-routine, unplanned events.	<ul style="list-style-type: none"> • Non-routine, unplanned event (e.g. spill or release) 	Mapping and characterization of Coastal communities, including indigenous communities, in the Project AOI will be mapped. Key informant interviews will be conducted to characterize socioeconomic conditions in communities, and their reliance on natural resources. Oil spill modeling will be used to simulate the trajectory of an oil spill and to assess the potential for oil to contact lands and natural resources of coastal communities.

9.1 Additional Analyses to Support the EIA

The EIA for the Project will leverage studies performed, data collected, impacts assessed, and related management planning that has been previously completed to support the current exploration drilling program. This information will be utilized to inform the EIA for development drilling operations and related support activities, which are similar to exploration drilling operations. ERM has completed an assessment of existing environmental and social data and has identified the following supplemental studies that will be required to support the EIA for the Project.

9.1.1 Oil Spill Modelling

Oil spill modeling was performed for the exploration drilling program. As the Project will include FPSO/SURF productions operations, additional oil spill response modeling will be performed that involves FPSO/SURF production operations related scenarios to help inform the EIA, as well as oil spill response planning. Previous oil spill modeling will be revised to address development drilling aspects in the EIA considering updated information about the Liza reservoir. All of the oil spill response modeling will also be used to inform the scope of the coastal sensitivity mapping (see Section 7) and the assessment of impacts on several resources/receptors as summarized in Table 9.1.

9.1.2 Offshore Discharge Modelling

Project activities will involve several types of discharges to offshore surface waters, including drill cuttings, hydrostatic test water and other commissioning fluids, ballast water, cooling water, produced water, and waste brines.

Potential environmental impacts related to planned localized discharges of drill cuttings and drilling fluids will be assessed for typical releases anticipated during development drilling operations. ERM will simulate releases near the seafloor from the riser-less drilling sections. For drilling performed in deeper sections that will be drilled with a riser in place, ERM will simulate overboard discharges of cuttings that contain adhered fluids. Estimated discharges from the two drill centers will address seasonal variability in the assessment. Potential impacts will be assessed in terms of the total thickness of deposits on the seafloor at the end of the simulation, the maximum total suspended solids (TSS) at any time in the simulation, and the mass of hydrocarbons per unit area deposited on the seafloor.

ERM will estimate the localized plume trajectory and patterns of dilution of the cooling water plume from the FPSO. Incremental changes to ambient water temperature over distance from the cooling water discharge point as well as

changes in concentrations of biofouling inhibitors such as chlorine will be assessed. ERM will utilize a similar approach to estimate the plume size and dilution patterns related to localized installation and commissioning-related discharges (hydrostatic test water and hydrate control fluids) and other production-related discharges (produced water and waste brines). In the cases when exact design parameters aren't yet known, multiple locations and discharge rates will be modeled to appropriately bracket the potential discharge plumes and related potential impacts.

9.1.3 Underwater Sound Analysis

ERM will evaluate the Project components and activities to identify the sound sources that have the potential to generate localized underwater sound impacts to sensitive receptors. Modeling of sound sources will be performed to establish the area that would be subjected to biologically relevant sound thresholds (i.e., sound levels that are known to induce harm or behavioral changes to marine mammals). These thresholds will be derived from biological literature. Thresholds relevant to receptors that are known to occur in the PDA will be used if available, otherwise suitable surrogates will be used.

The specific location and type of sound sources to be modeled are being determined. Potential sources to be studied include higher sound levels such as pipelaying, drilling, and vessel operation.

9.1.4 Air Emissions Monitoring and Analysis

ERM will assess potential environmental impacts to air quality due to emissions from Project components and activities. Inputs to the analysis will include locations, physical dimensions, flare and exhaust characteristics, and emission rates. ERM will estimate concentrations of nitrogen oxides (NO_x), sulfur dioxide (SO₂), particulate matter (PM), carbon monoxide (CO), and hydrogen sulfide (H₂S) emissions and will evaluate the associated potential impacts on onshore air quality.

As part of this analysis, ERM will collect existing condition concentration of important air quality pollutants in the Project AOI. Pollutants to be sampled are inhalable particulate matter (i.e., that fraction with aerodynamic diameter of less than 10 micrometers, "PM₁₀"), CO, SO₂, H₂S, nitrogen dioxide (NO₂), and volatile organic compounds (VOC). These data will be used to quantify background concentrations in the PDA and to inform the air quality impact analysis.

9.1.5 Geophysical and Shallow Geotechnical Analysis

Aa geophysical and shallow geotechnical analysis was completed that assessed the layout and field architecture for the Project AOI, in order to site facilities away from faults, seabed obstructions, archaeological resources, sensitive biological resources, or other resources or hazards that could either damage the wells or SURF, or be damaged by installation of these components. The results of these field surveys will be incorporated into the EIA to inform the analysis of potential impacts on subsea archaeological resources and benthic biological resources(to the extent they could exist in the PDA).

9.2 EIA Stakeholder Engagement

It is recognized that ERM has held meetings with over 30 Guyana government agencies/commissions, many elected officials and Regional Administrators, over 15 professional or business associations, various international and domestic non-governmental organizations, several universities and research institutes, various religious and ethnic organizations, and the media; and has participated in two sector agency scoping meetings, with over 150 attendees of which approximately 100 were members of the general public. These were followed by regional public scoping meetings, which had over 300 attendees, of which over 200 were public participants. Public and agency input from these meetings and the 28-day Public Notification period has helped shape the Final ToR and will shape the Draft EIA.

ERM will be required to continue to consult with members of the public, interested bodies, and organizations in the development and finalization of the EIA, and will provide to members of the public, upon request, copies of information obtained for the purpose of the EIA. After submission of the EIA, ERM will coordinate with the EPA to disclose the results of the EIA at formal public meetings, and will participate in additional informal public meetings, as required.

The objectives of Project stakeholder engagement activities are to:

- Promote the development of respectful and open relationships between stakeholders and EEPGL during the Project;
- Identify Project stakeholders and understand their interests and concerns in relation to Project activities, and incorporate such interests and concerns into the EIA and ESMP development processes;
- Provide stakeholders with timely information about the Project, in ways that are appropriate to their interests and needs, and also appropriate to the level of expected risk and potential adverse impacts;

- Support alignment with regulatory and EEPGL expectations for stakeholder engagement; and
- Record feedback and resolve any grievances that may arise from Project-related activities through a formal feedback mechanism.

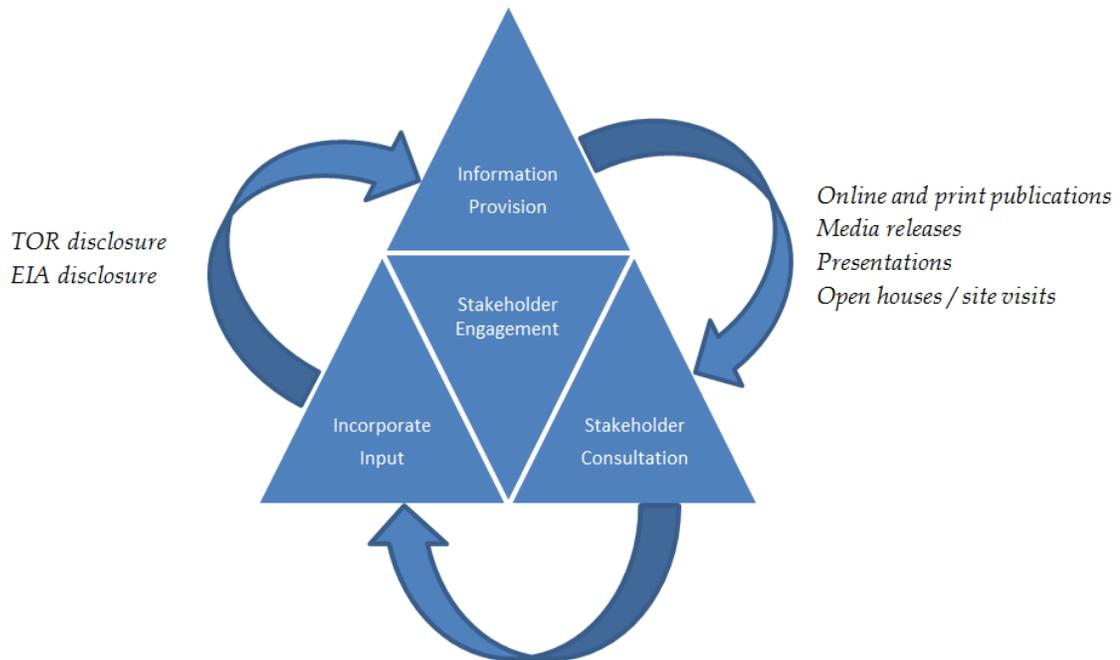
Project stakeholder engagement activities will be guided by a “evergreen” Stakeholder Engagement Plan, which will guide ongoing stakeholder engagements for the life of the Project. This Plan will describe:

- Stakeholders identified for engagement;
- A conceptual program of engagement and communications activities, and their frequency throughout the Project life cycle;
- The dedicated feedback mechanism through which stakeholders can contact EEPGL to voice concerns, provide information, or ask questions about the Project life cycle and its activities; and
- Mechanisms through which EEPGL will monitor and report on external engagement and communications.

Project stakeholders have been identified through a combination of desktop research and in-country assessment and engagement. Stakeholder categories include, but are not limited to: government officials; communities; civil society, interest groups and NGOs; the private sector; media; academic and research institutions; and professional, business and workers’ associations.

Building on the stakeholder identification and mapping analysis, ERM’s stakeholder engagement strategy identifies mechanisms and tools to facilitate stakeholder communications and public information sharing. As shown in Figure 9.1, these tools are divided into two tiers that interact to facilitate informed engagement. The first tier is information provision, which serves to offer Project information to stakeholders to support their understanding of what is proposed to occur. The second tier, consultation, is intended to support dialogue and active receipt of stakeholder feedback and input on what they have learned about the Project, and to capture their opinions, concerns and knowledge regarding the way the Project may interact with the natural and social environment.

Figure 9.1 Stakeholder Engagement Strategy for EIA Development



The tools and mechanisms listed in italics in Figure 9.1 describe how the Project intends to provide information to stakeholders, consult with and solicit information from stakeholders, and report back on the ways stakeholder input has been incorporated.

Information provision activities may include the dissemination of publications (both print and online) and media releases, as well as presentations and open houses. The intention of these types of activities is to provide information to a broad audience or group of stakeholders as efficiently as possible.

Consultation or dialogue activities involving a two-way flow or exchange of information between stakeholders and the Project may include one-on-one and small group meetings, public meetings including a question and answer session, town hall meetings, a feedback mechanism such as a webpage, email address and/or phone line. The intention of these activities is to allow for not only a two-way exchange of information but also provide a means for the Project to gather information concerning topics that are important to its stakeholders. These activities also give stakeholders an opportunity to ensure their comments and opinions are heard and their concerns are addressed.

Tools for engagement and information provision not specifically named above may include key messages, question and answer documents to prepare the Project for engagements with the public, and planning for outreach events such as informational Open Houses.

10.0 Structural Organization of the EIA

The EIA will contain the following major components:

Table of Contents and Glossary: The EIA will include a Table of Contents for the EIA as well as a glossary of technical terminology used in the EIA.

Environmental Impact Statement: The Environmental Impact Statement will provide a concise account of the most important results of the impact assessment, a description of the potential adverse impacts of significance, a description of the proposed key management measures to be implemented, and an overview of the proposed management and monitoring strategy.

Project Description: The description of the Project will provide a detailed overview of the Project development plan proposed by EEPGL, including a description of its various components, and a description of the various stages of the Project life cycle. The Project description will be prepared in a manner that is sufficiently detailed (consistent with the current level of Project definition) to allow rigorous review by technical experts while being accessible and understandable by persons with non-technical backgrounds. The Project description will have sufficient detail to facilitate a comprehensive and detailed identification of the potential interactions between Project activities and resources/receptors in the Project AOI, and the potential adverse impacts that could result from such interactions.

Alternatives: The EIA will include a description of proposed Project alternatives, an evaluation of the alternatives, an analysis of technically and economically feasible alternatives, and a justification for the selection of the preferred alternative.

Administrative Framework: The administrative framework will summarize the legislation, policies, and standards relevant to offshore oil and gas exploration in Guyana, as applicable to the Project. It will include laws which apply to environmental issues in general, as well as specific national laws with a narrower focus on specific activities or environmental sensitivities, a discussion of national environmental policies as they relate to the oil and gas industry, and international and regional conventions and protocols that could affect Project activities and to which Guyana has acceded or is a signatory.

Methodology for Preparing the Environmental Impact Assessment: This section will describe the approach and methodology used to assess the potential impacts associated with the Project, the process used to conduct the EIA as a whole.

Scope of the Environmental Impact Assessment: This section will describe the various components of the Project that will be assessed, any additional data or analyses required to complete the EIA, and the direct and indirect AOIs.

Description of Existing Conditions: A description of the existing conditions within the Project's AOI will be provided. It will discuss the existing conditions associated with the physical, natural, and cultural or human environments of the Project AOI based on available information and data collected in the field to provide the existing conditions against which the Project's potential impacts will be assessed; and to inform judgments about the sensitivity, vulnerability and/or importance of resources/receptors.

Although the exact organizational structure of the section has yet to be determined, ERM expects that the description of existing conditions will generally include at least the resources and receptors included in Table 9.1 and include specific discussions of the following resources:

- Physical Resources
 - Air Quality and Climate
 - Sound
 - Marine Geology and Sediments
 - Marine Water Quality
- Biological Resources
 - Protected Areas and Special Status Species
 - Coastal Habitats (Beaches, Mangroves, and Wetlands)
 - Coastal Wildlife and Shorebirds
 - Seabirds
 - Marine Mammals
 - Marine Turtles
 - Marine Fish
 - Marine Benthos

- Ecological Balance and Ecosystems
- Socioeconomic Resources
 - Employment and Livelihoods
 - Community Health and Wellbeing
 - Marine Use and Transportation
 - Social Infrastructure and Services
 - Cultural Heritage
 - Land Use
 - Ecosystem Services
 - Indigenous Peoples

Assessment of Impacts: The impact assessment will identify potential interactions between the Project and physical, biological, and socioeconomic resources, and predict the impacts that may result from these interactions. The impact assessment will be conducted according to the methodology described in Section 8 of this ToR. The EIA will objectively rate the significance of the predicted impacts on the basis of the sensitivity, vulnerability and/or importance of resources/receptors. The impact ratings will be critical inputs to the management and monitoring strategy as described in the description of existing environment. The ratings will also provide the basis for prioritizing impacts to be managed, and a benchmark against which the effectiveness of proposed management measures may be measured.

Environmental and Socioeconomic Management and Monitoring Plan: The management strategy will be based on the hierarchical approach described above, which emphasizes avoiding impacts as the preferred management approach, followed by minimizing unavoidable impacts, and remedying impacts that cannot be avoided or minimized further. The EIA will also include a monitoring component that will be used to assess the effectiveness of the management strategy.

Conclusions and Summary of Impacts: The conclusions and impact summary will review the predicted environmental and socioeconomic impacts of the Project resulting from planned activities and potential unplanned events, as well

the Project's contributions to cumulative impacts on important resources and receptors.

References: Reports, scientific literature, technical texts, websites, and other sources of information used to prepare the EIA.

Supplementary Information: Appendices, supplements, attachments, and any other information that is considered necessary to support the findings of the EIA, but cannot be integrated into the body of the documents will be included as supplements to the EIA.

11.0 Project Team

The following table identifies the primary members of ERM's team and their envisioned roles in preparing the Project EIA. Full CVs for each of these team members are included in Appendix A.

Member	Company and Position	Role
David Blaha	ERM: Partner in Charge	Quality assurance and control, final document review
Todd Hall	ERM: Senior Technical EIA Lead	Quality assurance and control
Jason Willey	ERM: Project Manager	Team leader and document coordination
Kamal Govender	ERM: Assistant Project Manager	Scheduling and ESMP
Greg Lockard	ERM: EIA Coordinator	Document coordination and cultural resources
Julia Tims	ERM: Technical Director	Technical oversight of biodiversity-related assessment
Matt Erbe	ERM: Senior Geologist	Assessment of impacts on marine sediments
Benjamin Sussman	ERM: Senior Transportation Specialist	Assessment of impacts on transportation infrastructure
Mark Garrison	ERM: Senior Air Quality Specialist	Assessment of air quality impacts
Shwet Prakash	ERM: Senior Water Quality Specialist	Assessment of impacts on surface water quality
Mike Fichera	ERM: Senior Water Quality Specialist	Assessment of impacts on surface water quality
Adeyinka Afon	ERM: Senior Noise	Assessment of noise impacts on marine

	Specialist	biota
Simon Ross	ERM: Senior GIS Analyst	GIS Lead
Melinda Todorov	ERM: Environmental Professional	Assessment of impacts on marine benthos
Peyun Kok	ERM: Social Specialist	Socioeconomic and health impact assessment
Dusty Insley	ERM: Geologist	Marine Sediment impact assessment
Jon Connelly	ERM: Environmental Professional	Ecological components of the environmental baseline and impact assessment
Ben Siegel	ERM: Cultural Professional	Cultural resources impact assessment
Erin Rykken	ERM: Technical Editor	Technical Editing, QA/QC
Noam Raffel	ERM: Environmental Professional	GIS analysis and graphics
Hance Thompson	Ground Structures Engineering Consulting: Local Support	Coastal Sensitivity Mapping and Stakeholder Engagement
Hema David	EcoEngineering: Coastal Resource Specialist	Coastal Sensitivity Mapping
Noelia Arispe	Independent Consultant: Coastal Resource Specialist	Coastal Sensitivity Mapping

12.0 Preparation of the EIA

ERM will be responsible for the compilation and presentation of the EIA Report. ERM will plan, coordinate, and execute all activities relating to the preparation and revision of the EIA. ERM will provide updates to EEPGL and the EPA, GGMC, and other government agencies on the EIA process as needed and appropriate.

13.0 EIA Submission

ERM will provide an electronic copy and signed hardcopies of the EIA to the EPA.

14.0 Sources

EPA, 2012.About Us.<http://www.epaguyana.org/index.php/aboutus>

FAO, 2013.Legal Office of the Food and Agriculture Organization of the United Nations (FAOLEX). Laws of Guyana: Environmental Protection Act. <http://faolex.fao.org/docs/pdf/guy39200.pdf>

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Appendix A
EIA Team CVs