UNITED STATES GOVERNMENT December 6, 2017
MEMORANDUM

To: Public Information (MS 5030)
From: Plan Coordinator, FO, Plans Section (MS 5231)

Subject: Public Information copy of plan

Control # - S-07870
Type - Supplemental Exploration Plan
Lease(s) - OCS-G34536 Block - 40 Green Canyon Area
Operator - Noble Energy, Inc.
Description - Subsea Wells F, I and J, and Well 001
Rig Type - Not Found

Attached is a copy of the subject plan.

It has been deemed submitted as of this date and is under review for approval.

Madonna Montz
Plan Coordinator

Site Type/Name	**Botm Lse/Area/Blk**	**Surface Location**	**Surf Lse/Area/Blk**
WELL/001	G34536/GC/40	4204 FNL, 7902 FWL	G34536/GC/40
WELL/F	G34536/GC/40	4931 FNL, 9029 FWL	G34536/GC/40
WELL/I	G34536/GC/40	5004 FNL, 8964 FWL	G34536/GC/40
WELL/J	G34536/GC/40	4834 FNL, 7457 FWL	G34536/GC/40

PUBLIC COPY
September 29, 2017

Supplemental Exploration Plan

Lease OCS-G 34536

Green Canyon 40

Prospect Name: Katmai

Offshore: Louisiana

Submitted by:

Noble Energy, Inc.
1001 Noble Energy Way
Houston, Texas 77070

Estimated start-up date: **February 1, 2018**

1001 Noble Energy Way
Houston, TX 77070
Tel: 281 872-3100
Fax: 281 872-3111

noble energy

November 22, 2017

Via UPS

U. S. Department of the Interior
Bureau of Ocean Energy Management
1201 Elmwood Park Blvd.
New Orleans, Louisiana 70123-2394

Attn: Madonna Montz

RE: Supplemental Exploration Plan
Leases OCS-G 34536, Block GC 40
OCS Federal Waters, Gulf of Mexico, Offshore, Louisiana

Ms. Montz:

Noble Energy, Inc. hereby submits an updated Supplemental Exploration Plan for the Green Canyon Block 40, which includes amendments requested by BOEM or initiated on behalf of Noble.

Below are the amendments included:

Date of the amendment	Page Number(s)	Brief synopsis of amendment
10/12/17	H-1 & H-2	Updated OSRP approval & compliance date
10/12/17	Form 0137	Added a page for GC 40 SSW 001
11/1/17	G-1 & G-2	Included AQR for DP semisubmersible

Enclosed are:

- One hard copy and one CD of the Proprietary and Public versions of the Supplemental Exploration Plan

If you have any questions or need additional information, I may be contacted at (281) 876-6229, or via email at Vanessa.villagran@nblenergy.com.

Sincerely,
Noble Energy, Inc.

V. Villagran
Vanessa Villagran
Regulatory Supervisor

Enclosures

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Section A
Plan Contents

A. Plan Summary
Noble Energy, Inc. (Noble) proposes to supplement the previously approved Initial Exploration Plan (N-9978), approved on March 19, 2014. This Supplemental Plan will call for the drilling, completion, testing, installation of subsea wellheads and/or manifold and temporarily abandoning well locations "F", "I", and "J" in the Green Canyon Block 40. These activities will either use a dynamically positioned drillship or a dynamically positioned semisubmersible as rig options, both options will use a subsea BOP. The anticipated spud date of the first well is February 1, 2018. If commercial quantities of hydrocarbons are discovered, a Development Operations Coordination Document will be submitted for approval.

Noble also proposes to perform completion operations and testing for the previously approved GC 40 "B" location. This location was approved under Initial EP Plan Control No. N-9778, approved on March 19, 2014. This well was drilled in 2014 and is currently temporarily abandoned. This well name is Green Canyon Well 001 with an API number of 608114062300. The previously approved EP rig type is a dynamically positioned semisubmersible. Noble hereby requests to **add** the rig type option of a dynamically positioned drillship to perform these operations.

The worst case discharge volume for this submittal was previously approved on December 1, 2015 in an Initial Exploration Plan, covering the Green Canyon Block 40 along with Green Canyon Block 39 and Ewing Bank Block 1009 with the plan Control No. N-9910.

B. Plan Information Form
See attached OCS Plan Information Form – Form BOEM-137, included as **Attachment A-1**.

C. Location
Included as **Attachment A-2** is a location map depicting the proposed surface locations of the new wells. This map was done at a scale of 1"=4000' in order for locations to be included on one location map.

Attachment A-3 is a bathymetry map showing the water depths at the surface location of each proposed well. This map was done at a scale of 1"=4000' in order for all of locations to be included on one map.

Attachment A-4 is a site-specific water depth and seafloor features map, showing a 2000' radius around the proposed wellsites. An anchor radius is also shown, however, no anchors will be used for the proposed operations.

D. Safety and Pollution Prevention Features
A description of the drilling unit is included on the OCS Plan Information Form. Rig specifications will be made part of each Application for Permit to Drill.

Safety features on the drilling unit will include well control, pollution prevention, and blowout prevention equipment as described in Title 30 CFR Part 250, Subparts C, D, E, and G; and as further clarified by BOEM Notices to Lessees, and current policy making invoked by the BOEM, Environmental

Protection Agency and the U.S. Coast Guard. Appropriate life rafts, life jackets, ring buoys, etc., will be maintained on the facility at all times.

Pollution prevention measures include installation of curbs, gutters, drip pans, and drains on drilling deck areas to collect all contaminants and debris.

E. Storage Tanks and/or Production Vessels. All facility tanks of 25 barrels or more.
This Plan is being submitted with the options of a dynamically positioned (DP) drillship and a dynamically positioned semisubmersible. Due to the size of a DP drillship vs. a DP semisubmersible, Noble is submitting the information for the drillship as its storage tanks will be greater than a DP semisubmersible.

The exact drillship is not known at the time of the EP submittal, therefore, the BOEM default values for maximum storage tanks is being used.

Drillship

Type of Storage Tank	Type of Facility	Tank Capacity (BBLS)	Total Capacity (BBLS)
Fuel Oil Storage	Drillship	32,000	80,000

F. Additional Measures
Noble does not propose additional safety, pollution prevention, or early spill detection measures beyond those required by 30 CFR 250.

Public

U.S. Department of the Interior
Bureau of Ocean Energy Management

OMB Control Number: 1010-0151
OMB Approval Expires: 12/31/18

OCS PLAN INFORMATION FORM

General Information

Type of OCS Plan:	X	Exploration Plan (EP)	Development Operations Coordination Document (DOCD)	

Company Name: Noble Energy, Inc.	BOEM Operator Number: 02237
Address:	Contact Person: Vanessa Villagran
1001 Noble Energy Way	Phone Number: 281-876-6229
Houston, TX 77067	E-Mail Address: vanessa.villagran@nblenergy.com

If a service fee is required under 30 CFR 550.125(a), provide the	Amount paid		Receipt No.	

Project and Worst Case Discharge (WCD) Information

Lease(s): OCS-G 34536	Area: GC	Block(s): 40	Project Name (If Applicable): Katmai East

Objective(s)	X	Oil	X	Gas		Sulphur		Salt

Onshore Support Base(s): Fourchon, LA

Platform/Well Name: GC 39 "A"	Total Volume of WCD: 248, 975 bbls per day	API Gravity: 36
Distance to Closest Land (Miles): 73	Volume from uncontrolled blowout: 36.1 million bbls	

Have you previously provided information to verify the calculations and assumptions for your WCD?	X	Yes		No
If so, provide the Control Number of the EP or DOCD with which this information was provided	N-9910			
Do you propose to use new or unusual technology to conduct your activities?		Yes	X	No
Do you propose to use a vessel with anchors to install or modify a structure?		Yes	X	No
Do you propose any facility that will serve as a host facility for deepwater subsea development?		Yes	X	No

Description of Proposed Activities and Tentative Schedule (Mark all that apply)

Proposed Activity	Start Date	End Date	No. of Days
Drill, Complete, TA & Installation of subsea wellhead/or manifold - GC 40 F	See attached schedule		
Drill, Complete, TA & Installation of subsea wellhead/or manifold - GC 40 I	See attached schedule		
Drill, Complete, TA & Installation of subsea wellhead/or manifold - GC 40 J	See attached schedule		
Complete, Install subsea wellhead/or manifold - GC 40 Well 001	See attached schedule		

Description of Drilling Rig

	Jackup	X	Drillship
	Gorilla Jackup		Platform rig
	Semisubmersible		Submersible
X	DP Semisubmersible		Other (Attach Description)

Drilling Rig Name (If Known):

Description of Structure

	Caisson		Tension leg platform
	Fixed platform		Compliant tower
	Spar		Guyed tower
	Floating production system		Other (Attach Description)

Description of Lease Term Pipelines

From (Facility/Area/Block)	To (Facility/Area/Block)	Diameter (Inches)	Length (Feet)

GC 40 - Supp EP
Attachment A-1 Activity Schedule

Proposed Activity	Start date	Duration	End date
Drill & temporarily abandon GC 40 F	2/1/2018	159	7/10/2018
Complete, install subsea wellhead/or manifold GC 40 F	8/1/2019	61	10/1/2019
Complete, install subsea wellhead/or manifold GC 40 Well 001	10/1/2019	61	12/1/2019
Drill & temporarily abandon GC 40 I	5/1/2021	159	10/7/2021
Complete, install subsea wellhead/or manifold GC 40 I	9/15/2022	61	11/15/2022
Drill & temporarily abandon GC 40 J	5/1/2023	159	10/7/2023
Complete, install subsea wellhead/or manifold GC 40 J	9/15/2024	61	11/15/2024

OCS PLAN INFORMATION FORM (CONTINUED)
Include one copy of this page for each proposed well/structure

Proposed Well/Structure Location							
Well or Structure Name/Number (If renaming well or structure, reference previous name): GC 40 F			Previously reviewed under an approved EP or DOCD?		Yes	X	No
Is this an existing well or structure?	Yes	No X	If this is an existing well or structure, list the Complex ID or API No.	No			
Do you plan to use a subsea BOP or a surface BOP on a floating facility to conduct your proposed activities?				X	Yes		No

WCD info	For wells, volume of uncontrolled blowout (Bbls/day):	For structures, volume of all storage and pipelines (Bbls):	API Gravity of fluid	

	Surface Location	Bottom-Hole Location (For Wells)	Completion (For multiple completions, enter separate lines)
Lease No.	OCS 34536	OCS	OCS OCS
Area Name	GC		
Block No.	40		
Blockline Departures (in feet)	N/S Departure: F____ L 4931 FNL	N/S Departure: F____ L	N/S Departure: F____ L N/S Departure: F____ L N/S Departure: F____ L
	E/W Departure: F____ L 9029 FWL	E/W Departure: F____ L	E/W Departure: F____ L E/W Departure: F____ L E/W Departure: F____ L
Lambert X-Y coordinates	X: 2,622,629.18	X:	X: X: X:
	Y: 10,148,508.82	Y:	Y: Y: Y:
Latitude/ Longitude	Latitude 27 55 56.76 N	Latitude	Latitude Latitude Latitude
	Longitude 89 57 28.42 W	Longitude	Longitude Longitude Longitude

Water Depth (Feet): 2127'	MD (Feet):	TVD (Feet):	MD (Feet): MD (Feet): MD (Feet):	TVD (Feet): TVD (Feet): TVD (Feet):
Anchor Radius (if applicable) in feet:				

Anchor Locations for Drilling Rig or Construction Barge (If anchor radius supplied above, not necessary)

Anchor Name or No.	Area	Block	X Coordinate	Y Coordinate	Length of Anchor Chain on Seafloor
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	

OCS PLAN INFORMATION FORM (CONTINUED)
Include one copy of this page for each proposed well/structure

Proposed Well/Structure Location

Well or Structure Name/Number (If renaming well or structure, reference previous name): GC 40 I	Previously reviewed under an approved EP or DOCD?		Yes	X	No	
Is this an existing well or structure?		Yes		No X	If this is an existing well or structure, list the Complex ID or API No.	No
Do you plan to use a subsea BOP or a surface BOP on a floating facility to conduct your proposed activities?	X	Yes		No		
WCD info	For wells, volume of uncontrolled blowout (Bbls/day):	For structures, volume of all storage and pipelines (Bbls):	API Gravity of fluid			

	Surface Location	Bottom-Hole Location (For Wells)	Completion (For multiple completions, enter separate lines)
Lease No.	OCS 34536	OCS	OCS OCS
Area Name	GC		
Block No.	40		
Blockline Departures (in feet)	N/S Departure: F____ L 5004 FNL	N/S Departure: F____ L	N/S Departure: F____ L N/S Departure: F____ L N/S Departure: F____ L
	E/W Departure: F____ L 8964 FWL	E/W Departure: F____ L	E/W Departure: F____ L E/W Departure: F____ L E/W Departure: F____ L
Lambert X-Y coordinates	X: 2,622,563.70	X:	X: X: X:
	Y: 10,148,435.51	Y:	Y: Y: Y:
Latitude/ Longitude	Latitude 27 55 56.06 N	Latitude	Latitude Latitude Latitude
	Longitude 89 57 29.17 W	Longitude	Longitude Longitude Longitude

Water Depth (Feet): 2129'	MD (Feet):	TVD (Feet):	MD (Feet): MD (Feet): MD (Feet):	TVD (Feet): TVD (Feet): TVD (Feet):
Anchor Radius (if applicable) in feet:				

Anchor Locations for Drilling Rig or Construction Barge (If anchor radius supplied above, not necessary)

Anchor Name or No.	Area	Block	X Coordinate	Y Coordinate	Length of Anchor Chain on Seafloor
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	

OCS PLAN INFORMATION FORM (CONTINUED)
Include one copy of this page for each proposed well/structure

Proposed Well/Structure Location

Well or Structure Name/Number (If renaming well or structure, reference previous name): GC 40 J	Previously reviewed under an approved EP or DOCD?		Yes	X	No
Is this an existing well or structure?		Yes		No X	If this is an existing well or structure, list the Complex ID or API No. No
Do you plan to use a subsea BOP or a surface BOP on a floating facility to conduct your proposed activities?	X	Yes		No	

WCD info	For wells, volume of uncontrolled blowout (Bbls/day):	For structures, volume of all storage and pipelines (Bbls):	API Gravity of fluid	

	Surface Location	**Bottom-Hole Location (For Wells)**	**Completion (For multiple completions, enter separate lines)**
Lease No.	OCS 34536	OCS	OCS OCS
Area Name	GC		
Block No.	40		
Blockline Departures (in feet)	N/S Departure: F____ L 4834 FNL	N/S Departure: F____ L	N/S Departure: F____ L N/S Departure: F____ L N/S Departure: F____ L
	E/W Departure: F____ L 7457 FWL	E/W Departure: F____ L	E/W Departure: F____ L E/W Departure: F____ L E/W Departure: F____ L
Lambert X-Y coordinates	X: 2,621,057.43	X:	X: X: X:
	Y: 10,148,605.82	Y:	Y: Y: Y:
Latitude/ Longitude	Latitude 27 55 58.11 N	Latitude	Latitude Latitude Latitude
	Longitude 89 57 45.90 W	Longitude	Longitude Longitude Longitude

Water Depth (Feet): 2124'	MD (Feet):	TVD (Feet):	MD (Feet): MD (Feet): MD (Feet):	TVD (Feet): TVD (Feet): TVD (Feet):
Anchor Radius (if applicable) in feet:				

Anchor Locations for Drilling Rig or Construction Barge (If anchor radius supplied above, not necessary)

Anchor Name or No.	**Area**	**Block**	**X Coordinate**	**Y Coordinate**	**Length of Anchor Chain on Seafloor**
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	

Public

OCS PLAN INFORMATION FORM (CONTINUED)
Include one copy of this page for each proposed well/structure

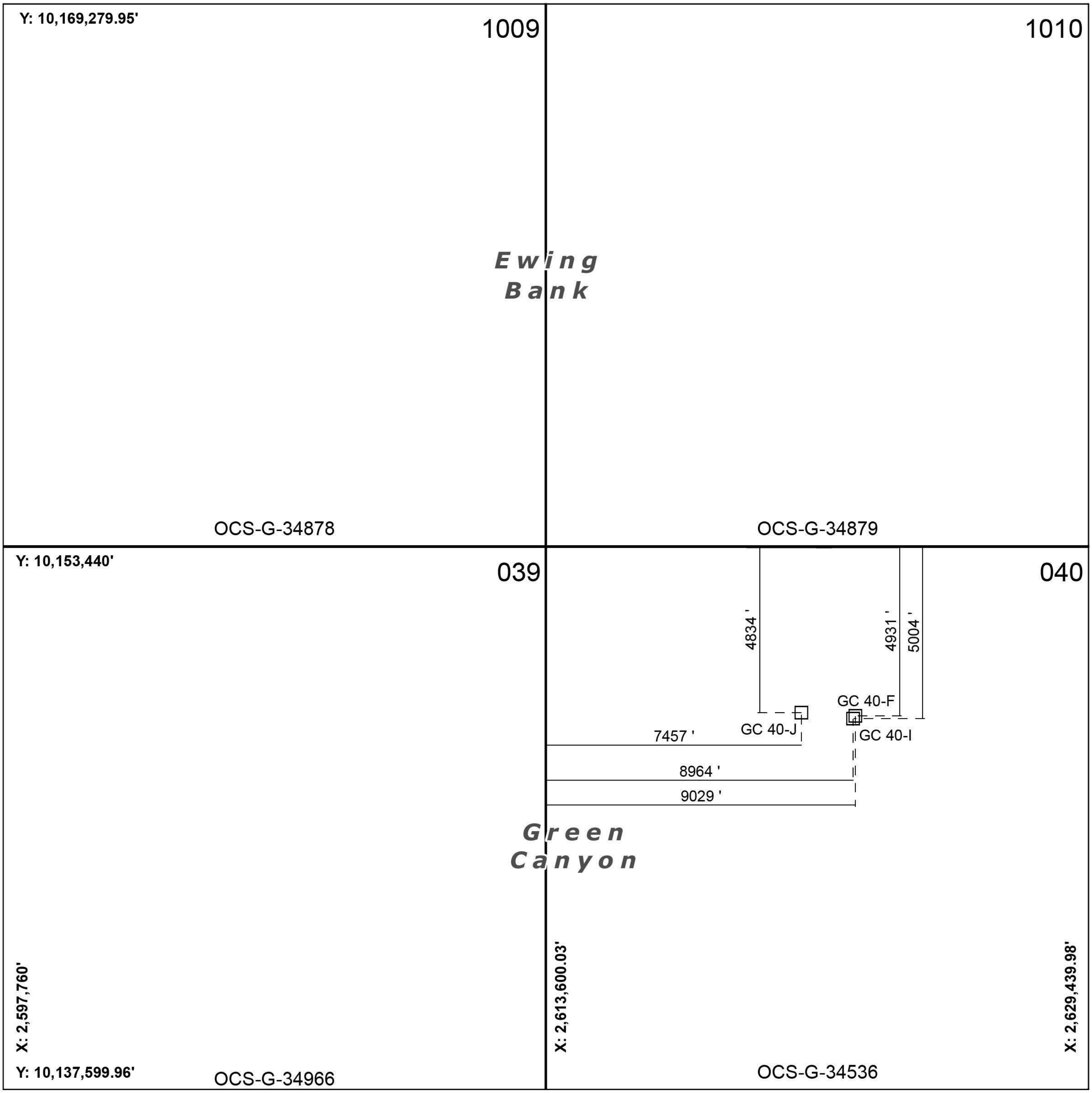
Proposed Well/Structure Location						
Well or Structure Name/Number (If renaming well or structure, reference previous name): GC 40 SSW 001	Previously reviewed under an approved EP or DOCD?	X	Yes		No	
Is this an existing well or structure?	Yes X		No	If this is an existing well or structure, list the Complex ID or API No.	6081 1406 2300	
Do you plan to use a subsea BOP or a surface BOP on a floating facility to conduct your proposed activities?	X	Yes		No		
WCD info	For wells, volume of uncontrolled blowout (Bbls/day):	For structures, volume of all storage and pipelines (Bbls):	API Gravity of fluid			

	Surface Location	**Bottom-Hole Location (For Wells)**	**Completion (For multiple completions, enter separate lines)**
Lease No.	OCS 34536	OCS	OCS OCS
Area Name	GC		
Block No.	40		
Blockline Departures (in feet)	N/S Departure: F____ L 4204 FNL	N/S Departure: F____ L	N/S Departure: F____ L N/S Departure: F____ L N/S Departure: F____ L
	E/W Departure: F____ L 7902 FWL	E/W Departure: F____ L	E/W Departure: F____ L E/W Departure: F____ L E/W Departure: F____ L
Lambert X-Y coordinates	X: 2,621,501.95	X:	X: X: X:
	Y: 10,149,235.45	Y:	Y: Y: Y:
Latitude/ Longitude	Latitude 27 56 4.23	Latitude	Latitude Latitude Latitude
	Longitude 89 57 40.77	Longitude	Longitude Longitude Longitude

Water Depth (Feet): 2079	MD (Feet):	TVD (Feet):	MD (Feet): MD (Feet): MD (Feet):	TVD (Feet): TVD (Feet): TVD (Feet):
Anchor Radius (if applicable) in feet:				

Anchor Locations for Drilling Rig or Construction Barge (If anchor radius supplied above, not necessary)

Anchor Name or No.	**Area**	**Block**	**X Coordinate**	**Y Coordinate**	**Length of Anchor Chain on Seafloor**
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	
			X =	Y =	



Public Information

C.I:	**Page 1 of 2**	0 1,000 2,000 4,000 Feet 1 in = 4,000 ft	Green Canyon 39, 40 / Ewing Bank 1009, 1010 Louisiana	noble energy
Geol/Geop: Staff			**Katmai East Prospect Location Plat**	
Date: 17 Aug 2017				
File Name: Katmai_East_Location_Public_GC40		**Attachment A-2**		
Projection: NAD 1927 UTM Zone 15N / Units: Foot US				

noble energy **OFFSHORE DIVISION**
GULF OF MEXICO

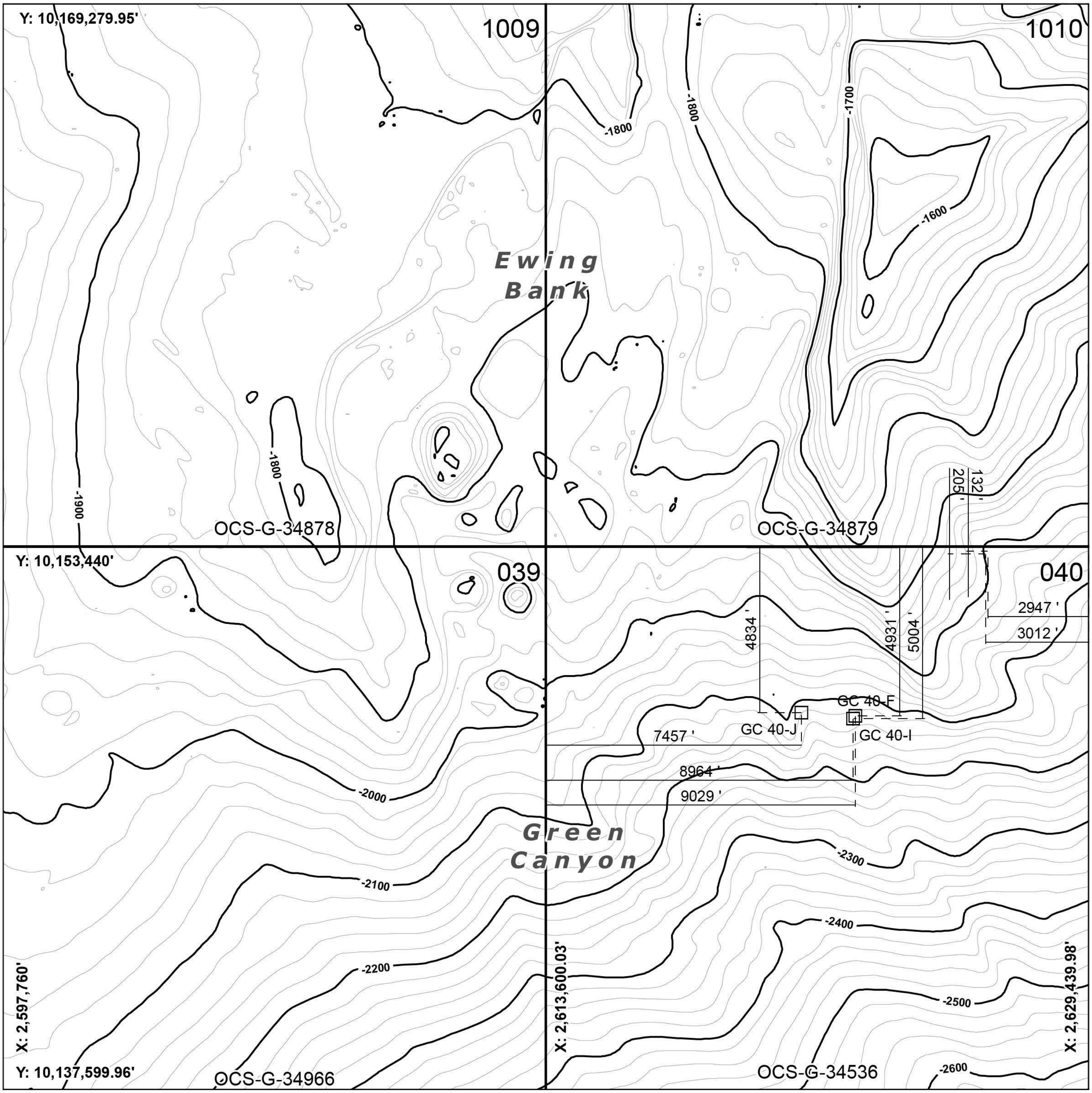
Public Information

GREEN CANYON 40
PROJECTION: UTM ZONE 15N NAD27 US FT

KATMAI EAST PROSPECT

Location Plat

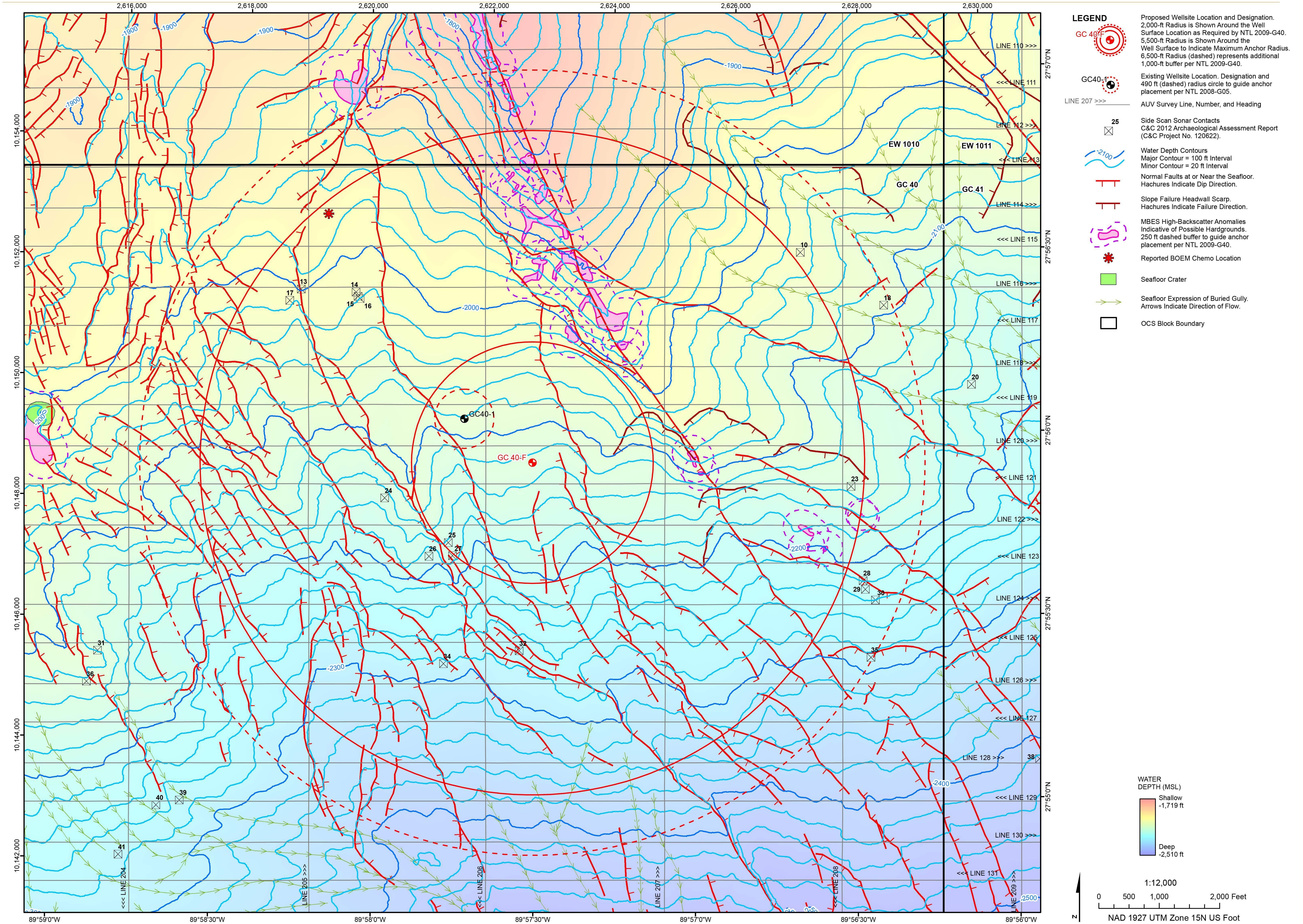
GC 40-F SHL	X= 2,622,629.18’ Y= 10,148,508.82’ LAT. 27° 55' 56.76"N LON. 89° 57' 28.42"W WD 2127’	GC 40-J SHL	X= 2,621,057.43’ Y= 10,148,605.82’ LAT. 27° 55' 58.11"N LON. 89° 57' 45.90"W WD 2124’
GC 40-I SHL	X= 2,622,563.70’ Y= 10,148,435.51’ LAT. 27° 55' 56.06"N LON. 89° 57' 29.17"W WD 2129’		



Public Information

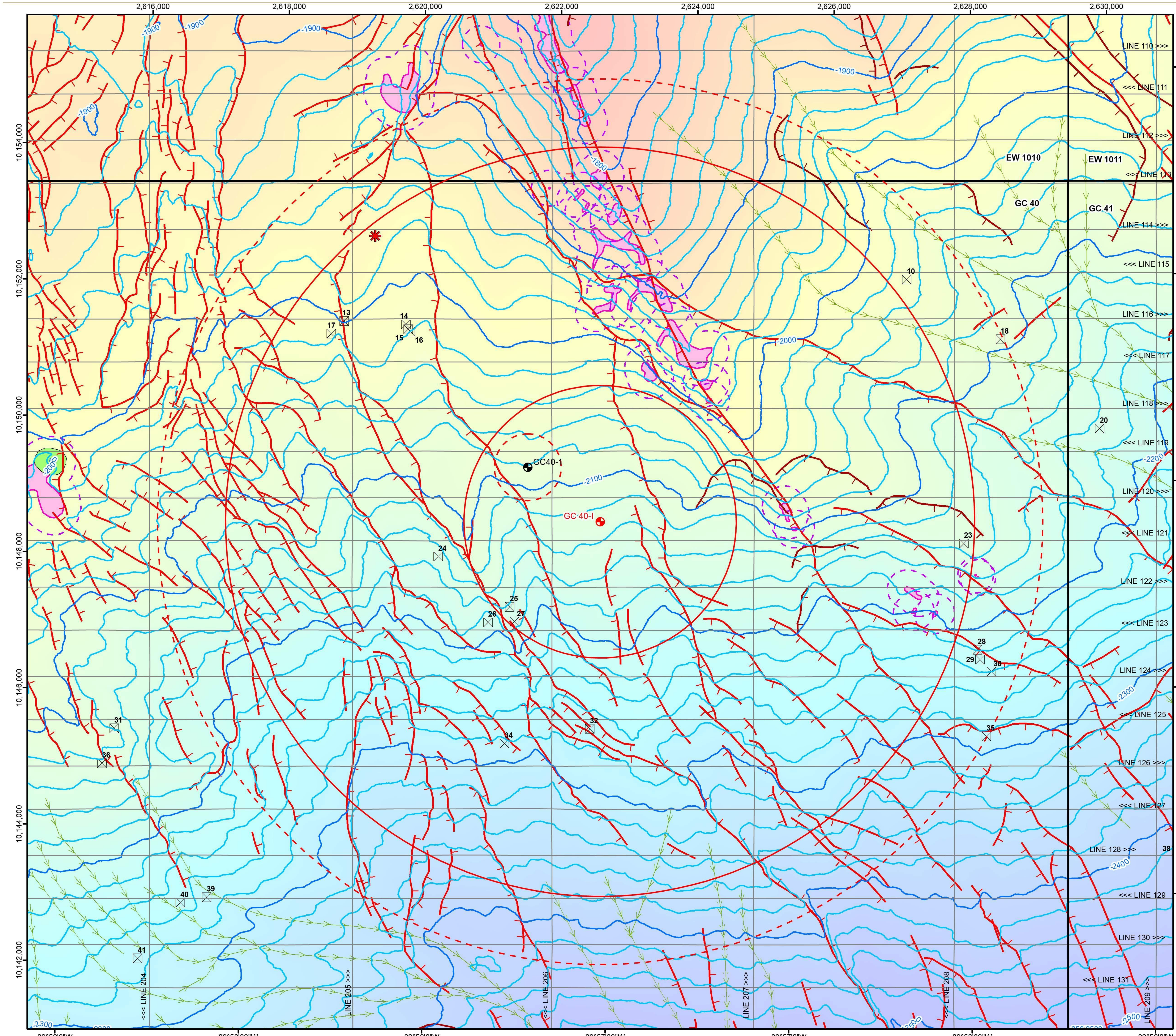
C.I: 20'	Page 1 of 1	0 1,000 2,000 4,000 Feet 1 in = 4,000 ft	Green Canyon 39, 40 / Ewing Bank 1009, 1010 Louisiana	noble energy
Geol/Geop: Staff			Katmai East Prospect Bathymetry Plat	
Date: 17 Aug 2017				
File Name: Katmai_East_Bathymetry_GC40		Attachment A-3		
Projection: NAD 1927 UTM Zone 15N / Units: Foot US				

NOBLE ENERGY, INC.
WELLSITE CLEARANCE LETTER
WELLSITE GC 40-F, GREEN CANYON, GULF OF MEXICO



WATER DEPTH AND SEAFLOOR FEATURES

FUGRO



WATER DEPTH AND SEAFLOOR FEATURES

LEGEND

GC 40-I — Proposed Wellsite Location and Designation. 2,000-ft Radius is Shown Around the Well Surface Location as Required by NTL 2009-G40. 5,500-ft Radius is Shown Around the Well Surface to Indicate Maximum Anchor Radius. 6,500-ft Radius (dashed) represents additional 1,000-ft buffer per NTL 2009-G40.

GC40-1 — Existing Wellsite Location. Designation and 490 ft (dashed) radius circle to guide anchor placement per NTL 2008-G05.

LINE 207 >>> — AUV Survey Line, Number, and Heading

25 — Side Scan Sonar Contacts C&C 2012 Archaeological Assessment Report (C&C Project No. 120622).

-2100 — Water Depth Contours
Major Contour = 100 ft Interval
Minor Contour = 20 ft Interval

Normal Faults at or Near the Seafloor. Hachures Indicate Dip Direction.

Slope Failure Headwall Scarp. Hachures Indicate Failure Direction.

MBES High-Backscatter Anomalies Indicative of Possible Hardgrounds. 250 ft dashed buffer to guide anchor placement per NTL 2009-G40.

Reported BOEM Chemo Location

Seafloor Crater

Seafloor Expression of Buried Gully. Arrows Indicate Direction of Flow.

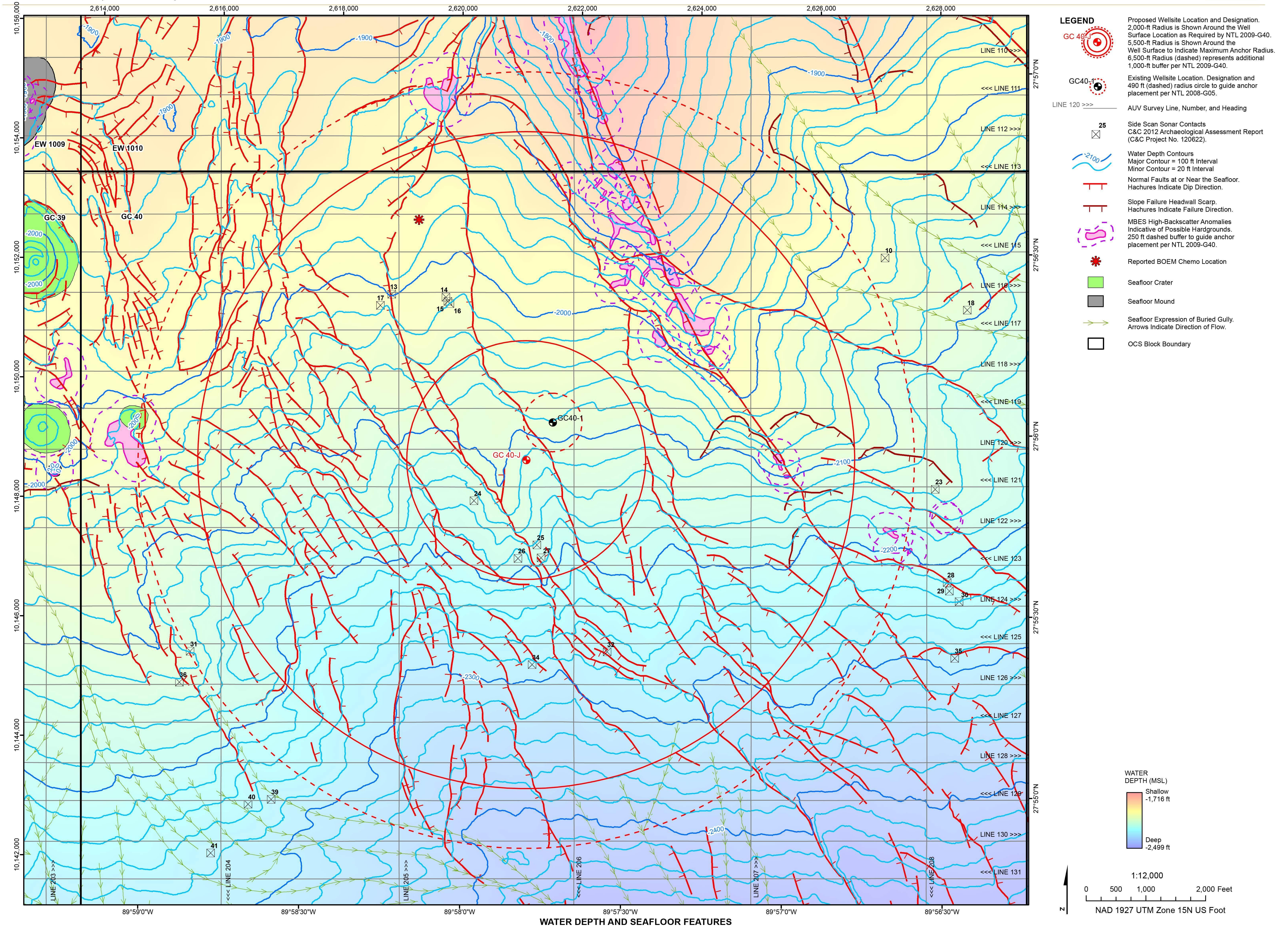
OCS Block Boundary

WATER DEPTH (MSL)
Shallow -1,722 ft
Deep -2,513 ft

N

1:12,000
0 500 1,000 2,000 Feet

NAD 1927 UTM Zone 15N US Foot



WATER DEPTH AND SEAFLOOR FEATURES

Section B
General Information

A. Applications and Permits
An application for a permit to drill (APD) will be submitted to BSEE for the approval of drilling and completion activities. An individual NPDES Permit will be submitted to EPA for approval prior to drilling and completions activities.

B. Drilling Fluids –

Type of Drilling Fluid	Estimated Volume of Drilling Fluid to be used per Well
Water-based	Please see table in Section F Page F-1
Synthetic-based	Please see table in Section L Page L-2

C. New or Unusual Technology
Noble does not propose to use any new or unusual technology to carry out the proposed exploration activities.

D. Bonding Statement
The bond requirements for the activities and facilities proposed in this EP are satisfied by an area-wide bond, furnished and maintained according to 30 CFR 556, subpart I; NTL No. 2015-N04, "General Financial Assurance.

E. Oil Spill Financial Responsibility (OSFR)
Noble BOEM company number 02237, has demonstrated oil spill financial responsibility for the facilities proposed in this EP according to 30 CFR Part 553; and NTL No. 2008-N05, "Guidelines for Oil Spill Financial Responsibility for Covered Facilities".

F. Deepwater Well Control Statement
Noble BOEM company number 02237, has the financial capability to drill a relief well and conduct other emergency well control operations.

G. Blowout Scenario
Per NTL 2015-N01, the worst case discharge volume for this submittal was previously approved on December 1, 2015 in an Initial Exploration Plan, covering the Green Canyon Block 40 along with Green Canyon Block 39 and Ewing Bank Block 1009 with the plan Control No. N-9910. The previously submitted and approved worst case discharge package is submitted as **Attachment B-1** for reference.

WCD Discharge Discussion
OCS-G34536 **Operator – Noble Energy, Inc.**
GC 40, Katmai East Prospect

Introduction

Noble Energy, Inc. (Noble) is planning to drill the sub-salt Katmai East Prospect, GC 40-F well, to a depth of 26,853' TVD / 28,037' MD to test Middle and Lower Miocene sands. The calculation of Worst Case Discharge (WCD) is based on the mapping of similar sands penetrated in the Katmai discovery well, GC 40-1 drilled in 2014. The calculated WCD for well GC 40-F is 114,432 BO/D, 252 MMscf/D, and 649,126 BW/D. However, the WCD for the greater Katmai area is 248,975 BO/D, 572 MMscf/D, and 5 BW/D which is calculated for Katmai West well GC 39-A, permitted in an Exploration Plan submitted September 2, 2015. ***For the purposes of the greater Katmai Field and for this EP the WCD will remain 248,975 BO/D, 572 MMscf/D, and 5 BW/D as calculated for the Katmai West area in well GC 39-A.***

WCD Hole Section

The GC 39-A WCD application is designed for the Katmai West well. The well is planned as a deviated hole and consists of eight hole sections planned to a depth of 29,954' MD/28,000' TVD.

WCD Geological Input

The WCD model was built using petrophysical values based on nearby well control, along with our experience from submitting WCD calculations on previous projects. Interpretation of lithology was based on seismic ties to offset wells. Seismic lines were tied to the following wells: EW 1010 Shell-001 ST1 (Hurricane), GC 36 Statoil-002 BP2 (Candy Bars), and the Noble GC 40-1 wells. The determination of potential hydrocarbon bearing sands is tied directly to the Katmai discovery well GC 40-1 drilled in 2014. Sands in the WCD model have thicknesses, rock properties, and fluid properties based on the values from the GC 40-1 well.

WCD Engineering Input

The petrophysical and fluid data used in the WCD calculations were based on the offset Katmai discovery well GC 40-1 drilled in 2014.

Katmai West GC 39-A WCD Calculation Results

Noble used a commercially available production modeling software suit by Gemini Solutions Inc. (Merlin/Avalon) to calculate a WCD value of 248,975 BO/D, 572 MMscf/D and 5 BW/D.

Description of the Drilling Blowout Scenario

The GC 39-A WCD is based on a drilling blowout scenario whereby all four oil bearing formations of the final hole section, two of which are the objective sands, are exposed and flowing. It is assumed that the drill pipe will be out of the hole and the subsea BOP and drilling riser are removed allowing the WCD fluid to exit the well at the subsea wellhead. At the time of the blowout, the wellbore consists of 14" casing from the subsea wellhead to the top of the 11-7/8" liner at 21,413' MD/20,300' TVD. The 11-7/8" liner extends from 21,413' MD/20,300' TVD to the casing shoe at 25,405' MD/23,900' TVD. The open hole section is drilled to 10-5/8" and under reamed to 12-1/4". It is at this time that the well is modeled to produce unrestricted from the open hole section to the wellhead with a sea water gradient, 0.445 psi/ft, as backpressure at the wellhead. The main assumption is the expectation of a failure to close the blowout preventers (BOP) and the absence of a riser.

Duration of the Worst Case Discharge

The Noble drilling department believes that the duration of the WCD is dependent on the characteristics of the blowout. The WCD will persist until the well is contained, a relief well is drilled, or the well bridges over due to wellbore instability.

Scenarios exist in which the duration of the WCD has the potential to flow from hours to months depending on the condition of the well at the time of the discharge as outlined below:

- The well could bridge over due to wellbore instability which should happen relatively early in the WCD scenario.

- Containment blowout preventer equipment (BOPE) is installed and closed using a prescribed procedure shutting in the well and eliminating the discharge. This would require between 15 – 21 days to accomplish – provided no debris removal is required. The range for the worst case volume discharge is between 3.3 and 4.7 million cumulative barrels of oil.

- Twisted riser material may need to be removed prior to any containment equipment installation, which could take considerable time depending on the amount and complexity of debris. It could take several weeks to a few months to clear a connection for the BOPE to eliminate the release of fluid.

- If all intervention attempts are unsuccessful, the well could discharge until intercepted and killed by a relief well. The estimated time to drill a relief well is approximately 241 days which includes the time to secure a DP rig and bring it to the location. The worst case volume discharge is 36.1 million cumulative barrels of oil.

In summary, the WCD duration may be short lived if it bridges over, last several days until the well is contained, or discharge for multiple months until the relief well kills the discharging well.

Potential of Open Hole to Bridge Over

Due to the unrestricted flow of a WCD scenario, the well has the potential to experience a downhole rock failure. The primary failure mechanism would be wellbore instability caused by the reduced wellbore pressure. The in situ stresses that exist in the reservoir rock are held in place by the hydrostatic pressure of the weighted drilling fluid in the wellbore. If the wellbore pressure is reduced, the high in situ stresses are no longer opposed by the weighted drilling fluid and the in situ rock may fail and collapse into the wellbore causing the wellbore to bridge over where the failed rock fragments accumulate and lodge downhole to prevent the well discharge from continuing.

Likelihood for Surface Intervention to Stop Blowout

There is a high likelihood that a combined surface and subsea intervention would stop a blowout of the GC 39-A well. Noble has access to and can deploy surface and subsea containment resources adequate to promptly respond to a blowout or loss of well control. The GC 39-A is designed to handle the worst case shut in pressure and contain all wellbore fluids in the formations below salt. This wellbore integrity and containment will allow the Helix Fast Response System (HFRS) subsea 15K capping stack to be utilized to its fullest potential of capping and killing the well in a timely manner. Clean Gulf Associates (CGA) has the capability to provide efficient mobilization of necessary equipment and procedures to effectively mitigate numerous blowout scenarios.

Availability of Drilling Rig for a Relief Well

Noble Energy has a team consistently tracking the rigs that are available in the Deepwater Gulf of Mexico (GoM) marketplace to understand the contracting market and availability for emergency operations such as relief well drilling. In the event of a WCD, there are multiple dynamically positioned (DP) rigs that are capable of drilling a relief well to the appropriate depth and in around 2000' of water. Noble Energy is also a member of a mutual aid agreement for rigs and other physical assets including, but not limited to, logistical support, cementing, tugs, towboats, supply boats, ROV boats, intervention vessels, firefighting vessels and anchor handlers used in connection with such drilling units and have access to employees or consultants with expertise in operations in the Gulf of Mexico. Contracting a rig and having that rig on location ready to spud may take up to 18 days.

Estimated Time to Drill a Relief Well

Given the current availability of suitable rigs in the GoM, a contract could be finalized in roughly 48 hours after undertaking the decision to begin relief well operations. Backup tubulars and wellhead systems are maintained in stock for each well. Mobilization of the rig, as well as mobilization of equipment and services to the rig could be completed in 432 hours, concurrent with contract execution.

The estimated time to drill a relief well is 241 days which includes 18 days for securing a DP rig and mobilizing it to the lease.

The relief well assumes 30% NPT and additional time for directional control. In order to reduce the angle, every measure will be taken to place the rig as close as possible to the blowout well and intersect the blowout well 1,000' above the 11-7/8" casing shoe at a planned set depth of 23,900' TVD-RKB. Once intersected the well can be killed with kill weight mud and cemented as necessary for a permanent abandonment. A deepwater drilling rig capable of drilling in +/- 1,900' of water must be utilized for a relief well. In this scenario, drilling a relief well from a nearby platform is not feasible.

Measures for Blowout Prevention

Certain measures will be taken to prevent and reduce the likelihood of a blowout as described in the WCD discharge scenario. The blowout prevention measures provide additional assurance in improving the safety of offshore oil and gas drilling. Key measures taken for blowout prevention include but are not limited to:

- Complying with all Federal rules and regulations: CFRs, NTLs, and Final Rules.
- Following provisions in API RP 65-Part 2 and API RP 53.
- Utilizing Noble's management systems: Global Management System (GMS), Safety and Environmental Management System (SEMS), Drilling Management System (DMS), Management of Change (MOC), and/or appropriate bridging documents to contractor's Safety Management Systems.
- Utilizing established well control practices, guidelines, and procedures.
- Ensuring proper physical barriers are in place to prevent uncontrolled flow.
- Utilizing established negative testing procedures and BSEE approved fluid displacement procedures.
- Utilizing experienced and fully trained personnel.
- Adhering strictly to well monitoring.
- Certifying that the BOPE is fit for purpose.
- Utilizing a rig and equipment fit for purpose.
- Utilizing a professionally certified and peer reviewed well design (casing and cementing).
- Engaging contractors in meetings to gain alignment on well plan.
- Utilizing specific procedures to execute well plan.

Early Intervention In the Event of a Blowout

Noble has access to and can deploy surface and subsea containment resources adequate to promptly respond to a blowout or loss of well control. In the event that all attempts to shut-in the well with the rig's BOP fail, Noble plans to utilize the HFRS containment system for intervention. Procedures have been developed and equipment has been identified for a fast deployment. Service companies who support the operation and their specific equipment have been identified and documented during several technical sessions to mature the well containment response. Procedures have been developed for: debris removal, BOP and/or lower marine riser package and/or riser removal, capping stack installation, well shut-in, and static top kill operations. Noble has access to the following through the CGA:

- Subsea containment and capture equipment
- Subsea equipment to cut riser and perform various interventions
- Dispersant injection equipment
- Riser systems
- Remotely operated vehicles
- Capture vessels
- Support vessels
- Storage facilities

GC 39-A Containment

In the event of a WCD scenario blowout, the GC 39-A is designed to handle the worst case shut in pressure and contain all wellbore fluids in the formations below salt. This wellbore integrity and containment will allow the HFRS 15K subsea capping stack to be utilized to its fullest potential of capping and killing the well in a timely manner. Contracts with CGA and Helix Energy Solutions will enable efficient mobilization of necessary equipment and procedures to effectively mitigate numerous blowout scenarios.

Relief Well Arrangements

Noble has taken additional measures for drilling a relief well to assist in conducting early and effective intervention of a blowout. Noble has identified relief well locations to the west and southwest of the GC 39-A well. The team has assessed the tangibles, equipment, and services necessary to drill a relief well and can source all of those requirements in the event of a blowout.

Conclusion

Noble calculates a Worst Case Discharge (WCD) rate of 248,975 BO/D, 572 MMscf/D and 5 BW/D in well GC 39-A based on detailed engineering calculations using geological and geophysical inputs from nearby offset wells. Noble Energy, Inc. has the resources to respond to this Worst Case Discharge (WCD) scenario in a timely manner.

Section C
Geological and Geophysical Information

A. Geological Description
Proprietary Data

B. Structure Contour Map
Proprietary Data

C. Interpreted 3-D Seismic Lines
Proprietary Data

D. Geological Structure Cross-Section
Proprietary Data

E. Shallow Hazards Report
Noble Energy, Inc. (Noble) contracted Fugro Marine Geoservices, Inc. to prepare a shallow geohazards assessment of the Katmai East Prospect area covering blocks Green Canyon 39, 40, and 41, and Ewing Banks 1009, 1010, and 1011. Archeological Assessments were completed by C&C Technologies, Inc. in October, 2012 (Report No. 120622), Fugro Marine Geoservices, Inc. in August, 2015 (Report No. 2415-5076), and Tesla Offshore, LLC in January, 2015 (Job No. 14-043-41).

F. Shallow Hazards Assessment
Utilizing the 3-D seismic exploration data, a shallow hazards assessment was prepared for the proposed surface locations and is included as **Attachment C-4**. The shallow hazards assessments for the proposed well locations are also included within the reports prepared by Fugro Marine Geoservices, Inc., entitled Wellsite Clearance Letter GC 40-F (Project No. 02.1602-1039-1), Wellsite Clearance Letter GC 40-I (Project No. 02.1602-1039-3), and Wellsite Clearance Letter GC 40-J (Project No. 02.1602-1039-5).

G. High-Resolution Seismic Lines
Included in the Shallow Hazards Assessment as **Attachment C-4** is high-resolution survey information including swath bathymetry/seafloor rendering/edge detection (fault scarp trends) overlain with the seafloor amplitude.

H. Stratigraphic Column
Proprietary Data

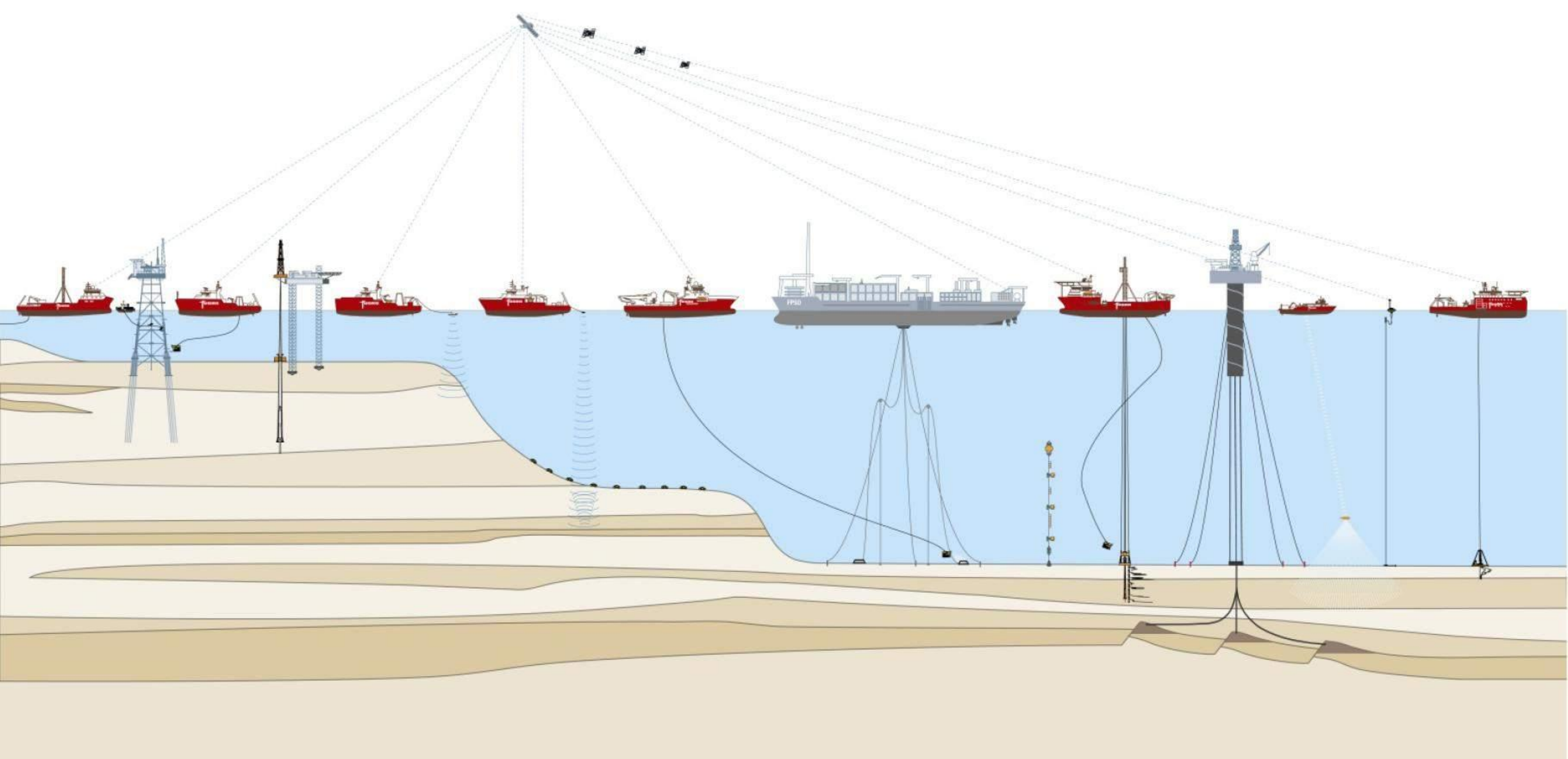
I. Time vs. Depth Table
Proprietary Data

Public Attachment C-4

FUGRO MARINE GEOSERVICES, INC.
Wellsite Clearance Letter
GC 40-F, Katmai Prospect
Block 40, Green Canyon
Gulf of Mexico (OCS G-34536)

27 March 2017
Fugro Project No.: 02.1602-1039-1

Noble Energy, Inc.



WELLSITE CLEARANCE LETTER
GC 40-F, KATMAI PROSPECT
BLOCK 40, GREEN CANYON
GULF OF MEXICO (OCS G-34536)

27 March 2017
Fugro Project No.: 02.1602-1039-1

Prepared for: Noble Energy, Inc
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03					
02					
01	Draft	Daniel Pryne	Steve Varnell	Steve Varnell	27 March 2017
Issue	**Report Status**	**Prepared**	**Checked**	**Approved**	**Date**

Report No. 02.1602-1039-1
27 March, 2017

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Attention: Krista Aleman

Wellsite Clearance Letter
GC 40-F, Katmai Prospect
Block 40, Green Canyon
Gulf of Mexico (OCS G-34536)

Introduction. Fugro Marine GeoServices, Inc. (Fugro) was contracted by Noble Energy, Inc (Noble) to prepare a wellsite clearance letter addressing shallow hazards for proposed wellsite GC 40-F in Block 40, Green Canyon (GC) Protraction Area, Gulf of Mexico (OCS G-34536; Figure 1). The proposed well is planned to be vertical within the tophole section and will be drilled by either a dynamically positioned or moored rig. This letter is intended to address specific seafloor conditions within a 2,000-ft radius and shallow geologic conditions within 245 ft of the proposed wellsite to the depth limit of investigation (DLI) at the top of salt, about 5,548 ft below mudline (BML). This letter follows the interpretation presented in the reports titled “Updated Shallow Geohazards Assessment, Katmai Prospect, Blocks EW 1009-1011, GC 40, and GC 41, and Vicinity, Ewing Bank and Green Canyon, Gulf of Mexico” (Fugro, 2015) and “Shallow Geohazards Assessment, Katmai Prospect, Block 40 and Vicinity, Green Canyon Area, Gulf of Mexico” (Fugro, 2013). Annotated data examples of a nearby autonomous underwater vehicle (AUV) sub-bottom profiler (SBP) line (Figure 2) and 3D seismic lines through the surface location (Figures 3 and 4) are attached to illustrate shallow geologic conditions in the vicinity of the proposed wellsite. A Water Depth and Seafloor Features ANSI C-size chart (Figure 5) showing the proposed wellsite, water depth contours derived from multibeam echosounder (MBES) bathymetry, seafloor features, and anchor radius accompanies this wellsite assessment. A maximum anchor radius (approximately two and a half times water depth) plus 1,000 ft radius buffer is shown around the proposed wellsite as required by Minerals Management Services (MMS) Notice to Lessees (NTL) 2009-G40 (MMS, 2009) and extended by Bureau of Ocean Energy Management (BOEM) NTL 2015-N02 (BOEM, 2015). Additionally, page-size AUV Side Scan Sonar Mosaic and AUV MBES Backscatter charts are included (Figures 6 and 7). A 2,000-ft radius around the proposed wellsite is shown on these charts as required by Minerals Management Services (MMS) Notice to Lessees (NTL) 2009-G40 (MMS, 2009). A page-size 1:12,000-scale Subsurface Geologic Features chart (Figure 8) is included to illustrate geologic conditions in the vicinity of the proposed wellbore down to the DLI. A 245-ft radius around the proposed well is shown on this chart in accordance with NTL 2008-G05 (MMS, 2008). Shallow geologic conditions at the proposed wellbore are summarized on the Tophole Prognosis Chart (Figure 9). The 3D Seismic Power Spectrum figure is included as an assessment of the frequency content of the 3D seismic time data at the proposed wellbore (Figure 10).

3D Seismic Survey Parameters. Two 3D seismic data volumes were provided for this assessment. The seismic data follow North American polarity convention and demonstrate a near-balanced, zero phase wavelet based on analysis of the seafloor reflector, top of salt reflector, and low-impedance, high-amplitude anomalies indicative of gas sands.

The post-stack time-migrated survey, named "pgs_st_so_ew2_gi_so1" is a subset of the Petroleum Geo-Services (PGS) survey "Grand Isle South/Ewing Bank/Green Canyon Phase 1" completed in 1997. The 3D data processing was performed by PGS using Kirchoff time migration. Inlines are oriented north-south, have a numerical increment of one, and are spaced at intervals of 65.6 ft (20 m). Crosslines are oriented east-west, have a numerical increment of one, and are spaced at intervals of 41.0 ft (12.5 m).

The pre-stack depth-migrated survey, named "tgs_freedom_waz" is a subset of the TGS WesternGeco (TGS) survey "Freedom Waz 3D" completed in 2009. The 3D data processing was performed by TGS using Kirchoff depth migration. Inlines are oriented northwest-southeast, have a numerical increment of one, and are spaced at intervals of 98.4 ft (30 m). Crosslines are oriented southwest-northeast, have a numerical increment of four, and are spaced at intervals of 82.0 ft (25 m).

AUV Survey Data. AUV data were collected by C&C Technologies, Inc. (C&C) for the purpose of satisfying the BOEM archaeological requirement. AUV data coverage includes MBES bathymetry and backscatter, side scan sonar (SSS), and SBP data. The AUV survey grid provides complete coverage of the seafloor with MBES and SSS data, and representative sampling of the other systems (e.g. SBP data). Data coverage for the proposed wellsite includes west-east primary tracklines spaced approximately 629 ft (192 m) apart and tie-lines oriented north-south spaced 2,960 ft (902 m) apart. For additional information regarding the AUV data collection and processing, please refer to C&C (2012).

3D Seismic Frequency. Based on power spectrum analysis of the 3D seismic data, the frequency bandwidth at 50% power at the proposed GC 40-F location ranges between about 5 Hz and 65 Hz (Figure 10). Using a dominant frequency of 14.2 Hz and assuming an average velocity of 6,000 ft/sec in the shallow section, the limit of separability ($\lambda/4$) is calculated to be 105.6 ft. The inclusion of AUV data significantly improves our ability to calibrate the shallow geologic interpretation. We assess the available data to be adequate or better for shallow hazards identification and geologic interpretation at the proposed wellsite.

Depth Conversions. Water column time-to-depth conversions were not necessary since AUV data included multibeam bathymetry data of the seafloor. Sediment column depths were determined using the depth attribute of the TGS 3D seismic volume; therefore, no conversions were necessary.

Offset Well Information. Noble provided offset well log data either as curves overlain on seismic displays, daily drilling reports, or scout ticket summaries for offset wells EW 1006-1 (Mobil), EW 1006-2 and 3 (Walter), EW 1010-1 (Texaco), GC 36 (Statoil), GC 38-1 (British Borneo Exploration), GC 39-1 (Placid Oil), GC 39-2 (Placid Oil), and AT 1-1 (Texaco). Well logs from GC 40-1 (Noble Energy), GC 40-2 (Noble Energy), EW 1006-2 (Walter), and EW 1010-1 (Texaco) were used to calibrate stratigraphic interpretations, and all other information contributed to the general understanding of the area. Please refer to Fugro (2013 and 2015) reports for seismic correlation of offset wells.

Previous Reports. Two 3D shallow hazards assessments were conducted for Block GC 40 and surrounding blocks (Fugro, 2013 and 2015). These reports were reviewed and the interpretation therein was deemed adequate to meet current NTLs. One of the proposed wellsite locations from the Fugro (2013) assessment was drilled successfully to total depth and did not encounter shallow gas accumulations above salt (GC 40-1, Figures 5 through 8). Amplitude

thresholds for the proposed wellsite GC 40-F are from Fugro's (2013) assessment. An archaeological assessment was also conducted for Block GC 40 and surrounding area (C&C, 2012).

Proposed Well Location. The surface location for proposed wellsite GC 40-F is located in the center of GC Block 40 as follows:

Proposed Wellsite GC 40-F Block 40, Green Canyon Protraction Area NAD 27, UTM Zone 15N	
X = 2,622,629.181 ft	Y = 10,148,508.82 ft
Latitude: 27° 55' 56.764" N	Longitude: 89° 57' 28.422" W
Nearest SBP Line: 120	
Nearest PGS 3D Inline: 4234	Nearest PGS 3D Crossline: 5024

Water Depth and Seafloor Gradient. The water depth at the proposed wellsite is predicted to be about 2,127 ft MSL with zero datum at sea surface (Figure 5). The local seafloor gradient is about 3° to the southeast. The regional gradient dips to the south.

Seafloor and Near-Surface Features. The seafloor surrounding the proposed wellsite exhibits numerous seafloor and near-surface fault scarps (Figure 5). Many of the faults reach the seafloor and are inferred to be active in the Holocene (Figure 2). The nearest fault scarp that breaks the seafloor lies approximately 500 ft east of the proposed location (Figure 5). MBES backscatter intensity is low and uniform in the vicinity of the proposed wellsite, indicating that no fluid is migrating to the seafloor along any of the faults within 2,000 ft of the proposed well (Figure 7).

Potential High-Density Benthic Communities. There is no geophysical evidence of hydrocarbon seepage sites or areas that could potentially support high-density benthic communities within 2,000 ft of the proposed location (Figures 5 and 7). Therefore, there is a negligible potential for high-density communities of benthic and/or chemosynthetic organisms within 2,000 ft of the proposed wellsite.

Man-Made Obstructions. According to the Fugro database of man-made facilities and seafloor obstructions, one man-made feature is located within 3,000 ft of the proposed GC 40-F wellsite, the GC 40-1 wellsite by Noble (Figure 5). One side scan sonar target plots within 2,000 ft of the proposed location (Figure 6). Contact No. 25 is an unidentified object measuring 4.3 ft by 4.3 ft and has no measurable height (C&C, 2012). It is possible for debris to have been deposited since the AUV survey; therefore, we recommend that an ROV be used to inspect the seafloor at the proposed wellsite immediately before drilling activities to confirm that there are no seafloor obstructions. No seafloor conditions that may adversely affect exploratory drilling were identified in the vicinity of the proposed wellsite.

Mooring Considerations. An anchored rig may be utilized to drill the exploration well at the proposed location; however, a specific anchor pattern is not available at this time. Therefore, a 5,500 ft radius (approximately 2.5 times water depth; provided by Noble) centered on the proposed surface location is shown to indicate the maximum area of anchorage. The following discussion assesses seafloor conditions relative to anchoring within the area encompassed by the 5,500 ft radius, plus a 1,000 ft buffer (Figure 5).

Water depths within the potential anchor area range from about 1,760 ft to about 2,420 ft and seafloor gradients range from 0° to over 15°. The higher gradients occur locally along seafloor fault scarps. Buried gullies are also present within the southern and northeastern portion of the proposed maximum anchor radius (Figure 5).

Several high backscatter and high sonar reflectivity features interpreted to be hardground areas as well as one reported chemosynthetic location (BOEM) are located within the northern portions of the anchor radius (Figure 5). These features are capable of supporting deepwater benthic communities and should be avoided by 250 ft as per the BOEM NTL No. 2009-G40. Buffers of 250 ft are shown on Figure 5 to guide anchor placement.

Eighteen SSS contacts are identified within the mooring radius and are interpreted to be unidentified debris. Six contacts have measurable relief (15, 16, 26, 29, 32, and 34) and the remaining 12 have no relief. These objects within the anchor radius should be avoided or visually inspected by ROV prior to anchor placement. One existing well, GC 40-1, is present northwest of the proposed wellsite within the mooring radius. According to NTL 2008-G05 either survey notations or physical buoys should be placed at this wellsite if the wellsite is within 490 ft of anchor activities (dashed outline on attached Figure 5).

Stratigraphy. The seafloor and eight subsurface horizons (10, 20, 30, 40, 50, 60, 70 and the top of salt) were mapped to divide the tophole section into eight stratigraphic sequences (Sequences 1 through 8) of distinct seismic and inferred lithologic character at the proposed wellbore (Figure 9). Exact sediment conditions along the proposed wellbore are predicted based upon nearby well logs and may be different at the GC 40-F location. Predicted depths and thicknesses associated with each of the mapped horizons and sequences are displayed on the attached Tophole Prognosis Chart (Figure 9) for the proposed Wellsite GC 40-F drilling location.

At the proposed wellbore, Sequence 1 is about 703 ft thick and is interpreted to comprise fine-grained marine clays deposited under normal gravitational settling of suspended material and mass transport derived sediments within the bottom third of the sequence. The lower portion of the sequence is a mixture of clay-prone sediments with layers and lenses of sands and silts of probable turbidite origin.

Sequence 2 at the proposed wellbore is about 997 ft thick. The sequence is clay-prone in the upper portion grading down into silts and/or sandy material near the base interval.

Sequence 3 is combined with Sequence 4 at the proposed wellbore and is about 1,228 ft thick and is composed of predominantly clay-prone sediments with sandy-silts near the top of the interval grading down into clay-prone sediments. The base of the sequence (Horizon 40) is identified to be a sandy interval in offset wells but appears clay-prone at the proposed GC 40-F location.

Sequence 5 is about 235 ft thick at the proposed wellbore between Horizons 40 and 50. The sequence is composed of predominantly clays with interbedded silts and sands.

Sequence 6 is about 558 ft thick and is interpreted to be clay-prone with sand and silt content increasing with depth. The base of the interval in particular is likely to be sand-prone based on offset well correlation.

Sequence 7 is about 875 ft thick and is likely interbedded sands, silts, and clays with a more sand-prone interval near Horizon 70. Thin sands or silts are possible in the lower portion of the sequence.

Sequence 8 between Horizon 70 and the top of salt, is about 952 ft thick. The interval is interpreted to be interbedded sands, silts and clays with a more sand-prone interval near the top at Horizon 70. A likely fractured and rubble zone of unknown thickness grades into salt. Offset wells indicate interbedded marls towards the base of the sequence.

Fault Penetrations. The proposed wellbore will penetrate three seafloor faults in the tophole section at 2,880 ft, 3,966 ft, and 5,220 ft BSS (Figure 9). The well will penetrate one buried fault near Horizon 60 at 5,978 ft BSS.

Although faults themselves are not considered a hazard to well installation, it is possible they have generated secondary permeability, allowing for fluid migration or circulation loss during drilling. Due to the complex, faulted nature of block GC 40 the proposed borehole is likely to encounter additional faults that are not identifiable in the seismic data. These possibilities should be considered and planned for during well design and installation.

Gas Hydrates. Gas hydrates are a solid form of hydrocarbon gases contained within an ice-like matrix of water molecules (Sloan, 1990). Hydrates form when migrating gases are of the proper chemistry, under sufficient hydrostatic pressure, and within the proper temperature regime (Kvenvolden and Barnard, 1983). The pressures and temperatures found at water depths surrounding the GC 40-F location could be conducive to forming gas hydrates within the tophole section, if other geologic factors are favorable.

The base of gas hydrate stability (BGHS) is sometimes manifested in seismic data, either by a reflector commonly referred to as a bottom-simulating reflector (BSR), because it often mimics the seafloor morphology, or by the lineation formed by the tops of shallow gas accumulations (high-amplitude anomalies) that may group just below the BGHS. However, it is important to note that a BSR is not a prerequisite for the presence of gas hydrates, nor is a BSR alone necessarily indicative of gas hydrates. Furthermore, seismic data cannot normally be used to directly predict the concentration of hydrates within the stability zone. Typically, sediment borings and detailed logging are needed to positively identify gas hydrate accumulations.

No BSR or other indication of gas hydrate was observed in the vicinity of the proposed GC 40-F location. The potential for encountering massive gas hydrate at the proposed wellbore is considered negligible.

It is important to note that although disseminated accumulations of gas hydrate generally do not cause problems for drilling operations in most cases, even small quantities of gas hydrates create significant challenges for the foundations and anchors of structures that may be used for development. If future development is planned in the study area, the effect of gas hydrate on foundation members should be considered.

Shallow Gas Accumulations. Amplitude anomalies indicative of possible shallow gas or other hydrocarbon accumulations were mapped using volume amplitude extractions between the mapped horizons. For specific parameters for the regional interpretation and mapping of shallow gas, please see Fugro (2013).

No amplitude anomalies indicative of shallow gas were identified within 245 ft of proposed wellsite GC 40-F (Figure 8). The proposed well is not assessed to penetrate hydrocarbon accumulations however, specific intervals are interpreted to encounter gas due to the complex nature of faults and their connection to silty and sandy intervals that reported gas in nearby wells.

The proposed GC 40-F wellsite is assessed a moderate potential of encountering gas from 2,630 ft to 4,497 ft BSS (503 ft to 2,370 ft BML), from 5,055 ft to 5,978 ft BSS (2,928 ft to 3,851 ft BML), and from 6,680 ft to 6760 ft BSS (4,553 ft to 4,633 ft BML) (Figure 9).

Note that our assessment of the potential for shallow gas refers to the *likelihood* of the proposed borehole experiencing this hazard, but the *severity* of the potential hazard cannot be reliably assessed using only the data provided for this study. The above assessment assumes open-hole drilling condition with no pressure control in place, and without regard to any specialized drilling fluid or casing program that may be planned.

Shallow Water Flow (SWF). Based on regional analysis, northeastern Green Canyon lies within a region of high risk for shallow water flow (Ostermeier, 2000). The BOEM published database and associated graphic on reported SWF occurrences in the Gulf of Mexico including the study area (BOEM, 2011) indicate that the nearest reported SWF events to the proposed GC 40-F wellsite are located approximately 7 miles to the west in GC 82 and approximately 12 miles to the west in GC 36 and Ewing Bank (EW) 1006. These reported events correlate to Sequences 1 and 2 at the GC 40-F location (Figures 3, 4, and 9). Offset well information provided by Noble show shallow water flow events associated with Sequences 1, 2, 3, 5, 6, and 7, as well as Horizon 70.

A moderate potential for shallow water flow is assessed for some sediments above and below Horizon 10, low potential for the upper, clay-prone portion of Sequence 2, and moderate for the lower portion of Sequence 2 through the upper portion of the combined Sequences 3 and 4 (Figure 9). A moderate potential is assessed from Horizon 40 to the buried fault at 5,978 ft BSS and for the section above and below Horizon 70 (Figure 9). All other portions of the tophole section are assessed a negligible potential for shallow water flow.

Note that our assessment of the potential for SWF refers to the *likelihood* of the proposed borehole experiencing this hazard, but the *severity* of the potential hazard cannot be reliably assessed using only the data provided for this study. The above assessment assumes open-hole drilling condition with no pressure control in place, and without regard to any specialized drilling fluid or casing program that may be planned.

We appreciate the opportunity to work with you on this project and look forward to continuing as your geohazards consultants. If you have any questions concerning this assessment, please do not hesitate to call Mr. Daniel Pryne at (713) 369-5575 or email at: dpryne@fugro.com.

Sincerely,

FUGRO MARINE GEOSERVICES, INC.

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Stephen Varnell, P.G., C.E.G.
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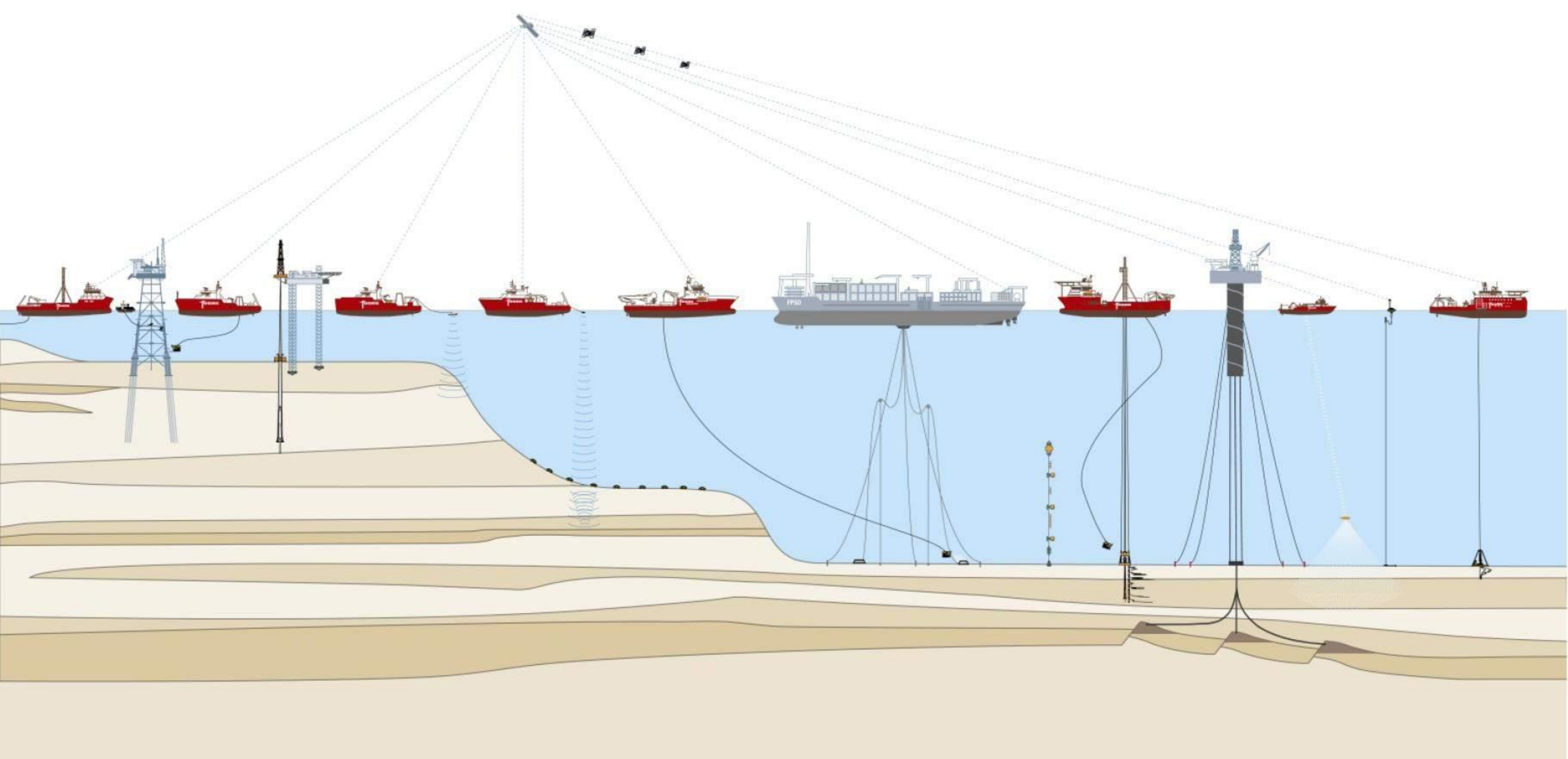
PROFESSIONAL GEOSCIENTIST

FUGRO MARINE GEOSERVICES, INC.
Wellsite Clearance Letter
GC 40-I, Katmai Prospect
Block 40, Green Canyon
Gulf of Mexico (OCS G-34536)

27 March 2017
Fugro Project No.: 02.1602-1039-3

Noble Energy, Inc.



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BLOCK 40, GREEN CANYON
GULF OF MEXICO (OCS G-34536)

27 March 2017
Fugro Project No.: 02.1602-1039-3

Prepared for: Noble Energy, Inc
1001 Noble Energy Way
Houston, TX 77070

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02					
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Issue	**Report Status**	**Prepared**	**Checked**	**Approved**	**Date**

Report No. 02.1602-1039-3
27 March, 2017

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Noble Energy, Inc
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Attention: Krista Aleman

Wellsite Clearance Letter
GC 40-I, Katmai Prospect
Block 40, Green Canyon
Gulf of Mexico (OCS G-34536)

Introduction. Fugro Marine GeoServices, Inc. (Fugro) was contracted by Noble Energy, Inc (Noble) to prepare a wellsite clearance letter addressing shallow hazards for proposed wellsite GC 40-I in Block 40, Green Canyon (GC) Protraction Area, Gulf of Mexico (OCS G-34536; Figure 1). The proposed well is planned to be vertical within the tophole section and will be drilled by either a dynamically positioned or moored rig. This letter is intended to address specific seafloor conditions within a 2,000-ft radius and shallow geologic conditions within 245 ft of the proposed wellsite to the depth limit of investigation (DLI) at the top of salt, about 5,531 ft below mudline (BML). This letter follows the interpretation presented in the reports titled "Updated Shallow Geohazards Assessment, Katmai Prospect, Blocks EW 1009-1011, GC 40, and GC 41, and Vicinity, Ewing Bank and Green Canyon, Gulf of Mexico" (Fugro, 2015) and "Shallow Geohazards Assessment, Katmai Prospect, Block 40 and Vicinity, Green Canyon Area, Gulf of Mexico" (Fugro, 2013). Annotated data examples of a nearby autonomous underwater vehicle (AUV) sub-bottom profiler (SBP) line (Figure 2) and 3D seismic lines through the surface location (Figures 3 and 4) are attached to illustrate shallow geologic conditions in the vicinity of the proposed wellsite. A Water Depth and Seafloor Features ANSI C-size chart (Figure 5) showing the proposed wellsite, water depth contours derived from multibeam echosounder (MBES) bathymetry, seafloor features, and anchor radius accompanies this wellsite assessment. A maximum anchor radius (approximately two and a half times water depth) plus 1,000 ft radius buffer is shown around the proposed wellsite as required by Minerals Management Services (MMS) Notice to Lessees (NTL) 2009-G40 (MMS, 2009) and extended by Bureau of Ocean Energy Management (BOEM) NTL 2015-N02 (BOEM, 2015). Additionally, page-size AUV Side Scan Sonar Mosaic and AUV MBES Backscatter charts are included (Figures 6 and 7). A 2,000-ft radius around the proposed wellsite is shown on these charts as required by Minerals Management Services (MMS) Notice to Lessees (NTL) 2009-G40 (MMS, 2009). A page-size 1:12,000-scale Subsurface Geologic Features chart (Figure 8) is included to illustrate geologic conditions in the vicinity of the proposed wellbore down to the DLI. A 245-ft radius around the proposed well is shown on this chart in accordance with NTL 2008-G05 (MMS, 2008). Shallow geologic conditions at the proposed wellbore are summarized on the Tophole Prognosis Chart (Figure 9). The 3D Seismic Power Spectrum figure is included as an assessment of the frequency content of the 3D seismic time data at the proposed wellbore (Figure 10).

3D Seismic Survey Parameters. Two 3D seismic data volumes were provided for this assessment. The seismic data follow North American polarity convention and demonstrate a near-balanced, zero phase wavelet based on analysis of the seafloor reflector, top of salt reflector, and low-impedance, high-amplitude anomalies indicative of gas sands.

The post-stack time-migrated survey, named "pgs_st_so_ew2_gi_so1" is a subset of the Petroleum Geo-Services (PGS) survey "Grand Isle South/Ewing Bank/Green Canyon Phase 1" completed in 1997. The 3D data processing was performed by PGS using Kirchoff time migration. Inlines are oriented north-south, have a numerical increment of one, and are spaced at intervals of 65.6 ft (20 m). Crosslines are oriented east-west, have a numerical increment of one, and are spaced at intervals of 41.0 ft (12.5 m).

The pre-stack depth-migrated survey, named "tgs_freedom_waz" is a subset of the TGS WesternGeco (TGS) survey "Freedom Waz 3D" completed in 2009. The 3D data processing was performed by TGS using Kirchoff depth migration. Inlines are oriented northwest-southeast, have a numerical increment of one, and are spaced at intervals of 98.4 ft (30 m). Crosslines are oriented southwest-northeast, have a numerical increment of four, and are spaced at intervals of 82.0 ft (25 m).

AUV Survey Data. AUV data were collected by C&C Technologies, Inc. (C&C) for the purpose of satisfying the BOEM archaeological requirement. AUV data coverage includes MBES bathymetry and backscatter, side scan sonar (SSS), and SBP data. The AUV survey grid provides complete coverage of the seafloor with MBES and SSS data, and representative sampling of the other systems (e.g. SBP data). Data coverage for the proposed wellsite includes west-east primary tracklines spaced approximately 629 ft (192 m) apart and tie-lines oriented north-south spaced 2,960 ft (902 m) apart. For additional information regarding the AUV data collection and processing, please refer to C&C (2012).

3D Seismic Frequency. Based on power spectrum analysis of the 3D seismic data, the frequency bandwidth at 50% power at the proposed GC 40-I location ranges between about 5 Hz and 63 Hz (Figure 10). Using a dominant frequency of 10.7 Hz and assuming an average velocity of 6,000 ft/sec in the shallow section, the limit of separability ($\lambda/4$) is calculated to be 140.2 ft. The inclusion of AUV data significantly improves our ability to calibrate the shallow geologic interpretation. We assess the available data to be adequate or better for shallow hazards identification and geologic interpretation at the proposed wellsite.

Depth Conversions. Water column time-to-depth conversions were not necessary since AUV data included multibeam bathymetry data of the seafloor. Sediment column depths were determined using the depth attribute of the TGS 3D seismic volume; therefore, no conversions were necessary.

Offset Well Information. Noble provided offset well log data either as curves overlain on seismic displays, daily drilling reports, or scout ticket summaries for offset wells EW 1006-1 (Mobil), EW 1006-2 and 3 (Walter), EW 1010-1 (Texaco), GC 36 (Statoil), GC 38-1 (British Borneo Exploration), GC 39-1 (Placid Oil), GC 39-2 (Placid Oil), and AT 1-1 (Texaco). Well logs from GC 40-1 (Noble Energy), GC 40-2 (Noble Energy), EW 1006-2 (Walter), and EW 1010-1 (Texaco) were used to calibrate stratigraphic interpretations, and all other information contributed to the general understanding of the area. Please refer to Fugro (2013 and 2015) reports for seismic correlation of offset wells.

Previous Reports. Two 3D shallow hazards assessments were conducted for Block GC 40 and surrounding blocks (Fugro, 2013 and 2015). These reports were reviewed and the interpretation therein was deemed adequate to meet current NTLs. One of the proposed wellsite locations from the Fugro (2013) assessment was drilled successfully to total depth and did not encounter shallow gas accumulations above salt (GC 40-1, Figures 5 through 8). Amplitude

thresholds for the proposed wellsite GC 40-I are from Fugro's (2013) assessment. An archaeological assessment was also conducted for Block GC 40 and surrounding area (C&C, 2012).

Proposed Well Location. The surface location for proposed wellsite GC 40-I is located in the center of GC Block 40 as follows:

Proposed Wellsite GC 40-I Block 40, Green Canyon Protraction Area NAD 27, UTM Zone 15N	
X = 2,622,563.695 ft	Y = 10,148,435.51 ft
Latitude: 27° 55' 56.055" N	Longitude: 89° 57' 29.172" W
Nearest SBP Line: 121	
Nearest PGS 3D Inline: 4233	Nearest PGS 3D Crossline: 5022

Water Depth and Seafloor Gradient. The water depth at the proposed wellsite is predicted to be about 2,129 ft MSL with zero datum at sea surface (Figure 5). The local seafloor gradient is about 2.5° to the southeast. The regional gradient dips to the south.

Seafloor and Near-Surface Features. The seafloor surrounding the proposed wellsite exhibits numerous seafloor and near-surface fault scarps (Figure 5). Many of the faults reach the seafloor and are inferred to be active in the Holocene (Figure 2). The nearest fault scarp that breaks the seafloor lies approximately 500 ft east of the proposed location (Figure 5). MBES backscatter intensity is low and uniform in the vicinity of the proposed wellsite, indicating that no fluid is migrating to the seafloor along any of the faults within 2,000 ft of the proposed well (Figure 7).

Potential High-Density Benthic Communities. There is no geophysical evidence of hydrocarbon seepage sites or areas that could potentially support high-density benthic communities within 2,000 ft of the proposed location (Figures 5 and 7). Therefore, there is a negligible potential for high-density communities of benthic and/or chemosynthetic organisms within 2,000 ft of the proposed wellsite.

Man-Made Obstructions. According to the Fugro database of man-made facilities and seafloor obstructions, one man-made feature is located within 3,000 ft of the proposed GC 40-I wellsite, the GC 40-1 wellsite by Noble (Figure 5). One side scan sonar target plots within 2,000 ft of the proposed location (Figure 6). Contact No. 25 is an unidentified object measuring 4.3 ft by 4.3 ft and has no measurable height (C&C, 2012). It is possible for debris to have been deposited since the AUV survey; therefore, we recommend that an ROV be used to inspect the seafloor at the proposed wellsite immediately before drilling activities to confirm that there are no seafloor obstructions. No seafloor conditions that may adversely affect exploratory drilling were identified in the vicinity of the proposed wellsite.

Mooring Considerations. An anchored rig may be utilized to drill the exploration well at the proposed location; however, a specific anchor pattern is not available at this time. Therefore, a 5,500 ft radius (approximately 2.5 times water depth; provided by Noble) centered on the proposed surface location is shown to indicate the maximum area of anchorage. The following discussion assesses seafloor conditions relative to anchoring within the area encompassed by the 5,500 ft radius, plus a 1,000 ft buffer (Figure 5).

Water depths within the potential anchor area range from about 1,760 ft to about 2,420 ft and seafloor gradients range from 0° to over 15°. The higher gradients occur locally along seafloor fault scarps. Buried gullies are also present within the southern and northeastern portion of the proposed maximum anchor radius (Figure 5).

Several high backscatter and high sonar reflectivity features interpreted to be hardground areas as well as one reported chemosynthetic location (BOEM) are located within the northern portions of the anchor radius (Figure 5). These features are capable of supporting deepwater benthic communities and should be avoided by 250 ft as per the BOEM NTL No. 2009-G40. Buffers of 250 ft are shown on Figure 5 to guide anchor placement.

Eighteen SSS contacts are identified within the mooring radius and are interpreted to be unidentified debris. Six contacts have measurable relief (15, 16, 26, 29, 32, and 34) and the remaining 12 have no relief. These objects within the anchor radius should be avoided or visually inspected by ROV prior to anchor placement. One existing well, GC 40-1, is present northwest of the proposed wellsite within the mooring radius. According to NTL 2008-G05 either survey notations or physical buoys should be placed at this wellsite if the wellsite is within 490 ft of anchor activities (dashed outline on attached Figure 5).

Stratigraphy. The seafloor and eight subsurface horizons (10, 20, 30, 40, 50, 60, 70 and the top of salt) were mapped to divide the tophole section into eight stratigraphic sequences (Sequences 1 through 8) of distinct seismic and inferred lithologic character at the proposed wellbore (Figure 9). Exact sediment conditions along the proposed wellbore are predicted based upon nearby well logs and may be different at the GC 40-I location. Predicted depths and thicknesses associated with each of the mapped horizons and sequences are displayed on the attached Tophole Prognosis Chart (Figure 9) for the proposed Wellsite GC 40-I drilling location.

At the proposed wellbore, Sequence 1 is about 690 ft thick and is interpreted to comprise fine-grained marine clays deposited under normal gravitational settling of suspended material and mass transport derived sediments within the bottom third of the sequence. The lower portion of the sequence is a mixture of clay-prone sediments with layers and lenses of sands and silts of probable turbidite origin.

Sequence 2 at the proposed wellbore is about 1,007 ft thick. The sequence is clay-prone in the upper portion grading down into silts and/or sandy material near the base interval.

Sequence 3 is combined with Sequence 4 at the proposed wellbore and is about 1,334 ft thick and is composed of predominantly clay-prone sediments with sandy-silts near the top of the interval grading down into clay-prone sediments. The base of the sequence (Horizon 40) is identified to be a sandy interval in offset wells but appears clay-prone at the proposed GC 40-I location.

Sequence 5 is about 167 ft thick at the proposed wellbore between Horizons 40 and 50. The sequence is composed of predominantly clays with interbedded silts and sands.

Sequence 6 is about 487 ft thick and is interpreted to be clay-prone with sand and silt content increasing with depth. The base of the interval in particular is likely to be sand-prone based on offset well correlation.

Sequence 7 is about 901 ft thick and is likely interbedded sands, silts, and clays with a more sand-prone interval near Horizon 70. Thin sands or silts are possible in the lower portion of the sequence.

Sequence 8 between Horizon 70 and the top of salt, is about 945 ft thick. The interval is interpreted to be interbedded sands, silts and clays with a more sand-prone interval near the top at Horizon 70. A likely fractured and rubble zone of unknown thickness grades into salt. Offset wells indicate interbedded marls towards the base of the sequence.

Fault Penetrations. The proposed wellbore will penetrate three seafloor faults in the tophole section at 2,868 ft, 4,005 ft, and 5,273 ft BSS (Figure 9). The well will penetrate one buried fault near Horizon 60 at 5,945 ft BSS.

Although faults themselves are not considered a hazard to well installation, it is possible they have generated secondary permeability, allowing for fluid migration or circulation loss during drilling. Due to the complex, faulted nature of block GC 40 the proposed borehole is likely to encounter additional faults that are not identifiable in the seismic data. These possibilities should be considered and planned for during well design and installation.

Gas Hydrates. Gas hydrates are a solid form of hydrocarbon gases contained within an ice-like matrix of water molecules (Sloan, 1990). Hydrates form when migrating gases are of the proper chemistry, under sufficient hydrostatic pressure, and within the proper temperature regime (Kvenvolden and Barnard, 1983). The pressures and temperatures found at water depths surrounding the GC 40-I location could be conducive to forming gas hydrates within the tophole section, if other geologic factors are favorable.

The base of gas hydrate stability (BGHS) is sometimes manifested in seismic data, either by a reflector commonly referred to as a bottom-simulating reflector (BSR), because it often mimics the seafloor morphology, or by the lineation formed by the tops of shallow gas accumulations (high-amplitude anomalies) that may group just below the BGHS. However, it is important to note that a BSR is not a prerequisite for the presence of gas hydrates, nor is a BSR alone necessarily indicative of gas hydrates. Furthermore, seismic data cannot normally be used to directly predict the concentration of hydrates within the stability zone. Typically, sediment borings and detailed logging are needed to positively identify gas hydrate accumulations.

No BSR or other indication of gas hydrate was observed in the vicinity of the proposed GC 40-I location. The potential for encountering massive gas hydrate at the proposed wellbore is considered negligible.

It is important to note that although disseminated accumulations of gas hydrate generally do not cause problems for drilling operations in most cases, even small quantities of gas hydrates create significant challenges for the foundations and anchors of structures that may be used for development. If future development is planned in the study area, the effect of gas hydrate on foundation members should be considered.

Shallow Gas Accumulations. Amplitude anomalies indicative of possible shallow gas or other hydrocarbon accumulations were mapped using volume amplitude extractions between the mapped horizons. For specific parameters for the regional interpretation and mapping of shallow gas, please see Fugro (2013).

No amplitude anomalies indicative of shallow gas were identified within 245 ft of proposed wellsite GC 40-I (Figure 8). The proposed well is not assessed to penetrate hydrocarbon accumulations however, specific intervals are interpreted to encounter gas due to the complex nature of faults and their connection to silty and sandy intervals that reported gas in nearby wells.

The proposed GC 40-I wellsite is assessed a moderate potential of encountering gas from 2,625 ft to 4,510 ft BSS (496 ft to 2,381 ft BML), from 5,160 ft to 5,945 ft BSS (3,031 ft to 3,816 ft BML), and from 6,666 ft to 6,780 ft BSS (4,537 ft to 4,651 ft BML) (Figure 9).

Note that our assessment of the potential for shallow gas refers to the *likelihood* of the proposed borehole experiencing this hazard, but the *severity* of the potential hazard cannot be reliably assessed using only the data provided for this study. The above assessment assumes open-hole drilling condition with no pressure control in place, and without regard to any specialized drilling fluid or casing program that may be planned.

Shallow Water Flow (SWF). Based on regional analysis, northeastern Green Canyon lies within a region of high risk for shallow water flow (Ostermeier, 2000). The BOEM published database and associated graphic on reported SWF occurrences in the Gulf of Mexico including the study area (BOEM, 2011) indicate that the nearest reported SWF events to the proposed GC 40-I wellsite are located approximately 7 miles to the west in GC 82 and approximately 12 miles to the west in GC 36 and Ewing Bank (EW) 1006. These reported events correlate to Sequences 1 and 2 at the GC 40-I location (Figures 3, 4, and 9). Offset well information provided by Noble show shallow water flow events associated with Sequences 1, 2, 3, 5, 6, and 7, as well as Horizon 70.

A moderate potential for shallow water flow is assessed for some sediments above and below Horizon 10, low potential for the upper, clay-prone portion of Sequence 2, and moderate for the lower portion of Sequence 2 through the upper portion of the combined Sequences 3 and 4 (Figure 9). A moderate potential is assessed from Horizon 40 to the buried fault at 5,945 ft BSS and for the section above and below Horizon 70 (Figure 9). All other portions of the tophole section are assessed a negligible potential for shallow water flow.

Note that our assessment of the potential for SWF refers to the *likelihood* of the proposed borehole experiencing this hazard, but the *severity* of the potential hazard cannot be reliably assessed using only the data provided for this study. The above assessment assumes open-hole drilling condition with no pressure control in place, and without regard to any specialized drilling fluid or casing program that may be planned.

We appreciate the opportunity to work with you on this project and look forward to continuing as your geohazards consultants. If you have any questions concerning this assessment, please do not hesitate to call Mr. Daniel Pryne at (713) 369-5575 or email at: dpryne@fugro.com.

Sincerely,

FUGRO MARINE GEOSERVICES, INC.

Daniel E. Pryne,
Project Geoscientist

Stephen Varnell, P.G., C.E.G.
Deputy Geoscience Department Manager/Consultant

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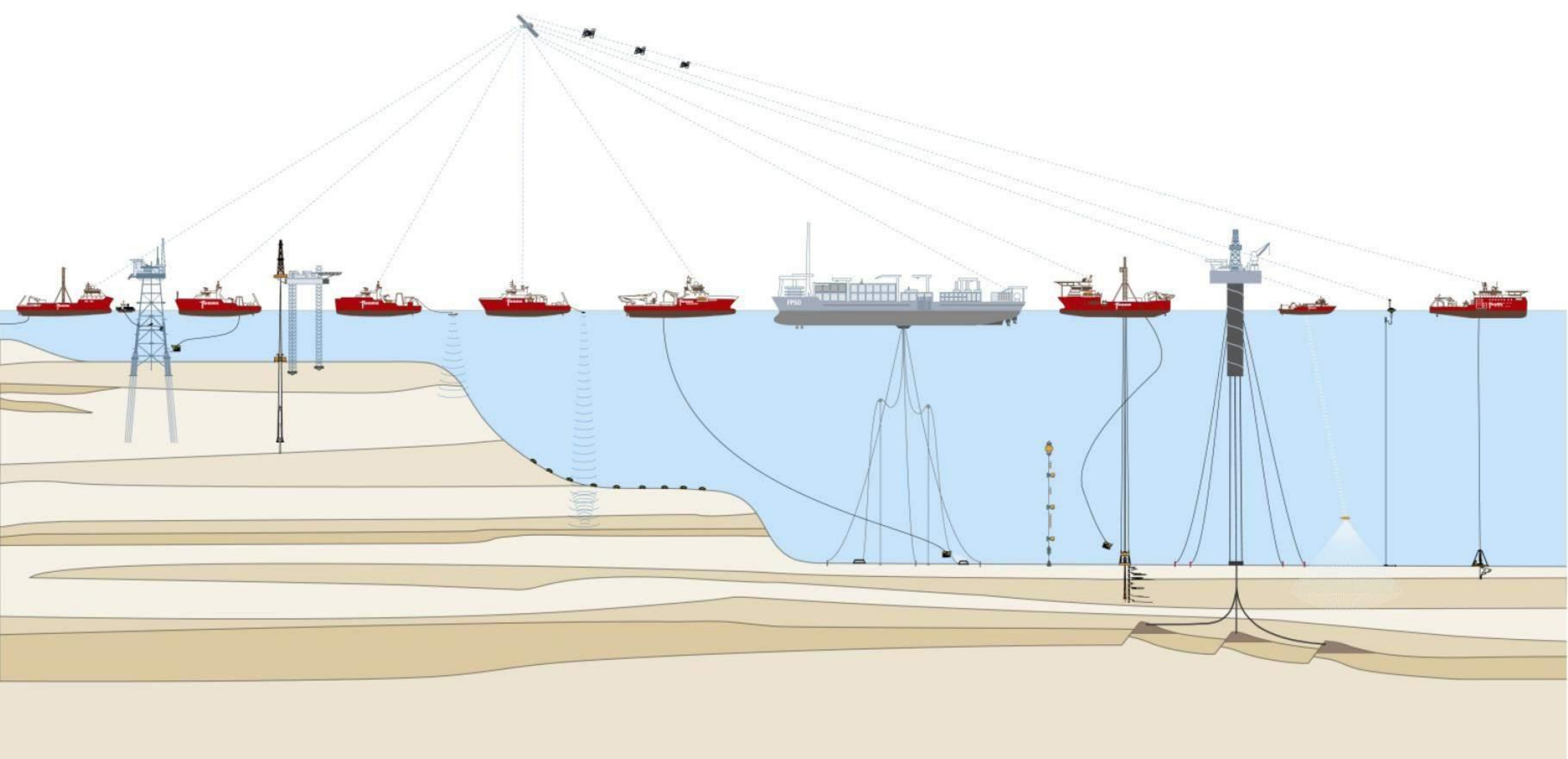
Noble Energy, Inc.



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Attention: Krista Aleman

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Gulf of Mexico (OCS G-34536)

Introduction. Fugro Marine GeoServices, Inc. (Fugro) was contracted by Noble Energy, Inc (Noble) to prepare a wellsite clearance letter addressing shallow hazards for proposed wellsite GC 40-J in Block 40, Green Canyon (GC) Protraction Area, Gulf of Mexico (OCS G-34536; Figure 1). The proposed well is planned to be vertical within the tophole section and will be drilled by either a dynamically positioned or moored rig. This letter is intended to address specific seafloor conditions within a 2,000-ft radius and shallow geologic conditions within 245 ft of the proposed wellsite to the depth limit of investigation (DLI) at the top of salt, about 5,166 ft below mudline (BML). This letter follows the interpretation presented in the reports titled "Updated Shallow Geohazards Assessment, Katmai Prospect, Blocks EW 1009-1011, GC 40, and GC 41, and Vicinity, Ewing Bank and Green Canyon, Gulf of Mexico" (Fugro, 2015) and "Shallow Geohazards Assessment, Katmai Prospect, Block 40 and Vicinity, Green Canyon Area, Gulf of Mexico" (Fugro, 2013). Annotated data examples of a nearby autonomous underwater vehicle (AUV) sub-bottom profiler (SBP) line (Figure 2) and 3D seismic lines through the surface location (Figures 3 and 4) are attached to illustrate shallow geologic conditions in the vicinity of the proposed wellsite. A Water Depth and Seafloor Features ANSI C-size chart (Figure 5) showing the proposed wellsite, water depth contours derived from multibeam echosounder (MBES) bathymetry, seafloor features, and anchor radius accompanies this wellsite assessment. A maximum anchor radius (approximately two and a half times water depth) plus 1,000 ft radius buffer is shown around the proposed wellsite as required by Minerals Management Services (MMS) Notice to Lessees (NTL) 2009-G40 (MMS, 2009) and extended by Bureau of Ocean Energy Management (BOEM) NTL 2015-N02 (BOEM, 2015). Additionally, page-size AUV Side Scan Sonar Mosaic and AUV MBES Backscatter charts are included (Figures 6 and 7). A 2,000-ft radius around the proposed wellsite is shown on these charts as required by Minerals Management Services (MMS) Notice to Lessees (NTL) 2009-G40 (MMS, 2009). A page-size 1:12,000-scale Subsurface Geologic Features chart (Figure 8) is included to illustrate geologic conditions in the vicinity of the proposed wellbore down to the DLI. A 245-ft radius around the proposed well is shown on this chart in accordance with NTL 2008-G05 (MMS, 2008). Shallow geologic conditions at the proposed wellbore are summarized on the Tophole Prognosis Chart (Figure 9). The 3D Seismic Power Spectrum figure is included as an assessment of the frequency content of the 3D seismic time data at the proposed wellbore (Figure 10).

3D Seismic Survey Parameters. Two 3D seismic data volumes were provided for this assessment. The seismic data follow North American polarity convention and demonstrate a near-balanced, zero phase wavelet based on analysis of the seafloor reflector, top of salt reflector, and low-impedance, high-amplitude anomalies indicative of gas sands.

The post-stack time-migrated survey, named “pgs_st_so_ew2_gi_so1” is a subset of the Petroleum Geo-Services (PGS) survey “Grand Isle South/Ewing Bank/Green Canyon Phase 1” completed in 1997. The 3D data processing was performed by PGS using Kirchoff time migration. Inlines are oriented north-south, have a numerical increment of one, and are spaced at intervals of 65.6 ft (20 m). Crosslines are oriented east-west, have a numerical increment of one, and are spaced at intervals of 41.0 ft (12.5 m).

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AUV Survey Data. AUV data were collected by C&C Technologies, Inc. (C&C) for the purpose of satisfying the BOEM archaeological requirement. AUV data coverage includes MBES bathymetry and backscatter, side scan sonar (SSS), and SBP data. The AUV survey grid provides complete coverage of the seafloor with MBES and SSS data, and representative sampling of the other systems (e.g. SBP data). Data coverage for the proposed wellsite includes west-east primary tracklines spaced approximately 629 ft (192 m) apart and tie-lines oriented north-south spaced 2,960 ft (902 m) apart. For additional information regarding the AUV data collection and processing, please refer to C&C (2012).

3D Seismic Frequency. Based on power spectrum analysis of the 3D seismic data, the frequency bandwidth at 50% power at the proposed GC 40-J location ranges between about 5 Hz and 65 Hz (Figure 10). Using a dominant frequency of 15.6 Hz and assuming an average velocity of 6,000 ft/sec in the shallow section, the limit of separability ($\lambda/4$) is calculated to be 96.2 ft. The inclusion of AUV data significantly improves our ability to calibrate the shallow geologic interpretation. We assess the available data to be adequate or better for shallow hazards identification and geologic interpretation at the proposed wellsite.

Depth Conversions. Water column time-to-depth conversions were not necessary since AUV data included multibeam bathymetry data of the seafloor. Sediment column depths were determined using the depth attribute of the TGS 3D seismic volume; therefore, no conversions were necessary.

Offset Well Information. Noble provided offset well log data either as curves overlain on seismic displays, daily drilling reports, or scout ticket summaries for offset wells EW 1006-1 (Mobil), EW 1006-2 and 3 (Walter), EW 1010-1 (Texaco), GC 36 (Statoil), GC 38-1 (British Borneo Exploration), GC 39-1 (Placid Oil), GC 39-2 (Placid Oil), and AT 1-1 (Texaco). Well logs from GC 40-1 (Noble Energy), GC 40-2 (Noble Energy), EW 1006-2 (Walter), and EW 1010-1 (Texaco) were used to calibrate stratigraphic interpretations, and all other information contributed to the general understanding of the area. Please refer to Fugro (2013 and 2015) reports for seismic correlation of offset wells.

Previous Reports. Two 3D shallow hazards assessments were conducted for Block GC 40 and surrounding blocks (Fugro, 2013 and 2015). These reports were reviewed and the interpretation therein was deemed adequate to meet current NTLs. One of the proposed wellsite locations from the Fugro (2013) assessment was drilled successfully to total depth and did not encounter shallow gas accumulations above salt (GC 40-1, Figures 5 through 8). Amplitude

thresholds for the proposed wellsite GC 40-J are from Fugro's (2013) assessment. An archaeological assessment was also conducted for Block GC 40 and surrounding area (C&C, 2012).

Proposed Well Location. The surface location for proposed wellsite GC 40-J is located in the center of GC Block 40 as follows:

Proposed Wellsite GC 40-J Block 40, Green Canyon Protraction Area NAD 27, UTM Zone 15N	
X = 2,621,057.43 ft	Y = 10,148,605.82 ft
Latitude: 27° 55' 58.110" N	Longitude: 89° 57' 45.900" W
Nearest SBP Line: 120	
Nearest PGS 3D Inline: 4210	Nearest PGS 3D Crossline: 5027

Water Depth and Seafloor Gradient. The water depth at the proposed wellsite is predicted to be about 2,124 ft MSL with zero datum at sea surface (Figure 5). The local seafloor gradient is about 3° to the southeast. The regional gradient dips to the south.

Seafloor and Near-Surface Features. The seafloor surrounding the proposed wellsite exhibits numerous seafloor and near-surface fault scarps (Figure 5). Many of the faults reach the seafloor and are inferred to be active in the Holocene (Figure 2). The nearest fault scarp that breaks the seafloor lies approximately 385 ft east of the proposed location (Figure 5). MBES backscatter intensity is low and uniform in the vicinity of the proposed wellsite, indicating that no fluid is migrating to the seafloor along any of the faults within 2,000 ft of the proposed well (Figure 7).

Potential High-Density Benthic Communities. There is no geophysical evidence of hydrocarbon seepage sites or areas that could potentially support high-density benthic communities within 2,000 ft of the proposed location (Figures 5 and 7). Therefore, there is a negligible potential for high-density communities of benthic and/or chemosynthetic organisms within 2,000 ft of the proposed wellsite.

Man-Made Obstructions. According to the Fugro database of man-made facilities and seafloor obstructions, one man-made feature is located within 3,000 ft of the proposed GC 40-J wellsite, the GC 40-1 wellsite by Noble (Figure 5). Four side scan sonar targets plot within 2,000 ft of the proposed location (Figure 6). Contact Nos. 24, 25, 26, and 27 are unidentified objects (C&C, 2012). No. 26 is the only contact with discernible height (0.3 ft). It is possible for debris to have been deposited since the AUV survey; therefore, we recommend that an ROV be used to inspect the seafloor at the proposed wellsite immediately before drilling activities to confirm that there are no seafloor obstructions. No seafloor conditions that may adversely affect exploratory drilling were identified in the vicinity of the proposed wellsite.

Mooring Considerations. An anchored rig may be utilized to drill the exploration well at the proposed location; however, a specific anchor pattern is not available at this time. Therefore, a 5,500 ft radius (approximately 2.5 times water depth; provided by Noble) centered on the proposed surface location is shown to indicate the maximum area of anchorage. The following discussion assesses seafloor conditions relative to anchoring within the area encompassed by the 5,500 ft radius, plus a 1,000 ft buffer (Figure 5).

Water depths within the potential anchor area range from about 1,760 ft to about 2,420 ft and seafloor gradients range from 0° to over 15°. The higher gradients occur locally along seafloor fault scarps. Buried gullies are also present within the southern and northeastern portion of the proposed maximum anchor radius (Figure 5).

Several high backscatter and high sonar reflectivity features interpreted to be hardground areas as well as one reported chemosynthetic location (BOEM) are located within the northern portions of the anchor radius (Figure 5). These features are capable of supporting deepwater benthic communities and should be avoided by 250 ft as per the BOEM NTL No. 2009-G40. Buffers of 250 ft are shown on Figure 5 to guide anchor placement.

Twelve SSS contacts are identified within the mooring radius and are interpreted to be unidentified debris. All of the contacts have measurable relief except for No. 17. These objects within the anchor radius should be avoided or visually inspected by ROV prior to anchor placement. One existing well, GC 40-1, is present northeast of the proposed wellsite within the mooring radius. According to NTL 2008-G05 either survey notations or physical buoys should be placed at this wellsite if the wellsite is within 490 ft of anchor activities (dashed outline on attached Figure 5).

Stratigraphy. The seafloor and eight subsurface horizons (10, 20, 30, 40, 50, 60, 70 and the top of salt) were mapped to divide the tophole section into eight stratigraphic sequences (Sequences 1 through 8) of distinct seismic and inferred lithologic character at the proposed wellbore (Figure 9). Exact sediment conditions along the proposed wellbore are predicted based upon nearby well logs and may be different at the GC 40-J location. Predicted depths and thicknesses associated with each of the mapped horizons and sequences are displayed on the attached Tophole Prognosis Chart (Figure 9) for the proposed Wellsite GC 40-J drilling location.

At the proposed wellbore, Sequence 1 is about 592 ft thick and is interpreted to comprise fine-grained marine clays deposited under normal gravitational settling of suspended material and mass transport derived sediments within the bottom third of the sequence. The lower portion of the sequence is a mixture of clay-prone sediments with layers and lenses of sands and silts of probable turbidite origin.

Sequence 2 at the proposed wellbore is about 1,188 ft thick. The sequence is clay-prone in the upper portion grading down into silts and/or sandy material near the base interval.

Sequence 3 is combined with Sequence 4 at the proposed wellbore and is about 797 ft thick and is composed of predominantly clay-prone sediments with sandy-silts near the top of the interval grading down into clay-prone sediments. The base of the sequence (Horizon 40) is identified to be a sandy interval in offset wells but appears clay-prone at the proposed GC 40-J location.

Sequence 5 is about 300 ft thick at the proposed wellbore between Horizons 40 and 50. The sequence is composed of predominantly clays with interbedded silts and sands.

Sequence 6 is about 406 ft thick and is interpreted to be clay-prone with sand and silt content increasing with depth. The base of the interval in particular is likely to be sand-prone based on offset well correlation.

Sequence 7 is about 955 ft thick and is likely interbedded sands, silts, and clays with a more sand-prone interval near Horizon 70. Thin sands or silts are possible in the lower portion of the sequence.

Sequence 8 between Horizon 70 and the top of salt, is about 928 ft thick. The interval is interpreted to be interbedded sands, silts and clays with a more sand-prone interval near the top at Horizon 70. A likely fractured and rubble zone of unknown thickness grades into salt. Offset wells indicate interbedded marls towards the base of the sequence.

Fault Penetrations. The proposed wellbore will penetrate three seafloor faults in the tophole section at 2,590 ft, 4,155 ft, and 5,435 ft BSS (Figure 9).

Although faults themselves are not considered a hazard to well installation, it is possible they have generated secondary permeability, allowing for fluid migration or circulation loss during drilling. Due to the complex, faulted nature of block GC 40 the proposed borehole is likely to encounter additional faults that are not identifiable in the seismic data. These possibilities should be considered and planned for during well design and installation.

Gas Hydrates. Gas hydrates are a solid form of hydrocarbon gases contained within an ice-like matrix of water molecules (Sloan, 1990). Hydrates form when migrating gases are of the proper chemistry, under sufficient hydrostatic pressure, and within the proper temperature regime (Kvenvolden and Barnard, 1983). The pressures and temperatures found at water depths surrounding the GC 40-J location could be conducive to forming gas hydrates within the tophole section, if other geologic factors are favorable.

The base of gas hydrate stability (BGHS) is sometimes manifested in seismic data, either by a reflector commonly referred to as a bottom-simulating reflector (BSR), because it often mimics the seafloor morphology, or by the lineation formed by the tops of shallow gas accumulations (high-amplitude anomalies) that may group just below the BGHS. However, it is important to note that a BSR is not a prerequisite for the presence of gas hydrates, nor is a BSR alone necessarily indicative of gas hydrates. Furthermore, seismic data cannot normally be used to directly predict the concentration of hydrates within the stability zone. Typically, sediment borings and detailed logging are needed to positively identify gas hydrate accumulations.

No BSR or other indication of gas hydrate was observed in the vicinity of the proposed GC 40-J location. The potential for encountering massive gas hydrate at the proposed wellbore is considered negligible.

It is important to note that although disseminated accumulations of gas hydrate generally do not cause problems for drilling operations in most cases, even small quantities of gas hydrates create significant challenges for the foundations and anchors of structures that may be used for development. If future development is planned in the study area, the effect of gas hydrate on foundation members should be considered.

Shallow Gas Accumulations. Amplitude anomalies indicative of possible shallow gas or other hydrocarbon accumulations were mapped using volume amplitude extractions between the mapped horizons. For specific parameters for the regional interpretation and mapping of shallow gas, please see Fugro (2013).

No amplitude anomalies indicative of shallow gas were identified within 245 ft of proposed wellsite GC 40-J (Figure 8). The proposed well is not assessed to penetrate hydrocarbon accumulations however, specific intervals are interpreted to encounter gas due to the complex nature of faults and their connection to silty and sandy intervals that reported gas in nearby wells.

The proposed GC 40-J wellsite is assessed a moderate potential of encountering gas from 2,590 ft to 4,155 ft BSS (466 ft to 2,031 ft BML), from 4,701 ft to 5,435 ft BSS (2,577 ft to 3,311 ft BML), and from 6,315 ft to 6,430 ft BSS (4,191 ft to 4,306 ft BML) (Figure 9).

Note that our assessment of the potential for shallow gas refers to the *likelihood* of the proposed borehole experiencing this hazard, but the *severity* of the potential hazard cannot be reliably assessed using only the data provided for this study. The above assessment assumes open-hole drilling condition with no pressure control in place, and without regard to any specialized drilling fluid or casing program that may be planned.

Shallow Water Flow (SWF). Based on regional analysis, northeastern Green Canyon lies within a region of high risk for shallow water flow (Ostermeier, 2000). The BOEM published database and associated graphic on reported SWF occurrences in the Gulf of Mexico including the study area (BOEM, 2011) indicate that the nearest reported SWF events to the proposed GC 40-J wellsite are located approximately 7 miles to the west in GC 82 and approximately 12 miles to the west in GC 36 and Ewing Bank (EW) 1006. These reported events correlate to Sequences 1 and 2 at the GC 40-J location (Figures 3, 4, and 9). Offset well information provided by Noble show shallow water flow events associated with Sequences 1, 2, 3, 5, 6, and 7, as well as Horizon 70.

A moderate potential for shallow water flow is assessed for some sediments above and below Horizon 10, low potential for the upper, clay-prone portion of Sequence 2, and moderate for the lower portion of Sequence 2 through the upper portion of the combined Sequences 3 and 4 (Figure 9). A moderate potential is assessed from Horizon 40 to the seafloor fault at 5,435 ft BSS and for the section above and below Horizon 70 (Figure 9). All other portions of the tophole section are assessed a negligible potential for shallow water flow.

Note that our assessment of the potential for SWF refers to the *likelihood* of the proposed borehole experiencing this hazard, but the *severity* of the potential hazard cannot be reliably assessed using only the data provided for this study. The above assessment assumes open-hole drilling condition with no pressure control in place, and without regard to any specialized drilling fluid or casing program that may be planned.

We appreciate the opportunity to work with you on this project and look forward to continuing as your geohazards consultants. If you have any questions concerning this assessment, please do not hesitate to call Mr. Daniel Pryne at (713) 369-5575 or email at: dpryne@fugro.com.

Sincerely,

FUGRO MARINE GEOSERVICES, INC.

Daniel E. Pryne,
Project Geoscientist

Stephen Varnell, P.G., C.E.G.
Deputy Geoscience Department Manager/Consultant

STATE OF TEXAS
Stephen L. Varnell
Geology
License #11337
LICENSED
PROFESSIONAL GEOSCIENTIST

Section D
Hydrogen Sulfide Information

A. Concentration
Noble does not anticipate encountering any H_2S during the proposed operations.

B. Classification
Green Canyon Block 40, has been deemed as H_2S absent by BOEM under Exploration Plan Control No. N-9778 which was approved March 19, 2014.

Section E

Biological, Physical and Socioeconomic Information

A. Chemosynthetic Communities Report

Activities proposed in this plan could disturb seafloor areas in deepwater, therefore, a report described in Attachment A of NTL No. 2009-G40 "Deepwater Benthic Communities" is provided below:

MAPS

Submitted under separate cover are maps prepared using high resolution seismic information and/or 3-D seismic data depicting bathymetry, seafloor and shallow geological features, surface location of proposed well(s), and a radius circle of 2,000 feet around each such location.

ANALYSIS

Using high-resolution seismic information and/or 3-D seismic information, all seafloor features and areas that could be disturbed by the activities proposed in this plan have been identified. The likelihood of these proposed activities disturbing these seafloor and shallow geologic features is discussed in the following summary statement:

No Associated Anchors – No Disturbances within 2,000 Feet of Chemosynthetic Communities

1. Sensitive Underwater Features

The activities proposed in this plan will not take place within 500 feet of any identified topographic feature; therefore topographic features information is not required.

2. Marine Sanctuaries

Green Canyon 40 is not located within 100 feet of any pinnacle trend feature with vertical relief equal to or greater than 8 feet; therefore, live bottom information is not required.

B. Topographic Features Map

Activities proposed in this EP do not fall within 305 meters (1,000 feet) of the “no activity zone”, therefore no map is required.

C. Topographic Features Statement (Shunting)

All activities proposed under this EP will be conducted outside all Topographic Feature Protective Zones, therefore, shunting of drill cuttings and drilling fluids is not required.

D. Live Bottoms (Pinnacle Trend) Map

Green Canyon 40 is not located within 61 meters (200 feet) of any pinnacle trend feature with vertical relief equal to or greater than 8 feet; therefore, live bottom information is not required.

E. Live Bottoms (Low Relief) Map

Green Canyon 40 is not located within 100 feet of any pinnacle trend feature with vertical relief equal to or greater than 8 feet; therefore, live bottom (low relief) maps are not required.

F. Potentially Sensitive Biological Features

Green Canyon 40 is not located within 30 meters (100 feet) of potentially sensitive biological features; therefore, biologically sensitive area maps are not required.

G. Remotely Operated Vehicle (ROV) Monitoring Survey Plan

This information is no longer required by BOEM GoM.

H. Threatened and Endangered Species Information, Critical Habitat, and Marine Mammal Information

Please reference Attachment N-1, the section titled "Threatened, Endangered and Protected Species and Critical Habitat". In the event, a federally listed species becomes present on GC 40, Noble will mitigate impact through compliance with BOEM NTL No. 2016-G01 "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting" and BSEE NTL No. 2015-G03 "Marine Trash and Debris Awareness and Elimination".

I. Archaeological Report

The Archaeological Assessment Report for Green Canyon Block 40, was previously submitted in the Exploration Plan Control No. N-9778 which was approved on March 19, 2014. The report was performed by C&C Technologies Survey Services, dated October 2012, and the C&C Project number is 120622.

Section F
Waste and Discharge Information

A. Waste Estimated to be Generated, Treated and/or Downhole Disposed or Discharged to the GOM

All discharges associated with operations proposed in this Exploration Plan will be in accordance with regulations implemented by Bureau of Ocean Energy Management (BOEM), Bureau of Safety and Environmental Enforcement (BSEE), U. S. Coast Guard (USCG) and the U.S. Environmental Protection Agency(EPA).

Projected generated waste			Projected ocean discharges		Projected Downhole Disposal
Type of Waste	Composition	Projected Amount	Discharge rate	Discharge Method	Answer yes or no
Will drilling occur? If yes, you should list muds and cuttings					
EXAMPLE: Cuttings wetted with synthetic based fluid	*Cuttings generated while using synthetic based drilling fluid.*	*X bbl/well*	*X bbl/day/ well*	*discharge overboard*	*No*
Water-based drilling fluid	**Seawater**	**56,692**	**5,669**	**Riserless at sea floor**	**No**
Synthetic based drilling fluids or muds	**Internal Olefine**	**1,669**	**12**	**Discharge overboard with cuttings**	**No**
Cuttings wetted with water-based fluid	**Cuttings generated while using water based drilling fluid.**	**3,468**	**347**	**Riserless at sea floor**	**No**
Cuttings wetted with synthetic-based fluid	**Cutting generated while using synthetic based drilling fluid.**	**6,674**	**48**	**Discharge overboard**	**No**
Will humans be there? If yes, expect conventional waste					
EXAMPLE: Sanitary waste water	*Sanitary waste from living quarters*	*X bbl/well*	*X bbl/hr/well*	*chlorinate and discharge overboard*	*No*
Domestic waste – gray water	**Food waste disposal**	**216 bbls/day**	**30 bbls/hr**	**Discharge overboard**	**No**
Sanitary waste	**Human Waste**	**79 bbls/day**	**138 bbls/hr**	**Chlorinated**	**No**
Is there a deck? If yes, there will be Deck Drainage					
Deck Drainage	**Rain Water**	**N/A**	**N/A**	**Closed loop system**	**No**
Will you conduct well treatment, completion, or workover?					
Well treatment fluids	**12.5 ppg Sodium Bromide based well treatment fluid**	**3000 bbls/well**	**600 bbls / treatment**	**80% lost to formation 20% discharge overboard**	**No**
Workover fluids	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Miscellaneous discharges. If yes, only fill in those associated with your activity.					
Desalinization unit discharge (2 units operation)	**Seawater(Brine Overboard)**	**1,448 bbls/day**	**2,534 GPH**	**Discharge overboard**	**No**
Blowout prevent fluid	**Houghton Stack Magic N**	**15 bbls/day (only whenwe perform BOP test)**		**Stack**	**No**
Ballast water	**Seawater**	**16 bbls/day**	**600 GPM (x2)**	**Pump**	**No**
Bilge water	**N/A**	**N/A**	**N/A**	**N/A**	**No**
Excess cement at seafloor	**Type 1 Cement**	**600-800 bbls (foam) /120 BBLS**	**8 BPM**	**Pump**	**No**
Fire water	**Seawater**	**0 bbls – only use in case of fire**	**7,368 GPM**	**Discharge overboard**	**No**
Cooling water	**N/A**	**27,846,720 gal per well**	**1,160,280 gal/hr**	**Pump**	**N/A**
Will you produce hydrocarbons? If yes fill in for produced water.					
Produced water	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Will you be covered by an individual or general NPDES permit?		**General**			

Section G
Air Emissions Information

A. Emissions Worksheets and Screening Questions

Screen Procedures for EP's	Yes	No
Is any calculated Complex Total (CT) Emission amount (tons) associated with your proposed exploration activities more than 90% of the amounts calculated using the following formulas: $CT = 3400D^{2/3}$ for CO, and $CT = 33.3D$ for the other air pollutants (where D = distance to shore in miles)?		X
Do your emission calculations include any emission reduction measures or modified emission factors?	X	
Are your proposed exploration activities located east of 87.5° W longitude?		X
Do you expect to encounter H_2S at concentrations greater than 20 parts per million (ppm)?		X
Do you propose to flare or vent natural gas for more than 48 continuous hours from any proposed well?		X
Do you propose to burn produced hydrocarbon liquids?		X

If you answer no to all of the above screening questions, then provide the following:
There are no existing facilities or activities co-located with the currently proposed activities, therefore, the Complex Total Emissions are the same as the Plan Emissions and are provided in the table below.

Noble proposes to perform drilling operations with a drillship and proposes to perform completion operations with either a drillship or a DP semisubmersible.

The plan emission amounts below are representative of the drillship emissions.

Air Pollutant	Plan Emission Amounts[1] (tons)	Calculated Exemption Amounts[2] (tons)	Calculated Complex Total Emission Amounts[3] (tons)
Carbon Monoxide (CO)	678.35	59,387.38	678.35
Particular matter (PM)	86.90	2,430.90	86.90
Sulphur dioxide (SO_2)	1.330	2,430.90	1.330
Nitrogen oxides (NO_x)	1823.38	2,430.90	1823.38
Volatile organic compounds (VOC)	90.41	2,430.90	90.41

[1]For activities proposed in your EP, list the projected emissions calculated from the worksheets.
[2]List the exemption amounts for your proposed activities calculated by using the formulas in 30 CFR 250.303(d).
[3]List the complex total emissions associated with your proposed activities calculated from the worksheets.

The plan emission amounts below are representative of the DP semisubmersible emissions.

Air Pollutant	Plan Emission Amounts[1] (tons)	Calculated Exemption Amounts[2] (tons)	Calculated Complex Total Emission Amounts[3] (tons)
Carbon Monoxide (CO)	**545.03**	**59,387.38**	**545.03**
Particular matter (PM)	**69.76**	**2,430.90**	**69.76**
Sulphur dioxide (SO_2)	**1.07**	**2,430.90**	**1.07**
Nitrogen oxides (NO_x)	**2154.88**	**2,430.90**	**2154.88**
Volatile organic compounds (VOC)	**72.56**	**2,430.90**	**72.56**

[1]For activities proposed in your EP, list the projected emissions calculated from the worksheets.

[2]List the exemption amounts for your proposed activities calculated by using the formulas in 30 CFR 250.303(d).

[3]List the complex total emissions associated with your proposed activities calculated from the worksheets.

Included as **Attachment G-1**, is the AQR spreadsheet calculations for the drillship. **Attachment G-2**, is the AQR spreadsheet calculations for the DP semisubmersible.

Contact Information:
Vanessa Villagran
281-876-6229
Vanessa.Villagran@nblenergy.com

EXPLORATION PLAN (EP)
AIR QUALITY SCREENING CHECKLIST

COMPANY	Noble Energy Inc.
AREA	Green Canyon
BLOCK	GC 40
LEASE	34536
PLATFORM	-
WELL	GC 40 F, I , J & GC 40 #1
COMPANY CONTACT	Vanessa Villagran
TELEPHONE NO.	+1 (281) 876-6229
REMARKS	Drill three (3) wells and complete four (4) wells using a drillship/ MPD.

EMISSIONS FACTORS

Fuel Usage Conversion Factors	Natural Gas Turbines		Natural Gas Engines		Diesel Recip Engine		REF	DATE
	SCF/hp-hr	9 524	SCF/hp-hr	7 143	GAL/hp-hr	0 0483	AP42 3 2-1	4/76 & 8/84
	Btu/hp-hr	2543 5						
Equipment/Emission Factors	units	PM	SOx	NOx	VOC	CO	REF	DATE
Diesel Turbines	lb/MMBtu	0 0203	0 00152	0 88	0 00803	0 0124	AP-42 3 1-2a & Background 3 4-2	04/00
Diesel Recip < 600 hp	lb/hp-hr	0 0022	1 08E-05	0 031	2 51E-03	6 68E-03	AP-42 3 3-1	10/96
Diesel Recip < 600 hp	g/hp-hr	1	4 89E-03	14 06	1 14	3 03	AP42 3 3-1	10/96
Diesel Recip > 600 hp -IMO Tier I (130<rpm<2000) [1]	g/kW-hr			12 1			IMO Tier I	
Diesel Recip > 600 hp -Marine Tier I (130-1999 rpm) [6]	g/kW-hr			45*(N)^(-0 2)			40CFR94 8(a)(1)	12/07
Diesel Recip ≥37kw (1 2 ≤disp <2 5 all power levels) - EPA Marine Tier II (disp = 1 47 L/cylinder)[3]	g/kW-hr	0 2		7 2		5 0	40CFR94 8(a)(2)	12/07
Diesel Recip > 600 hp -IMO Tier II (720 rpm) [2]	g/kW-hr			9 7			IMO Tier II	
Diesel Recip > 600 hp -IMO Tier III (720 rpm) [5]	g/kW-hr			3 4			IMO Tier III	
Diesel Recip > 600 hp -IMO Tier II (720 rpm) [2]	lb/m³			100 9			Fuel Consumption of 192 g/kW-hr from Engine Manufacturer's Data	
Diesel Recip 3 5 ≤ disp < 7 0 all power levels - EPA Marine Tier III (disp = 4 88 L/cylinder) [3]	g/kW-hr	0 11		5 8			40CFR1042 101(a)(3)	
Diesel Recip > 600 hp	lb/hp-hr	7 00E-04	1 08E-05	0 024	0 0007	0 0055	AP-42 3 4-1	10/96
Diesel Recip > 600 hp	g/hp-hr	0 32	0 0049	11	0 33	2 49	AP42 3 4-1	10/96
Diesel Recip > 600 hp - EPA Tier I	g/kW-hr	0 54		9 2	1 3	11 4	EPA Tier 1	
Diesel Recip > 600 hp - EPA Tier II	g/kW-hr	0 2		6 4		3 5	EPA Tier 2	
Diesel Recip < 600 hp - EPA Tier III	g/kW-hr	0 2		4 0		3 5	EPA Tier 3	
Duel Fuel (NG & Diesel)	lb/MMBtu	0 0573	0 183150	2 7	0 02	1 16	AP-42 3 4-1	10/96
Duel Fuel (NG & Diesel)	lb/hp-hr	0 0007	0 001352	0 018	0 00132	0 0075	AP-42 3 4-1	10/96
Diesel Boiler	lbs/bbl	0 084	0 009075	0 84	0 008	0 21	AP-42 1 3-12,14	9/98
NG Heaters/Boilers/Burners	lbs/mmscf	7 6	0 5617	100	5 5	84	AP-42 1 4-1 & 1 4-2	7/98
NG Flares	lbs/mmscf	7 6	0 5617	0 0	0 0	0 0	AP-42 13 5-1 & 1 4-2	9/91
NG Flares	lbs/MMBtu	0 0075	0 00058	0 068	0 040	0 37	AP-42 13 5-1 & 1 4-2	9/91
NG Flares	lbs/mmscf		0 593	71 4	60 3	388 5	AP42 11 5-1	9/91
Liquid Flaring	lbs/bbl	0 42	0 195338	2	0 01	0 21	AP-42 1 3-1 & 1 3-3	9/98
Tank Vapors	lbs/bbl				0 03		E&P Forum	1/93
Fugitives	lbs/hr/comp				0 0005		API Study	12/93
Fugitives	lbs/hr/comp				0 0005		API Greenhouse Gas Compe	2009/10
Glycol Dehydrator Vent	lbs/mmscf				6 6		La DEQ	1991
Gas Venting	lbs/scf				0 0034			
Gas Venting	lbs/scf				0		TLP GC	2009/10

Sulphur Content Source	Value	Units
Fuel Gas	3 33	ppm
Diesel Fuel [4]	0 0015	% weight
Produced Gas(Flares)	3 33	ppm
Produced Oil (Liquid Flaring)	2 86	% weight

The following equations were used in formulating the conversion factors used in the application package
kW hp = (kW) x (1 341 hp/kW) Factor = 1 341 hp/kW

[1] Diesel Recip > 600 hp -IMO Tier I (130<rpm<2000) NOx emission factors for IMO Tier I diesel engines
[2] Diesel Recip > 600 hp -IMO Tier II (130<rpm<2000) NOx emission factors for IMO Tier II diesel engines
[3] Diesel Recip - EPA Marine Tier II (1 2L ≤disp <2 5L)
[4] Noble Energy utilizes Ultra Low Sulfur Diesel for all diesel combustion sources Therefore, SO_2 emissions have been calculated based on a maximum sulfur content of 15 ppm in diesel fuel assuming that 100 percent of sulfur in the fuel is oxidized to SO_2
[5] Diesel Recip > 600 hp -IMO Tier III (130<rpm<1999) NOx emission factors for IMO Tier III diesel engines

EMISSIONS CALCULATIONS 1ST YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT	PHONE	REMARKS
Noble Energy Inc.	Green Canyon	GC 40	34536	-	GC 40 F, I, J & GC 40 #1		Vanessa Villagran	+1 (281) 876-6229	Drill three (3) wells and complete four (4) wells using a drillship/ MPD.

OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	ACT. FUEL	RUN TIME		MAXIMUM POUNDS PER HOUR					ESTIMATED TONS				
	Diesel Engines	HP	GAL/HR	GAL/D												
	Nat. Gas Engines	HP	SCF/HR	SCF/D												
	Burners	MMBTU/HR	SCF/HR	SCF/D	HR/D	DAYS	PM	SOx	NOx	VOC	CO	PM	SOx	NOx	VOC	CO
DRILLING																
DP	DRILLSHIP															
	PRIME MOVER>600hp diesel [1] [2]	53,640	2590.81	62179.49	24	159	37.55	0.58	854.40	39.02	295.02	71.64	1.10	1630.20	74.46	562.90
	Emergency Generator>600hp diesel [3]	2,548	123.06	2953.53	2	159	1.78	0.03	50.56	1.85	14.01	0.28	0.00	8.04	0.29	2.23
	EMERGENCY EQUIP <600hp diesel-Fast Rescue	54	2.60	62.49	2	159	0.12	0.00	1.67	0.14	0.36	0.02	0.00	0.27	0.02	0.06
	6-29HP EMERGENCY EQUIP <600hp diesel-Lifeboat	40	1.94	46.63	2	159	0.09	0.00	1.25	0.10	0.27	0.01	0.00	0.20	0.02	0.04
	EMERGENCY EQUIP <600hp diesel-Air Compressor	23	1.12	26.89	2	159	0.05	0.00	0.72	0.06	0.15	0.01	0.00	0.11	0.01	0.02
	Incinerator	2,012	97.16	2331.73	2	159	1.41	0.02	48.28	1.46	11.06	0.22	0.00	7.68	0.23	1.76
Work Boat	VESSELS>600hp diesel(work) (main-2)	12,700	613.41	14721.84	24	91	8.89	0.14	70.99	9.24	69.85	9.69	0.15	77.40	10.07	76.16
(Pecan Island)[4]	VESSELS>600hp diesel(work) (e-gen)	624	30.14	723.34	24	91	0.44	0.01	3.49	0.45	3.43	0.48	0.01	3.80	0.49	3.74
Support Vessel	VESSELS>600hp diesel(work) (main-2)[6]	4,800	231.84	5564.16	24	91	3.36	0.05	76.46	3.49	26.40	3.66	0.06	83.36	3.81	28.78
(Ginny Lab)[5]	VESSELS<600hp diesel(work) (gen-2)	215	10.36	248.72	24	91	0.47	0.00	6.65	0.54	1.43	0.51	0.00	7.25	0.59	1.56
	Bow Thruster	150	7.25	173.88	24	91	0.33	0.00	4.65	0.38	1.00	0.36	0.00	5.07	0.41	1.09
2018	YEAR TOTAL (ANNUAL)						54.49	0.83	1119.11	56.74	423.00	86.90	1.33	1823.38	90.41	678.35
EXEMPTION CALCULATION	DISTANCE FROM LAND IN MILES[7]											2430.90	2430.90	2430.90	2430.90	59387.38
	73															

[1] PRIME MOVER >600 hp diesel-Dolphin Bolette (or equivalent): Dolphin Bolette's maximum output per main engine is 8,000 kW. These calculations assume operating 5 of 6 engines simultaneously at 100% load.
[2] PRIME MOVER >600 hp diesel-Dolphin Bolette (or equivalent): The main engines on Dolphin Bolette are IMO Tier II certified engines.
[3] NOx emission factor is based on the IMO Tier I certification.
[4] Work Boat Pecan Island (or equivalent) Main and Emergency Engines - IMO Tier III emission factor for NOx. Trip frequency is assumed to be four (4) days per week as per information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.
[5] Support vessel Ginny Lab (or equivalent) trip frequency is assumed at four (4) days per week.
[6] Ginny Lab main engines [CUMMINS KTA38-M2] are IMO Tier II certified.
[7] Worst case drilling location based on the lease block information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.

Attachment G-1

EMISSIONS CALCULATIONS 2ND YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT	PHONE	REMARKS
Noble Energy Inc.	Green Canyon	GC 40	34536	-	GC 40 F, I, J & GC 40 #1		Vanessa Villagran	+1 (281) 876-6229	Drill three (3) wells and complete four (4) wells using a drillship/ MPD.

OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	ACT. FUEL	RUN TIME		MAXIMUM POUNDS PER HOUR					ESTIMATED TONS				
	Diesel Engines	HP	GAL/HR	GAL/D												
	Nat. Gas Engines	HP	SCF/HR	SCF/D												
	Burners	MMBTU/HR	SCF/HR	SCF/D	HR/D	DAYS	PM	SOx	NOx	VOC	CO	PM	SOx	NOx	VOC	CO
DRILLING																
DP	DRILLSHIP															
	PRIME MOVER>600hp diesel [1] [2]	53,640	2590.81	62179.49	24	122	37.55	0.58	854.40	39.02	295.02	54.97	0.85	1250.85	57.13	431.91
	Emergency Generator>600hp diesel [3]	2,548	123.06	2953.53	2	122	1.78	0.03	50.56	1.85	14.01	0.22	0.00	6.17	0.23	1.71
	EMERGENCY EQUIP <600hp diesel-Fast Rescue	54	2.60	62.49	2	122	0.12	0.00	1.67	0.14	0.36	0.01	0.00	0.20	0.02	0.04
	6-29HP EMERGENCY EQUIP <600hp diesel-Lifeboat	40	1.94	46.63	2	122	0.09	0.00	1.25	0.10	0.27	0.01	0.00	0.15	0.01	0.03
	EMERGENCY EQUIP <600hp diesel-Air Compressor	23	1.12	26.89	2	122	0.05	0.00	0.72	0.06	0.15	0.01	0.00	0.09	0.01	0.02
	Incinerator	2,012	97.16	2331.73	2	122	1.41	0.02	48.28	1.46	11.06	0.17	0.00	5.89	0.18	1.35
Work Boat	VESSELS>600hp diesel(work) (main-2)	12,700	613.41	14721.84	24	70	8.89	0.14	70.99	9.24	69.85	7.44	0.11	59.39	7.73	58.43
(Pecan Island)[4]	VESSELS>600hp diesel(work) (e-gen)	624	30.14	723.34	24	70	0.44	0.01	3.49	0.45	3.43	0.37	0.01	2.92	0.38	2.87
Support Vessel	VESSELS>600hp diesel(work) (main-2)[6]	4,800	231.84	5564.16	24	70	3.36	0.05	76.46	3.49	26.40	2.81	0.04	63.96	2.92	22.09
(Ginny Lab)[5]	VESSELS<600hp diesel(work) (gen-2)	215	10.36	248.72	24	70	0.47	0.00	6.65	0.54	1.43	0.39	0.00	5.56	0.45	1.20
	Bow Thruster	150	7.25	173.88	24	70	0.33	0.00	4.65	0.38	1.00	0.28	0.00	3.89	0.32	0.84
2019 YEAR TOTAL (ANNUAL)							54.49	0.83	1119.11	56.74	423.00	66.68	1.02	1399.07	69.37	520.49
EXEMPTION CALCULATION	DISTANCE FROM LAND IN MILES[7]											2430.90	2430.90	2430.90	2430.90	59387.38
	73															

[1] PRIME MOVER >600 hp diesel-Dolphin Bolette (or equivalent): Dolphin Bolette's maximum output per main engine is 8,000 kW. These calculations assume operating 5 of 6 engines simultaneously at 100% load.

[2] PRIME MOVER >600 hp diesel-Dolphin Bolette (or equivalent): The main engines on Dolphin Bolette are IMO Tier II certified engines.

[3] NOx emission factor is based on the IMO Tier I certification.

[4] Work Boat Pecan Island (or equivalent) Main and Emergency Engines - IMO Tier III emission factor for NOx. Trip frequency is assumed to be four (4) days per week as per information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.

[5] Support vessel Ginny Lab (or equivalent) trip frequency is assumed at four (4) days per week.

[6] Ginny Lab main engines [CUMMINS KTA38-M2] are IMO Tier II certified.

[7] Worst case drilling location based on the lease block information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.

Attachment G-1

EMISSIONS CALCULATIONS 3RD YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT	PHONE	REMARKS
Noble Energy Inc.	Green Canyon	GC 40	34536	-	GC 40 F, I, J & GC 40 #1		Vanessa Villagran	+1 (281) 876-6229	Drill three (3) wells and complete four (4) wells using a drillship/ MPD.

OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	ACT. FUEL	RUN TIME		MAXIMUM POUNDS PER HOUR					ESTIMATED TONS				
	Diesel Engines	HP	GAL/HR	GAL/D												
	Nat. Gas Engines	HP	SCF/HR	SCF/D												
	Burners	MMBTU/HR	SCF/HR	SCF/D	HR/D	DAYS	PM	SOx	NOx	VOC	CO	PM	SOx	NOx	VOC	CO
DRILLING																
DP	DRILLSHIP															
	PRIME MOVER>600hp diesel [1] [2]	53,640	2590.81	62179.49	24	0	37.55	0.58	854.40	39.02	295.02	0.00	0.00	0.00	0.00	0.00
	Emergency Generator>600hp diesel [3]	2,548	123.06	2953.53	2	0	1.78	0.03	50.56	1.85	14.01	0.00	0.00	0.00	0.00	0.00
	EMERGENCY EQUIP <600hp diesel-Fast Rescue	54	2.60	62.49	2	0	0.12	0.00	1.67	0.14	0.36	0.00	0.00	0.00	0.00	0.00
	6-29HP EMERGENCY EQUIP <600hp diesel-Lifeboat	40	1.94	46.63	2	0	0.09	0.00	1.25	0.10	0.27	0.00	0.00	0.00	0.00	0.00
	EMERGENCY EQUIP <600hp diesel-Air Compressor	23	1.12	26.89	2	0	0.05	0.00	0.72	0.06	0.15	0.00	0.00	0.00	0.00	0.00
	Incinerator	2,012	97.16	2331.73	2	0	1.41	0.02	48.28	1.46	11.06	0.00	0.00	0.00	0.00	0.00
Work Boat	VESSELS>600hp diesel(work) (main-2)	12,700	613.41	14721.84	24	0	8.89	0.14	70.99	9.24	69.85	0.00	0.00	0.00	0.00	0.00
(Pecan Island)[4]	VESSELS>600hp diesel(work) (e-gen)	624	30.14	723.34	24	0	0.44	0.01	3.49	0.45	3.43	0.00	0.00	0.00	0.00	0.00
Support Vessel	VESSELS>600hp diesel(work) (main-2)[6]	4,800	231.84	5564.16	24	0	3.36	0.05	76.46	3.49	26.40	0.00	0.00	0.00	0.00	0.00
(Ginny Lab)[5]	VESSELS<600hp diesel(work) (gen-2)	215	10.36	248.72	24	0	0.47	0.00	6.65	0.54	1.43	0.00	0.00	0.00	0.00	0.00
	Bow Thruster	150	7.25	173.88	24	0	0.33	0.00	4.65	0.38	1.00	0.00	0.00	0.00	0.00	0.00
2020 YEAR TOTAL (ANNUAL)							54.49	0.83	1119.11	56.74	423.00	0.00	0.00	0.00	0.00	0.00
EXEMPTION CALCULATION	DISTANCE FROM LAND IN MILES[7] 73											2430.90	2430.90	2430.90	2430.90	59387.38

[1] PRIME MOVER >600 hp diesel-Dolphin Bolette (or equivalent): Dolphin Bolette's maximum output per main engine is 8,000 kW. These calculations assume operating 5 of 6 engines simultaneously at 100% load.
[2] PRIME MOVER >600 hp diesel-Dolphin Bolette (or equivalent): The main engines on Dolphin Bolette are IMO Tier II certified engines.
[3] NOx emission factor is based on the IMO Tier I certification.
[4] Work Boat Pecan Island (or equivalent) Main and Emergency Engines - IMO Tier III emission factor for NOx. Trip frequency is assumed to be four (4) days per week as per information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.
[5] Support vessel Ginny Lab (or equivalent) trip frequency is assumed at four (4) days per week.
[6] Ginny Lab main engines [CUMMINS KTA38-M2] are IMO Tier II certified.
[7] Worst case drilling location based on the lease block information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.

Attachment G-1

EMISSIONS CALCULATIONS 4TH YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT	PHONE	REMARKS
Noble Energy Inc.	Green Canyon	GC 40	34536	-	GC 40 F, I, J & GC 40 #1		Vanessa Villagran	+1 (281) 876-6229	Drill three (3) wells and complete four (4) wells using a drillship/ MPD.

OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	ACT. FUEL	RUN TIME		MAXIMUM POUNDS PER HOUR					ESTIMATED TONS				
	Diesel Engines	HP	GAL/HR	GAL/D												
	Nat. Gas Engines	HP	SCF/HR	SCF/D												
	Burners	MMBTU/HR	SCF/HR	SCF/D	HR/D	DAYS	PM	SOx	NOx	VOC	CO	PM	SOx	NOx	VOC	CO
DRILLING																
DP	DRILLSHIP															
	PRIME MOVER>600hp diesel [1] [2]	53,640	2590.81	62179.49	24	159	37.55	0.58	854.40	39.02	295.02	71.64	1.10	1630.20	74.46	562.90
	Emergency Generator>600hp diesel [3]	2,548	123.06	2953.53	2	159	1.78	0.03	50.56	1.85	14.01	0.28	0.00	8.04	0.29	2.23
	EMERGENCY EQUIP <600hp diesel-Fast Rescue	54	2.60	62.49	2	159	0.12	0.00	1.67	0.14	0.36	0.02	0.00	0.27	0.02	0.06
	6-29HP EMERGENCY EQUIP <600hp diesel-Lifeboat	40	1.94	46.63	2	159	0.09	0.00	1.25	0.10	0.27	0.01	0.00	0.20	0.02	0.04
	EMERGENCY EQUIP <600hp diesel-Air Compressor	23	1.12	26.89	2	159	0.05	0.00	0.72	0.06	0.15	0.01	0.00	0.11	0.01	0.02
	Incinerator	2,012	97.16	2331.73	2	159	1.41	0.02	48.28	1.46	11.06	0.22	0.00	7.68	0.23	1.76
Work Boat	VESSELS>600hp diesel(work) (main-2)	12,700	613.41	14721.84	24	91	8.89	0.14	70.99	9.24	69.85	9.69	0.15	77.40	10.07	76.16
(Pecan Island)[4]	VESSELS>600hp diesel(work) (e-gen)	624	30.14	723.34	24	91	0.44	0.01	3.49	0.45	3.43	0.48	0.01	3.80	0.49	3.74
Support Vessel	VESSELS>600hp diesel(work) (main-2)[6]	4,800	231.84	5564.16	24	91	3.36	0.05	76.46	3.49	26.40	3.66	0.06	83.36	3.81	28.78
(Ginny Lab)[5]	VESSELS<600hp diesel(work) (gen-2)	215	10.36	248.72	24	91	0.47	0.00	6.65	0.54	1.43	0.51	0.00	7.25	0.59	1.56
	Bow Thruster	150	7.25	173.88	24	91	0.33	0.00	4.65	0.38	1.00	0.36	0.00	5.07	0.41	1.09
2021	YEAR TOTAL (ANNUAL)						54.49	0.83	1119.11	56.74	423.00	86.90	1.33	1823.38	90.41	678.35
EXEMPTION CALCULATION	DISTANCE FROM LAND IN MILES[7] 73											2430.90	2430.90	2430.90	2430.90	59387.38

[1] PRIME MOVER >600 hp diesel-Dolphin Bolette (or equivalent): Dolphin Bolette's maximum output per main engine is 8,000 kW. These calculations assume operating 5 of 6 engines simultaneously at 100% load.
[2] PRIME MOVER >600 hp diesel-Dolphin Bolette (or equivalent): The main engines on Dolphin Bolette are IMO Tier II certified engines.
[3] NOx emission factor is based on the IMO Tier I certification.
[4] Work Boat Pecan Island (or equivalent) Main and Emergency Engines - IMO Tier III emission factor for NOx. Trip frequency is assumed to be four (4) days per week as per information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.
[5] Support vessel Ginny Lab (or equivalent) trip frequency is assumed at four (4) days per week.
[6] Ginny Lab main engines [CUMMINS KTA38-M2] are IMO Tier II certified.
[7] Worst case drilling location based on the lease block information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.

Attachment G-1

EMISSIONS CALCULATIONS 5TH YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT	PHONE	REMARKS
Noble Energy Inc.	Green Canyon	GC 40	34536	-	GC 40 F, I, J & GC 40 #1		Vanessa Villagran	+1 (281) 876-6229	Drill three (3) wells and complete four (4) wells using a drillship/ MPD.

OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	ACT. FUEL	RUN TIME		MAXIMUM POUNDS PER HOUR					ESTIMATED TONS				
	Diesel Engines	HP	GAL/HR	GAL/D												
	Nat. Gas Engines	HP	SCF/HR	SCF/D												
	Burners	MMBTU/HR	SCF/HR	SCF/D	HR/D	DAYS	PM	SOx	NOx	VOC	CO	PM	SOx	NOx	VOC	CO
DRILLING																
DP	DRILLSHIP															
	PRIME MOVER>600hp diesel [1] [2]	53,640	2590.81	62179.49	24	61	37.55	0.58	854.40	39.02	295.02	27.49	0.42	625.42	28.57	215.95
	Emergency Generator>600hp diesel [3]	2,548	123.06	2953.53	2	61	1.78	0.03	50.56	1.85	14.01	0.11	0.00	3.08	0.11	0.85
	EMERGENCY EQUIP <600hp diesel-Fast Rescue	54	2.60	62.49	2	61	0.12	0.00	1.67	0.14	0.36	0.01	0.00	0.10	0.01	0.02
	6-29HP EMERGENCY EQUIP <600hp diesel-Lifeboat	40	1.94	46.63	2	61	0.09	0.00	1.25	0.10	0.27	0.01	0.00	0.08	0.01	0.02
	EMERGENCY EQUIP <600hp diesel-Air Compressor	23	1.12	26.89	2	61	0.05	0.00	0.72	0.06	0.15	0.00	0.00	0.04	0.00	0.01
	Incinerator	2,012	97.16	2331.73	2	61	1.41	0.02	48.28	1.46	11.06	0.09	0.00	2.94	0.09	0.67
Work Boat	VESSELS>600hp diesel(work) (main-2)	12,700	613.41	14721.84	24	35	8.89	0.14	70.99	9.24	69.85	3.72	0.06	29.69	3.86	29.22
(Pecan Island)[4]	VESSELS>600hp diesel(work) (e-gen)	624	30.14	723.34	24	35	0.44	0.01	3.49	0.45	3.43	0.18	0.00	1.46	0.19	1.44
Support Vessel	VESSELS>600hp diesel(work) (main-2)[6]	4,800	231.84	5564.16	24	35	3.36	0.05	76.46	3.49	26.40	1.41	0.02	31.98	1.46	11.04
(Ginny Lab)[5]	VESSELS<600hp diesel(work) (gen-2)	215	10.36	248.72	24	35	0.47	0.00	6.65	0.54	1.43	0.20	0.00	2.78	0.23	0.60
	Bow Thruster	150	7.25	173.88	24	35	0.33	0.00	4.65	0.38	1.00	0.14	0.00	1.95	0.16	0.42
2022 YEAR TOTAL (ANNUAL)							54.49	0.83	1119.11	56.74	423.00	33.34	0.51	699.53	34.69	260.25
EXEMPTION CALCULATION	DISTANCE FROM LAND IN MILES[7]											2430.90	2430.90	2430.90	2430.90	59387.38
	73															

[1] PRIME MOVER >600 hp diesel-Dolphin Bolette (or equivalent): Dolphin Bolette's maximum output per main engine is 8,000 kW. These calculations assume operating 5 of 6 engines simultaneously at 100% load.
[2] PRIME MOVER >600 hp diesel-Dolphin Bolette (or equivalent): The main engines on Dolphin Bolette are IMO Tier II certified engines.
[3] NOx emission factor is based on the IMO Tier I certification.
[4] Work Boat Pecan Island (or equivalent) Main and Emergency Engines - IMO Tier III emission factor for NOx. Trip frequency is assumed to be four (4) days per week as per information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.
[5] Support vessel Ginny Lab (or equivalent) trip frequency is assumed at four (4) days per week.
[6] Ginny Lab main engines [CUMMINS KTA38-M2] are IMO Tier II certified.
[7] Worst case drilling location based on the lease block information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.

Attachment G-1

EMISSIONS CALCULATIONS 6TH YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT	PHONE	REMARKS
Noble Energy Inc.	Green Canyon	GC 40	34536	-	GC 40 F, I, J & GC 40 #1		Vanessa Villagran	+1 (281) 876-6229	Drill three (3) wells and complete four (4) wells using a drillship/ MPD.

OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	ACT. FUEL	RUN TIME		MAXIMUM POUNDS PER HOUR					ESTIMATED TONS				
	Diesel Engines	HP	GAL/HR	GAL/D												
	Nat. Gas Engines	HP	SCF/HR	SCF/D												
	Burners	MMBTU/HR	SCF/HR	SCF/D	HR/D	DAYS	PM	SOx	NOx	VOC	CO	PM	SOx	NOx	VOC	CO
DRILLING																
DP	DRILLSHIP															
	PRIME MOVER>600hp diesel [1] [2]	53,640	2590.81	62179.49	24	159	37.55	0.58	854.40	39.02	295.02	71.64	1.10	1630.20	74.46	562.90
	Emergency Generator>600hp diesel [3]	2,548	123.06	2953.53	2	159	1.78	0.03	50.56	1.85	14.01	0.28	0.00	8.04	0.29	2.23
	EMERGENCY EQUIP <600hp diesel-Fast Rescue	54	2.60	62.49	2	159	0.12	0.00	1.67	0.14	0.36	0.02	0.00	0.27	0.02	0.06
	6-29HP EMERGENCY EQUIP <600hp diesel-Lifeboat	40	1.94	46.63	2	159	0.09	0.00	1.25	0.10	0.27	0.01	0.00	0.20	0.02	0.04
	EMERGENCY EQUIP <600hp diesel-Air Compressor	23	1.12	26.89	2	159	0.05	0.00	0.72	0.06	0.15	0.01	0.00	0.11	0.01	0.02
	Incinerator	2,012	97.16	2331.73	2	159	1.41	0.02	48.28	1.46	11.06	0.22	0.00	7.68	0.23	1.76
Work Boat	VESSELS>600hp diesel(work) (main-2)	12,700	613.41	14721.84	24	91	8.89	0.14	70.99	9.24	69.85	9.69	0.15	77.40	10.07	76.16
(Pecan Island)[4]	VESSELS>600hp diesel(work) (e-gen)	624	30.14	723.34	24	91	0.44	0.01	3.49	0.45	3.43	0.48	0.01	3.80	0.49	3.74
Support Vessel	VESSELS>600hp diesel(work) (main-2)[6]	4,800	231.84	5564.16	24	91	3.36	0.05	76.46	3.49	26.40	3.66	0.06	83.36	3.81	28.78
(Ginny Lab)[5]	VESSELS<600hp diesel(work) (gen-2)	215	10.36	248.72	24	91	0.47	0.00	6.65	0.54	1.43	0.51	0.00	7.25	0.59	1.56
	Bow Thruster	150	7.25	173.88	24	91	0.33	0.00	4.65	0.38	1.00	0.36	0.00	5.07	0.41	1.09
2023 YEAR TOTAL (ANNUAL)							54.49	0.83	1119.11	56.74	423.00	86.90	1.33	1823.38	90.41	678.35
EXEMPTION CALCULATION	DISTANCE FROM LAND IN MILES[7] 73											2430.90	2430.90	2430.90	2430.90	59387.38

[1] PRIME MOVER >600 hp diesel-Dolphin Bolette (or equivalent): Dolphin Bolette's maximum output per main engine is 8,000 kW. These calculations assume operating 5 of 6 engines simultaneously at 100% load.
[2] PRIME MOVER >600 hp diesel-Dolphin Bolette (or equivalent): The main engines on Dolphin Bolette are IMO Tier II certified engines.
[3] NOx emission factor is based on the IMO Tier I certification.
[4] Work Boat Pecan Island (or equivalent) Main and Emergency Engines - IMO Tier III emission factor for NOx. Trip frequency is assumed to be four (4) days per week as per information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.
[5] Support vessel Ginny Lab (or equivalent) trip frequency is assumed at four (4) days per week.
[6] Ginny Lab main engines [CUMMINS KTA38-M2] are IMO Tier II certified.
[7] Worst case drilling location based on the lease block information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.

EMISSIONS CALCULATIONS 7TH YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT	PHONE	REMARKS
Noble Energy Inc.	Green Canyon	GC 40	34536	-	GC 40 F, I, J & GC 40 #1		Vanessa Villagran	+1 (281) 876-6229	Drill three (3) wells and complete four (4) wells using a drillship/ MPD.

OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	ACT. FUEL	RUN TIME		MAXIMUM POUNDS PER HOUR					ESTIMATED TONS				
	Diesel Engines	HP	GAL/HR	GAL/D												
	Nat. Gas Engines	HP	SCF/HR	SCF/D												
	Burners	MMBTU/HR	SCF/HR	SCF/D	HR/D	DAYS	PM	SOx	NOx	VOC	CO	PM	SOx	NOx	VOC	CO
DRILLING																
DP	DRILLSHIP															
	PRIME MOVER>600hp diesel [1] [2]	53,640	2590.81	62179.49	24	61	37.55	0.58	854.40	39.02	295.02	27.49	0.42	625.42	28.57	215.95
	Emergency Generator>600hp diesel [3]	2,548	123.06	2953.53	2	61	1.78	0.03	50.56	1.85	14.01	0.11	0.00	3.08	0.11	0.85
	EMERGENCY EQUIP <600hp diesel-Fast Rescue	54	2.60	62.49	2	61	0.12	0.00	1.67	0.14	0.36	0.01	0.00	0.10	0.01	0.02
	6-29HP EMERGENCY EQUIP <600hp diesel-Lifeboat	40	1.94	46.63	2	61	0.09	0.00	1.25	0.10	0.27	0.01	0.00	0.08	0.01	0.02
	EMERGENCY EQUIP <600hp diesel-Air Compressor	23	1.12	26.89	2	61	0.05	0.00	0.72	0.06	0.15	0.00	0.00	0.04	0.00	0.01
	Incinerator	2,012	97.16	2331.73	2	61	1.41	0.02	48.28	1.46	11.06	0.09	0.00	2.94	0.09	0.67
Work Boat	VESSELS>600hp diesel(work) (main-2)	12,700	613.41	14721.84	24	35	8.89	0.14	70.99	9.24	69.85	3.72	0.06	29.69	3.86	29.22
(Pecan Island)[4]	VESSELS>600hp diesel(work) (e-gen)	624	30.14	723.34	24	35	0.44	0.01	3.49	0.45	3.43	0.18	0.00	1.46	0.19	1.44
Support Vessel	VESSELS>600hp diesel(work) (main-2)[6]	4,800	231.84	5564.16	24	35	3.36	0.05	76.46	3.49	26.40	1.41	0.02	31.98	1.46	11.04
(Ginny Lab)[5]	VESSELS<600hp diesel(work) (gen-2)	215	10.36	248.72	24	35	0.47	0.00	6.65	0.54	1.43	0.20	0.00	2.78	0.23	0.60
	Bow Thruster	150	7.25	173.88	24	35	0.33	0.00	4.65	0.38	1.00	0.14	0.00	1.95	0.16	0.42
2024 YEAR TOTAL (ANNUAL)							54.49	0.83	1119.11	56.74	423.00	33.34	0.51	699.53	34.69	260.25
EXEMPTION CALCULATION	DISTANCE FROM LAND IN MILES[7]											2430.90	2430.90	2430.90	2430.90	59387.38
	73															

[1] PRIME MOVER >600 hp diesel-Dolphin Bolette (or equivalent): Dolphin Bolette's maximum output per main engine is 8,000 kW. These calculations assume operating 5 of 6 engines simultaneously at 100% load.
[2] PRIME MOVER >600 hp diesel-Dolphin Bolette (or equivalent): The main engines on Dolphin Bolette are IMO Tier II certified engines.
[3] NOx emission factor is based on the IMO Tier I certification.
[4] Work Boat Pecan Island (or equivalent) Main and Emergency Engines - IMO Tier III emission factor for NOx. Trip frequency is assumed to be four (4) days per week as per information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.
[5] Support vessel Ginny Lab (or equivalent) trip frequency is assumed at four (4) days per week.
[6] Ginny Lab main engines [CUMMINS KTA38-M2] are IMO Tier II certified.
[7] Worst case drilling location based on the lease block information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.

Attachment G-1

SUMMARY

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL
Noble Energy Inc.	Green Canyon	GC 40	34536	-	GC 40 F, I , J & GC 40 #1
Year	**Emitted**		**Substance**		
	PM	**SOx**	**NOx**	**VOC**	**CO**
2018	**86.90**	**1.33**	**1,823.38**	**90.41**	**678.35**
2019	**66.68**	**1.02**	**1,399.07**	**69.37**	**520.49**
2020	**-**	**-**	**-**	**-**	**-**
2021	**86.90**	**1.33**	**1,823.38**	**90.41**	**678.35**
2022	**33.34**	**0.51**	**699.53**	**34.69**	**260.25**
2023	**86.90**	**1.33**	**1,823.38**	**90.41**	**678.35**
2024	**33.34**	**0.51**	**699.53**	**34.69**	**260.25**
Allowable	**2,430.90**	**2,430.90**	**2,430.90**	**2,430.90**	**59,387.38**

EXPLORATION PLAN (EP)
AIR QUALITY SCREENING CHECKLIST

COMPANY	Noble Energy Inc.
AREA	Green Canyon
BLOCK	GC 40
LEASE	34536
PLATFORM	-
WELL	GC 40 F, I, J & GC 40 #1
COMPANY CONTACT	Vanessa Villagran
TELEPHONE NO.	+1 (281) 876-6229
REMARKS	Complete four (4) wells using a DP Semisubmersible.

EMISSIONS FACTORS

Fuel Usage Conversion Factors	Natural Gas Turbines		Natural Gas Engines		Diesel Recip Engine		REF	DATE
	SCF/hp-hr	9 524	SCF/hp-hr	7 143	GAL/hp-hr	0 0483	AP42 3 2-1	4/76 & 8/84
	Btu/hp-hr	2543 5						

Equipment/Emission Factors	units	PM	SOx	NOx	VOC	CO	REF	DATE
Diesel Turbines	lb/MMBtu	0 0203	0 00152	0 88	0 00803	0 0124	AP-42 3 1-2a & Background 3 4-2	04/00
Diesel Recip < 600 hp	lb/hp-hr	0 0022	1 08E-05	0 031	2 51E-03	6 68E-03	AP-42 3 3-1	10/96
Diesel Recip < 600 hp	g/hp-hr	1	4 89E-03	14 06	1 14	3 03	AP42 3 3-1	10/96
Diesel Recip > 600 hp -IMO Tier I (130<rpm<2000) [1]	g/kW-hr			12 1			IMO Tier I	
Diesel Recip > 600 hp -Marine Tier I (130-1999 rpm) [6]	g/kW-hr			45*(N)^(-0 2)			40CFR94 8(a)(1)	12/07
Diesel Recip ≥37kw (1 2 ≤disp <2 5 all power levels) - EPA Marine Tier II (disp = 1 47 L/cylinder)[3]	g/kW-hr	0 2		7 2		5 0	40CFR94 8(a)(2)	12/07
Diesel Recip > 600 hp -IMO Tier II (720 rpm) [2]	g/kW-hr			9 7			IMO Tier II	
Diesel Recip > 600 hp -IMO Tier III (720 rpm) [5]	g/kW-hr			3 4			IMO Tier III	
Diesel Recip > 600 hp -IMO Tier II (720 rpm) [2]	lb/m^3			100 9			Fuel Consumption of 192 g/kW-hr from Engine Manufacturer's Data	
Diesel Recip 3 5 ≤ disp < 7 0 all power levels - EPA Marine Tier III (disp = 4 88 L/cylinder) [3]	g/kW-hr	0 11		5 8			40CFR1042 101(a)(3)	
Diesel Recip > 600 hp	lb/hp-hr	7 00E-04	1 08E-05	0 024	0 0007	0 0055	AP-42 3 4-1	10/96
Diesel Recip > 600 hp	g/hp-hr	0 32	0 0049	11	0 33	2 49	AP42 3 4-1	10/96
Diesel Recip > 600 hp - EPA Tier I	g/kW-hr	0 54		9 2	1 3	11 4	EPA Tier 1	
Diesel Recip > 600 hp - EPA Tier II	g/kW-hr	0 2		6 4		3 5	EPA Tier 2	
Diesel Recip < 600 hp - EPA Tier III	g/kW-hr	0 2		4 0		3 5	EPA Tier 3	
Duel Fuel (NG & Diesel)	lb/MMBtu	0 0573	0 183150	2 7	0 02	1 16	AP-42 3 4-1	10/96
Duel Fuel (NG & Diesel)	lb/hp-hr	0 0007	0 001352	0 018	0 00132	0 0075	AP-42 3 4-1	10/96
Diesel Boiler	lbs/bbl	0 084	0 009075	0 84	0 008	0 21	AP-42 1 3-12,14	9/98
NG Heaters/Boilers/Burners	lbs/mmscf	7 6	0 5617	100	5 5	84	AP-42 1 4-1 & 1 4-2	7/98
NG Flares	lbs/mmscf	7 6	0 5617	0 0	0 0	0 0	AP-42 13 5-1 & 1 4-2	9/91
NG Flares	lbs/MMBtu	0 0075	0 00058	0 068	0 040	0 37	AP-42 13 5-1 & 1 4-2	9/91
NG Flares	lbs/mmscf		0 593	71 4	60 3	388 5	AP42 11 5-1	9/91
Liquid Flaring	lbs/bbl	0 42	0 195338	2	0 01	0 21	AP-42 1 3-1 & 1 3-3	9/98
Tank Vapors	lbs/bbl				0 03		E&P Forum	1/93
Fugitives	lbs/hr/comp				0 0005		API Study	12/93
Fugitives	lbs/hr/comp				0 0005		API Greenhouse Gas Compe	2009/10
Glycol Dehydrator Vent	lbs/mmscf				6 6		La DEQ	1991
Gas Venting	lbs/scf				0 0034			
Gas Venting	lbs/scf				0		TLP GC	2009/10

Sulphur Content Source	Value	Units
Fuel Gas	3 33	ppm
Diesel Fuel [4]	0 0015	% weight
Produced Gas(Flares)	3 33	ppm
Produced Oil (Liquid Flaring)	2 86	% weight

The following equations were used in formulating the conversion factors used in the application package
kW hp = (kW) x (1 341 hp/kW) Factor = 1 341 hp/kW

[1] Diesel Recip > 600 hp -IMO Tier I (130<rpm<2000) NOx emission factors for IMO Tier I diesel engines

[2] Diesel Recip > 600 hp -IMO Tier II (130<rpm<2000) NOx emission factors for IMO Tier II diesel engines

[3] Diesel Recip - EPA Marine Tier II (1 2L ≤disp <2 5L)

[4] Noble Energy utilizes Ultra Low Sulfur Diesel for all diesel combustion sources Therefore, SO_2 emissions have been calculated based on a maximum sulfur content of 15 ppm in diesel fuel assuming that 100 percent of sulfur in the fuel is oxidized to SO_2

[5] Diesel Recip > 600 hp -IMO Tier III (130<rpm<1999) NOx emission factors for IMO Tier III diesel engines

EMISSIONS CALCULATIONS 2ND YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT	PHONE	REMARKS
Noble Energy Inc.	Green Canyon	GC 40	34536	-	GC 40 F, I & J		Vanessa Villagran	+1 (281) 876-6229	Complete three (3) wells using a DP Semisubmersible.

OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	ACT. FUEL	RUN TIME		MAXIMUM POUNDS PER HOUR					ESTIMATED TONS				
	Diesel Engines	HP	GAL/HR	GAL/D												
	Nat. Gas Engines	HP	SCF/HR	SCF/D												
	Burners	MMBTU/HR	SCF/HR	SCF/D	HR/D	DAYS	PM	SOx	NOx	VOC	CO	PM	SOx	NOx	VOC	CO
DRILLING																
DP	DRILLSHIP															
	DP Semisubmersible (Default Rating)	61,200	2955.96	70943.04	24	115	42.84	0.66	1468.80	44.52	336.60	59.12	0.91	2026.94	61.44	464.51
Work Boat	VESSELS>600hp diesel(work) (main-2)	12,700	613.41	14721.84	24	66	8.89	0.14	70.99	9.24	69.85	7.01	0.11	55.98	7.29	55.08
(Pecan Island)[1]	VESSELS>600hp diesel(work) (e-gen)	624	30.14	723.34	24	66	0.44	0.01	3.49	0.45	3.43	0.34	0.01	2.75	0.36	2.71
Support Vessel	VESSELS>600hp diesel(work) (main-2)[3]	4,800	231.84	5564.16	24	66	3.36	0.05	76.46	3.49	26.40	2.65	0.04	60.29	2.75	20.82
(Ginny Lab)[2]	VESSELS<600hp diesel(work) (gen-2)	215	10.36	248.72	24	66	0.47	0.00	6.65	0.54	1.43	0.37	0.00	5.25	0.43	1.13
	Bow Thruster	150	7.25	173.88	24	66	0.33	0.00	4.65	0.38	1.00	0.26	0.00	3.67	0.30	0.79
2019 YEAR TOTAL (ANNUAL)							56.33	0.86	1631.03	58.63	438.72	69.76	1.07	2154.88	72.56	545.03
EXEMPTION CALCULATION	DISTANCE FROM LAND IN MILES[4]											2430.90	2430.90	2430.90	2430.90	59387.38
	73															

[1] Work Boat Pecan Island Main and Emergency Engines - IMO Tier III emission factor for NOx. Trip frequency is assumed to be four (4) days per week as per information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.

[2] Support vessel Ginny Lab trip frequency is assumed at four (4) days per week.

[3] Ginny Lab main engines [CUMMINS KTA38-M2] are IMO Tier II certified.

[4] Worst case drilling location based on the lease block information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.

Attachment G-2

EMISSIONS CALCULATIONS 5TH YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT	PHONE	REMARKS
Noble Energy Inc.	Green Canyon	GC 40	34536	-	GC 40 F, I & J		Vanessa Villagran	+1 (281) 876-6229	Complete three (3) wells using a DP Semisubmersible.

OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	ACT. FUEL	RUN TIME		MAXIMUM POUNDS PER HOUR					ESTIMATED TONS				
	Diesel Engines	HP	GAL/HR	GAL/D												
	Nat. Gas Engines	HP	SCF/HR	SCF/D												
	Burners	MMBTU/HR	SCF/HR	SCF/D	HR/D	DAYS	PM	SOx	NOx	VOC	CO	PM	SOx	NOx	VOC	CO
DRILLING																
DP	DRILLSHIP															
	DP Semisubmersible (Default Rating)	61,200	2955.96	70943.04	24	61	42.84	0.66	1468.80	44.52	336.60	31.36	0.48	1075.16	32.59	246.39
Work Boat	VESSELS>600hp diesel(work) (main-2)	12,700	613.41	14721.84	24	35	8.89	0.14	70.99	9.24	69.85	3.72	0.06	29.69	3.86	29.22
(Pecan Island)[1]	VESSELS>600hp diesel(work) (e-gen)	624	30.14	723.34	24	35	0.44	0.01	3.49	0.45	3.43	0.18	0.00	1.46	0.19	1.44
Support Vessel	VESSELS>600hp diesel(work) (main-2)[3]	4,800	231.84	5564.16	24	35	3.36	0.05	76.46	3.49	26.40	1.41	0.02	31.98	1.46	11.04
(Ginny Lab)[2]	VESSELS<600hp diesel(work) (gen-2)	215	10.36	248.72	24	35	0.47	0.00	6.65	0.54	1.43	0.20	0.00	2.78	0.23	0.60
	Bow Thruster	150	7.25	173.88	24	35	0.33	0.00	4.65	0.38	1.00	0.14	0.00	1.95	0.16	0.42
2022	YEAR TOTAL (ANNUAL)						56.33	0.86	1631.03	58.63	438.72	37.00	0.57	1143.02	38.49	289.11
EXEMPTION CALCULATION	DISTANCE FROM LAND IN MILES[4]											2430.90	2430.90	2430.90	2430.90	59387.38
	73															

[1] Work Boat Pecan Island Main and Emergency Engines - IMO Tier III emission factor for NOx. Trip frequency is assumed to be four (4) days per week as per information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.
[2] Support vessel Ginny Lab trip frequency is assumed at four (4) days per week.
[3] Ginny Lab main engines [CUMMINS KTA38-M2] are IMO Tier II certified.
[4] Worst case drilling location based on the lease block information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.

Attachment G-2

EMISSIONS CALCULATIONS 7TH YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT	PHONE	REMARKS
Noble Energy Inc.	Green Canyon	GC 40	34536	-	GC 40 F, I & J		Vanessa Villagran	+1 (281) 876-6229	Complete three (3) wells using a DP Semisubmersible.

OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	ACT. FUEL	RUN TIME		MAXIMUM POUNDS PER HOUR					ESTIMATED TONS				
	Diesel Engines	HP	GAL/HR	GAL/D												
	Nat. Gas Engines	HP	SCF/HR	SCF/D												
	Burners	MMBTU/HR	SCF/HR	SCF/D	HR/D	DAYS	PM	SOx	NOx	VOC	CO	PM	SOx	NOx	VOC	CO
DRILLING																
DP	DRILLSHIP															
	DP Semisubmersible (Default Rating)	61,200	2955.96	70943.04	24	61	42.84	0.66	1468.80	44.52	336.60	31.36	0.48	1075.16	32.59	246.39
Work Boat	VESSELS>600hp diesel(work) (main-2)	12,700	613.41	14721.84	24	35	8.89	0.14	70.99	9.24	69.85	3.72	0.06	29.69	3.86	29.22
(Pecan Island)[1]	VESSELS>600hp diesel(work) (e-gen)	624	30.14	723.34	24	35	0.44	0.01	3.49	0.45	3.43	0.18	0.00	1.46	0.19	1.44
Support Vessel	VESSELS>600hp diesel(work) (main-2)[3]	4,800	231.84	5564.16	24	35	3.36	0.05	76.46	3.49	26.40	1.41	0.02	31.98	1.46	11.04
(Ginny Lab)[2]	VESSELS<600hp diesel(work) (gen-2)	215	10.36	248.72	24	35	0.47	0.00	6.65	0.54	1.43	0.20	0.00	2.78	0.23	0.60
	Bow Thruster	150	7.25	173.88	24	35	0.33	0.00	4.65	0.38	1.00	0.14	0.00	1.95	0.16	0.42
2024 YEAR TOTAL (ANNUAL)							56.33	0.86	1631.03	58.63	438.72	37.00	0.57	1143.02	38.49	289.11
EXEMPTION CALCULATION	DISTANCE FROM LAND IN MILES[4]											2430.90	2430.90	2430.90	2430.90	59387.38
	73															

[1] Work Boat Pecan Island Main and Emergency Engines - IMO Tier III emission factor for NOx. Trip frequency is assumed to be four (4) days per week as per information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.
[2] Support vessel Ginny Lab trip frequency is assumed at four (4) days per week.
[3] Ginny Lab main engines [CUMMINS KTA38-M2] are IMO Tier II certified.
[4] Worst case drilling location based on the lease block information provided by Ms. Vanessa Villagran (Noble Energy) to Ms. Kalindi Khadapkar (Trinity) via email on September 12, 2017.

SUMMARY

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL
Noble Energy Inc.	Green Canyon	GC 40	34536	-	GC 40 F, I & J
Year	Emitted		Substance		
	PM	SOx	NOx	VOC	CO
2019	69.76	1.07	2,154.88	72.56	545.03
2022	37.00	0.57	1,143.02	38.49	289.11
2024	37.00	0.57	1,143.02	38.49	289.11
Allowable	2,430.90	2,430.90	2,430.90	2,430.90	59,387.38

Section H
Oil Spill Information

A. Oil Spill Response Planning

Noble Energy, Inc.'s (BOEM Operator Number 02237) Regional Oil Spill Response Plan (OSRP) was approved on December 1, 2014 and found to be in compliance on October 10, 2017 for the biennial update. Activities proposed in this EP will be covered by the Regional OSRP in accordance with 30 CFR 254.

Surface Containment – In the event of an oil spill, resources have been contracted and are available to deploy ocean boom to collect product on the water and direct it to skimmers for recovery or to conduct in-situ burn operations. By utilizing multiple contractors over 100,000 feet of ocean boom is available for use within 48 hours.

If product continues to move closer to shore both collection and protection booming strategies can be utilized to minimize impact to the Coastal Zone. In the near-shore environment over 235,000 feet of 18" hard boom is available within 48 hours. The primary focus is to collect and/or remove the product from the surface of the water via mechanical recovery and/or in-situ burning.

The final protection is beach boom and would need to be deployed very strategically based on the conditions observed and the movement of the product. Utilizing the same 48 hour window of availability 4,850 feet is available. Based on the WCD information Cameron, LA has a 5% chance of impact within the first 30 days, with Plaquemines, LA having a 4% chance in 30 days. All other parishes on the coastline have a 2% or less chance in the same period.

Noble has taken extra steps to ensure resources are available quickly from around the Gulf of Mexico to respond to a release from Green Canyon 40 to the extent possible minimize potential impacts to the Coastal Zone by engaging the product early in the offshore and near-shore environments.

B. Spill Response Sites

Primary Response Equipment Location	Preplanned Staging Location
Houma/ Leeville/Venice, LA	**Houma/ Fourchon/ Venice, LA**

C. OSRO Information

Noble utilizes Clean Gulf Associates (CGA) as its primary provider for oil spill response equipment. CGA is an industry cooperative owning an inventory of oil spill clean-up equipment. CGA is supported by Clean Gulf Associates Services (CGAS), which is responsible for storing, inspecting, maintaining, and dispatching CGA's equipment. In addition to CGAS, CGA has created the Preferred Response Organizations program, a network of highly trained response service providers that work hand-in hand with CGAS employees during a response.

D. Worst-Case Scenario Comparison

Category	Regional OSRP WCD	EP WCD
Type of Activity	Drilling	Drilling
Facility Location (Area/Block)	MC 948	GC 39-A
Facility Designation	Well No. 002 ST2	Well No. 001
Distance to Nearest Shoreline (miles)	67	73
Volume Storage tanks (total) Uncontrolled blowout Total Volume	286,186	248,975
Type of Oil(s) (crude, condensate, diesel)	Crude	Crude
API Gravity	30°	36°

The Regional OSRP for exploratory worst case discharge was reviewed and accepted under plan S-7696 for the Mississippi Canyon Block 948, 949, 992 and 993.

Noble has the capability to respond to the worst-case spill scenario included in our regional OSRP approved on December 1, 2014 and found to be in compliance on October 10, 2017 for the biennial update. The worst-case scenario determined for our EP does not replace the appropriate worst-case scenario in our regional OSRP, therefore, Noble certifies that it has the capability to respond, to the maximum extent practicable, to a worst-case discharge, or a substantial threat of such a discharge, resulting from the activities proposed in this EP.

E. Oil Spill Response Discussion

See attachment H-1.

SPILL RESPONSE DISCUSSION

For the purpose of NEPA and Coastal Zone Management Act analysis, the largest spill volume originating from the proposed activity would be a well blowout during drilling operations, estimated to be 248,975 barrels of crude oil with an API gravity of 36°.

Land Segment and Resource Identification

Trajectories of a spill and the probability of it impacting a land segment have been projected utilizing information in the BOEM Oil Spill Risk Analysis Model (OSRAM) for the Central and Western Gulf of Mexico available on the BOEM website. The results are shown in **Figure 1.** The BOEM OSRAM identifies a 5% probability of impact to the shorelines of Cameron Parish, Louisiana within 30 days. Cameron Parish includes the east side of Sabine Lake, Sabine National Wildlife Refuge, Calcasieu Lake, Lacassine National Wildlife Refuge (inland) and Grand Lake. Cameron Parish also includes the area along the coastline from Sabine Pass to Big Constance Lake in Rockefeller Wildlife Refuge. This region is composed of open public beaches, marshlands and swamps. It serves as a habitat for numerous birds, finfish and other animals, including several rare, threatened and endangered species.

Response

Noble Energy, Inc. will make every effort to respond to the Worst Case Discharge as effectively as practicable. A description of the response equipment under contract to contain and recover the Worst Case Discharge is shown in **Figure 2.**

General Considerations for all Oil Spill Recovery Operations (Also refer to the Tactics discussion below for more detail)

Noble Energy, Inc. will use all appropriate measures possible to safely and efficiently recover all oil spills from its facilities. These include but are not limited to:

- Conducting detailed safety analyses on all operations and preparing/disseminating resulting safety plans to all response personnel
- Use of tactics described in the most current MSRC Gulf Area Tactics Guide Book and any other appropriate tactics developed during the event
- Configuring all surface recovery systems to achieve maximum throughput and recovery efficiency rates:
    - Maximization of the use of advanced and adverse weather recovery systems to increase oil to recovery system encounter rates
    - Use of vessels with the largest possible on-board recovered oil storage to minimize off-load times
    - Use of appropriate vessels to deploy ocean boom to form the widest practical width to maximize oil to recovery system encounter rate
    - Use of appropriate recovery systems to maximize recovery rate in all operable environmental conditions

- Early deployment of MSRC's Responder class OSRVs (4,000 bbl storage) and large OSRBs (minimum of 36,000 bbl storage) to recover and store oil while minimizing rig/derig and transit time, maximizing on-board storage and on-station time
- Obtaining early approval for decanting of oil to maximize storage capacity
- Use of most efficient, high volume pumps for oil recovery and decanting, offloading and lightering
- Use of advanced technology (such as thermal infrared and multi-spectral cameras) to detect oil on the water's surface and classify it as recoverable or non-recoverable. This will allow more efficient use of on-water recovery task forces, maximize recovery rates and expand operational windows. This advanced technology is effective in both day and night time surveillance activities depending upon atmospheric conditions
- Early consideration of advanced oil removal methods (e.g. dispersant application and in-situ burning) and coordination/consultation with the USCG and appropriate Regional Response Team for obtaining permission to proceed as necessary
- Providing effective communication systems to allow for the command and control of deployed resources to ensure safety, reduce response times, and collect information necessary to develop a comprehensive, timely, and accurate Common Operating Picture (COP)

Using the estimated chemical and physical characteristics of crude oil, an ADIOS weathering model was run on a similar product from the ADIOS oil database. The results indicate 22% or approximately 54,775 barrels of crude oil would be evaporated/dispersed within 24 hours, with approximately 194,200 barrels remaining.

Spill Response GC 39, Well Location A	Barrels of Oil
WCD Volume	248,975
Less 22% natural evaporation/dispersion	54,775
Remaining volume	194,200

Figure 2 outlines equipment, personnel, materials and support vessels as well as temporary storage equipment available to respond to the worst case discharge. The volume accounts for the amount remaining after evaporation/dispersion at 24 hours. The list estimates individual times needed for procurement, load out, travel time to the site and deployment. **Figure 2** also indicates how operations will be supported.

Noble Energy, Inc.'s Oil Spill Response Plan includes alternative response technologies such as dispersants and in-situ burn. Strategies will be decided by Unified Command based on the size of the spill, weather and potential impacts. If aerial dispersants are utilized, 8 sorties (9,600 gallons) from two of the DC-3 aircrafts and 4 sorties (8,000 gallons) from the Basler aircraft would provide a daily dispersant capability of 7,540 barrels. If the conditions are favorable for in-situ burning, the proper approvals have been obtained and the proper planning is in place, in-situ burning of oil may be attempted. Slick containment boom would be immediately called out and on-scene as soon as possible. Offshore response strategies may include attempting to skim utilizing CGA and MSRC spill response equipment with a total derated skimming capacity of

1,172,654 barrels. Temporary storage associated with skimming equipment equals 255,296 barrels. If additional storage is needed, various tank barges with a total of 1.06 million+ barrels of storage capacity may be mobilized and centrally located to provide temporary storage allowing the skimmers to stay in the area of operations as much as possible. **Safety is first priority. Air monitoring will be accomplished and operations deemed safe prior to any containment/skimming attempts.**

If the spill went unabated, shoreline impact in Cameron Parish, Louisiana would depend upon existing environmental conditions. Shoreline protection would include the use of CGA's and MSRC's near shore and shallow water skimmers with a totaled derated skimming capacity of 220,742 barrels. Temporary storage associated with skimming equipment equals 8,642 barrels. If additional storage is needed, various tank barges with a total of 281,000+ barrels of storage capacity may be mobilized and centrally located to provide temporary storage allowing the skimmers to stay in the area of operations as much as possible. Onshore response may include the deployment of shoreline boom on beach areas, or protection and sorbent boom on vegetated areas. A Master Service Agreement with OMI Environmental will ensure access to approximately 31,400 feet of 18" shoreline boom. **Figure 2** outlines individual times needed for procurement, load out, travel time to the site and deployment. Strategies would be based upon surveillance and real time trajectories that depict areas of potential impact given actual sea and weather conditions. Applicable Area Contingency Plans (ACPs), Geographic Response Plans (GRPs), and Unified Command (UC) will be consulted to ensure that environmental and special economic resources are correctly identified and prioritized to ensure optimal protection. Shoreline protection strategies depict the protection response modes applicable for oil spill clean-up operations. As a secondary resource, the State of Louisiana Initial Oil Spill Response Plan will be consulted as appropriate to provide detailed shoreline protection strategies and describe necessary action to keep the oil spill from entering Louisiana's coastal wetlands. The UC should take into consideration all appropriate items detailed in Tactics discussion of this Appendix. The UC and their personnel have the option to modify the deployment and operation of equipment to allow for a more effective response to site-specific circumstances. Noble Energy, Inc.'s Spill Management Team has access to the applicable ACP(s) and GRP(s).

Based on the anticipated worst case discharge scenario, Noble Energy, Inc. can be onsite with contracted oil spill recovery equipment with adequate response capacity to contain and recover surface hydrocarbons, and prevent land impact, to the maximum extent practicable, within an estimated 70 hours (based on the equipment's Effective Daily Recovery Capacity (EDRC)).

Initial Response Considerations

Actual actions taken during an oil spill response will be based on many factors to include but not be limited to:

- Weather
- Equipment and materials availability
- Ocean currents and tides
- Location of the spill
- Product spilled
- Amount spilled
- Environmental risk assessments
- Trajectory and product analysis
- Well status, i.e., shut in or continual release

Noble Energy, Inc. will take action to provide a safe, aggressive response to contain and recover as much of the spilled oil as quickly as it is safe to do so. In an effort to protect the environment, response actions will be designed to provide an "in-depth" protection strategy meant to recover as much oil as possible as far from environmentally sensitive areas as possible. Safety will take precedence over all other considerations during these operations.

Coordination of response assets will be supervised by the designation of a SIMOPS group as necessary for close quarter vessel response activities. Most often, this group will be used during source control events that require a significant number of large vessels operating independently, but in coordination to complete a common objective, in a small area and in close coordination and support of each other. This group must also monitor the subsurface activities of each vessel (ROV, dispersant application, well control support, etc.). The SIMOPS group leader reports to the Source Control Section Chief.

In addition, these activities will be monitored by the spill management team (SMT) and Unified Command via a structured Common Operating Picture (COP) established to track resource and slick movement in real time.

Upon notification of a spill, the following actions will be taken:

- Information will be confirmed
- An assessment will be made and initial objectives set
- OSROs and appropriate agencies will be notified
- ICS 201, Initial Report Form completed
- Initial Safety plan will be written and published
- Unified Command will be established
    - Overall safety plan developed to reflect the operational situation and coordinated objectives
    - Areas of responsibility established for Source Control and each surface operational site
    - On-site command and control established

Offshore Response Actions

Equipment Deployment

Surveillance

- Aerial Observation:
    - Surveillance Aircraft: deployment within two hours of QI notification, or at first light
    - Provide trained observer to provide on site status reports
    - Provide aerial photography and visual confirmation
- Provide command and control platform at the site if needed
- Remote Sensing:
    - Use of thermal infrared and multi-spectral sensing systems or other technology to detect oil and classify it as recoverable or non-recoverable to enhance on-water recovery capability
    - Surveillance platforms should be appropriate for weather and atmospheric conditions to provide the greatest altitude (e.g. aircraft, aerostats or ship mounted)
    - Continued surveillance of oil movement by remote sensing systems
- Continual monitoring of vessel assets using vessel monitoring systems

Dispersant application assets

- Put aerial dispersant providers on standby
- With the FOSC, conduct analysis to determine appropriateness of dispersant application (refer to Section 18)
- Gain FOSC approval for use of dispersants on the surface
- Deploy aircraft in accordance with a plan developed for the actual situation
- Coordinate deployment of a Special Monitoring of Applied Response Technologies (SMART) team as required
- Coordinate movement of dispersants, aircraft, and support equipment and personnel
- Confirm dispersant availability for current and long range operations
- Consider ordering dispersant stocks required for expected operations

Containment boom

- Call out early and expedite deployment to be on scene ASAP
- Ensure boom handling and mooring equipment is deployed with boom
- Provide continuing reports to vessels to expedite their arrival at sites that will provide for their most effective containment
- Use Vessels of Opportunity (VOO) to deploy and maintain boom
- MSRC OSRVs and OSRBs have on-board ocean boom inventories and additional significant stockpiles are available in MSRC warehouses

Dedicated off-shore skimming systems

General

- Deployed to the highest concentration of oil
- Assets deployed at safe distance from aerial dispersant and in-situ burn operations

CGA HOSS Barge

- Use in areas with heaviest oil concentrations
- Consider for use in areas of known debris (seaweed, and other floating materials)

CGA 95' Fast Response Vessels (FRVs)

- Designed to be a first vessel on scene
- Capable of maintaining the initial Command and Control function for on water recovery operations
- 24 hour oil spill detection capability
- Highly mobile and efficient skimming capability
- Use as far off-shore as safely possible

CGA FRUs

- To the area of the thickest oil
- Use as far off-shore as allowed

T&T Koseq Skimming Systems

- To the area of the thickest oil
- Use as far off-shore as allowed

MSRC Responder Class Vessels / Oil Spill Response Vessels (OSRV)

- Use in areas with heaviest oil concentrations
- Use as near-shore as allowed by draft of vessel
- Use as far off-shore as needed
- Consider for use in areas of known debris (seaweed and other floating materials)

MSRC Oil Spill Response Barges (OSRB)

- Use for oil removal operations and storage in areas with heaviest oil concentrations, as appropriate
- Consider for use in areas of known debris (seaweed and other floating materials)

MSRC PSV-VOO Skimming Systems

- Use in areas with heaviest oil concentrations
- Use as near-shore as allowed by draft of vessel
- Use as far off-shore as needed
- Expected 24-hour mobilization
- Expected length of 200 foot or greater
- PSV-VOO with deck space of 150' x 40' to provide space for skimmer, marine storage tanks and boom
- PSV-VOO with 2,000-20,000 bbl below deck storage supplemented with two or more 500 bbl marine portable tanks depending on below deck storage compatibility with flashpoint of recovered product

Storage Vessels

- Establish availability of contracted assets (See Appendix E)
- Early call out (to allow for tug boat acquisition and deployment speeds)
- Phase mobilization to allow storage vessels to arrive at the same time as skimming systems
- Position as closely as possible to skimming assets to minimize offloading time

Vessels of Opportunity (VOO)

- Use Noble Energy, Inc.'s contracted resources as applicable
- Industry vessels are ideal for deployment of Vessel of Opportunity Skimming Systems (VOSS)
- Acquire additional resources as needed
- Consider use of local assets, i.e. fishing and pleasure craft
- Expect mission specific and safety training to be required
- Plan with the US Coast Guard/ABS for vessel inspections
- Place VOOs in Division or Groups as needed
- Use organic on-board storage if appropriate
- Maximize non-organic storage appropriate to vessel limitations
- Decant as appropriate after approval to do so has been granted
- Assign bulk storage barges to each Division/Group
- Position bulk storage barges as close to skimming units as possible
- Utilize large skimming vessel (e.g. barges) storage for smaller vessel offloading
- Maximize skimming area (swath) to the optimum width given sea conditions and available equipment
- Maximize use of oleophilic skimmers in all operations, but especially offshore
- Nearshore, use shallow water barges and shuttle to skimming units to minimize offloading time
- Plan and equip to use all offloading capabilities of the storage vessel to minimize offloading time

In-situ Burn assets

- Determine appropriateness of in-situ burn operation in coordination with the FOSC and affected SOSC
- Determine availability of fire boom and selected ignition systems
- Start ordering fire boom stocks required for expected operations
- Ensure VOO crew members are trained prior to operations
- Determine assets to perform on water operation
- Build operations into safety plan
- Conduct operations in accordance with an approved plan
- Initial test burn to ensure effectiveness

Adverse Weather Operations:
In adverse weather, when seas are $\geq$ 3 feet, the use of larger recovery and storage vessels, oleophilic skimmers, and large offshore boom will be maximized. Safety will be the overriding factor in all operations and will cease at the order of the Unified Command, vessel captain, or in an emergency, "stop work" may be directed by any crew member.

Surface Oil Recovery Considerations and Tactics
(Offshore and Near-shore Operations)

Maximization of skimmer-oil encounter rate

- Place barges in skimming task forces, groups, etc., to reduce recovered oil offloading time
- Place barges alongside skimming systems for immediate offloading of recovered oil when practicable
- Use two vessels, each with heavy sea boom, in an open-ended "V" configuration to funnel surface oil into a trailing skimming unit's organic, V-shaped boom and skimmer (see page 7, *CGA Equipment Guide Book and Tactic Manual* (CGATM)
- Use secondary vessels and heavy sea boom to widen boom swath beyond normal skimming system limits (see page 15, CGATM)
- Consider night-time operations, first considering safety issues
- Utilize all available advanced technology systems (IR, X-Band Radar, etc.) to determine the location of, and move to, recoverable oil
- Confirm the presence of recoverable oil prior to moving to a new location

Maximize skimmer system efficiency

- Place weir skimming systems in areas of calm seas and thick oil
- Maximize the use of oleophilic skimming systems in heavier seas
- Place less mobile, high EDRC skimming systems (e.g. HOSS Barge) in the largest pockets of the heaviest oil
- Maximize onboard recovered oil storage for vessels.
- Obtain authorization for decanting of recovered water as soon as possible
- Use smaller, more agile skimming systems to recover streamers of oil normally found farther from the source. Place recovered oil barges nearby

Recovered Oil Storage

- Smaller barges in larger quantities will increase flexibility for multi-location skimming operations
- Place barges in skimming task forces, groups, etc., to reduce recovered oil offloading time
- Procure and deploy the maximum number of portable tanks to support Vessel of Opportunity Skimming Systems if onboard storage is not available
- Maximize use of the organic recovered oil storage capacity of the skimming vessel

Command, Control, and Communications (C^3)

- Publish, implement, and fully test an appropriate communications plan
- Design an operational scheme, maintaining a manageable span of control
- Designate and mark C^3 vessels for easy aerial identification
- Designate and employ C^3 aircraft for task forces, groups, etc.
- Use reconnaissance air craft and Rapid Response Teams (RAT) to confirm the presence of recoverable oil

On Water Recovery Group

When the first skimming vessel arrives on scene, a complete site assessment will be conducted before recovery operations begin. Once it is confirmed that the air monitoring readings for O2, LEL, H2S, CO, VOC, and Benzene are all within the permissible limits, oil recovery operations may begin.

As skimming vessels arrive, they will be organized to work in areas that allow for the most efficient vessel operation and free vessel movement in the recovery of oil. Vessel groups will vary in structure as determined by the Operations Section of the Unified Command, but will generally consist, at a minimum, of the following dedicated assets:

- 3 to 5 – Offshore skimming vessels (recovery)
- 1 – Tank barge (temporary storage)
- 1 – Air asset (tactical direction)
- 2 – Support vessels (crew/utility for supply)
- 6 to 10 – Boom vessels (enhanced booming)

Example ***(Note:*** *Actual organization of TFs will be dependent on several factors including, asset availability, weather, spilled oil migration, currents, etc.)*

The 95' FRV Breton Island out of Venice arrives on scene and conducts an initial site assessment. Air monitoring levels are acceptable and no other visual threats have been observed. The area is cleared for safe skimming operations. The Breton Island assumes command and control (CoC) of on-water recovery operations until a dedicated non-skimming vessel arrives to relieve it of those duties.

A second 95' FRV arrives and begins recovery operations alongside the Breton Island. Several more vessels begin to arrive, including a third 95' FRV out of Galveston, the HOSS Barge (High Volume Open Sea Skimming System) out of Harvey, a boom barge (CGA 300) with 25,000' of 42" auto boom out of Leeville, and 9 Fast Response Units (FRUs) from the load-out location at C-Port in Port Fourchon.

As these vessels set up and begin skimming, they are grouped into task forces (TFs) as directed by the Operations Section of the Unified Command located at the command post.

Initial set-up and potential actions:

- A 1,000 meter safety zone has been established around the incident location for vessels involved in Source Control
- The HOSS Barge is positioned facing the incident location just outside of this safety zone or at the point where the freshest oil is reaching the surface
- The HOSS Barge engages its Oil Spill Detection (OSD) system to locate the heaviest oil and maintains that ability for 24-hour operations
- The HOSS Barge deploys 1,320’ of 67” Sea Sentry boom on each side, creating a swath width of 800’
- The Breton Island and H.I. Rich skim nearby, utilizing the same OSD systems as the HOSS Barge to locate and recover oil
- Two FRUs join this group and it becomes TF1
- The remaining 7 FRUs are split into a 2 and 3 vessel task force numbered TF2 and TF3
- A 95’ FRV is placed in each TF
- The boom barge (CGA 300) is positioned nearby and begins deploying auto boom in sections between two utility vessels (1,000’ to 3,000’ of boom, depending on conditions) with chain-link gates in the middle to funnel oil to the skimmers
- The initial boom support vessels position in front of TF2 and TF3
- A 100,000+ barrel offshore tank barge is placed with each task force as necessary to facilitate the immediate offload of skimming vessels

The initial task forces (36 hours in) may be structured as follows:

TF 1

- 1 – 95’ FRV
- 1 – HOSS Barge with 3 tugs
- 2 – FRUs
- 1 – 100,000+ barrel tank barge and associated tug(s)
- 1 – Dedicated air asset for tactical direction
- 8 – 500’ sections of auto boom with gates
- 8 – Boom-towing vessels
- 2 – Support vessels (crew/utility)

TF 2

- 1 – 95’ FRV
- 4 – FRUs
- 1 – 100,000+ barrel tank barge and associated tug(s)
- 1 – Dedicated air asset for tactical direction
- 10 – 500’ sections of auto boom with gates
- 10 – Boom-towing vessels
- 2 – Support vessels (crew/utility)

TF 3

- 1 – 95' FRV
- 3 – FRUs
- 1 – 100,000+ barrel tank barge and associated tug(s)
- 1 – Dedicated air asset for tactical direction
- 8 – 500' sections of auto boom with gates
- 8 – Boom-towing vessels
- 2 – Support vessels (crew/utility)

Offshore skimming equipment continues to arrive in accordance with the ETA data listed in figure H.3; this equipment includes 2 AquaGuard skimmers and 11 sets of Koseq Rigid Skimming Arms. These high volume heavy weather capable systems will be divided into functional groups and assigned to specific areas by the Operations Section of the Unified Command.

At this point of the response, the additional TFs may assume the following configurations:

TF 4

- 2 – Sets of Koseq Rigid Skimming Arms w/ associated 200'+ PIDVs
- 1 – AquaGuard Skimmer
- 1 – 100,000+ barrel tank barge and associated tug(s)
- 1 – Dedicated air asset for tactical direction
- 2 – Support vessels (crew/utility)
- 6 – 500' sections of auto boom with gates
- 6 – Boom-towing vessels

TF 5

- 3 – Sets of Koseq Rigid Skimming Arms w/ associated 200'+ PIDVs
- 1 – AquaGuard Skimmer
- 1 – 100,000+ barrel tank barge and associated tug(s)
- 1 – Dedicated air asset for tactical direction
- 2 – Support vessels (crew/utility)
- 8 – 500' sections of auto boom with gates
- 8 – Boom-towing vessels

TF 6

- 3 – Sets of Koseq Rigid Skimming Arms w/ associated 200'+ PIDVs
- 1 – 100,000+ barrel tank barge and associated tug(s)
- 1 – Dedicated air asset for tactical direction
- 2 – Support vessels (crew/utility)
- 6 – 500' sections of auto boom with gates
- 6 – Boom-towing vessels

TF 7

- 3 – Sets of Koseq Rigid Skimming Arms w/ associated 200'+ PIDVs
- 1 – 100,000+ barrel tank barge and associated tug(s)
- 1 – Dedicated air asset for tactical direction
- 2 – Support vessels (crew/utility)
- 6 – 500' sections of auto boom with gates
- 6 – Boom-towing vessels

CGA Minimum Acceptable Capabilities for Vessels of Opportunity (VOO)
Minimum acceptable capabilities of Petroleum Industry Designed Vessels (PIDV) for conducting Vessel of Opportunity (VOO) skimming operations are shown in the table below. PIDVs are "purpose-built" to provide normal support to offshore oil and gas operators. They include but are not limited to utility boats, offshore supply vessels, etc. They become VOOs when tasked with oil spill response duties.

Capability	**FRU**	**KOSEQ**	**AquaGuard**
Type of Vessel	Utility Boat	Offshore Supply Vessel	Utility Boat
Operating parameters			
Sea State	3-5 ft max	9.8 ft max	3-5 ft max
Skimming speed	≤1 kt	≤3 kts	≤1 kt
Vessel size			
Minimum Length	100 ft	200 ft	100 ft
Deck space for: • Tank(s) • Crane(s) • Boom Reels • Hydraulic Power Units • Equipment Boxes	18x32 ft	100x40 ft	18x32 ft
Communication Assets	Marine Band Radio	Marine Band Radio	Marine Band Radio

Tactical use of Vessels of Opportunity (VOO): Noble Energy, Inc. will take all possible measures to maximize the oil-to-skimmer encounter rate of all skimming systems, to include VOOs, as discussed in this section. VOOs will normally be placed within an On-water recovery unit as shown in figures below.

Skimming Operations: PIDVs are the preferred VOO skimming platform. OSROs are more versed in operating on these platforms and the vessels are generally large enough with crews more likely versed in spill response operations. They also have a greater possibility of having on-board storage capacity and the most likely vessels to be under contract, and therefore more readily available to the operator. These vessels would normally be assigned to an on-water recovery group/division (see figure below) and outfitted with a VOSS suited for their size and capabilities. Specific tactics used for skimming operations would be dependent upon many parameters which include, but are not limited to, safety concerns, weather, type VOSS on board, product being recovered, and area of oil coverage. Planners would deploy these assets with the objective of safely maximizing oil- to-skimmer encounter rate by taking actions to minimize non-skimming time and maximizing boom swath. Specific tactical configurations are shown in figures below.

The Fast Response Unit (FRU): A self-contained, skid based, skimming system that is deployed from the right side of a vessel of opportunity (VOO). An outrigger holds a 75' long section of air inflatable boom in place that directs oil to an apex for recovery via a Foilex 250 weir skimmer. The outrigger creates roughly a 40' swath width dependent on the VOO beam. The lip of the collection bowl on the skimmer is placed as close to the oil and water interface as possible to maximize oil recovery and minimize water retention. The skimmer then pumps all fluids recovered to the storage tank where it is allowed to settle, and with the approval of the Coast Guard, the water is decanted from the bottom of the tank back into the water ahead of the containment boom to be recycled through the system. Once the tank is full of as much pure recovered oil as possible it is offloaded to a storage barge for disposal in accordance with an approved disposal plan. A second 100 barrel storage tank can be added if the appropriate amount of deck space is available to use as secondary storage.

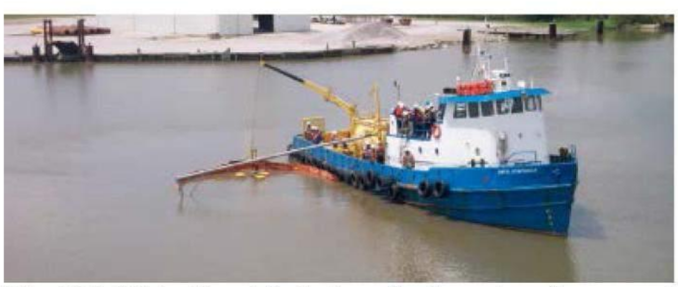
Tactical Overview

Mechanical Recovery – The FRU is designed to provide fast response skimming capability in the offshore and nearshore environment in a stationary or advancing mode. It provides a rated daily recovery capacity of 4,100 barrels. An additional boom reel with 440' of offshore boom can be deployed along with the FRU, and a second support vessel for boom towing, to extend the swath width when attached to the end of the fixed boom. The range and sustainability offshore is dependent on the VOO that the unit is placed on, but generally these can stay offshore for extended periods. The FRU works well independently or assigned with other on-water recovery assets in a task force. In either case, it is most effective when a designated aircraft is assigned to provide tactical direction to ensure the best placement in recoverable oil.

Maximum Sea Conditions – Under most circumstances the FRU can maintain standard oil spill recovery operations in 2' to 4' seas. Ultimately, the Coast Guard licensed Captain in charge of the VOO (with input from the CGAS Supervisor assigned) will be responsible to determine when the sea conditions have surpassed the vessel's safe operating capabilities.

Possible Task Force Configuration (Multiple VOOs can be deployed in a task force)

1 – VOO (100' to 165' Utility or Supply Vessel)
1 – Boom reel w/support vessel for towing
1 – Tank barge (offshore) for temporary storage
1 – Utility/Crewboat (supply)
1 – Designated spotter aircraft



The VOSS (yellow) is being deployed and connected to an out-rigged arm. This is suitable for collection in both large pockets of oil and for recovery of streaming oil.

The oil-to-skimmer encounter rate is limited by the length of the arm. Skimming pace is ≤ 1 knot.

Through the use of an additional VOO, and using extended sea boom, the swath of the VOSS is increased therefore maximizing the oil-to-skimmer encounter rate. Skimming pace is ≤ 1 knot.

The Koseq Rigid Sweeping Arm: A skimming system deployed on a vessel of opportunity. It requires a large Offshore or Platform Supply Vessel (OSV/PSV), greater than 200' with at least 100' x 50' of free deck space. On each side of the vessel, a 50' long rigid framed Arm is deployed that consists of pontoon chambers to provide buoyancy, a smooth nylon face, and a hydraulically adjustable mounted weir skimmer. The Arm floats independently of the vessel and is attached by a tow bridle and a lead line. The movement of the vessel forward draws the rubber end seal of the arm against the hull to create a collection point for free oil directed to the weir by the Arm face. The collection weir is adjusted to keep the lip as close to the oil water interface as possible to maximize oil recovery while attempting to minimize excess water collection. A transfer pump (combination of positive displacement, screw type and centrifuge suited for highly viscous oils) pump the recovered liquid to portable tanks and/or dedicated fixed storage tanks onboard the vessel. After being allowed to sit and separate, with approval from the Coast Guard, the water can be decanted (pumped off) in front of the collection arm to be reprocessed through the system. Once full with as much pure recovered oil as possible, the oil is transferred to a temporary storage barge where it can be disposed of in accordance with an approved disposal plan.

Tactical Overview

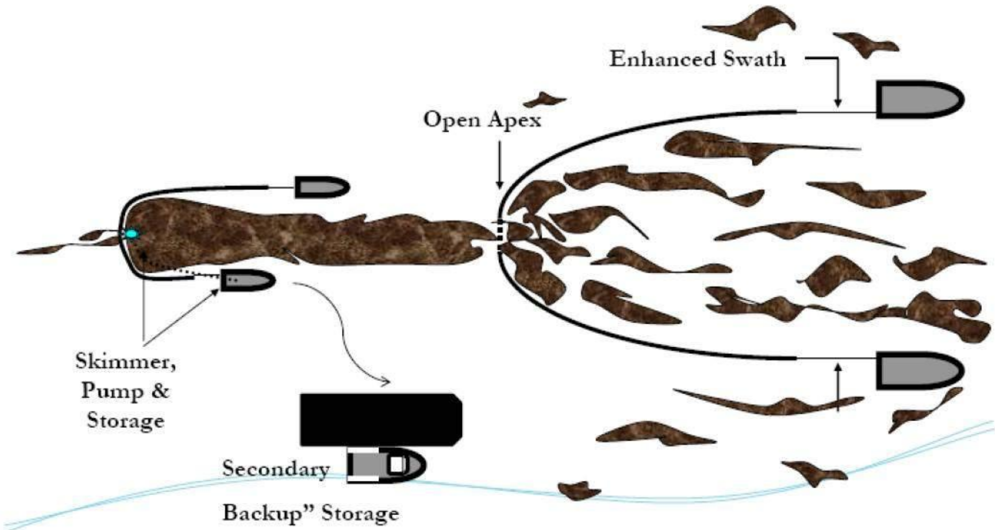
Mechanical Recovery – Deployed on large vessels of opportunity (VOO) the Koseq Rigid Sweeping Arms are high volume surge capacity deployed to increase recovery capacity at the source of a large oil spill in the offshore and outer nearshore environment of the Gulf of Mexico. They are highly mobile and sustainable in rougher sea conditions than normal skimming vessels (9.8' seas). The large Offshore Supply Vessels (OSV) required to deploy the Arms are able to remain on scene for extended periods, even when sea conditions pick up. Temporary storage on deck in portable tanks usually provides between 1,000 and 3,000 bbls. In most cases, the OSV will be able to pump 20% of its deadweight into the liquid mud tanks in accordance with the vessels Certificate of Inspection (COI). All storage can be offloaded utilizing the vessels liquid transfer system.

Maximum Sea Conditions - Under most circumstances the larger OSVs are capable of remaining on scene well past the Skimming Arms maximum sea state of 9.8'. Ultimately it will be the decision of the VOO Captain, with input from the T&T Supervisor onboard, to determine when the sea conditions have exceeded the safe operating conditions of the vessel.

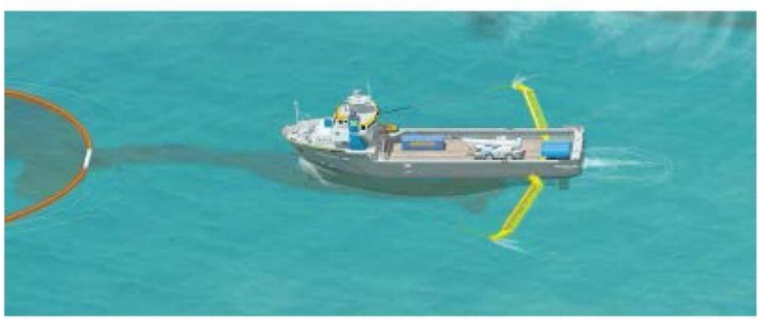
Command and Control – The large OSVs in many cases have state of the art communication and electronic systems, as well as the accommodations to support the function of directing all skimming operations offshore and reporting back to the command post.

Possible Task Force Configuration (Multiple Koseq VOOs can be deployed in a task force)

1 – ≥ 200' Offshore Supply Vessels (OSV) with set of Koseq Arms
2 to 4 portable storage tanks (500 bbl)
1 – Modular Crane Pedestal System set (MCPS) or 30 cherry picker (crane) for deployment
1 – Tank barge (offshore) for temporary storage
1 – Utility/Crewboat (supply)
1 – Designated spotter aircraft
4 – Personnel (4 T&T OSRO)



Scattered oil is "caught" by two VOO and collected at the apex of the towed sea boom. The oil moves thought a "gate" at that apex, forming a larger stream of oil which moves into the boom of the skimming vessel. Operations are paced at >1. A recovered oil barge stationed nearby to minimize time taken to offload recovered oil.



This is a depiction of the same operation as above but using KOSEQ Arms. In this configuration, the collecting boom speed dictates the operational pace at $\geq$ 1 knot to minimize entrainment of the oil.

Clean Gulf Associates (CGA) Procedure for Accessing Member-Contracted and other Vessels of Opportunity (VOOs) for Spill Response

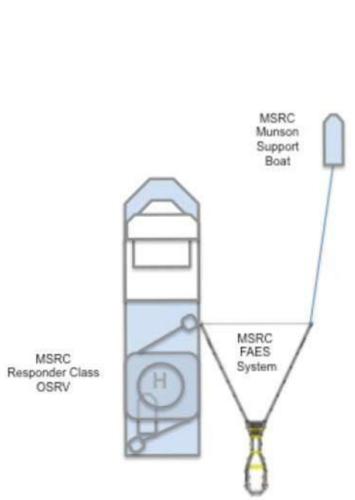
- CGA has procedures in place for CGA member companies to acquire vessels of opportunity (VOOs) from an existing CGA member's contracted fleet or other sources for the deployment of CGA portable skimming equipment including Koseq Arms, Fast Response Units (FRUs) and any other portable skimming system(s) deemed appropriate for the response for a potential or actual oil spill, WCD oil spill or a Spill of National Significance (SONS).

- CGA uses Port Vision, a web-based vessel and terminal interface that empowers CGA to track vessels through Automatic Identification System (AIS) and terminal activities using a Geographic Information System (GIS). It provides live AIS/GIS views of waterways showing current vessel positions, terminals, created vessel fleets, and points-of-interest. Through this system, CGA has the ability to get instant snapshots of the location and status of all vessels contracted to CGA members, day or night, from any web-enabled PC.

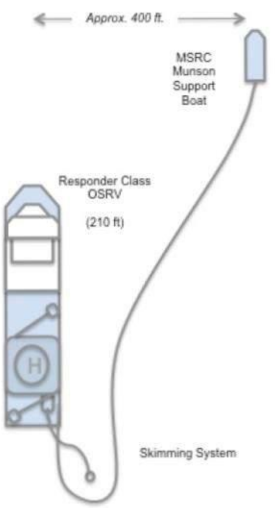
Typical On-Water Oil Recovery and Removal Tactics *(See MSRC Gulf Area Tactics Guidebook for more information)*

Mechanical Recovery
Large Scale Resources

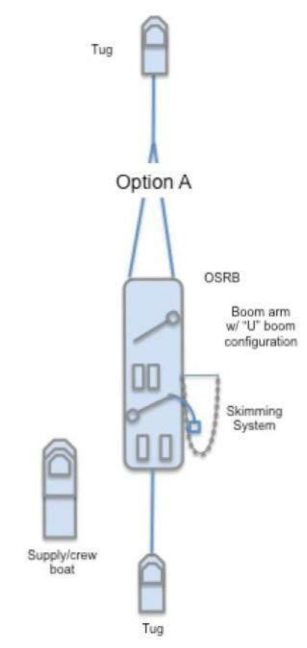
Option A – OSRV FAES Deployment (Example)



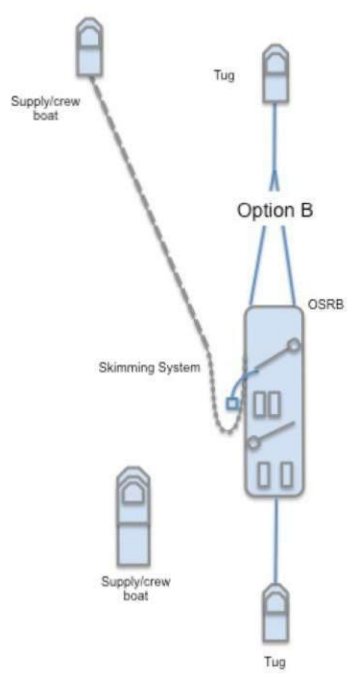
Option B – OSRV Ocean Boom in a "J" Configuration (Example)



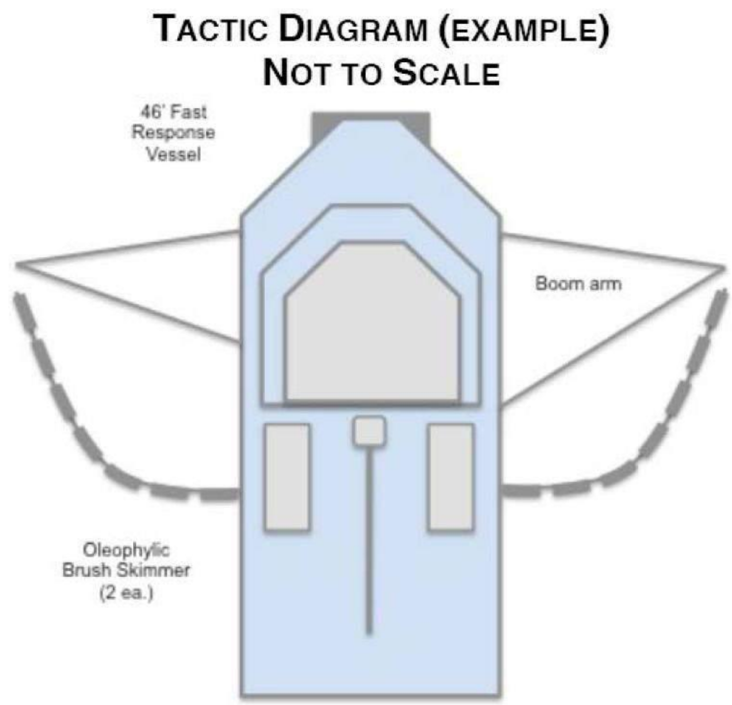
Option A – OSRB in a "U" Configuration

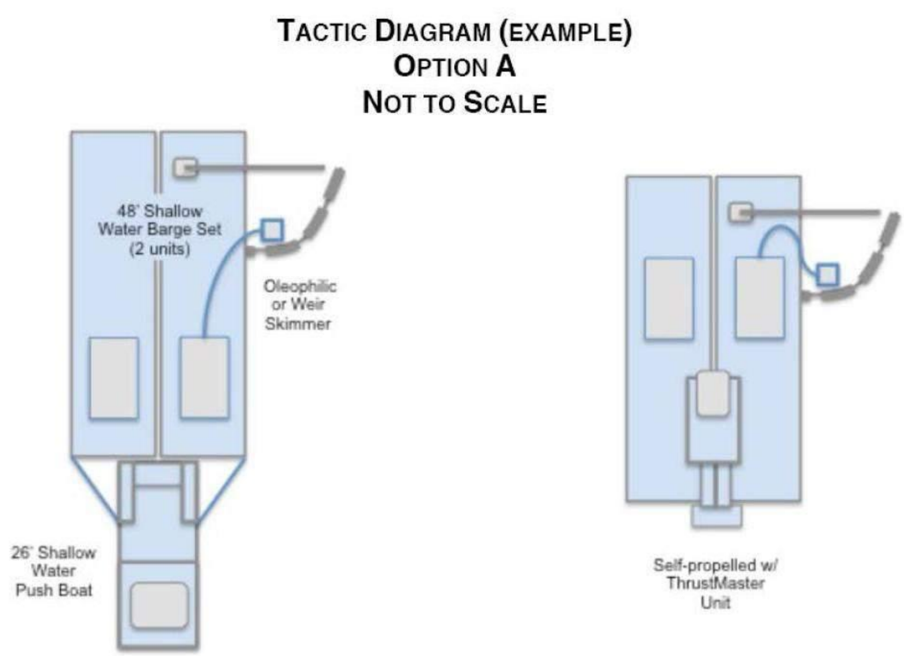


Option B – OSRB in a "J" Configuration

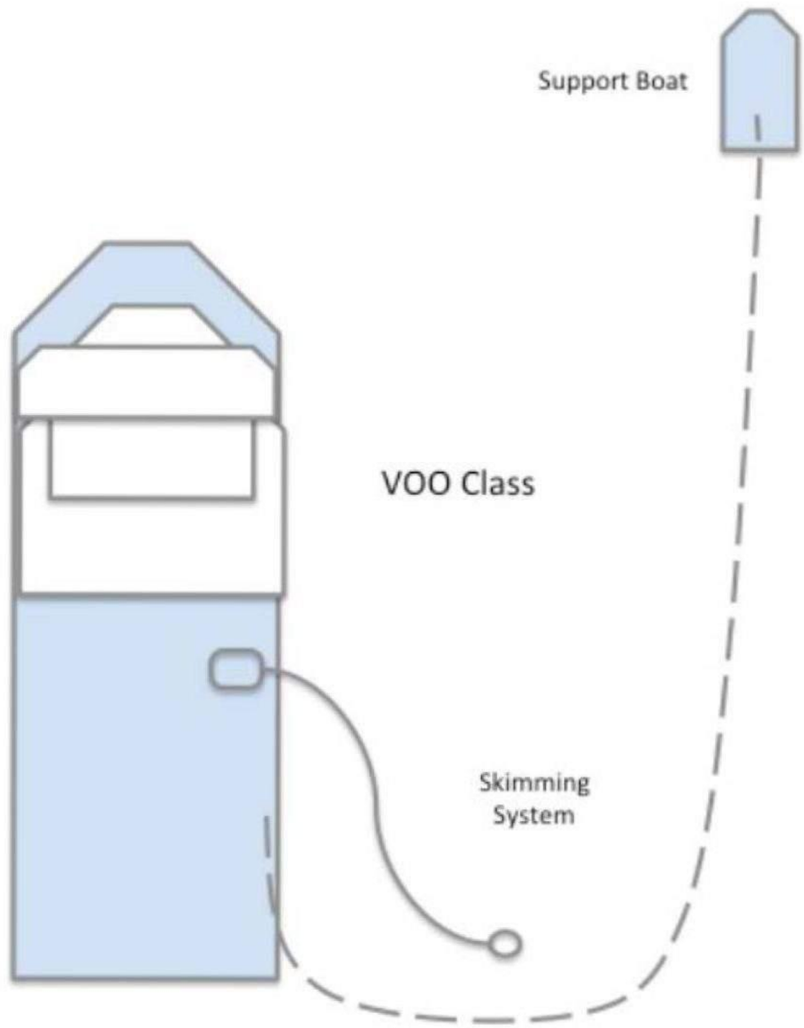


Small Scale Resources

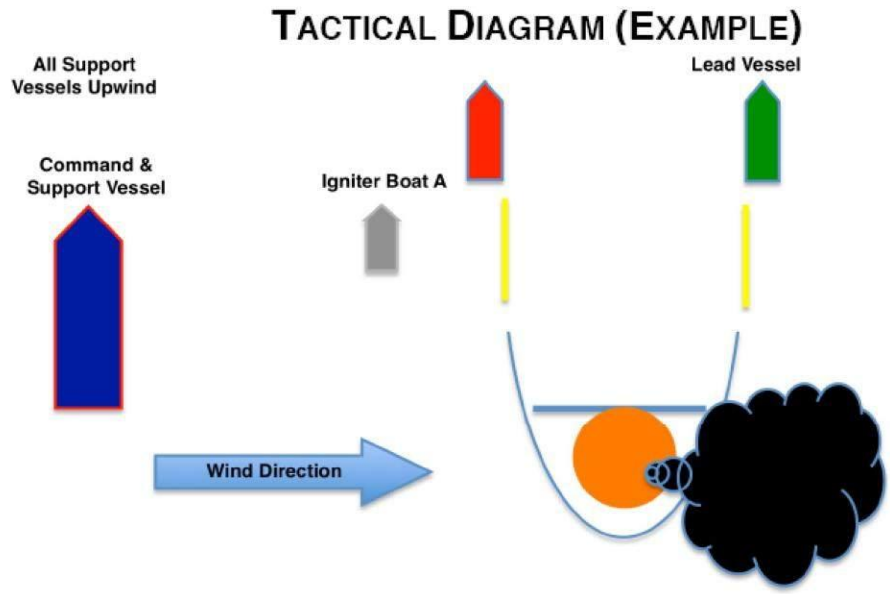




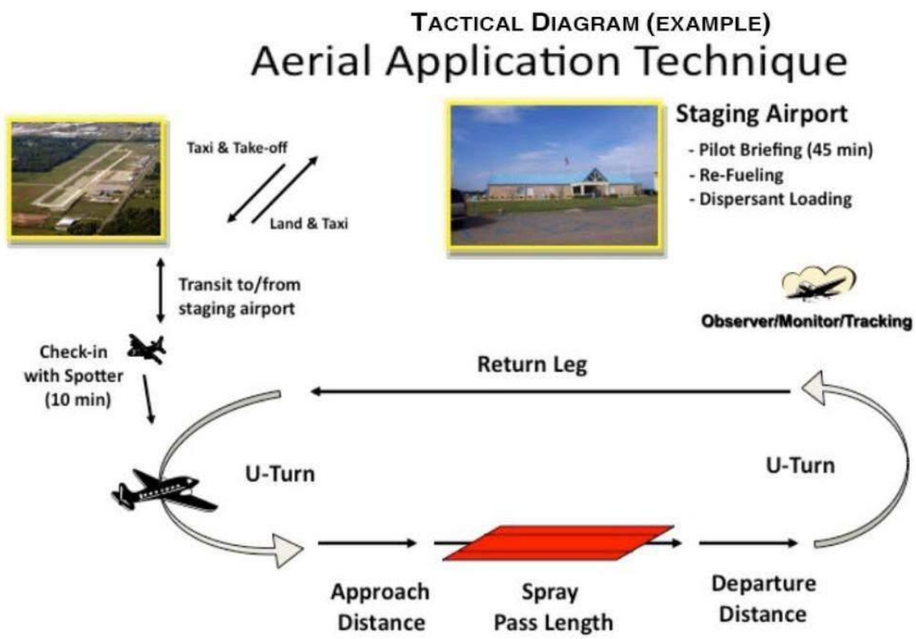
TACTIC DIAGRAM (EXAMPLE)
NOT TO SCALE



In-situ Burn (ISB)



Aerial Dispersant



Near Shore Response Actions

Timing

- Put near shore assets on standby and deployment in accordance with planning based on the actual situation, actual trajectories and oil budgets
- VOO identification and training in advance of spill nearing shoreline if possible
- Outfitting of VOOs for specific missions
- Deployment of assets based on actual movement of oil

Considerations

- Water depth, vessel draft
- Shoreline gradient
- State of the oil
- Use of VOOs
- Distance of surf zone from shoreline

Surveillance

- Provide trained observer to direct skimming operations
- Continual surveillance of oil movement by remote sensing systems, aerial photography and visual confirmation
- Continual monitoring of vessel assets

Dispersant Use

- Generally will not be approved within 3 miles of shore or with less than 10 meters of water depth
- Approval would be at Regional Response Team level (Region 6)

Dedicated Near Shore skimming systems

- FRVs
- Egmopol and Marco SWS
- Operate with aerial spotter directing systems to observed oil slicks

VOO

- Use Company Name's contracted resources as applicable
- Industry vessel are usually best for deployment of Vessel of Opportunity Skimming Systems (VOSS)
- Acquire additional resources as needed
- Consider use of local assets, i.e. fishing and pleasure craft
- Expect mission specific and safety training to be required
- Plan with the US Coast Guard for vessel inspections
- Operate with aerial spotter directing systems to oil patches

Shoreline Protection Operations

Response Planning Considerations

- Review appropriate Area Contingency Plan(s)
- Locate and review appropriate Geographic Response and Site Specific Plans
- Refer to appropriate Environmentally Sensitive Area Maps
- Capability for continual analysis of trajectories run periodically during the response
- Environmental risk assessments (ERA) to determine priorities for area protection
- Time to acquire personnel and equipment and their availability
- Refer to the State of Louisiana Initial Oil Spill Response Plan, Deep Water Horizon, dated 2 May 2010, as a secondary reference
- Aerial surveillance of oil movement
- Pre-impact beach cleaning and debris removal
- Shoreline Cleanup Assessment Team (SCAT) operations and reporting procedures
- Boom type, size and length requirements and availability
- Possibility of need for In-situ burning in near shore areas
- Current wildlife situation, especially status of migratory birds and endangered species in the area
- Check for Archeological sites and arrange assistance for the appropriate state agency when planning operations the may impact these areas

Placement of boom

- Position boom in accordance with the information gained from references listed above and based on the actual situation
- Determine areas of natural collection and develop booming strategies to move oil into those areas
- Assess timing of boom placement based on the most current trajectory analysis and the availability of each type of boom needed. Determine an overall booming priority and conduct booming operations accordingly. Consider:
    - Trajectories
    - Weather forecast
    - Oil Impact forecast
    - Verified spill movement
    - Boom, manpower and vessel (shallow draft) availability
    - Near shore boom and support material, (stakes, anchors, line)

Beach Preparation - Considerations and Actions

- Use of a 10 mile go/no go line to determine timing of beach cleaning
- SCAT reports and recommendations
- Determination of archeological sites and gaining authority to enter
- Monitoring of tide tables and weather to determine extent of high tides
- Pre cleaning of beaches by moving waste above high tide lines to minimize waste
- Determination of logistical requirements and arranging of waste removal and disposal

- Staging of equipment and housing of response personnel as close to the job site as possible to maximize on-site work time
- Boom tending, repair, replacement and security (use of local assets may be advantageous)
- Constant awareness of weather and oil movement for resource re-deployment as necessary
- Earthen berms and shoreline protection boom may be considered to protect sensitive inland areas
- Requisitioning of earth moving equipment
- Plan for efficient and safe use pf personnel, ensuring:
    - A continual supply of the proper Personal Protective Equipment
    - Heating or cooling areas when needed
    - Medical coverage
    - Command and control systems (i.e. communications)
    - Personnel accountability measures
- Remediation requirements, i.e., replacement of sands, rip rap, etc.
- Availability of surface washing agents and associated protocol requirements for their use (see National Contingency Plan Product Schedule for list of possible agents)
- Discussions with all stakeholders, i.e., land owners, refuge/park managers, and others as appropriate, covering the following:
    - Access to areas
    - Possible response measures and impact of property and ongoing operations
    - Determination of any specific safety concerns
    - Any special requirements or prohibitions
    - Area security requirements
    - Handling of waste
    - Remediation expectations
    - Vehicle traffic control
    - Domestic animal safety concerns
    - Wildlife or exotic game concerns/issues

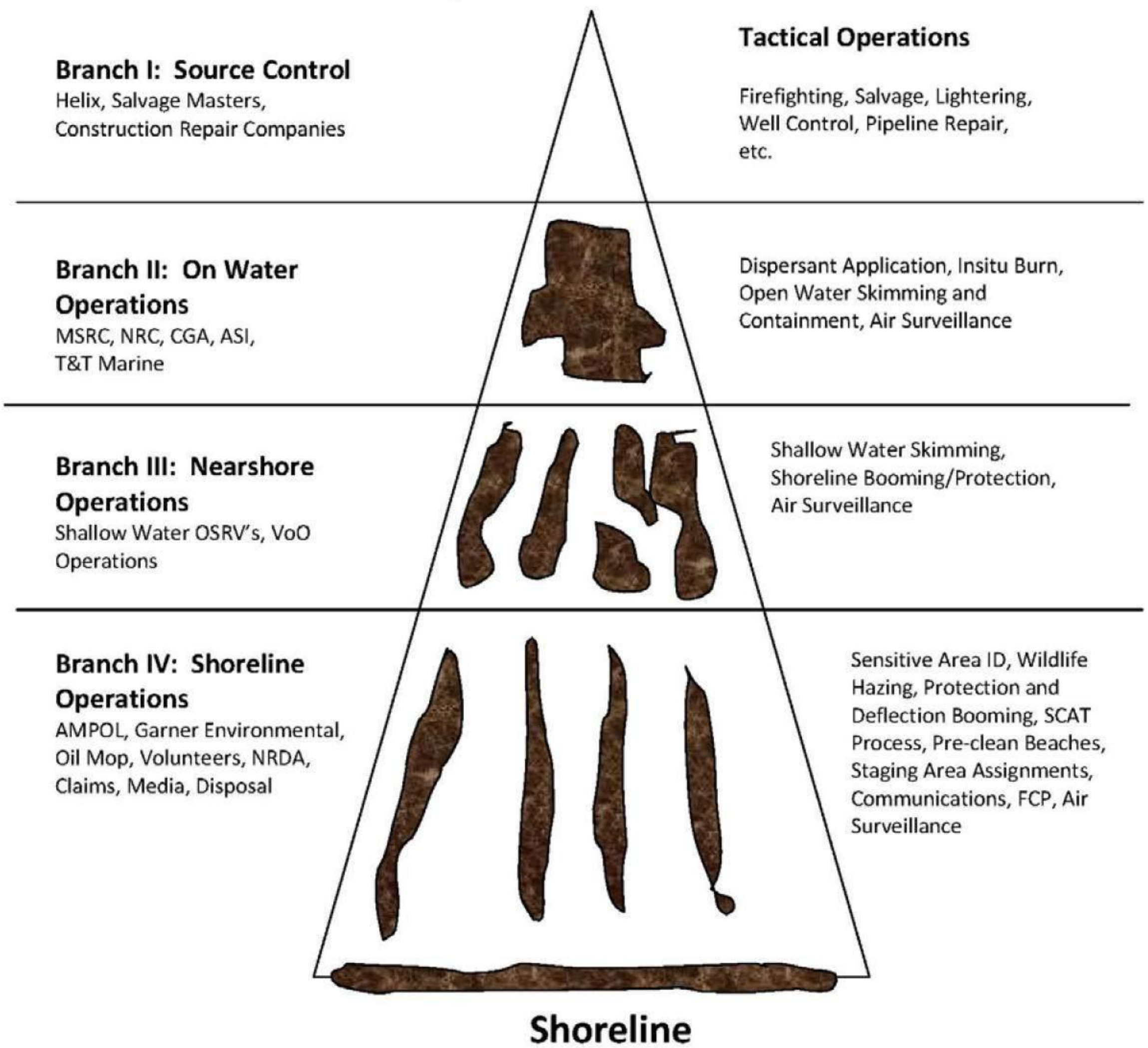
Inland and Coastal Marsh Protection and Response
Considerations and Actions

- All considered response methods will be weighed against the possible damage they may do to the marsh. Methods will be approved by the Unified Command only after discussions with local Stakeholder, as identified above.
    - In-situ burn may be considered when marshes have been impacted
- Passive clean up of marshes should considered and appropriate stocks of sorbent boom and/or sweep obtained.
- Response personnel must be briefed on methods to traverse the marsh, i.e.,
    - use of appropriate vessel
    - use of temporary walkways or road ways
- Discuss and gain approval prior cutting or moving vessels through vegetation
- Discuss use of vessels that may disturb wildlife, i.e, airboats
- Safe movement of vessels through narrow cuts and blind curves

- Consider the possibility that no response in a marsh may be best
- In the deployment of any response asset, actions will be taken to ensure the safest, most efficient operations possible. This includes, but is not limited to:
  - Placement of recovered oil or waste storage as near to vessels or beach cleanup crews as possible.
  - Planning for stockage of high use items for expeditious replacement
  - Housing of personnel as close to the work site as possible to minimize travel time
  - Use of shallow water craft
  - Use of communication systems appropriate ensure command and control of assets
  - Use of appropriate boom in areas that I can offer effective protection
  - Planning of waste collection and removal to maximize cleanup efficiency
- Consideration or on-site remediation of contaminated soils to minimize replacement operations and impact on the area

Branch I	**Source Control**
Branch II	**On Water Operation**
Div A	**Dispersants**
Div B	**Mechanical Recovery**
Div C	**Surveillance**
Branch III	**Nearshore Operations**
Branch IV	**Shoreline Operations**

Response Tactics



Decanting Strategy
Recovered oil and water mixtures will typically separate into distinct phases when left in a quiescent state. When separation occurs, the relatively clean water phase can be siphoned or decanted back to the recovery point with minimal, if any, impact. Decanting therefore increases the effective on-site oil storage capacity and equipment operating time. FOSC/SOSC approval will be requested prior to decanting operations. This practice is routinely used for oil spill recovery.

CGA Equipment Limitations
The capability for any spill response equipment, whether a dedicated or portable system, to operate in differing weather conditions will be directly in relation to the capabilities of the vessel the system in placed on. Most importantly, however, the decision to operate will be based on the judgment of the Unified Command and/or the Captain of the vessel, who will ultimately have the final say in terminating operations. Skimming equipment listed below may have operational limits which exceed those safety thresholds. As was seen in the Deepwater Horizon (DWH) oil spill response, vessel skimming operations ceased when seas reached 5-6 feet and vessels were often recalled to port when those conditions were exceeded. Systems below are some of the most up-to-date systems available and were employed during the DWH spill.

Boom	3 foot seas, 20 knot winds
Dispersants	Winds more than 25 knots Visibility less than 3 nautical miles Ceiling less than 1,000 feet.
FRU	8 foot seas
HOSS Barge/OSRB	8 foot seas
Koseq Arms	8 foot seas
OSRV	4 foot seas

Environmental Conditions in the GOM

Louisiana is situated between the easterly and westerly wind belts, and therefore, experiences westerly winds during the winter and easterly winds in the summer. Average wind speed is generally 14-15 mph along the coast. Wave heights average 4 and 5 feet. However, during hurricane season, Louisiana has recorded wave heights ranging from 40 to 50 feet high and winds reaching speeds of 100 mph. Because much of southern Louisiana lies below sea level, flooding is prominent.

Surface water temperature ranges between 70 and 80 $^\circ$F during the summer months. During the winter, the average temperature will range from 50 and 60 $^\circ$F.

The Atlantic and Gulf of Mexico hurricane season is officially from 1 June to 30 November. 97% of all tropical activity occurs within this window. The Atlantic basin shows a very peaked season from August through October, with 78% of the tropical storm days, 87% of the minor (Saffir-Simpson Scale categories 1 and 2) hurricane days, and 96% of the major (Saffir-Simpson categories 3, 4 and 5) hurricane days occurring then. Maximum activity is in early to mid September. Once in a few years there may be a hurricane occurring "out of season" - primarily in May or December. Globally, September is the most active month and May is the least active month.

FIGURE 1
TRAJECTORY BY LAND SEGMENT

Trajectory of a spill and the probability of it impacting a land segment have been projected utilizing Noble Energy, Inc.'s WCD and information in the BOEM Oil Spill Risk Analysis Model (OSRAM) for the Central and Western Gulf of Mexico available on the BOEM website using 30 day impact. The results are tabulated below.

Area/Block	OCS-G	Launch Area	Land Segment and/or Resource	Conditional Probability (%) within 30 days
GC 39, Well Location A *73 miles from shore*	G34966	C44	Matagorda, TX Galveston, TX Jefferson, TX **Cameron, LA** Vermilion, LA Terrebonne, LA Lafourche, LA Jefferson, LA Plaquemines, LA	1 2 1 **5** 2 2 1 1 4

WCD Scenario– BASED ON WELL BLOWOUT DURING DRILLING OPERATIONS (73 miles from shore)
194,200 bbls of crude oil (Volume considering natural weathering)
API Gravity 36°

FIGURE 2 – Equipment Response Time to GC 39, Well Location A

Dispersants/Surveillance

Dispersant/Surveillance	Dispersant Capacity (gal)	Storage Capacity	Persons Req.	From	Hrs to Procure	Hrs to Loadout	Travel to site	Total Hrs
ASI								
Basler 67T	2000	NA	2	Houma	2	2	0.6	3.6
DC 3	1200	NA	2	Houma	2	2	0.8	3.8
DC 3	1200	NA	2	Houma	2	2	0.8	3.8
Aero Commander	NA	NA	2	Houma	2	2	0.6	3.6
MSRC								
C-130 Spray AC	3,250	NA	2	Kiln	3	0	0.5	3.5
King Air BE90 Spray AC	250	NA	2	Kiln	3	0	0.8	3.8

Offshore Response

Offshore Equipment Pre-determined Staging	EDRC	Storage Capacity	VOO	Persons Required	From	Hrs to Procure	Hrs to Loadout	Hrs to GOM	Travel to Spill Site	Hrs to Deploy	Total Hrs
CGA											
HOSS Barge	76285	4000	3 Tugs	8	Harvey	7	0	5	10	1	23
95' FRV	22885	249	NA	4	Venice	2	0	2	4	0	8
95' FRV	22885	249	NA	4	Vermilion	2	0	2	6.5	0	10.5
95' FRV	22885	249	NA	4	Leeville	2	0	2	4	0	8
95' FRV	22885	249	NA	4	Galveston	2	0	2	16	0	20
Boom Barge (CGA-300) 42" Auto Boom (25000')	NA	NA	1 Tug 50 Crew	4 (Barge) 2 (Per Crew)	Leeville	4	0	6	12	1.5	23.5
Kirby Offshore (available through contract with CGA)											
RO Barge	NA	80000+	1 Tug	6	Venice	48	0	2	10	0	60
RO Barge	NA	80000+	1 Tug	6	Venice	48	0	2	10	0	60
RO Barge	NA	80000+	1 Tug	6	Venice	48	0	2	10	0	60
RO Barge	NA	100000+	1 Tug	6	Venice	48	0	2	10	0	60
RO Barge	NA	100000+	1 Tug	6	Venice	48	0	2	10	0	60
RO Barge	NA	100000+	1 Tug	6	Venice	48	0	2	10	0	60
RO Barge	NA	100000+	1 Tug	6	Venice	48	0	2	10	0	60
RO Barge	NA	130000+	1 Tug	6	Venice	48	0	2	10	0	60
RO Barge	NA	140000+	1 Tug	6	Venice	48	0	2	10	0	60
RO Barge	NA	150000+	1 Tug	6	Venice	48	0	2	10	0	60

Offshore Equipment Pre-determined Staging	EDRC	Storage Capacity	VOO	Persons Required	From	Hrs to Procure	Hrs to Loadout	Hrs to GOM	Travel to Spill Site	Hrs to Deploy	Total Hrs
MSRC											
Louisiana Responder Transrec 350 + OSRV *2,640' 67" Curtain Pressure Boom*	10567	4000	NA	19	Fort Jackson, LA	2	0	4.5	13	1	20.5
MSRC 452 Offshore Barge 1 Crucial Disk 88/30 1 Desmi Ocean *2,640' 67" Curtain Pressure Boom*	11122 3017	45000	3 Tugs	9	Fort Jackson, LA	2.5	0	6	23	1	32.5
Mississippi Responder Transrec 350 + OSRV *2,640' 67" Curtain Pressure Boom*	10567	4000	NA	19	Pascagoula, MS	2	0	2	17	1	22
MSRC 402 Offshore Barge 2 Crucial Disk 88/30 *2,640' 67" Curtain Pressure Boom*	22244	40300	3 Tugs	9	Pascagoula, MS	2.5	0	3	28.5	1	35
Deep Blue Responder LFF 100 Brush + OSRV *2,640' 67" Curtain Pressure Boom*	18086	4000	NA	19	Fourchon, LA	2	0	1	7	1	11
Gulf Coast Responder Transrec 350 + OSRV *2,640' 67" Curtain Pressure Boom*	10567	4000	NA	19	Lake Charles, LA	2	0	4	20	1	27
Texas Responder Transrec 350 + OSRV *2,640' 67" Curtain Pressure Boom*	10567	4000	NA	19	Galveston, TX	2	0	1	26	1	30
MSRC 570 Offshore Barge 2 Crucial Disk 88/30 *2,640' 67" Curtain Pressure Boom*	22244	56900	3 Tugs	9	Galveston, TX	2.5	0	2	44	1	49.5
Southern Responder Transrec 350 + OSRV *2,640' 67" Curtain Pressure Boom*	10567	4000	NA	19	Ingleside, TX	2	0	1	37	1	41
MSRC 403 Offshore Barge 1 Crucial Disk 88/30 *2,640' 67" Curtain Pressure Boom*	11122	40300	3 Tugs	9	Ingleside, TX	2.5	0	2	63	1	68.5

Staging Area: Venice

Offshore Equipment Preferred Staging	EDRC	Storage Capacity	VOO	Persons Req.	From	Hrs to Procure	Hrs to Loadout	Travel to Staging	Travel to Site	Hrs to Deploy	Total Hrs
T&T Marine (Available through contract with CGA)											
Aqua Guard Triton RBS (1)	22323	2000	1 Utility	6	Galveston	4	12	13	7	2	38
Aqua Guard Triton RBS (1)	22323	2000	1 Utility	6	Harvey	4	12	2	7	2	27
Koseq Skimming Arms (10) Lamor brush	228850	10000	5 Utility	30	Galveston	24	24	13	7	2	70
Koseq Skimming Arms (6) MariFlex 150 HF	108978	6000	3 Utility	18	Galveston	24	24	13	7	2	70
Koseq Skimming Arms (2) Lamor brush	45770	2000	1 Utility	6	Harvey	24	24	2	7	2	59
Koseq Skimming Arms (4) MariFlex 150 HF	72652	4000	2 Utility	12	Harvey	24	24	2	7	2	59
CGA											
Hydro-Fire Boom	NA	NA	8 Utility	40	Harvey, LA	2	4	2	7	6	21
FRU (1) + 100 bbl Tank (2)	4251	200	1 Utility	6	Morgan City	2	2	4.5	7	1	16.5
FRU (1) + 100 bbl Tank (2)	4251	200	1 Utility	6	Vermilion	2	2	7	7	1	19
FRU (1) + 100 bbl Tank (2)	4251	200	1 Utility	6	Galveston	2	2	13	7	1	25
FRU (1) + 100 bbl Tank (2)	4251	200	1 Utility	6	Aransas Pass	2	2	18	7	1	30
FRU (1) + 100 bbl Tank (2)	4251	200	1 Utility	6	Lake Charles	2	2	8	7	1	20
FRU (2) + 100 bbl Tank (4)	8502	400	2 Utility	12	Leeville	2	2	4.5	7	1	16.5
FRU (2) + 100 bbl Tank (4)	8502	400	2 Utility	12	Venice	2	2	0	7	1	12

Staging Area: Venice

Offshore Equipment Preferred Staging	EDRC	Storage Capacity	VOO	Persons Req.	From	Hrs to Procure	Hrs to Loadout	Travel to Staging	Travel to Site	Hrs to Deploy	Total Hrs
MSRC											
Stress I Skimmer (1)	15840	400	1 Utility	6	Ingleside	1	2	18	7	1	29
GT-185 Skimmer w Adaptor (1)	1371	400	1 Utility	6	Ingleside	1	2	18	7	1	29
Foilex 250 Skimmer (1)	3977	400	1 Utility	6	Ingleside	1	2	18	7	1	29
Crucial Disk 56/30 Skimmer (1)	5671	400	1 Utility	6	Ingleside	1	2	18	7	1	29
GT-185 Skimmer w Adaptor (2)	2742	400	2 Utility	12	Galveston	1	2	13	7	1	24
Walosep 4 Skimmer (1)	3017	400	1 Utility	6	Galveston	1	2	13	7	1	24
Foilex 250 Skimmer (1)	3977	400	1 Utility	6	Galveston	1	2	13	7	1	24
Stress I Skimmer (1)	15840	400	1 Utility	6	Galveston	1	2	13	7	1	24
GT-185 Skimmer w Adaptor (1)	1371	400	1 Utility	6	Port Arthur	1	2	10	7	1	21
Desmi Skimmer (1)	3017	400	1 Utility	6	Lake Charles	1	2	8	7	1	19
Foilex 250 Skimmer (1)	3977	400	1 Utility	6	Lake Charles	1	2	8	7	1	19
Stress I Skimmer (2)	31680	800	2 Utility	12	Lake Charles	1	2	8	7	1	19
GT-185 Skimmer w Adaptor (1)	1371	400	1 Utility	6	Lake Charles	1	2	8	7	1	19
LFF 100 Brush Skimmer (1) *1,320' 67" Curtain Pressure Boom*	18086	400	1 PSV	14	Lake Charles	1	2	8	7	1	19
LFF 100 Brush Skimmer (1) *1,320' 67" Curtain Pressure Boom*	18086	400	1 PSV	14	Lake Charles	1	2	8	7	1	19
Transrec 350 Skimmer (1) *1,320' 67" Curtain Pressure Boom*	10567	400	1 PSV	14	Lake Charles	1	2	8	7	1	19

Staging Area: Venice

Offshore Equipment Preferred Staging	EDRC	Storage Capacity	VOO	Persons Req.	From	Hrs to Procure	Hrs to Loadout	Travel to Staging	Travel to Site	Hrs to Deploy	Total Hrs
MSRC											
GT-185 Skimmer w Adaptor (1)	1371	400	1 Utility	6	Baton Rouge	1	2	4.5	7	1	15.5
Transrec 350 Skimmer (1) *1,320' 67" Curtain Pressure Boom*	10567	400	1 PSV	14	Houma	1	2	3.5	7	1	14.5
Stress I Skimmer (1)	15840	400	1 Utility	6	Port Fourchon	1	2	5	7	1	16
LFF 100 Brush Skimmer (1) *1,320' 67" Curtain Pressure Boom*	18086	400	1 PSV	14	Port Fourchon	1	2	5	7	1	16
LFF 100 Brush Skimmer (1) *1,320' 67" Curtain Pressure Boom*	18086	400	1 PSV	14	Port Fourchon	1	2	5	7	1	16
GT-185 Skimmer w Adaptor (1)	1371	400	1 Utility	6	Belle Chasse	1	2	2	7	1	13
Walosep W4 Skimmer (1)	3017	400	1 Utility	6	Belle Chasse	1	2	2	7	1	13
Foilex 250 Skimmer (1)	3977	400	1 Utility	6	Belle Chasse	1	2	2	7	1	13
Stress I Skimmer (1)	15840	400	1 Utility	6	Belle Chasse	1	2	2	7	1	13
Foilex 200 Skimmer (1)	1989	400	1 Utility	6	Belle Chasse	1	2	2	7	1	13
Crucial Disk 56/30 Skimmer (1)	5671	400	1 Utility	6	Belle Chasse	1	2	2	7	1	13
Crucial Disk 88/30 Skimmer (1) *1,320' 67" Curtain Pressure Boom*	11122	400	1 PSV	14	Fort Jackson	1	2	0.5	7	1	11.5
Crucial Disk 88/30 Skimmer (1) *1,320' 67" Curtain Pressure Boom*	11122	400	1 PSV	14	Fort Jackson	1	2	0.5	7	1	11.5
Stress I Skimmer (1)	15840	400	1 Utility	6	Pascagoula	1	2	5.5	7	1	16.6
GT-185 Skimmer (1)	1371	400	1 Utility	6	Pascagoula	1	2	5.5	7	1	16.5
Stress II Skimmer (1)	3017	400	1 Utility	6	Pascagoula	1	2	5.5	7	1	16.5
Stress I Skimmer (1)	15840	400	1 Utility	6	Tampa	1	2	21	7	1	32
GT-185 Skimmer w Adaptor (1)	1371	400	1 Utility	6	Tampa	1	2	21	7	1	32
Crucial Disk 56/30 Skimmer (1)	5671	400	1 Utility	6	Tampa	1	2	21	7	1	32
GT-185 Skimmer w Adaptor (1)	1371	400	1 Utility	6	Miami	1	2	27	7	1	38
Stress I Skimmer (1)	15840	400	1 Utility	6	Miami	1	2	27	7	1	38
Walosep W4 Skimmer (1)	3017	400	1 Utility	6	Miami	1	2	27	7	1	38
Desmi Skimmer (1)	3017	400	1 Utility	6	Miami	1	2	27	7	1	38

Nearshore Response

Nearshore Equipment Pre-determined Staging	EDRC	Storage Capacity	VOO	Persons Required	From	Hrs to Procure	Hrs to Loadout	Hrs to GOM	Travel to Spill Site	Hrs to Deploy	Total Hrs
CGA											
Trinity SWS	21500	249	NA	4	Morgan City	2	6	N/A	48	0	56
Trinity SWS	21500	249	NA	4	Lake Charles	2	6	N/A	48	0	56
Trinity SWS	21500	249	NA	4	Vermilion	2	6	N/A	48	0	56
Trinity SWS	21500	249	NA	4	Galveston	2	6	N/A	48	0	56
46' FRV	15257	65	NA	4	Aransas Pass	2	0	3	12	0	17
46' FRV	15257	65	NA	4	Morgan City	2	0	3	6	0	11
46' FRV	15257	65	NA	4	Lake Charles	2	0	3	2.5	0	7.5
46' FRV	15257	65	NA	4	Venice	2	0	3	12	0	17
MSRC											
30 ft. Kvichak	3588	24	NA	6	Ingleside	1	1	2	13	0	17
30 ft. Kvichak	3588	24	NA	6	Galveston	1	1	2	6	0	10
MSRC Quick Strike	5000	50	NA	6	Lake Charles	1	1	2	3	0	7
30 ft. Kvichak	3588	24	NA	6	Belle Chasse	1	1	2	11	0	15
30 ft. Kvichak	3588	24	NA	6	Pascagoula	1	1	2	18	0	22
Kirby Offshore (Available through contract with CGA)											
RO Barge	NA	80000+	1 Tug	6	Amelia	42	0	2	16	0	60
Enterprise Marine Services LLC (Available through contract with CGA)											
CTCo 2603	NA	25000	1 Tug	6	Amelia	27	12	4	16	1	60
CTCo 2604	NA	20000	1 Tug	6	Amelia	27	12	4	16	1	60
CTCo 2605	NA	20000	1 Tug	6	Amelia	27	12	4	16	1	60
CTCo 2606	NA	20000	1 Tug	6	Amelia	27	12	4	16	1	60
CTCo 2607	NA	23000	1 Tug	6	Amelia	27	12	4	16	1	60
CTCo 2608	NA	23000	1 Tug	6	Amelia	27	12	4	16	1	60
CTCo 2609	NA	23000	1 Tug	6	Amelia	27	12	4	16	1	60
CTCo 5001	NA	47000	1 Tug	6	Amelia	27	12	4	16	1	60

Staging Area: Cameron

Nearshore Equipment With Staging	EDRC	Storage Capacity	VOO	Persons Req.	From	Hrs to Procure	Hrs to Load Out	Travel to Staging	Travel to Deployment	Hrs to Deploy	Total Hrs
					CGA						
SWS Egmopol	1810	100	NA	3	Galveston	2	2	5	2	0	11
SWS Egmopol	1810	100	NA	3	Morgan City	2	2	4.5	2	0	10.5
SWS Marco	3588	20	NA	3	Lake Charles	2	2	1.5	2	0	7.5
SWS Marco	3588	34	NA	3	Leeville	2	2	7	2	0	13
SWS Marco	3588	34	NA	3	Venice	2	2	9.5	2	0	15.5
Rope Mop	77	2	0	3	Harvey	2	2	7	2	0	13
Foilex Skim Package (TDS 150)	1131	50	NA	3	Lake Charles	2	2	1.5	2	0	7.5
Foilex Skim Package (TDS 150)	1131	50	NA	3	Galveston	2	2	5	2	0	11
Foilex Skim Package (TDS 150)	1131	50	NA	3	Harvey	2	2	7	2	0	13
4 Drum Skimmer (Magnum	680	100	1 Crew	3	Lake Charles	2	2	1.5	2	0	7.5
4 Drum Skimmer (Magnum	680	100	1 Crew	3	Harvey	2	2	7	2	0	13
2 Drum Skimmer (TDS 118)	240	100	1 Crew	3	Lake Charles	2	2	1.5	2	0	7.5
2 Drum Skimmer (TDS 118)	240	100	1 Crew	3	Harvey	2	2	7	2	0	13
					MSRC						
WP 1 Skimmer (1)	3017	400	1 Utility	4	Ingleside	1	1	9.5	2	0	13.5
Queensboro Skimmer (1)	905	400	1 Utility	4	Galveston	1	1	5	2	0	9
Queensboro Skimmer (5)	4525	2000	5 Utility	20	Lake Charles	1	1	1	2	0	5
AardVac Skimmer (1)	3840	400	1 Utility	4	Lake Charles	1	1	1	2	0	5
Queensboro Skimmer (1)	905	400	1 Utility	4	Belle Chasse	1	1	7	2	0	11
AardVac Skimmer (1)	3840	400	1 Utility	4	Pascagoula	1	1	9.5	2	0	13.5
WP 1 Skimmer (1)	3017	400	1 Utility	4	Pascagoula	1	1	9.5	2	0	13.5
Queensboro Skimmer (1)	905	400	1 Utility	4	Pascagoula	1	1	9.5	2	0	13.5
WP 1 Skimmer (1)	3017	400	1 Utility	4	Tampa	1	1	25	2	0	29
AardVac Skimmer (2)	7680	800	2 Utility	8	Miami	1	1	31	2	0	35
WP 1 Skimmer (1)	3017	400	1 Utility	4	Miami	1	1	31	2	0	35

Staging Area: Cameron

Shoreline Protection Boom	VOO	Persons Req.	Storage/Warehouse Location	Hrs to Procure	Hrs to Loadout	Travel to Staging	Travel to Deployment Site	Hrs to Deploy	Total Hrs
OMI Environmental (available through MSA)									
12,500’ 18” Boom	6 Crew	12	New Iberia, LA	1	1	4	2	3	11
6,400’ 18” Boom	3 Crew	6	Houston, TX	1	1	4	2	3	11
3,500’ 18” Boom	2 Crew	4	Port Arthur, TX	1	1	2	2	3	9
8,000’ 18” Boom	3 Crew	6	Port Allen, LA	1	1	5	2	3	12
1,000’ 18” Boom	1 Crew	2	Hackberry, LA	1	1	1	2	3	8

Wildlife Response	EDRC	Storage Capacity	VOO	Persons Req.	From	Hrs to Procure	Hrs to Loadout	Travel to Staging	Travel to Deployment	Hrs to Deploy	Total Hrs
CGA											
Wildlife Support Trailer	NA	NA	NA	2	Harvey	2	2	7	1	2	14
Bird Scare Guns (24)	NA	NA	NA	2	Harvey	2	2	7	1	2	14
Bird Scare Guns (12)	NA	NA	NA	2	Galveston	2	2	5	1	2	12
Bird Scare Guns (12)	NA	NA	NA	2	Aransas Pass	2	2	9.5	1	2	16.5
Bird Scare Guns (48)	NA	NA	NA	2	Lake Charles	2	2	1.5	1	2	8.5
Bird Scare Guns (24)	NA	NA	NA	2	Leeville	2	2	7	1	2	14

Response Asset	Total
Offshore EDRC (bbls)	1,172,654
Offshore Recovered Oil Storage (bbls)	1,315,296+
Nearshore / Shallow Water EDRC (bbls)	220,742
Nearshore / Shallow Water Recovered Oil Storage (bbls)	289,642+

Section I

Environmental Monitoring and Mitigation Information

A. Monitoring Systems

Noble subscribes to the Storm-Geo Weather Service which provides access to real-time weather conditions, and provides periodic updates on impending severe or tropical weather conditions. During impending severe weather conditions, Noble closely coordinates the activity with our field personnel to ensure they remain safe during the event. The information provided is used to coordinate response actions to ensure protection of the people, environment, facility and equipment.

B. Incidental Takes

Noble does not anticipate the incidental taking of any species as a result of the activities proposed in this Supplemental Exploration Plan. Noble will comply with BOEM NTL No. 2016-G01 "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting" and BSEE NTL No. 2015-G03 "Marine Trash and Debris Awareness and Elimination".

C. Flower Garden Banks National Marine Sanctuary

Green Canyon 40 is not located in the Flower Garden Banks National Marine Sanctuary; therefore, the requested information is not required in this EP.

Section J
Lease Stipulations Information

Exploration activities are subject to the following stipulations attached to Lease OCS-G 34536, Green Canyon 40.

Marine Protected Species

Lease Stipulation No. 8 is meant to reduce the potential taking of marine protected species. Noble will operate in accordance with BOEM NTL No. 2016-G01 "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting" and BSEE NTL No. 2015-G03 "Marine Trash and Debris Awareness and Elimination".

Section K
Support Vessels and Aircraft Information

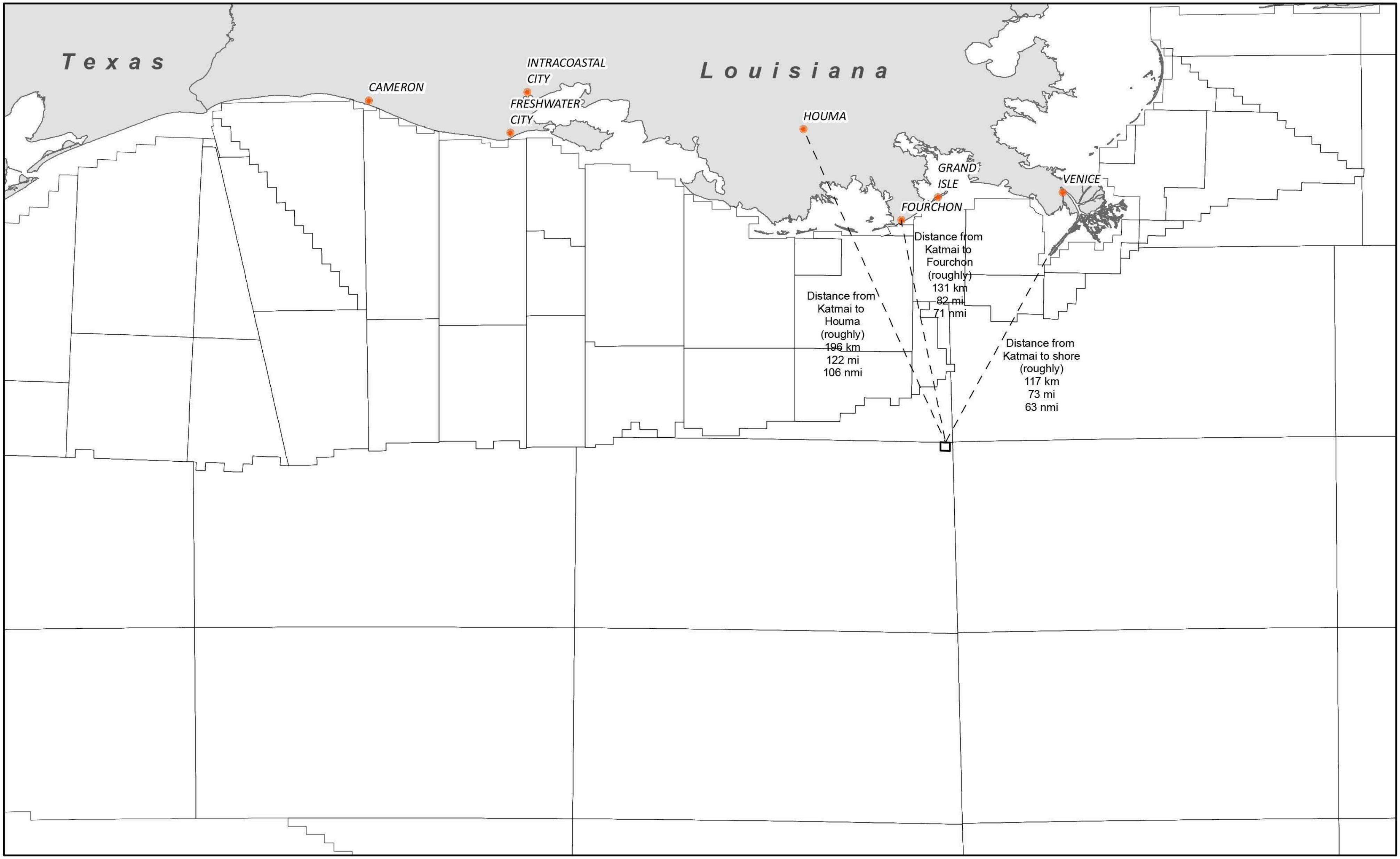
A. General
The most practical, direct route from the shorebase as permitted by weather and traffic conditions will be utilized.

Type	Maximum Fuel Tank Capacity	Maximum Number in Area at Any Time	Trip Frequency or Duration
Work Boat	256,311 gals	2	4 trips per week
Supply Boat	23,650 gals	1	4 trips per week
Helicopter S-92	764 gals	1	6 trips per week

B. Diesel Oil Supply Vessels
The proposed activities in this Exploration Plan, do not meet the criteria for this section.

C. Solid and Liquid Wastes Transportation
See section F, Waste and Discharge Information and Section L, Onshore Support Facilities Information, Waste Disposal.

D. Vicinity Map
Enclosed as **Attachment K-1** is a vicinity map showing the location of the activities proposed herein relative to the shoreline with the distance of the proposed activities from the shoreline and the primary route(s) of the support vessels and aircraft that will be used when traveling between the onshore support facilities and the drilling unit.



C.I:	Page 1 of 1	Not to Scale	Green Canyon 40 Louisiana	noble energy
Geol/Geop: Staff			Katmai East Prospect Vicinity Plat	
Date: 27 Sep 2017				
File Name: Katmai_East_Plats_Vicinity		Attachment K-1		
Projection: GCS North American 1927 / Units: Degree				

Public Information

Section L

Onshore Support Facilities Information

A. General

Provide a listing in the table below of the onshore facilities that will be used to provide supply and service support for the proposed activities:

Name of Shorebase	Location	Existing/New/Modified
C Port 1 Slip 4	Port Fourchon, LA	Existing
PHI	Houma, LA	Existing

B. Support Base Construction or Expansion

There will be no new construction of an onshore support base, nor will we expand the existing shorebase as a result of the operations proposed in this Exploration Plan.

C. Waste and Surplus Estimated to be Transported and/or Disposed of Onshore

Provide information in the table below on the onshore facilities you will use to store and dispose of any solid and liquid wastes generated by the proposed activities.

Type of Waste	Composition	Solid and Liquid Wastes Transport Method	Name/Location of Facility	Amount	Disposal Method
Will drilling occur? If yes, fill in the muds and cuttings.					
EXAMPLE: Synthetic-based drilling fluid or mud	*internal olefin, ester*	*Below deck storage tanks on offshore support vessels*	*Newport Environmental Services Inc., Ingleside, TX*	*X bbl/well*	*Recycled*
Oil-based drilling fluid or mud	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Synthetic-based drilling fluid or mud	**Internal Olefin**	**25 bbl transport**	**US Fluids Port Fourchon**	**667 bbls**	**Injection**
Synthetic-based drilling fluid or mud	**Internal Olefin**	**Boat tank**	**Baroid Port Fourchon, LA**	**12,131 bbls**	**Reclamation**
Cuttings wetted with Water-based fluid	**Cuttings generated while using water based drilling fluid.**	**Seafloor**	**N/A**	**N/A**	**N/A**
Cuttings wetted with Synthetic-based fluid	**Interfaces, cement contamination**	**Cutting boxes**	**Newpark Environmental Fourchon, LA**	**450 bbls**	**Injection**
Cuttings wetted with oil-based fluids	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Will you produce hydrocarbons? If yes fill in for produced sand.					
Produced sand	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Will you have additional wastes that are not permitted for discharge? If yes, fill in the appropriate rows.				**Lbs/ month**	
Recyclables	**Plastic, paper, aluminum**	**Approved Compactor Bags**	**Progressive Waste Houma, LA**	**127 lbs/day**	**Recycled**
Trash and debris	**Household Debris**	**Approved Compactor Bags**	**Progressive Waste Houma, LA**	**30 cuft/day**	**Landfill/Disposal**
Used oil	**40 wt, 90 wt & hyd**	**DOT approved tote tank**	**American Recovery Houma, LA**	**189 gal/day**	**Recycled**
Scrap Irons	**Iron, Copper, Brass & Stainless**	**4' x 8' Solid Bin Basket**	**C Port Chouest Offshore Fourchon, LA**	**16,000 lbs/mth**	**Recycled**
Chemical product wastes	**Paint, Oily Rags, Gloves & Tyvek Suits**	**DOT approved drum**	**American Recovery Houma, LA**	**20,000 lbs**	**Processed, Recycled/Disposed**
Spent, dirty completion fluid	**Calcium Bromide**	**Offshore Support Vessels**	**Newpark Environmental Fourchon, LA**	**1000 bbls**	**Injection**
Completion fluid filtration media & wash water	**Diatomaceous Earth and Water**	**25-bbl Cuttings Boxes**	**Newpark Environmental Fourchon, LA**	**800 bbls**	**Injection**
Well completion fluids	**16.0 lb/gal Zinc Bromide**	**Offshore Support Vessels**	**Newpark Environmental Fourchon, LA**	**7,500 bbls**	**Reclamation**

Section M

Coastal Zone Management Act (CZMA) Information

Relevant enforceable policies were considered in certifying consistency for Louisiana. A certificate of Coastal Zone Management Consistency for the state of Louisiana is enclosed as **Attachment M-1**.

COASTAL ZONE MANAGEMENT

CONSISTENCY CERTIFICATION

SUPPLEMENTAL EXPLORATION PLAN

GREEN CANYON 40

OCS-G 34536

The proposed activities described in detail in this OCS Plan comply with Louisiana's approved Coastal Management Program and will be conducted in a manner consistent with such Program.

Noble Energy, Inc.
Lessee or Operator

T. Hodge Walker, Vice President
Certifying Official

September 29, 2017
Date

Evaluation of Consistency with the Enforceable Policies of the Louisiana Coastal Resource Program

1 Background

Noble Energy, Inc. (Noble Energy) is submitting a Supplemental Exploration Plan (EP) for Green Canyon Block 40 (GC 40), Gulf of Mexico, OCS-G 34536. Under this EP, Noble Energy proposes to drill three wells and complete four wells (GC 40 F, GC 40 I, GC 40 J & GC 40 #1). It is estimated the project will commence in 2018 and be completed in 2024.

This document evaluates Noble Energy's proposed activities for any reasonably foreseeable coastal effects on the land, water uses, or natural resources of the coastal zone of Louisiana, and evaluates the consistency of Noble Energy's EP with the enforceable policies of the Louisiana Coastal Resource Program (LCRP). The analysis, compliant with the Coastal Zone Management Act (CZMA), is submitted pursuant to 15 Code of Federal Regulations (CFR) 930.76 and is supported by documentation provided in the Environmental Impact Analysis (EIA). The EIA provides an environmental impacts analysis for the development activities based on the location in GC 40 and is included in EP Section N. The EIA was prepared in accordance with applicable regulations, including 30 CFR 550.242(s) and 550.261 as well as Notice to Lessees and Operators (NTL) 2008-G04, extended by NTL 2015-N02.

The proposed activities will be conducted in accordance with Bureau of Ocean Energy Management (BOEM), Bureau of Safety and Environmental Enforcement, and U.S. Environmental Protection Agency regulations, applicable NTLs, conditions in the approved permits, and lease stipulations. All required federal permits will be obtained, and all activities will be conducted in compliance with such regulations, NTLs, conditions, and stipulations.

The proposed activities will occur in Federal Outer Continental Shelf (OCS) waters, approximately 75 statute miles (121 km) from the nearest Louisiana shoreline (**Figure 1**). A dynamically positioned (DP) semisubmersible drilling rig or a DP drillship is anticipated to be on site for approximately 220 days per well, inclusive of drilling and completion.

All land-based support activities, including transport to and from the site, will occur in Louisiana (Port Fourchon for vessels and Houma for helicopters). No new expansion of facilities or personnel for shorebases is anticipated to result from this exploration project. No significant impacts on the State of Louisiana are expected from routine activities as described in Noble Energy's EP.

Noble Energy has a system in place to prevent blowouts. Noble Energy's response to NTL 2015-N01 is provided in EP Sections B and H, which include descriptions of measures to prevent a blowout, reduce the likelihood of a blowout, and conduct effective and early intervention in the event of a blowout. If a blowout were to occur, Noble Energy will implement the plans and procedures of its Regional Oil Spill Response Plan (OSRP), which describes specific response actions for potential spill events and addresses plans and procedures for containment, recovery, and removal of an oil spill. As discussed in Section A.9.2 of the EIA (Large Oil Spill [Worst Case Discharge]), the trajectory of a hypothetical spill in GC 40, projected using information in the 60-day Oil Spill Risk Analysis (OSRA) model for the Gulf of Mexico (see BOEM, 2017), indicates there is up to a 52% conditional probability of a spill contacting any Louisiana shoreline within 60 days of a spill.

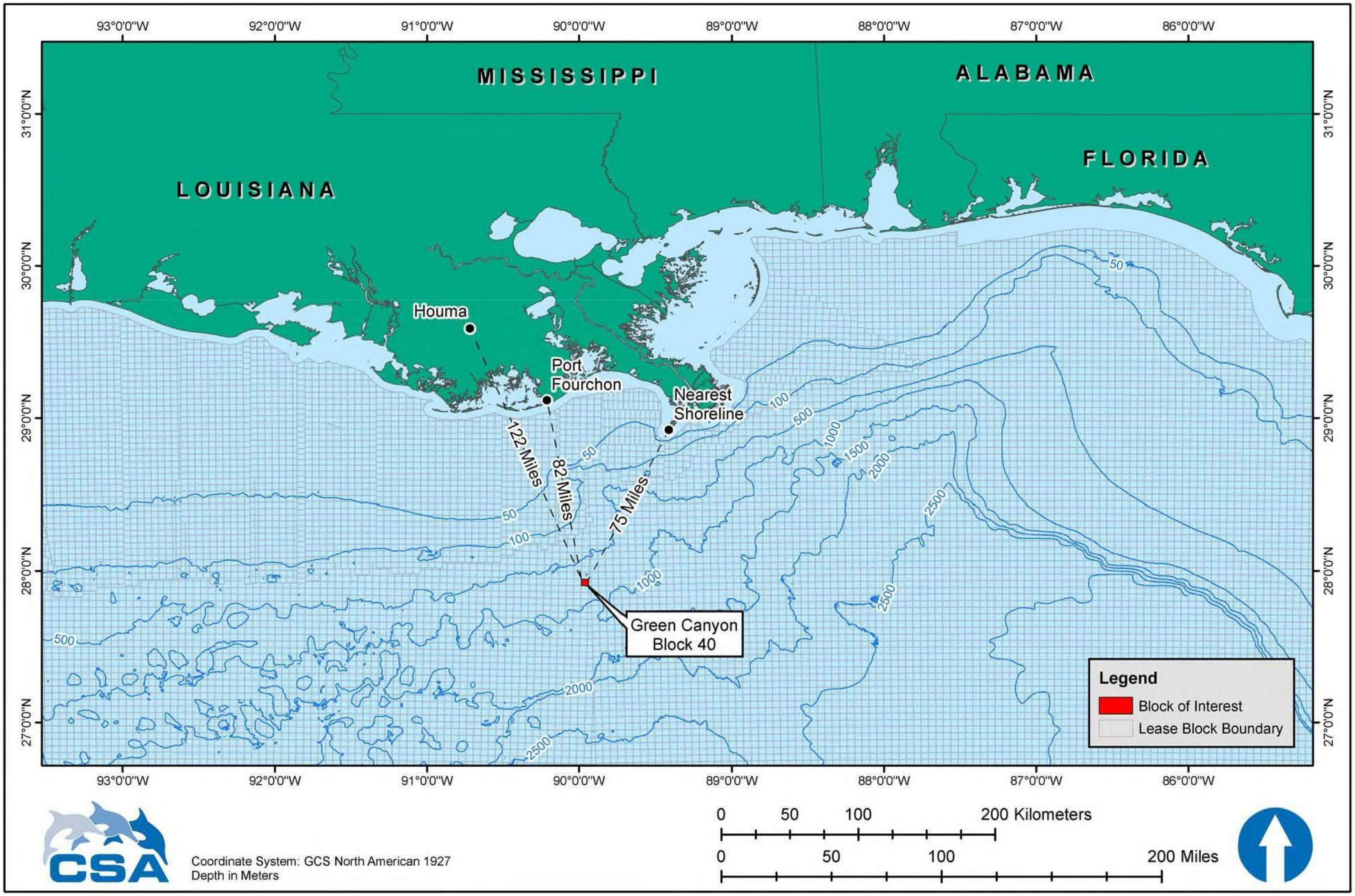


Figure 1. Location of Green Canyon Block 40.

2 Louisiana Coastal Resource Program Guidelines

Pursuant to the Louisiana State and Local Resources Management Act of 1978 and as amended (Act 361, La. R.S. 49:214.21 et seq.), the Office of Coastal Management of the Louisiana Department of Natural Resources has created guidelines to implement the LCRP (LAC 43:I.Chapter 7). The guidelines are organized as a set of performance standards that are used to evaluate the impacts of a proposed action on coastal resources. All guidelines applicable to Noble Energy's project in GC 40 are summarized below.

§701. Guidelines Applicable to All Uses

A. *The guidelines must be read in their entirety. Any proposed use may be subject to the requirements of more than one guideline or section of guidelines and all applicable guidelines must be complied with.*

The guidelines have been read in their entirety in preparation of this consistency analysis for the GC 40 project, and all applicable guidelines will be complied with.

B. *Conformance with applicable water and air quality laws, standards and regulations, and with those other laws, standards and regulations which have been incorporated into the coastal resources program shall be deemed in conformance with the program except to the extent that these guidelines would impose additional requirements.*

Addressed in EP Sections F and G.

C. *The guidelines include both general provisions applicable to all uses and specific provisions applicable only to certain types of uses. The general guidelines apply in all situations. The specific guidelines apply only to the situations they address. Specific and general guidelines should be interpreted to be consistent with each other. In the event there is an inconsistency, the specific should prevail.*

The guidelines have been read in their entirety, and all applicable guidelines are summarized and addressed herein.

F. *Information regarding the following general factors shall be utilized by the permitting authority in evaluating whether the proposed use is in compliance with the guidelines:*

1. *type, nature, and location of use;*
2. *elevation, soil, and water conditions and flood and storm hazard characteristics of site;*
3. *techniques and materials used in construction, operation, and maintenance of use;*
4. *existing drainage patterns and water regimes of surrounding area including flow, circulation, quality, quantity, and salinity; and impacts on them;*
5. *availability of feasible alternative sites or methods of implementing the use;*
6. *designation of the area for certain uses as part of a local program;*
7. *economic need for use and extent of impacts of use on economy of locality;*
8. *extent of resulting public and private benefits;*
9. *extent of coastal water dependency of the use;*
10. *existence of necessary infrastructure to support the use and public costs resulting from use;*

11. *extent of impacts on existing and traditional uses of the area and on future uses for which the area is suited;*
12. *proximity to and extent of impacts on important natural features such as beaches, barrier islands, tidal passes, wildlife and aquatic habitats, and forest lands;*
13. *the extent to which regional, state, and national interests are served including the national interest in resources and the siting of facilities in the coastal zone as identified in the coastal resources program;*
14. *proximity to, and extent of impacts on, special areas, particular areas, or other areas of particular concern of the state program or local programs;*
15. *likelihood of; and extent of impacts of; resulting secondary impacts and cumulative impacts;*
16. *proximity to and extent of impacts on public lands or works, or historic, recreational, or cultural resources;*
17. *extent of impacts on navigation, fishing, public access, and recreational opportunities;*
18. *extent of compatibility with natural and cultural setting; and*
19. *extent of long term benefits or adverse impacts.*

    Addressed in EP Sections A, B, E, I, and N.

G. *It is the policy of the coastal resources program to avoid the following adverse impacts. To this end, all uses and activities shall be planned, sited, designed, constructed, operated, and maintained to avoid to the maximum extent practicable significant:*

1. *reductions in the natural supply of sediment and nutrients to the coastal system by alterations of freshwater flow;*
2. *adverse economic impacts on the locality of the use and affected governmental bodies;*
3. *detrimental discharges of inorganic nutrient compounds into coastal waters;*
4. *alterations in the natural concentration of oxygen in coastal waters;*
5. *destruction or adverse alterations of streams, wetland, tidal passes, inshore waters and water bottoms, beaches, dunes, barrier islands, and other natural biologically valuable areas or protective coastal features;*
6. *adverse disruption of existing social patterns;*
7. *alterations of the natural temperature regime of coastal waters;*
8. *detrimental changes in existing salinity regimes;*
9. *detrimental changes in littoral and sediment transport processes;*
10. *adverse effects of cumulative impacts;*
11. *detrimental discharges of suspended solids into coastal waters, including turbidity resulting from dredging;*
12. *reductions or blockage of water flow or natural circulation patterns within or into an estuarine system or a wetland forest;*

13. *discharges of pathogens or toxic substances into coastal waters;*
14. *adverse alteration or destruction of archaeological, historical, or other cultural resources;*
15. *fostering of detrimental secondary impacts in undisturbed or biologically highly productive wetland areas;*
16. *adverse alteration or destruction of unique or valuable habitats, critical habitat for endangered species, important wildlife or fishery breeding or nursery areas, designated wildlife management or sanctuary areas, or forestlands;*
17. *adverse alteration or destruction of public parks, shoreline access points, public works, designated recreation areas, scenic rivers, or other areas of public use and concern;*
18. *adverse disruptions of coastal wildlife and fishery migratory patterns;*
19. *land loss, erosion, and subsidence;*
20. *increases in the potential for flood, hurricane and other storm damage, or increases in the likelihood that damage will occur from such hazards; and*
21. *reduction in the long term biological productivity of the coastal ecosystem.*

Addressed in EP Sections E, F, L, and N.

I. Uses shall to the maximum extent practicable be designed and carried out to permit multiple concurrent uses which are appropriate for the location and to avoid unnecessary conflicts with other uses of the vicinity.

Addressed in EP Sections A and L.

§703. Guidelines for Levees

Not applicable.

§705. Guidelines for Linear Facilities

Not applicable.

§707. Guidelines for Dredged Spoil Deposition

Not applicable.

§709. Guidelines for Shoreline Modification

Not applicable.

§711. Guidelines for Surface Alterations

Not applicable. Surface alterations to shorebases are not required for this project.

§713. Guidelines for Hydrologic and Sediment Transport Modifications

Not applicable.

§715. Guidelines for Disposal of Wastes

A. *The location and operation of waste storage, treatment, and disposal facilities shall be avoided in wetlands to the maximum extent practicable, and best practical techniques shall be used to minimize adverse impacts which may result from such use.*

Addressed in EP Sections F and L.

B. *The generation, transportation, treatment, storage, and disposal of hazardous wastes shall be pursuant to the substantive requirements of the Department of Environmental Quality adopted pursuant to the provisions of R.S. 30:217, et seq.; as amended and approved pursuant to the Resource Conservation and Recovery Act of 1976 P.L. 94-580, as amended, and of the Office of Conservation for injection below surface.*

Addressed in EP Section F.

C. *Waste facilities located in wetlands shall be designed and built to withstand all expectable adverse conditions without releasing pollutants.*

Not applicable.

D. *Waste facilities shall be designed and constructed using best practical techniques to prevent leaching, control leachate production, and prevent the movement of leachate away from the facility.*

Not applicable.

E. *The use of overland flow systems for nontoxic, biodegradable wastes, and the use of sump lagoons and reservoirs utilizing aquatic vegetation to remove pollutants and nutrients shall be encouraged.*

Not applicable.

F. *All waste disposal sites shall be marked and, to the maximum extent practicable, all components of waste shall be identified.*

Not applicable.

G. *Waste facilities in wetlands with identifiable pollution problems that are not feasible and practical to correct shall be closed and either removed or sealed, and shall be properly revegetated using the best practical techniques.*

Not applicable.

H. *Waste shall be disposed of only at approved disposal sites.*

Addressed in EP Section F.

I. *Radioactive wastes shall not be temporarily or permanently disposed of in the coastal zone.*

Not applicable.

§717. Guidelines for Uses that Result in the Alteration of Waters Draining into Coastal Waters

Not applicable.

§719. Guidelines for Oil, Gas, and Other Mineral Activities

A. *Geophysical surveying shall utilize the best practical techniques to minimize disturbance or damage to wetlands, fish and wildlife, and other coastal resources.*

Not applicable; all geophysical survey work related to this project was conducted on the OCS in GC 40, approximately 75 statute miles (121 km) from the nearest Louisiana shoreline. Geological and geophysical information is provided in EP Section C.

B. *To the maximum extent practicable, the number of mineral exploration and production sites in wetland areas requiring floatation access shall be held to the minimum number, consistent with good recovery and conservation practices and the need for energy development, by directional drilling, multiple use of existing access canals, and other practical techniques.*

Not applicable; all development activities related to this project will be conducted on the OCS in GC 40, approximately 75 statute miles (121 km) from the nearest Louisiana shoreline.

C. *Exploration, production, and refining activities shall, to the maximum extent practicable, be located away from critical wildlife areas and vegetation areas. Mineral operations in wildlife preserves and management areas shall be conducted in strict accordance with the requirements of the wildlife management body.*

Addressed in EP Sections A, E, I, L, and N. No activities will be conducted in wildlife preserves or management areas. All drilling activities related to this project will be conducted on the OCS in GC 40, and support vessels will only transit from shorebase to the project area, approximately 75 statute miles (121 km) from the nearest Louisiana shoreline. A selected list of Louisiana Wildlife Refuges, Wilderness Areas, and State and National Parks that could potentially be affected by oiling within 60 days of a large spill, along with the natural resources found in each area, is provided in **Table 1**.

D. *Mineral exploration and production facilities shall be to the maximum extent practicable designed, constructed, and maintained in such a manner to maintain natural water flow regimes, avoid blocking surface drainage, and avoid erosion.*

Not applicable; all development activities related to this project will be conducted on the OCS in GC 40, approximately 75 statute miles (121 km) from the nearest Louisiana shoreline.

E. *Access routes to mineral exploration, production, and refining sites shall be designed and aligned so as to avoid adverse impacts on critical wildlife and vegetation areas to the maximum extent practicable.*

Addressed in EP Section I, L, and N.

F. *Drilling and production sites shall be prepared, constructed, and operated using the best practical techniques to prevent the release of pollutants or toxic substances into the environment.*

Addressed in EP Sections A, B, and H.

Table 1. Louisiana Wildlife Refuges, Wilderness Areas, State and National Parks, and natural resources within the geographic range of potential shoreline oil contact within 60 days of a large discharge event based on Oil Spill Risk Analysis (OSRA) Launch Point 3 (From: BOEM, 2017).

Wildlife Refuge, Wilderness Area, State or National Park	Resource Description
Cameron Parish	
Lacassine National Wildlife Refuge (NWR)	Established in 1937, Lacassine NWR is approximately 35,000 acres of freshwater marsh. Approximately half of the acreage of the NWR is natural freshwater marsh and open water. Notable wildlife includes nesting colonies of wading and water birds, alligators, eagles, falcons, and Louisiana black bears as well as wintering populations of several species of ducks. The NWR is known for vast numbers of pintails congregating each winter. The NWR is available for a multitude of recreational opportunities, including fishing, hunting, boating, and hiking (U.S. Fish and Wildlife Service [USFWS], 2016a).
Peveto Woods Bird and Wildlife Sanctuary	A bird sanctuary owned by the Baton Rouge Audubon Society, this sanctuary is a 40-acre tract of coastal land in Cameron Parish. During the spring and fall migrations, the sanctuary is home to numerous species of songbirds. It is estimated that nearly 2 million birds seek refuge in the sanctuary each year before and after their trans-Gulf migrations. The sanctuary is also used by numerous species of butterflies, including the migratory Monarch butterfly (Baton Rouge Audubon Society, 2010).
Rockefeller Wildlife Refuge and Game Preserve	Rockefeller Wildlife Refuge, located in eastern Cameron and western Vermilion Parishes, is owned and maintained by the State of Louisiana. The refuge is a flat, treeless area with highly organic soils that are capable of producing immense quantities of waterfowl foods in the form of annual emergents and submerged aquatics. When deeded to the state, the refuge encompassed approximately 86,000 acres, but beach erosion has taken a heavy toll, and the most recent surveys indicate only 76,042 acres remain. This area borders the Gulf of Mexico for 26.5 miles and extends inland toward the Grand Chenier ridge, a stranded beach ridge 6 miles from the Gulf of Mexico. Common resident animals include Mottled Ducks, nutria, muskrat, rails, raccoon, mink, otter, opossum, white-tailed deer, and alligators. An abundant fisheries population provides recreational opportunities to fishermen seeking shrimp, redfish, speckled trout, black drum, and largemouth bass, among others (Louisiana Department of Wildlife and Fisheries, n.d. - a).
Sabine NWR	Sabine NWR includes 124,511 acres of fresh, intermediate, and brackish marshes that provide habitat for waterfowl and other birds. Designated as an Internationally Important Bird Area, the refuge is known to provide habitat for more than 300 species of birds, 26 species of mammals, 41 species of reptiles and amphibians, 132 species of fish, and 68 species of marine invertebrates. Common bird species include Mottled Ducks, Great Egrets, Neotropic Cormorants, Snowy Egrets, and various species of wading birds and shorebirds. American alligators are known to be very common in the refuge as well (USFWS, 2016d).
Vermilion Parish	
Paul J. Rainey Wildlife Refuge and Game Preserve	Paul J. Rainey Wildlife Refuge and Game Preserve is a privately owned 26,000-acre coastal wetland in Vermilion Parish owned by the National Audubon Society. Formerly open to gas drilling, hydrocarbon exploration ended in 1999. Notable fauna include deer, muskrats, otters, geese, and numerous other species of birds. No hunting or fishing is currently allowed in the Sanctuary (National Audubon Society, 2017).
Rockefeller Wildlife Refuge and Game Preserve	See description under Cameron Parish.

Table 1. (Continued).

Wildlife Refuge, Wilderness Area, State or National Park	Resource Description
State Wildlife Refuge	State Wildlife Refuge is a 13,000-acre tract owned by the State of Louisiana. Located on the southwest shore of Vermilion Bay, the focus of the refuge is on natural resource conservation. The refuge is an important waterfowl wintering area and serves as habitat for numerous species of shorebirds, wading birds, alligators, shrimp, fish, and crabs. Mammals such as raccoons, muskrats, nutria, mink, and deer are common as well (Louisiana Department of Wildlife and Fisheries, n.d. - b).
White Lake Wetlands Conservation Area	Located in southwest Vermilion Parish, the area is approximately 72,000 acres of freshwater marsh, cropland, wetlands, wooded areas, and campsites. The marsh areas are managed to provide habitat for wintering waterfowl and other native species (Louisiana Department of Wildlife and Fisheries, n.d. - c).
Iberia Parish	
Attakapas Island Wildlife Management Area (WMA)	Located in Iberia, St. Mary, and St Martin Parishes, Attakapas Island WMA was acquired by the State of Louisiana in 1976. The WMA is approximately 28,000 acres accessible only by boat and generally consists of flat swampland that occasionally floods due to the nearby Atachafalaya River. Recreational activities include hunting (primarily for deer rabbits, squirrels, and waterfowl), trapping of furbearing animals, and fishing (primarily catfish, mullet, bluegill, gar, bowfin, and freshwater drum) (Louisiana Department of Wildlife and Fisheries, 2017a).
Lake Fausse Pointe State Park	Lake Fausse Pointe State Park is located on approximately 6,000 acres that was once part of the Atchafalaya Basin. Activities available in the park include fishing, boating, canoeing, camping, and hiking (Louisiana Department of Culture Recreation and Tourism, 2017a).
Marsh Island Wildlife Refuge	Marsh Island Wildlife Refuge is located between Vermilion Bay and the Gulf of Mexico. Owned and operated by the State of Louisiana, the Refuge is approximately 70,000 acres of treeless brackish marsh. The Refuge is an important wintering area for Blue and Snow Geese and also provides habitat for alligators, larval shrimp, deer, and a variety of shore and wading birds. The Refuge is a popular location for recreational fishing and shrimping, with an estimated 30,000 man-days of recreational activity occurring annually (Louisiana Department of Wildlife and Fisheries, n.d. - d).
Shell Keys NWR	The Shell Keys NWR was established in 1908 and originally consisted of numerous un-surveyed islets offshore of Marsh Island, Louisiana. Due to erosion, only a single shell-fragment islet remains. The exposed land is extremely dynamic, with the size changing frequently due to erosion and storms. Shell Key is known as nesting grounds for Royal Terns, Sandwich Terns, Black Skimmers, and Laughing Gulls, but no nesting has been documented since 1992 due to severe erosion. White and Brown Pelicans as well as other species of terns and gulls are known to periodically visit the islet (USFWS, 2016c).
St. Mary Parish	
Atchafalaya Delta WMA	Atchafalaya Delta WMA is 197,695 acres. Located at the mouths of the Atchafalaya River and the Wax Lake Outlet, Atchafalaya Delta WMA mostly consists of open water in Atchafalaya Bay. Within the bay, two deltas (Main Delta and Wax Lake Delta) have formed from the accretion of sediments from the Atchafalaya River and from dredged material deposited by the U.S. Army Corps of Engineers. Main Delta has about 15,000 acres of marsh and scrubby habitat; Wax Lake Delta has about 12,000 acres of marsh. Atchafalaya Delta WMA is popular for birding and fishing (especially for redfish, catfish, bass, and bluegill) (Louisiana Department of Wildlife and Fisheries, 2017b).
Bayou Teche NWR	Bayou Teche NWR 9,028 acres and situated along and on either side of Bayou Teche, an ancient channel of the Mississippi River. The refuge consists of 6 non-contiguous management units, ranging in size from 81 to 3,619 acres. The refuge consists mostly of back-swamp land located off of the natural levees of the bayou. Habitats on the refuge include bottomland hardwood forests, cypress-tupelo swamps, bayous, and freshwater marshes. The refuge is an important habitat for the Louisiana black bear, as well as songbirds, wading birds, waterfowl, reptiles and amphibians (USFWS, 2016d).

Table 1. (Continued).

Wildlife Refuge, Wilderness Area, State or National Park	Resource Description
Cypremort Point State Park	Cypremort Point is located Grand Isle and Cameron. A half-mile stretch of a man-made beach provides an opportunity for fishing, crabbing, water skiing, windsurfing, and sailing. Within the state park, nutria, muskrat, alligator, a number of bird species, deer, black bear, rabbits, opossum, and red fox may be observed (National Geographic, 2017).
Terrebonne Parish	
Isles Dernieres Barrier Islands Refuge	This refuge is made up of three barrier islands offshore of Terrebonne Parish: Wine Island, Whiskey Island, and Raccoon Island, for a total of approximately 630 acres. The primary management goal of the refuge is to provide and protect habitat for nesting waterbirds. Raccoon Island is one of the most important waterbird nesting sites on the Gulf coast (Louisiana Department of Wildlife and Fisheries, n.d. - e).
Mandalay NWR	Mandalay NWR was established in 1996 as 4,419 acres of freshwater marsh and cypress-tupelo swamp. Access to the refuge is by boat only. Popular activities in the refuge include wildlife observation, boating, fishing, and hunting. The refuge proves important habitat for wintering waterfowl of the Mississippi flyway. Other notable wildlife include ducks, white tailed deer, alligators, and numerous bird species, including herons, egrets, and eagles (USFWS, 2016e).
Point-aux-Chenes WMA	Point-aux-Chenes WMA is a 35,000-acre marshland owned and operated by the Louisiana Department of Wildlife and Fisheries. Access to the WMA typically is limited to boats as there are no roads through the marshland. Notable game species present in the WMA include waterfowl, deer, rabbit, squirrels, rails, gallinules, and snipe. Both saltwater and freshwater fishing in the WMA is considered excellent due to the nearby Timbalier and Terrebonne Bay watersheds. Annual lotteries are held by the Louisiana Department of Wildlife and Fisheries for a waterfowl hunt exclusively for physically challenged hunters and a deer hunt for youth (Louisiana Department of Wildlife and Fisheries, 2016a).
Lafourche Parish	
Wisner WMA	Owned by the Edward Wisner Donation Advisory Committee, the WMA is approximately 21,000 acres of bayous and canals. The WMA is open seasonally for small game and waterfowl hunting.
Point-aux-Chenes WMA	See description under Terrebonne Parish.
Jefferson Parish	
Grand Isle State Park	Part of the Louisiana State Park system, Grand Isle State Park is a small beach ridge that serves as a breakwater between the Gulf of Mexico and the island channels that connect numerous bayous to the Mississippi River. The park is used extensively for swimming, fishing, boating, camping, and bird watching. Saltwater fishing is especially prolific in the waters offshore of the park, with speckled trout and redfish being two of the most popular targets (Louisiana Department of Culture Recreation and Tourism, 2017b).
Plaquemines Parish	
Delta NWR	The Delta NWR was established in 1935 and covers 49,000 acres formed by the deposition of sediment from the Mississippi River. Its lush vegetation is the food source for a multitude of fish, waterfowl, and animals. The Delta NWR is the winter home for hundreds of thousands of snow geese, coots, and ducks. Endangered and threatened species in the NWR include the Piping Plover and the American alligator, which was de-listed as an endangered species in 1987 but remains listed as threatened due to similarity in appearance to the endangered American crocodile. The Delta NWR supports a wide variety of non-listed wildlife species. Tens of thousands of wintering waterfowl take advantage of the rich food resources found in the Delta NWR. Large numbers of other bird species can be found in the NWR, with numbers peaking during the spring and fall migrations. Large numbers of wading birds nest on the refuge, and thousands of shorebirds can be found on tidal mudflats and deltaic splays. Numerous furbearers and game mammals are year-round residents, and the marshes and waterways provide year-round and seasonal habitat for a diversity of fish and shellfish species (USFWS, 2017).

Table 1. (Continued).

Wildlife Refuge, Wilderness Area, State or National Park	Resource Description
Pass A Loutre WMA	The Pass A Loutre WMA is located in southern Plaquemines Parish at the mouth of the Mississippi River, approximately 10 miles south of Venice, and is accessible only by boat. The area is characterized by river channels with attendant channel banks, natural bayous, and man-made canals interspersed with intermediate and fresh marshes. The area is owned by the Louisiana Department of Wildlife and Fisheries and encompasses approximately 115,000 acres. The area is home to numerous species of shorebirds and other water fowl. Alligators and small mammals are abundant. The inland waters provide habitat for fish, shrimp, and crabs (Louisiana Department of Wildlife and Fisheries, 2016b).
Breton NWR	Established in 1904, the Breton NWR is the second oldest NWR in the United States. Historically, the Breton NWR has been the site of a lighthouse station (destroyed by Hurricane Katrina), a quarantine station, a small fishing village, and an oil production facility. The Chandeleur Islands are designated as critical habitat for the endangered Piping Plover, which is a common visitor to the refuge during fall, winter, and spring. The Western Gulf Coast population of Brown Pelican was de-listed under the Endangered Species Act in 2009. The Brown Pelican is a year-round resident of southeast Louisiana, and the Breton NWR serves as important breeding grounds for these birds each year. The Breton NWR also provides habitat for colonies of nesting wading birds and seabirds as well as wintering shorebirds and waterfowl. Twenty-three species of seabirds and shorebirds frequently use the refuge, and 13 species nest on the various islands. The most abundant nesters are Brown Pelicans, Laughing Gulls, Royal Gulls, and Caspian and Sandwich Terns. Waterfowl winter near the refuge islands and use the adjacent shallows, marshes, and sounds for feeding and for protection during inclement weather. Redheads and Lesser Scaup account for the majority of waterfowl on the refuge. Other wildlife species found in the NWR include nutria, raccoons, and several species of sea turtles (USFWS, 2013).
St. Bernard Parish	
Breton NWR	See description under Plaquemines Parish.

G. *All drilling activities, supplies, and equipment shall be kept on barges, on drilling rigs, within ring levees, or on the well site.*

Addressed in EP Sections A and B.

H. *Drilling ring levees shall to the maximum extent practicable be replaced with small production levees or removed entirely.*

Not applicable; no drilling ring levees will be used during the proposed activities.

I. *All drilling and production equipment, structures, and storage facilities shall be designed and constructed utilizing best practical techniques to withstand all expectable adverse conditions without releasing pollutants.*

Addressed in EP Sections A and H.

J. *Mineral exploration, production, and refining facilities shall be designed and constructed using best practical techniques to minimize adverse environmental impacts.*

Addressed in EP Sections A, B, and N.

K. *Effective environmental protection and emergency or contingency plans shall be developed and complied with for all mineral operations.*

Addressed in EP Sections A, B, D, H, and N.

L. *The use of dispersants, emulsifiers, and other similar chemical agents on oil spills is prohibited without the prior approval of the Coast Guard or Environmental Protection Agency on-scene coordinator, in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan.*

Addressed in EP Section H.

M. *Mineral exploration and production sites shall be cleared, revegetated, detoxified, and otherwise restored as near as practicable to their original condition upon termination of operations to the maximum extent practicable.*

Addressed in EP Sections A and N.

N. *The creation of underwater obstructions which adversely affect fishing or navigation shall be avoided to the maximum extent practicable.*

Addressed in EP Sections A and B.

3 Consistency Certification

The analysis indicates that Noble Energy's Supplemental EP for GC 40 is consistent with the enforceable policies of the LCRP according to the guidelines provided by the LCRP. Routine operations will have limited environmental impacts in the immediate vicinity of the development activities. All land-based support activities, including transport to and from the site, will be from existing support bases in Louisiana.

In the event of an accidental spill, Noble Energy will implement the measures of its Regional OSRP, which details plans and procedures for containment, recovery, and removal of an oil spill. This project is expected to conform to existing regulatory requirements. The EP thoroughly describes the project and related activities, and the EIA analyzes potential environmental impacts. The intent and requirements of all enforceable Louisiana Statutes have been considered and discussed as well as other information requirements of Louisiana. A CZMA consistency certification according to 16 U.S.C. 1456(c)(3)(B) and 15 CFR 930.76(c) for Louisiana is provided on the cover page.

4 References

Baton Rouge Audubon Society. 2010. Peveto Woods Sanctuary. http://www.braudubon.org/peveto-woods-sanctuary.php.

Bureau of Ocean Energy Management. 2017. Catastrophic Spill Event Analysis: High-Volume, Extended Duration Oil Spill Resulting from Loss of Well Control on the Gulf of Mexico Outer Continental Shelf. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS Report BOEM 2017-007.

Louisiana Department of Culture Recreation and Tourism. 2017a. Lake Fausse Pointe State Park. http://www.crt.state.la.us/louisiana-state-parks/parks/lake-fausse-pointe-state-park/.

Louisiana Department of Culture Recreation and Tourism. 2017b. Grand Isle State Park. Accessed 20 April 2015 at: http://www.crt.state.la.us/louisiana-state-parks/parks/grand-isle-state-park/.

Louisiana Department of Wildlife and Fisheries. n.d. - a. Rockefeller Wildlife Refuge and Game Preserve. http://www.wlf.louisiana.gov/refuge/rockefeller-wildlife-refuge.

Louisiana Department of Wildlife and Fisheries. n.d - b. State Wildlife Refuge. http://www.wlf.louisiana.gov/refuge/state-wildlife-refuge.

Louisiana Department of Wildlife and Fisheries. n.d. - c. White Lake Wetlands Conservation Area. http://www.wlf.louisiana.gov/refuge/white-lake-wetlands-conservations-area.

Louisiana Department of Wildlife and Fisheries. n.d. - d. Marsh Island Wildlife Refuge. http://www.wlf.louisiana.gov/refuge/marsh-island-wildlife-refuge.

Louisiana Department of Wildlife and Fisheries. n.d. - e. Isle Dernieres Barrier Islands Refuge. http://www.wlf.louisiana.gov/refuge/terrebonne-barrier-islands-refuge.

Louisiana Department of Wildlife and Fisheries. 2016a. Pointe-aux-Chenes WMA. http://www.wlf.louisiana.gov/wma/2790.

Louisiana Department of Wildlife and Fisheries. 2016b. Pass A Loutre WMA. http://www.wlf.louisiana.gov/wma/2786.

Louisiana Department of Wildlife and Fisheries. 2017a. Attakapas Island. http://www.wlf.louisiana.gov/wma/32640.

Louisiana Department of Wildlife and Fisheries. 2017b. Atchafalaya Delta. http://www.wlf.louisiana.gov/wma/32639.

National Audubon Society. 2017. Paul J. Rainey Wildlife Sanctuary. http://la.audubon.org/conversation/paul-j-rainey-wildlife-sanctuary.

National Geographic. 2017. The Mississippi River – Cypremort Point State Park – cabins and pavilions. https://mississippiriver.natgeotourism.com/content/cypremort-point-state-park-cabins-and-pavilions/msp50632eb44fb733b96.

U.S. Fish and Wildlife Service. 2013. Breton National Wildlife Refuge. http://www.fws.gov/breton/.

U.S. Fish and Wildlife Service. 2016a. Lacassine National Wildlife Refuge. https://www.fws.gov/refuge/Lacassine/.

U.S. Fish and Wildlife Service. 2016b. Sabine National Wildlife Refuge. https://www.fws.gov/refuge/sabine/.

U.S. Fish and Wildlife Service. 2016c. Shell Keys National Wildlife Refuge. http://www.fws.gov/swlarefugecomplex/shellkeys/.

U.S. Fish and Wildlife Service. 2016d. Bayou Teche National Wildlife Refuge, Louisiana. https://www.fws.gov/refuge/Bayou_Teche/wildlife_and_habitat/index.html.

U.S. Fish and Wildlife Service. 2016e. Mandalay National Wildlife Refuge. http://www.fws.gov/mandalay/.

U.S. Fish and Wildlife Service. 2017. Delta National Wildlife Refuge. http://www.fws.gov/delta/.

Section N

Environmental Impact Analysis (EIA)

See attachment N – 1.

Environmental Impact Analysis

For a

SUPPLEMENTAL EXPLORATION PLAN

Green Canyon Block 40

(OCS-G 34536)

Offshore Louisiana

September 2017

Prepared for:

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Environmental Impact Analysis

For a

SUPPLEMENTAL EXPLORATION PLAN
for
Green Canyon Block 40

(OCS-G 34536)

DOCUMENT NO. CSA-Noble-FL-17-80603-3203-01-REP-01-FIN

VERSION	DATE	DESCRIPTION	PREPARED BY:	REVIEWED BY:	APPROVED BY:
01	09/25/2017	Revised draft	J. Tiggelaar	P. Connelly	J. Tiggelaar
FIN	09/28/17	Final	J. Tiggelaar	P. Connelly	P. Connelly

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Acronyms and Abbreviations

ADIOS2	Automated Data Inquiry for Oil Spills 2
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BOP	blowout preventer
BSEE	Bureau of Safety and Environmental Enforcement
CFR	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CGA	Clean Gulf Associates
DP	dynamically positioned
DPS	distinct population segment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIA	Environmental Impact Analysis
EIS	Environmental Impact Statement
EP	Exploration Plan
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FAD	fish aggregating device
GC	Green Canyon
GMFMC	Gulf of Mexico Fishery Management Council
GPS	global positioning system
H_2S	hydrogen sulfide
HAPC	Habitat Area of Particular Concern
HOSS	high-volume open sea skimmer
IPF	impact-producing factor
MARPOL	International Convention for the Prevention of Pollution from Ships
MMC	Marine Mammal Commission
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MODU	Mobile Offshore Drilling Unit
MSRC	Marine Spill Response Corporation
NAAQS	National Ambient Air Quality Standards
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
Noble	Noble Energy, Inc.
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NRDA	Natural Resource Damage Assessment
NTL	Notice to Lessees and Operators
NWR	National Wildlife Refuge
OCS	Outer Continental Shelf
OSRA	Oil Spill Risk Analysis
OSRP	Oil Spill Response Plan
PAH	polycyclic aromatic hydrocarbon
PM	particulate matter
SBM	synthetic-based drilling mud
SO_x	sulfur oxides
UME	Unusual Mortality Event
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound
WBM	water-based drilling mud
WCD	worst case discharge

Introduction

Noble Energy, Inc. (Noble Energy) is submitting a Supplemental Exploration Plan (EP) for Green Canyon (GC) Block 40 (GC 40). Under this EP, Noble proposes to drill and complete three wells: GC 40 F, I, and J. The Environmental Impact Analysis (EIA) provides information on potential environmental impacts of Noble's proposed drilling activities for these wells.

The lease area is approximately 75 miles (121 km) from the nearest shoreline (Louisiana), 82 miles (132 km) from the onshore support base at Port Fourchon, Louisiana, and 122 miles (196 km) from the helicopter base at Houma, Louisiana (**Figure 1**). The water depth at the proposed wellsites ranges from approximately 2,124 to 2,129 ft (647 to 649 m). The mobile offshore drilling unit (MODU) has not yet been determined, but will be a dynamically positioned (DP) drillship or DP semisubmersible rig. The operations are expected to require approximately 220 days per well, inclusive of drilling and completion activities.

The EIA for this EP was prepared for submittal to the Bureau of Ocean Energy Management (BOEM) in accordance with applicable regulations, including 30 Code of Federal Regulations (CFR) 550.212(o) and 550.227. The EIA is a project- and site-specific analysis of Noble Energy's planned activities under this EP. The EIA complies with guidance provided in existing Notices to Lessees and Operators (NTLs) issued by the BOEM and its predecessors, Minerals Management Service (MMS) and Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), including NTL 2008-G04 (extended by 2015-N02) and 2015-N01. Potential impacts have been analyzed at a broader level in the 2017 to 2022 Programmatic Environmental Impact Statement (EIS) for the Outer Continental Shelf (OCS) Oil and Gas Leasing Program (BOEM, 2016a) and in multisale EISs for the Western and Central Gulf of Mexico Planning Areas (BOEM, 2012a, b, 2013a, 2014a, 2015, 2016b, 2017a). The most recent multisale EISs update environmental baseline information in light of the Macondo (*Deepwater Horizon*) incident and address potential impacts of a catastrophic spill (BOEM, 2012a, b, 2013a, 2014a, 2015, 2016b, 2017a). The analyses from those documents are incorporated here by reference.

All the proposed activities and facilities discussed in this EP are covered by Noble Energy's Gulf of Mexico Regional Oil Spill Response Plan (OSRP) last approved in September 2015 in accordance with 30 CFR Part 254. The biennial OSRP update was submitted to BSEE in September 2017. The OSRP details Noble Energy's plan to rapidly and effectively manage oil spills that may result from drilling and production operations. Noble Energy has designed its spill response program based on a regional capability of response to spills ranging from small operational spills to a worst case discharge (WCD) from a well blowout. Noble Energy's spill response program meets the response planning requirements of the relevant coastal states and applicable federal oil spill planning regulations. The OSRP also includes information regarding Noble Energy's regional oil spill organization and dedicated response assets, potential spill risks, and local environmental sensitivities. It describes personnel and equipment mobilization, incident management team organization, and an overview of actions and notifications to be taken in the event of a spill.

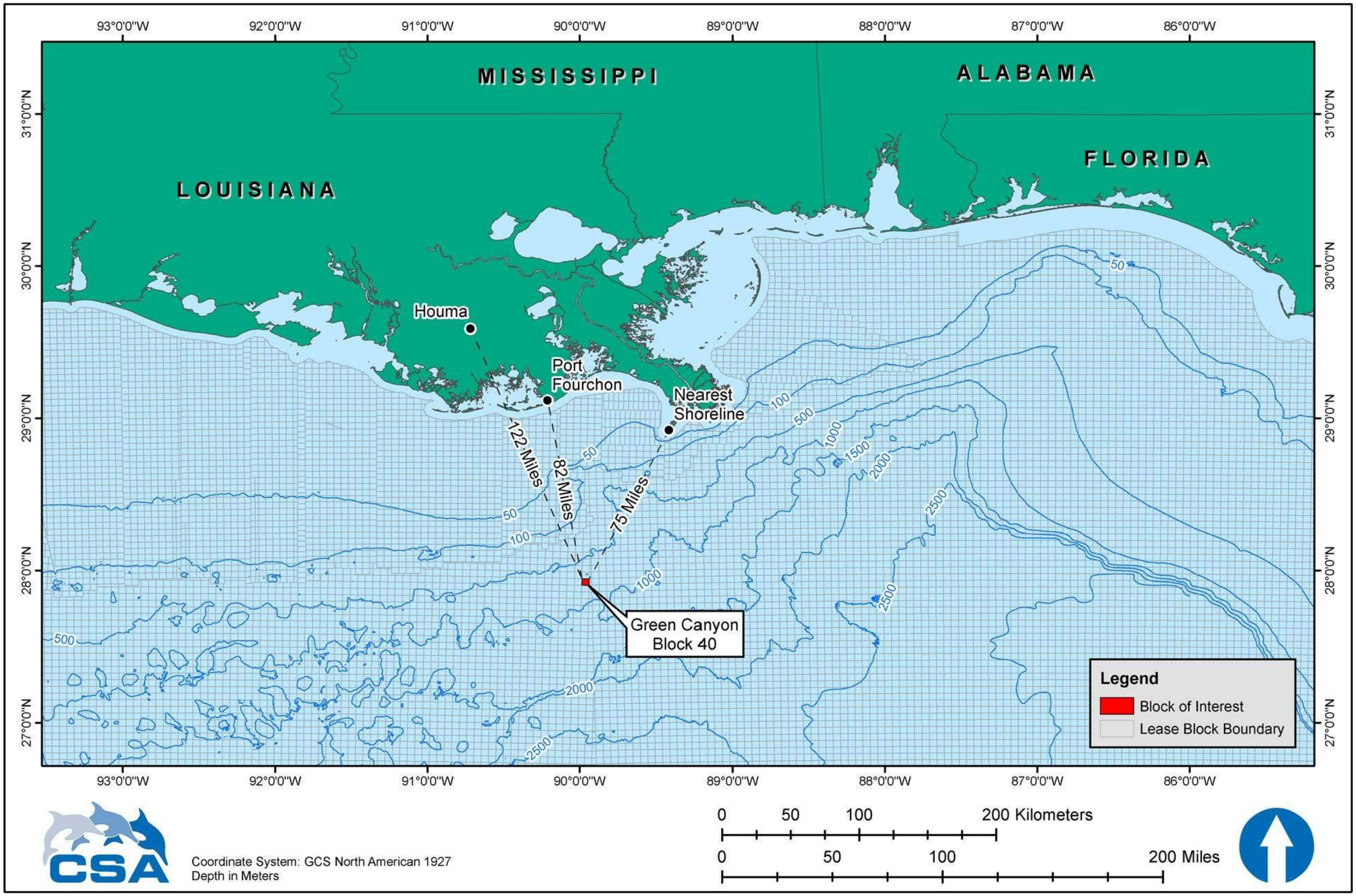

Figure 1. Location of Green Canyon Block 40, offshore Louisiana.

The EIA is organized into **Sections A** through **I**, corresponding to the information required by NTLs 2008-G04 (extended by NTL 2015-N02) and 2015-N01. The main impact-related discussions are in **Section A** (Impact-Producing Factors) and **Section C** (Impact Analysis). **Table 1** lists and summarizes the NTLs applicable to the EIA.

Table 1. Notices to Lessees and Operators (NTLs) applicable to this Environmental Impact Analysis (EIA).

NTL	Title	Summary
BOEM-2016-G01	Vessel Strike Avoidance and Injured/Dead Protected Species Reporting	Recommends protected species identification training; recommends that vessel operators and crews maintain a vigilant watch for marine mammals and slow down or stop their vessel movement to avoid striking protected species; and requires operators to report sightings of any injured or dead protected species. Supersedes NTL 2012-JOINT-G01.
BSEE-2015-G03	Marine Trash and Debris Awareness and Elimination	Instructs operators to exercise caution in the handling and disposal of small items and packaging materials; requires the posting of instructional placards at prominent locations on offshore vessels and structures; and mandates a yearly marine trash and debris awareness training and certification process. Supersedes and replaces NTL 2012-G01.
BOEM 2015-N02	Elimination of Expiration Dates on Certain Notices to Lessees and Operators Pending Review and Reissuance	Eliminates expiration dates (past or upcoming) of all NTLs currently posted on the BOEM website.
BOEM 2015-N01	Information Requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS for Worst Case Discharge and Blowout Scenarios	Provides guidance regarding information required in WCD descriptions and blowout scenarios. Supersedes NTL 2010-06.
BOEM 2014-G04	Military Warning and Water Test Areas	Provides contact links to individual command headquarters for the military warning and water test areas in the Gulf of Mexico.
BSEE-2012-N06	Guidance to Owners and Operators of Offshore Facilities Seaward of the Coast Line Concerning Regional Oil Spill Response Plans	Provides clarification, guidance, and information for preparation of regional Oil Spill Response Plans. Recommends description of response strategy for worst case discharge scenarios to ensure capability to respond to oil spills is both efficient and effective.
2011-JOINT-G01	Revisions to the List of Outer Continental Shelf (OCS) Blocks Requiring Archaeological Resource Surveys and Reports	Provides new information of which OCS blocks require archaeological surveys and reports; identifies required survey line spacing in each block. This NTL augments NTL 2005-G07.

Table 1. (Continued).

NTL	Title	Summary
2010-N10	Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources	Informs operators using subsea blowout preventers (BOPs) or surface BOPs on floating facilities that applications for well permits must include a statement signed by an authorized company official stating that the operator will conduct all activities in compliance with all applicable regulations, including the increased safety measures regulations (75 *Federal Register* 63346). Informs operators that the Bureau of Ocean Energy Management will be evaluating whether each operator has submitted adequate information demonstrating that it has access to and can deploy containment resources to promptly respond to a blowout or other loss of well control.
2009-G40	Deepwater Benthic Communities	Provides guidance for avoiding and protecting high-density deepwater benthic communities (including chemosynthetic and deepwater coral communities) from damage caused by OCS oil and gas activities in water depths greater than 984 ft (300 m). Prescribes separation distances of 2,000 ft (610 m) from each mud and cuttings discharge location and 250 ft (76 m) from all other seafloor disturbances.
2009-G39	Biologically Sensitive Underwater Features and Areas	Provides guidance for avoiding and protecting biologically sensitive features and areas (i.e., topographic features, pinnacles, low relief live bottom areas, and other potentially sensitive biological features) when conducting OCS operations in water depths less than 984 ft (300 m) in the Gulf of Mexico.
2008-G04	Information Requirements for Exploration Plans and Development Operations Coordination Documents	Provides guidance on information requirements for OCS plans, including EIA requirements and information regarding compliance with the provisions of the Endangered Species Act and Marine Mammal Protection Act.
2005-G07	Archaeological Resource Surveys and Reports	Provides guidance on regulations regarding archaeological discoveries, specifies requirements for archaeological resource surveys and reports, and outlines options for protecting archaeological resources.

A. Impact-Producing Factors

Based on the description of Noble Energy's proposed activities, a series of impact-producing factors (IPFs) have been identified. **Table 2** identifies the environmental resources that may be affected in the left column, and identifies sources of impacts associated with the proposed project across the top. **Table 2,** adapted from Form BOEM-0142, has been developed *a priori* to focus the impact analysis on those environmental resources that may be impacted as a result of one or more IPFs. The tabular matrix indicates which of the routine activities and accidental events could affect specific resources. An "X" indicates that an IPF could reasonably be expected to affect a certain resource, and a dash (--) indicates no impact or negligible impact. Where there may be an effect, an analysis is provided in **Section C**. Potential IPFs for the proposed activities are listed below and briefly discussed in the following sections.

- MODU presence (including noise and lights)
- Physical disturbance to the seafloor
- Air pollutant emissions
- Effluent discharges
- Water intake
- Onshore waste disposal
- Marine debris
- Support vessel and helicopter traffic
- Accidents

A.1 MODU Presence (Including Noise and Lights)

The exploration wells proposed in this EP will be drilled using a DP MODU. DP MODUs use a global positioning system (GPS), specific computer software, and sensors in conjunction with their own propellers and thrusters to maintain position. The precise location of the MODU is monitored by operators using satellite navigation. Thrusters positioned at various locations around the MODU's hull are activated as needed to maintain position. This process, known as station-keeping, allows operations at sea in water depths or locations where mooring or anchoring is impractical or not feasible. The MODU will be on site for an estimated 220 days per well and will maintain exterior lighting in accordance with applicable federal navigation and aviation safety regulations (International Regulations for Preventing Collisions at Sea, 1972 [72 COLREGS], Part C).

The MODU operations and equipment can be expected to produce noise that transmits to the water during station keeping, drilling, and maintenance operations. Additional sound and vibration will be transmitted through the hull to the water from auxiliary machinery, such as generators, pumps, and compressors onboard the MODU (Richardson et al., 1995). The noise levels produced by DP vessels for station keeping are largely dependent on the level of thruster activity required to keep position and, therefore, vary based on local ocean currents, sea and weather conditions, and operational requirements. Representative source levels for vessels in DP mode range from 184 to 190 decibels relative to one micropascal (dB re 1 µPa), with a primary amplitude frequency below 600 Hz (Blackwell and Greene Jr., 2003, Kyhn et al., 2011, McKenna et al., 2012). Drilling operations produce noise that includes strong tonal components at low frequencies (MMS, 2000). When drilling, the drill string represents a long vertical sound source (McCauley, 1998). Sound pressure levels associated with drilling activities have a broadband (10 Hz to 10 kHz) energy of up to 190 decibels relative to one micropascal meter (dB re 1 µPa m) (Hildebrand, 2005). Based on available data, marine sound generated from MODUs during drilling, in the absence of thrusters, can be expected to range between 154 and 176 dB re 1 µPa m (Nedwell et al., 2001). The use of thrusters, whether drilling or not, can elevate sound source levels from a drillship or semisubmersible to approximately 188 dB re 1 µPa m (Nedwell and Howell, 2004). Nedwell and Edwards (2004) reported that the majority of noise from an operational MODU was in the 40 to 600 Hz band when measured at a range of 0.3 to 1.2 miles (0.5 to 2 km). At a range of 3 miles (5 km), there was no perceptible noise above ambient.

Table 2. Matrix of impact-producing factors and environmental resources (Modified from: Form BOEM-0142).

Environmental Resources	Impact-Producing Factors									
	MODU Presence (incl. noise & lights)	Physical Disturbance to Seafloor	Air Pollutant Emissions	Effluent Discharges	Water Intake	Onshore Waste Disposal	Marine Debris	Support Vessel/Helicopter Traffic	Accidents	
									Small Diesel Fuel Spill	Large Oil Spill
Physical/Chemical Environment										
Air quality	--	--	**X**(9)	--	--	--	--	--	**X**(6)	**X**(6)
Water quality	--	--	--	**X**	--	--	--	--	**X**(6)	**X**(6)
Seafloor Habitats and Biota										
Soft bottom benthic communities	--	**X**	--	**X**	--	--	--	--	--	**X**(6)
High-density deepwater benthic communities	--	–(4)	--	--(4)	--	--	--	--	--	**X**(6)
Designated topographic features	--	–(1)	--	--(1)	--	--	--	--	--	--
Pinnacle trend area live bottoms	--	–(2)	--	--(2)	--	--	--	--	--	--
Eastern Gulf live bottoms	--	–(3)	--	--(3)	--	--	--	--	--	--
Threatened, Endangered, and Protected Species and Critical Habitat										
Sperm whale (endangered)	**X**(8)	–	--	--	--	--	--	**X**(8)	**X**(6,8)	**X**(6,8)
West Indian manatee (endangered)	--	–	--	--	--	--	--	**X**(8)	--	**X**(6,8)
Non-endangered marine mammals (protected)	**X**	–	--	--	--	--	--	**X**	**X**(6)	**X**(6)
Sea turtles (endangered/threatened)	**X**(8)	–	--	--	--	--	--	**X**(8)	**X**(6,8)	**X**(6,8)
Piping Plover (threatened)	--	–	--	--	--	--	--	--	--	**X**(6)
Whooping Crane (endangered)	--	–	--	--	--	--	--	--	--	**X**(6)
Gulf sturgeon (threatened)	--	–	--	--	--	--	--	--	--	**X**(6)
Beach mouse (endangered)	--	–	--	--	--	--	--	--	--	**X**(6)
Threatened coral species	--	–	--	--	--	--	--	--	--	**X**(6)
Coastal and Marine Birds										
Marine birds	**X**	–	--	--	--	--	--	**X**	**X**(6)	**X**(6)
Shorebirds and coastal nesting birds	--	–	--	--	--	--	--	**X**	--	**X**(6)
Fisheries Resources										
Pelagic communities and ichthyoplankton	**X**	–	--	**X**	**X**	--	--	--	**X**(6)	**X**(6)
Essential Fish Habitat	**X**	–	--	**X**	**X**	--	--	--	**X**(6)	**X**(6)
Archaeological Resources										
Shipwreck sites	--	–(7)	--	--	--	--	--	--	--	**X**(6)
Prehistoric archaeological sites	--	–(7)	--	--	--	--	--	--	--	**X**(6)
Coastal Habitats and Protected Areas										
Barrier beaches and dunes	--	–	--	--	--	--	--	**X**	--	**X**(6)
Wetlands and seagrass beds	--	–	--	--	--	--	--	**X**	--	**X**(6)
Coastal wildlife refuges and wilderness areas	--	–	--	--	--	--	--	--	--	**X**(6)
Socioeconomic and Other Resources										
Recreational and commercial fishing	**X**	–	--	--	--	--	--	--	**X**(6)	**X**(6)
Public health and safety	--	–	--	--	--	--	--	--	--	**X**(5,6)
Employment and infrastructure	--	–	--	--	--	--	--	--	--	**X**(6)
Recreation and tourism	--	–	--	--	--	--	--	--	--	**X**(6)
Land use	--	–	--	--	--	--	--	--	--	**X**(6)
Other marine uses	--	–	--	--	--	--	--	--	--	**X**(6)

X indicates potential impact; dash (--) indicates no impact or negligible impact; numbers refer to table footnotes; MODU = mobile offshore drilling unit.

Table 2 Footnotes and Applicability to this Program:

*Footnotes are numbered to correspond to entries in **Table 2**; applicability to this case is noted by a bullet point following the footnote.*

(1) *Activities that may affect a marine sanctuary or topographic feature. Specifically, if the well, rig site, or any anchors will be on the seafloor within the following:*
   (a) *4-mile zone of the Flower Garden Banks or the 3-mile zone of Stetson Bank;*
   (b) *1,000-m, 1-mile, or 3-mile zone of any topographic feature (submarine bank) protected by the Topographic Features Stipulation attached to an Outer Continental Shelf (OCS) lease;*
   (c) *Essential Fish Habitat (EFH) criteria of 500 ft from any no-activity zone; or*
   (d) *Proximity of any submarine bank (500-ft buffer zone) with relief greater than 2 m that is not protected by the Topographic Features Stipulation attached to an OCS lease.*
   - None of these conditions (a through d) are applicable. The lease is not within or near any marine sanctuary, topographic feature, submarine bank, or no-activity zone.

(2) *Activities with any bottom disturbance within an OCS lease block protected through the Live Bottom (Pinnacle Trend) Stipulation attached to an OCS lease.*
   - The Live Bottom (Pinnacle Trend) Stipulation is not applicable to the lease area.

(3) *Activities within any Eastern Gulf OCS block where seafloor habitats are protected by the Live Bottom (Low-Relief) Stipulation attached to an OCS lease.*
   - The Live Bottom (Low-Relief) Stipulation is not applicable to the lease area.

(4) *Activities on blocks designated by the BOEM as being in water depths 1,312 ft (400 m) or greater.*

No impacts on high-density deepwater benthic communities are anticipated. No geophysical evidence of hydrocarbon seepage or areas that could support high density benthic communities were noted within 2,000 ft (610 m) of the proposed wellsites (Fugro Marine Geoservices, 2017).

(5) *Exploration or production activities where hydrogen sulfide (H_2S) concentrations greater than 500 parts per million (ppm) might be encountered.*
   - The proposed wells are located in a block that that has been classified as H_2S absent.

(6) *All activities that could result in an accidental spill of produced liquid hydrocarbons or diesel fuel that would potentially impact these environmental resources. If the proposed action is located a sufficient distance from a resource that no impact would occur, the EIA can note that in a sentence or two.*
   - Accidental hydrocarbon spills could affect the resources marked (X) in the matrix, and potential impacts are analyzed in **Section C**.

(7) *All activities that involve seafloor disturbances, including anchor emplacements, in any OCS block designated by the BOEM as having high probability for the occurrence of shipwrecks or prehistoric sites, including such blocks that will be affected that are adjacent to the lease block in which your planned activity will occur. If the proposed activities are located a sufficient distance from a shipwreck or prehistoric site that no impact would occur, the EIA can note that in a sentence or two.*
   - No impacts on archaeological resources are expected. While the lease area is on BOEM's list of archaeology survey blocks (BOEM, 2011), the locations of the proposed wellsites are well beyond the 197 ft (60 m) depth contour used by BOEM as the seaward extent for prehistoric archaeological site potential in the Gulf of Mexico. A dynamically positioned MODU will be used; therefore, seafloor disturbances due to anchoring will not occur. Several side-scan sonar targets located within 2,000 ft (610 m) of the proposed wellsites were noted by Fugro Marine Geoservices (2017), but none were assigned an archaeological avoidance zone.

(8) All activities that you determine might have an adverse effect on endangered or threatened marine mammals or sea turtles or their critical habitats.
   - Impact-producing factors that may affect marine mammals, sea turtles, or their critical habitats include MODU presence, support vessel and helicopter traffic, and accidents. See **Section C**.

(9) *Production activities that involve transportation of produced fluids to shore using shuttle tankers or barges.*
   - Not applicable.

A.2 Physical Disturbance to the Seafloor

In water depths of 1,969 ft (600 m) or greater, DP MODUs disturb a small area of the seafloor around the wellbore where the bottom template and blowout preventer (BOP) are located. Depending on the specific well configuration, the total disturbed area is estimated to be 0.25 ha (0.62 ac) per well (BOEM, 2012a). For the well activity proposed in this EP, the total potential area of seafloor disturbance could be 0.75 ha (1.9 ac). However, the overall area of seafloor disturbance could be lower due to the geographic proximity of several of the proposed wells.

A.3 Air Pollutant Emissions

Offshore air pollutant emissions will result from MODU operations as well as support vessel (both supply and crew vessels) and helicopter transits. These emissions occur mainly from combustion of diesel and aviation fuel (Jet-A). The combustion of fuels occurs in diesel-powered generators, pumps, or motors and from lighter fuel motors. Primary air pollutants typically associated with emissions from internal combustion engines are suspended particulate matter (PM), sulfur oxides (SO_x), nitrogen oxides (NO_x), volatile organic compounds (VOCs), and carbon monoxide (CO).

The Air Quality Emissions Report (see **EP Section G**) prepared in accordance with BOEM requirements demonstrates that the projected emissions are below exemption levels set by the applicable regulations in 30 CFR 550.303. Based on this and the distance from shore, it can be concluded that the emissions will not significantly affect the air quality of the onshore area for any of the criteria pollutants. No further analysis or control measures are required.

A.4 Effluent Discharges

Effluent discharges are summarized in **EP Section F**. The discharges will include treated sanitary and domestic wastes, deck drainage, desalination unit brine, BOP fluid, non-pollutant well treatment and workover fluids, uncontaminated ballast and bilge water, noncontact cooling water, fire water, water-based drilling muds and cuttings, cuttings wetted with synthetic-based muds, and excess cement. All offshore discharges will be in accordance with requirements of the National Pollutant Discharge Elimination System (NPDES) General Permit No. GMG290000 issued by the U.S. Environmental Protection Agency (USEPA), including permit compliance terms, discharge volumes, discharge rates, and associated monitoring requirements.

Water-based drilling muds and cuttings will be released at the seafloor during initial well-drilling intervals. The marine riser that enables the return of muds and cuttings to the surface vessel will not be in place during the initial drilling intervals, requiring deposition of drilling muds and cuttings on the seafloor until the riser is in place. Excess cement slurry also will be released at the seafloor during casing installation for the riserless portion of the drilling operations. Once the riser is in place, synthetic-based drilling muds (SBMs) will be used and collected on the MODU. The collected SBM will be re-used by the vendor or transported to Port Fourchon, Louisiana, for recycling and disposal at an approved facility. Cuttings wetted with SBMs will be treated and discharged to the seafloor in accordance with the NPDES permit. An estimated 5% to 10% of SBM cuttings may be transported to shore for disposal at appropriate waste facility. Final drilling fluid and cement volumes for the proposed activities have not been determined.

A.5 Water Intake

Seawater will be drawn from the ocean for once-through, non-contact cooling of machinery on the MODU. Section 316(b) of the Clean Water Act requires NPDES permits to ensure that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available to minimize adverse environmental impact from impingement and entrainment of aquatic organisms. The current NPDES General Permit No. GMG290000 does not specify requirements for facilities that started construction before 17 July 2006. The MODU ultimately selected for this project will be in compliance with all cooling water intake structure requirements.

A.6 Onshore Waste Disposal

Wastes generated during the proposed activities are tabulated in **EP Section F**. A total of approximately 0.85 m^2 day^{-1} (30 ft^2 day^{-1}) of trash and debris will be generated over the life of the project. Trash will be transported to shore in disposal bags for final disposal by municipal operators in accordance with applicable regulations. Other wastes transported to shore for re-use, recycling, or disposal includes SBM and associated cuttings, chemical product waste (well treatment fluids), completion fluids, workover fluids, and used oil. All wastes will be transported to shore in containers approved by the U.S. Department of Transportation for re-use, recycling, or disposal in accordance with applicable regulations.

A.7 Marine Debris

Noble Energy will comply with all regulations relating to solid waste handling, transporation and disposal, including the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) Annex V requirements as well as USEPA, U.S. Coast Guard (USCG), and BOEM regulations. These regulations include prohibitions and compliance requirements regarding the deliberate discharging of containers and other similar materials (i.e., trash and debris) into the marine environment as well as the protective measures to be implemented to prevent the accidental loss of solid materials into the marine environment. For example, the BSEE regulations 30 CFR 250.300(a) and (b)(6) prohibit operators from deliberately discharging containers and other similar materials (i.e., trash and debris) into the marine environment, and 30 CFR 250.300(c) requires durable identification markings on equipment, tools, containers (especially drums), and other material. The USEPA and USCG regulations require operators to be proactive in avoiding accidental loss of solid materials by developing waste management plans, posting informational placards, manifesting trash sent to shore, and using special precautions such as covering outside trash bins to prevent accidental loss of solid waste. In addition to the regulations in 30 CFR 250, BSEE issued NTL BSEE-2015-G03, which instructs operators to exercise caution in the handling and disposal of small items and packaging materials, requires the posting of placards at prominent locations on offshore vessels and structures, and mandates a yearly training and certification process for marine trash and debris awareness.

A.8 Support Vessel and Helicopter Traffic

The project will be supported by one work vessel and one crew boat, each making an estimated four round trips per week between the project area and Port Fourchon, Louisiana. Detailed information is presented in **EP Section K**.

The vessels typically will transit to and from the project area via the most direct route from the shorebase. Noble Energy will use existing shorebase facilities at Port Fourchon, Louisiana, for the onshore support of crew and supply vessel activities. No port terminal expansion or construction is planned.

Offshore support vessels associated with the proposed project will contribute to the overall acoustic environment by transmitting noise through both air and water. The support vessels will use conventional diesel-powered screw propulsion. Vessel noise is a combination of narrow-band (tonal) and broadband sound (Richardson et al., 1995, Hildebrand, 2009, McKenna et al., 2012). Tones typically dominate up to approximately 50 Hz, whereas broadband sounds may extend to 100 kHz. The primary sources of vessel noise are propeller cavitation, propeller singing, and propulsion; other sources include auxiliary engine noise, flow noise from water dragging along the hull, and bubbles breaking in the vessel's wake (Richardson et al., 1995). The intensity of noise from support vessels is roughly related to ship size, weight, and speed. Broadband source levels for smaller boats (a category that include supply and other service vessels) are in the range of 150 to 180 dB re 1 µPa m (Richardson et al., 1995, Hildebrand, 2009, McKenna et al., 2012).

The project will be supported by one helicopter that will be used to transport personnel as well as small supplies and will take the most direct route of travel between the heliport and the lease area when air traffic and weather conditions permit. Details regarding helicopter trip frequency is presented in **EP Section K**. Helicopters typically maintain a minimum altitude of 700 ft (213 m) while in transit offshore, 1,000 ft (305 m) over unpopulated areas or across coastlines, and 2,000 ft (610 m) over populated areas and sensitive habitats such as wildlife refuges and park properties (BOEM, 2012a). Additional guidelines and regulations specify that helicopters maintain an altitude of 1,000 ft (305 m) within 300 ft (91 m) of marine mammals (BOEM, 2017a). Noble Energy will use existing air transportation (helicopter) facilities in Houma, Louisiana. No terminal expansion or construction is planned.

Dominant tones in noise spectra from helicopters are below 500 Hz with a source level of approximately 149 to 151 dB re 1 Pa m (for a Bell 212 helicopter) (Richardson et al., 1995). Levels of noise received underwater from passing aircraft depend on the aircraft's altitude, the aspect (direction and angle) of the aircraft relative to the receiver, receiver depth, water depth, and seafloor type (Richardson et al., 1995). Received level diminishes with increasing receiver depth when an aircraft is directly overhead, but may be stronger at mid-water than at shallow depths when an aircraft is not directly overhead (Richardson et al., 1995). Because of the relatively high expected airspeeds during transits and these physical variables, aircraft-related noise (including both airborne and underwater noise) is expected to be very brief in duration.

A.9 Accidents

The EIA focuses on two potential accidents:

- a small diesel fuel spill, which is the most likely type of spill during OCS activities (discussed in **Section A.9.1)**; and
- a large oil spill, up to and including the WCD for this EP (as detailed in **EP Section H**), which is an oil spill resulting from an uncontrolled blowout (discussed in **Section A.9.2**).

The following subsections summarize details regarding the sizes and fates of these spill scenarios. Impacts are analyzed in **Section C**.

Recent EISs (BOEM, 2014b, 2015, 2016b, 2017a) analyzed other types of accidents relevant to offshore operations that could lead to potential impacts to the marine environment: loss of well control, vessel collision, and chemical spills. These types of accidents, along with a hydrogen sulfide (H_2S) release, are discussed briefly below.

Loss of Well Control. A loss of well control is the uncontrolled flow of a reservoir fluid that may result in the release of gas, condensate, oil, drilling fluids, sand, or water. Loss of well control is a broad term that includes very minor up to the most serious well control incidents, while blowouts are considered to be a subset of more serious incidents with greater risk of oil spill or human injury (BOEM, 2016a, 2017a). Loss of well control may result in the release of drilling fluid or loss of oil. Not all loss of well control events result in blowouts (BOEM, 2017b). In addition to the potential release of gas, condensate, oil, sand, or water, the loss of well control can also resuspend and disperse bottom sediments (BOEM, 2012a, 2017a). BOEM (2016a) noted that most OCS blowouts have resulted in the release of gas.

Noble Energy has a robust system in place to prevent loss of well control. Measures to prevent a blowout, reduce the likelihood of a blowout, and conduct effective and early intervention in the event of a blowout are described in the NTL 2015-N01 package submitted with this EP, as required by BOEM. The potential for a loss of well control event will be minimized by adhering to the requirements of applicable regulations such as the Well Control Rule and NTL 2010-N10, which specify additional safety measures for OCS activities.

Vessel Collisions. BSEE data show that there were 110 OCS-related collisions between 2009 and 2015 (BSEE, 2016). Most collision mishaps are the result of support vessels colliding with platforms or vessel collisions with pipeline risers. Approximately 10% of vessel collisions with platforms in the OCS resulted in diesel spills, and in several collision incidents, fires resulted from hydrocarbon releases. To date, the largest diesel spill associated with a collision occurred in 1979 when an anchor-handling vessel collided with a drilling platform in the Main Pass lease area, spilling 1,500 bbl of diesel fuel. Diesel fuel is the product most frequently spilled, but oil, natural gas, corrosion inhibitor, hydraulic fluid, and lube oil also have been released as a result of vessel collisions. Human error accounted for approximately half of all reported vessel collisions from 2006 to 2010. As summarized by BOEM (2017b), vessel collisions occasionally occur during routine operations. Some of these collisions have caused spills of diesel fuel or chemicals. Noble Energy will comply with all USCG- and BOEM-mandated safety requirements to minimize the potential for vessel collisions.

Chemical Spills. Chemicals are stored and used for pipeline hydrostatic testing and during drilling and in well completion operations. The relative quantities of their use is reflected in the largest volumes spilled (BOEM, 2017b). Completion, workover, and treatment fluids are the largest quantity used and comprise the largest releases. Between 2007 and 2014, an average of two chemical spills <50 bbl in volume and three checmical spills >50 bbl in volume occurred each year (BOEM, 2017a).

H_2S Release. The lease area is classified as H_2S absent.

A.9.1 Small Diesel Fuel Spill

Spill Size. According to the analysis by BOEM (2017a), the most likely type of small spill (<1,000 bbl) resulting from OCS activities is a failure related to the storage of oil or diesel fuel. Historically, most diesel spills have been ≤1 bbl, and this is predicted to be the most common spill volume in ongoing and future OCS activities in the Western and Central Gulf of Mexico Planning Areas (Anderson et al., 2012). As the spill volume increases, the incident rate declines dramatically (BOEM, 2017a). The median size for spills ≤1 bbl is 0.024 bbl, and the median volume for spills of 1 to 10 bbl is 3 bbl (Anderson et al., 2012). For the EIA, a small diesel fuel spill of 3 bbl is used. Operational experience suggests that the most likely cause of such a spill would be a rupture of the fuel transfer hose resulting in a loss of contents (<3 bbl of fuel) (BOEM, 2012a).

Spill Fate. The fate of a small diesel fuel spill in the lease area would depend on meteorological and oceanographic conditions at the time of the spill as well as the effectiveness of spill response activities. However, given the open ocean location of the lease area and response actions required to be implemented by the responsible party, it is expected that impacts from a small spill would be minimal (BOEM, 2016a).

The water-soluble fractions of diesel are dominated by two- and three-ringed polycyclic aromatic hydrocarbons (PAHs), which are moderately volatile (National Research Council, 2003b). The constituents of these oils are light to intermediate in molecular weight and can be readily degraded by aerobic microbial oxidation. Due to its low density, diesel will not sink to the seafloor. Diesel dispersed in the water column can adhere to suspended sediments, but this generally occurs only in coastal areas with high suspended solids loads (National Research Council, 2003b) and would not be expected to occur to any appreciable degree in offshore waters of the Gulf of Mexico. The National Oceanic and Atmospheric Administration (NOAA) has reported that diesel oil is readily and completely degraded by naturally occurring microbes (NOAA, 2006).

Oil slicks from diesel spills within the marine environment are expected to persist for relatively short periods of time, ranging from minutes (for a <1 bbl spill) to hours (for a 1 to 10 bbl spill) to a few days (for a 10 to 1,000 bbl spill), and will rapidly spread out, evaporate, and disperse into the water column (BOEM, 2012a).

For the purposes of the EIA, the fate of a small diesel fuel spill was estimated using NOAA's Automated Data Inquiry for Oil Spills 2 (ADIOS2) model (NOAA, 2016a). This model uses the physical properties of various oil types in its database to predict the rate of evaporation and dispersion over time as well as changes in the density, viscosity, and water content of the spilled product. Based on model results, it is estimated that more than 90% of a small diesel spill would evaporate or disperse within 24 hours. The area of sea surface exhibiting floating diesel fuel during this 24-hour period would range from 0.5 to 5 ha (1.2 to 12 ac), depending on sea state and weather conditions.

The ADIOS2 results, coupled with spill trajectory information for a large spill, indicate that a small diesel fuel spill would not impact coastal or shoreline resources because of the distance of the lease area to the nearest shoreline (75 miles [121 km]). Modeling results indicate that a spill in the lease area would have a 1% conditional probbaility of reaching coastal Louisiana within 10 days of a spill and up to a 5% conditional probability of reaching coastal areas of Texas or

Louisiana within 30 days following a spill. By that time, essentially 100% of a small diesel fuel spill is expected to have dispersed or evaporated through natural processes, without taking into account Noble Energy's spill response measures. Because of the lack of persistence of small oil spills in the environment and the project's distance from shore, it is unlikely that a small spill within the project area would make landfall prior to dissipating (BOEM, 2012a, 2017a).

Spill Response. In the unlikely event that shipboard prevention procedures fail to circumvent a fuel spill, response equipment and trained personnel will be activated so that spill effects will be localized and will result only in short-term environmental consequences. **EP Section H** provides a detailed discussion of Noble Energy's response to a spill.

A.9.2 Large Oil Spill (Worst-Case Discharge)

Spill Size. The WCD scenario for this project is defined as an uncontrollable oil discharge from the subsea wellbore resulting from a blowout incident during drilling operations. The estimated worst case discharge at the seafloor for the proposed activities are 248,975 bbl with an API gravity of 36°. Detailed information is presented in **EP Section B**.

Blowout Scenario. In accordance with NTL 2015-N01 and as required by 30 CFR 550.213g, a scenario for a potential blowout of a well, and the highest volume of liquid hydrocarbons potentially released, has been detailed and is provided within **EP Section B**. The detailed analysis of the WCD calculations can be found in **EP Section B**, as required by NTL 2015-N01 and 30 CFR 550.219(a)(2)(iv). Descriptions of the measures to be undertaken by Noble Energy to prevent a blowout, reduce the likelihood of a blowout, and conduct effective and early intervention in the event of a blowout are included in the analysis. Noble Energy will also comply with NTL 2010-N10 and the Well Control Rule which specify additional safety measures for OCS activities.

Spill Probability. Holand (1997) estimated a probability of 0.0021 for a deep drilling blowout during exploration drilling based on U.S. Gulf of Mexico data. The International Association of Oil & Gas Producers (2010) conducted an analysis using the SINTEF[1] database and estimated a blowout frequency of 0.0017 per exploratory well for non-North Sea locations. BOEM updated OCS spill frequencies (barrels spilled per barrels produced) to include the Macondo incident. Spill rates for OCS platforms has decreased in recent years as the volume of oil handled has increased with no large spills since the Macondo spill. According to ABS Consulting Inc. (2016), the spill rate for spills >1,000 bbl dropped to 0.22 spills per billion barrels. According to BSEE's Well Control Rule (75 *Federal Register* 63365), issued following the Macondo spill, the baseline risk of a catastrophic blowout is estimated to be once every 26 years.

Spill Trajectory. The fate of a large oil spill in the lease area would depend on meteorological and oceanographic conditions at the time of the spill. The Oil Spill Risk Analysis (OSRA) model is a computer simulation of oil spill transport that uses realistic data for winds and currents to estimate spill trajectory. The OSRA report by Ji et al. (2004) provides conditional contact probabilities for shoreline segments along the Gulf of Mexico.

The results for the 30-day OSRA model for Launch Area 44 (where GC 40 is located) are presented in **Table 3**. Based on Launch Area 44, the model predicts a less than 0.5% chance of

[1] Stiftelsen for Industriell og Teknisk Forskning (Foundation for Scientific and Industrial Research, Norwegian Institute of Technology).

shoreline contact within 10 days of a spill for all shorelines except Terrebonne and Plaquemines Parishes, Louisiana, where a 1% chance of contact is predicted. Shoreline contact is predicted within 30 days of a spill for shorelines ranging from Matagorda County, Texas, to Plaquemines Parish, Louisiana. The conditional probability of shoreline contact is low (1% to 5%) for all shorelines with predicted contact within 30 days (**Table 3**).

Table 3. Conditional probabilities of a spill in the lease area contacting shoreline segments. From: Ji et al. (2004). Values are conditional probabilities that a hypothetical spill in the lease area (represented by Oil Spill Risk Analysis [OSRA] Launch Area 44) could contact shoreline segments within 3, 10, or 30 days.

Shoreline Segment	County or Parish and State	Conditional Probability[1] of Contact (%)		
		3 Days	10 Days	30 Days
C08	Matagorda County, Texas	--	--	1
C10	Galveston County, Texas	--	--	2
C12	Jefferson County, Texas	--	--	1
C13	Cameron Parish, Louisiana	--	--	5
C14	Vermilion Parish, Louisiana	--	--	2
C17	Terrebonne Parish, Louisiana	--	1	2
C18	Lafourche Parish, Louisiana	--	--	1
C19	Jefferson Parish, Louisiana	--	--	1
C20	Plaquemines Parish, Louisiana	--	1	4

[1] Conditional probability refers to the probability of contact within the stated time period, assuming that a spill has occurred (-- indicates <0.5%). Values are conditional probabilities that a hypothetical spill in GC 40 (represented by OSRA Launch Area 44) could contact shoreline segments within 3, 10, or 30 days.

The 30-day OSRA modeling results reported reported by Ji et al. (2004) did not evaluate the fate of a spill over time periods exceeding 30 days, nor did they estimate the fate of a release that continues over a period of weeks or months. As noted by Ji et al. (2004), the OSRA model does not consider the chemical composition or biological weathering of oil spills, the spreading and splitting of oil spills, or spill response activities. The model does not specify a particular spill size but has been used by BOEM to evaluate contact probabilities for spills of more than 1,000 bbl.

BOEM (2017b) presents additional OSRA modeling to simulate a spill that continues for 90 consecutive days, with each trajectory tracked for 60 days during four seasons. In this updated OSRA model, 60 days was chosen as a conservative estimate of the maximum duration that spilled oil would persist on the sea surface following a spill (BOEM, 2017b). The spatial resolution is limited, with seven launch points in the entire Western, Central, and Eastern Planning Areas of the Gulf of Mexico. These launch points were deliberately located in areas identified as having a high possibility of containing large oil reserves. The launch point most appropriate for modeling a spill in the lease area is Launch Point 3. The 60-day OSRA results for Launch Point 3 are presented in **Table 4**.

Table 4. Shoreline segments with a 1% or greater conditional probability of contact from a spill starting at Launch Point 3 based on the 60-day Oil Spill Risk Analysis. Values are conditional probabilities that a hypothetical spill in the lease area could contact shoreline segments within 60 days. Modified from: BOEM (2017b).

Season	Spring				Summer				Fall				Winter			
Day	3	10	30	60	3	10	30	60	3	10	30	60	3	10	30	60
County or Parish	Conditional Probability of Contact[1] (%)															
Cameron, Texas	--	--	--	--	--	--	--	2	--	--	--	1	--	--	--	1
Willacy, Texas	--	--	--	--	--	--	--	1	--	--	--	1	--	--	--	2
Kenedy, Texas	--	--	--	--	--	--	1	5	--	--	--	2	--	--	--	3
Kleberg, Texas	--	--	--	--	--	--	1	3	--	--	1	2	--	--	--	2
Nueces, Texas	--	--	--	--	--	--	--	2	--	--	1	2	--	--	--	3
Aransas, Texas	--	--	--	--	--	--	--	2	--	--	1	2	--	--	--	3
Calhoun, Texas	--	--	--	--	--	--	--	3	--	--	1	2	--	--	1	4
Matagorda, Texas	--	--	3	5	--	--	1	4	--	--	2	5	--	--	3	10
Brazoria, Texas	--	--	3	3	--	--	2	5	--	--	1	2	--	--	3	8
Galveston, Texas	--	--	3	5	--	--	2	3	--	--	1	2	--	--	2	5
Jefferson, Texas	--	--	4	5	--	--	1	1	--	--	--	--	--	--	1	2
Cameron, Louisiana	--	--	9	11	--	--	1	3	--	--	--	2	--	--	1	3
Vermilion, Louisiana	--	1	5	6	--	--	1	1	--	--	--	--	--	--	1	2
Iberia, Louisiana	--	1	3	3	--	--	--	--	--	--	--	--	--	--	--	1
St. Mary, Louisiana		--	1	1	--	--	--	--	--	--	--	--	--	--	--	--
Terrebonne, Louisiana	--	5	12	13	--	--	1	2	--	--	1	1	--	1	2	2
Lafourche, Louisiana	--	2	5	6	--	--	1	2	--	--	--	--	--	--	1	2
Jefferson, Louisiana	--	--	1	1	--	--	--	1	--	--	--	--	--	--	--	--
Plaquemines, Louisiana	--	3	10	10	--	--	2	3	--	--	--	--	--	--	2	2
St. Bernard, Louisiana	--	--	1	1	--	--	--	--	--	--	--	--	--	--	--	--
Baldwin, Alabama	--	--	1	1	--	--	--	--	--	--	--	--	--	--	--	--
Escambia, Florida	--	--	1	1	--	--	--	--	--	--	--	--	--	--	--	--
Okaloosa, Florida	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Bay, Florida	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Miami-Dade, Florida	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--
State Coastline	Conditional Probability of Contact[1] (%)															
Texas	--	--	13	19	--	--	7	30	--	--	7	21	--	--	11	44
Louisiana	--	12	46	52	--	2	6	12	--	1	2	4	--	2	8	12
Mississippi	--	--	1	1	--	--	--	1	--	--	--	--	--	--	--	--
Alabama	--	--	1	1	--	--	--	--	--	--	--	--	--	--	--	--
Florida	--	--	2	5	--	--	--	2	--	--	--	3	--	--	--	1

[1] Conditional probability refers to the probability of contact within the stated time period assuming that a spill has occurred (-- indicates <0.5%). Values are conditional probabilities that a hypothetical spill in the lease area could contact shoreline segments within 60 days.

From Launch Point 3, potential shoreline contacts within 60 days range from Cameron County, Texas (at the Texas-Mexico border), to Miami-Dade County in southeastern Florida. Based on statewide contact probabilities within 60 days, Texas and Louisiana have the highest likelihood of contact during all four seasons, with Louisiana having higher probabilities in spring (52%) and Texas having higher probabilities during summer, fall, and winter (ranging from 21% to 44% within 60 days). The model predicts a 1% probability of a spill contacting Mississippi shorelines during spring and summer, and a 1% probability of a spill contacting Alabama shorelines during spring. Florida shorelines are predicted to be contacted in any season with a probability up to 5% in spring. Based on the 60-day trajectories, counties or parishes with greater than

10% contact probability during any season include Matagorda County, Texas; and Cameron, Terrebonne, and Plaquemines Parishes in Louisiana (**Table 4**).

OSRA is a preliminary risk assessment model. In the event of an actual oil spill, real-time monitoring and trajectory modeling would be conducted using current and wind data available from the rigs and permanent production structures in the area. Satellite and aerial monitoring of the plume and real-time trajectory modeling using wind and current data would continue on a daily basis to help position equipment and human resources throughout the duration of any major spill or uncontrolled release.

Weathering. Following an oil spill, several physical, chemical, and biological processes, collectively called weathering, interact to change the physical and chemical properties of the oil, influencing potential effects to marine organisms and ecosystems. The most important weathering processes include spreading, evaporation, dissolution, dispersion into the water column, formation of water-in-oil emulsions, photochemical oxidation, microbial degradation, adsorption to suspended particulate matter, and stranding on shore or sedimentation to the seafloor (National Research Council, 2003b).

Weathering decreases the concentration of oil and produces changes in its chemical composition, physical properties, and toxicity (Tarr et al., 2016). The more toxic, light aromatic and aliphatic hydrocarbons are lost rapidly by evaporation and dissolution from a slick on the water surface. For example, the light, paraffinic crude oil spilled during the *Deepwater Horizon* incident lost approximately 55 wt. % to evaporation during the first 3 to 5 days while floating on the sea surface (Daling et al., 2014). Evaporated hydrocarbons are degraded rapidly by sunlight. Biodegradation of oil on the water surface and in the water column by marine bacteria is a dynamic process; microbes have been shown to first degrade the n-alkanes and then the light aromatics from the oil. Other petroleum components are biodegraded more slowly (Hazen et al., 2016). Photo-oxidation affects mainly the medium and high molecular weight PAHs in the oil on the water surface.

Spill Response. Noble Energy's Regional OSRP was last approved in September 2015. A bienneal update to the OSRP was submitted to BSEE in September 2017. The OSRP provides a detailed plan that enables Noble Energy to respond rapidly and effectively manage response efforts for oil spills that may result from drilling and production operations. In the event of a large oil spill up to and including a WCD, Noble Energy has access to surface and subsea response/containment capabilities that could be implemented through Clean Gulf Associates (CGA) or Marine Spill Response Corporation (MSRC) .

CGA has several skimming vessels capable of operating in shallow waters, nearshore areas, and offshore areas. These vessels have oleophilic brush pack skimming systems operating in troughs built into the hulls; below deck storage; and marine electronics packages including marine, aircraft, and company frequency radios, radar, moving map plotters, GPS, satellite phones, and depth finders. CGA also offers several fast response units and vessels staged throughout the Gulf of Mexico available for offshore use, in addition to 11 sets of Koseq skimming arms.

The CGA high-volume open sea skimmer (HOSS) barge consists of a skimming system built into an oil recovery barge. There are four 1,000-bbl recovered oil storage tanks built into the hull where oil can be separated and offloaded. Skimming operations are conducted from the control room overlooking the skimmer deck. An x-band radar/infrared tracking system is installed on the HOSS barge. Additional CGA equipment can be referenced online at http://www.cleangulfassoc.com/equipment.

Noble Energy also has a contract with the MSRC for additional spill response equipment. MSRC has a dedicated fleet for the Atlantic/Gulf of Mexico region and additional available equipment staged throughout the U.S. MSRC equipment staged throughout the Gulf of Mexico includes 7 oil spill response vessels, 2 fast response vessels, 5 oil spill response barges, 4 skimming vessels, and 18 shallow water barges. Various equipment is outfitted with x-band radar and infrared technology for detecting surface oil.

MSRC expanded its resources and capability in the Gulf of Mexico with particular focus on deep water, known as "Deep Blue." Additional MSRC capabilities and a complete equipment listing are available online at http://www.msrc.org/.

See **EP Section H** for a detailed description of Noble Energy's site-specific spill response measures for the plan.

B. Affected Environment

The lease area is approximately 75 miles (121 km) from the nearest shoreline (Louisiana), 82 miles (132 km) from the onshore support base at Port Fourchon, Louisiana, and 122 miles (196 km) from the helicopter base at Houma, Louisiana (**Figure 1**). The water depth at the proposed wellsites ranges from approximately 2,124 to 2,129 ft (647 to 649 m) (**Figure 2**).

The site clearance letters for the proposed wellsites noted the existence of the GC 40-1 wellsite within 3,000 ft (915 m) of the proposed wellsites. Additionally, Fugro Marine Geoservices (2017) noted several side scan sonar contacts within 2,000 ft (610 m) of the proposed wellsites, but none were recommended for archaoelogical avoidance.

The proposed area is clear of constraining geological seafloor conditions. No high-density deepwater benthic or chemosynthetic communities were noted within 2,000 ft (610 m) of the proposed wellsite locations (Fugro Marine Geoservices, 2017).

A detailed description of the regionally affected environment, including meteorology, oceanography, geology, air and water quality, benthic communities, threatened and endangered species, biologically sensitive resources, archaeological resources, socioeconomic conditions, and other marine uses is provided by BOEM (2012a, 2013a, 2014a, 2015, 2016b, 2017a). These regional descriptions remain valid and are incorporated by reference. Brief descriptions of each potentially affected resource, including site-specific or new information if available, are presented in **Section C**.

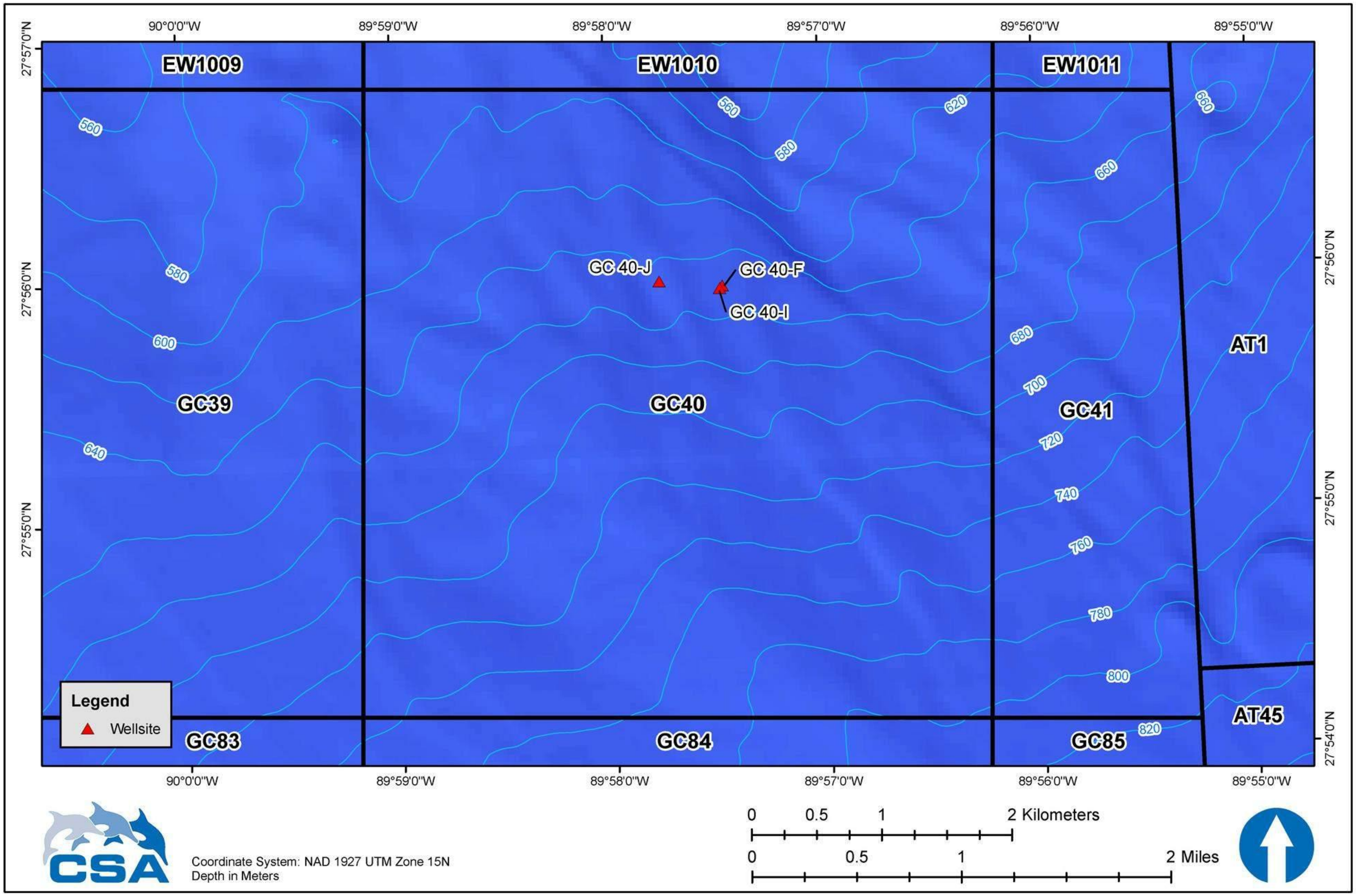

Figure 2. Bathymetric profile of the lease area showing the surface hole locations of the proposed wellsites in Green Canyon Block 40.

C. Impact Analysis

This section analyzes the potential direct and indirect impacts of routine activities and accidents. Impacts have been analyzed extensively in multisale EISs for the Western and Central Gulf of Mexico Planning Areas (BOEM, 2012a, 2013b, 2014a, 2015, 2017a). The information in these documents is incorporated by reference. Potential site-specific issues are addressed in this section. The following sections are organized by the Environmental Resources identified in **Table 2**, and address each potential IPF. Potential site-specific issues are addressed in this section.

C.1 Physical/Chemical Environment

C.1.1 Air Quality

There are no site-specific air quality data for the project area due to the distance from shore. However, because of the distance from shore-based pollution sources and the lack of sources of pollutants offshore, air quality at the wellsites is expected to be good. The attainment status of federal OCS waters is unclassified because there is no provision in the Clean Air Act for classification of areas outside state waters (BOEM, 2012a).

In general, the ambient air quality of coastal counties along the Gulf of Mexico is relatively good (BOEM, 2012a). As of June 2017, Mississippi, Alabama, and Florida Panhandle coastal counties are in attainment of the National Ambient Air Quality Standards (NAAQS) for all criteria pollutants. St. Bernard Parish in Louisiana is a nonattainment area for sulfur dioxide based on the 2010 standard. Houston-Galveston-Brazoria in Texas is a nonattainment areas for 8-hr ozone based on the 1997 and 2008 standards, and one coastal metropolitan area in Florida (Tampa) is a nonattainment area for lead based on the 2008 standard (USEPA, 2017).

As noted earlier, based on calculations made pursuant to applicable regulations, emissions from drilling and completion activities are not expected to be significant because they are below exemption levels. Therefore, the only potential effects to air quality would be from air pollutant emissions associated with routine operations, and accidental spills (a small diesel fuel spill or a large oil spill). These IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of Air Pollutant Emissions

Offshore air pollutant emissions are the only routine IPF likely to affect air quality. Offshore air pollutant emissions will result from MODU, helicopter, and support vessel operations. These emissions occur mainly from combustion or burning of diesel fuel and Jet-A aircraft fuel. The combustion of fuels occurs primarily in diesel-powered generators, pumps, or motors as well as from lighter fuel motors. Primary air pollutants typically associated with OCS activities are suspended particulate matter (PM), sulfur oxides (SOx), nitrogen oxides (NOx), volatile organic compounds (VOCs), and carbon monoxide (CO). As noted by BOEM (2012a, 2017a), air pollutant emissions from routine activities are projected to have minimal impacts to onshore air quality because of the prevailing atmospheric conditions, anticipated emission rates, anticipated heights of emission sources, and the distance from shore of the proposed activities and associated pollutant concentrations. The Air Quality Emissions Report (see **EP Section G**) prepared in accordance with BOEM requirements shows that the projected emissions are below exemption levels. Given the levels of expected emissions and the distance of the project from shore, emissions from the proposed activities described in Noble Energy's EP are not likely to contribute to violations of any NAAQS on shore. Therefore, according to 30 CFR 550.303, the emissions will not significantly affect the air quality of the onshore area for any of the criteria pollutants.

Greenhouse gas emissions contribute to climate change, with important impacts on temperature, rainfall, frequency of severe weather, ocean acidification, and sea level rise (Intergovernmental Panel on Climate Change, 2014). Greenhouse gas emissions from the proposed project represent a negligible contribution to the total greenhouse gas emissions from reasonably foreseeable activities in the Gulf of Mexico area and would not significantly alter or exceed any climate change impacts evaluated in the Programmatic EIS (BOEM, 2016a). Carbon dioxide (CO_2) and methane (CH_4) emissions from the project would constitute a small incremental contribution to greenhouse gas emissions from all OCS activities. According to Programmatic and OCS lease sale EISs (BOEM, 2012a, 2016a), estimated CO_2 emissions from OCS oil and gas sources represent 0.4% of the U.S. total. Greenhouse gas emissions from the proposed project represent a negligible contribution to the total greenhouse gas emissions from reasonably foreseeable activities in the Gulf of Mexico area and would not significantly alter any climate change impacts evaluated in the Programmatic EIS (BOEM, 2016a).

The Breton Wilderness Area, which is part of the Breton National Wildlife Refuge (NWR), is designated under the Clean Air Act as a Prevention of Significant Deterioration Class I air quality area. BOEM is required to notify the National Park Service and U.S. Fish and Wildlife Service (USFWS) if emissions from proposed projects may affect the Breton Class I area. Additional review and mitigation measures may be required for sources that exceed emission limits agreed upon by the administering agencies within 186 miles (300 km) of the Breton Class I area (National Park Service, 2010). The lease area is approximately 113 miles (182 km) from the Breton Wilderness Area. Based on Noble Energy's Air Quality Emissions report (**EP Section G**), no significant impacts on coastal air quality are expected, including in the Breton Wilderness Area. Noble Energy will comply with all BOEM requirements regarding air emissions.

Impacts of a Small Diesel Fuel Spill

Potential impacts of a small diesel spill on air quality are expected to be consistent with those analyzed and discussed by BOEM (2012a, 2015, 2016b, 2017a). The probability of a small spill occurring would be minimized by Noble Energy's preventative measures that will be implemented during routine operations, including fuel transfer. In the unlikely event of a spill, implementation of Noble Energy's Regional OSRP could reduce the potential impacts. **EP Section H** includes a detailed discussion of the spill response measures that would be employed. Given the open ocean location of the lease area, the extent and duration of air quality impacts from a small spill would not be significant.

A small diesel fuel spill would affect air quality near the spill site by introducing VOCs into the atmosphere through evaporation. The ADIOS2 model (see **Section A.9.1**) indicates that more than 90% of a small diesel spill would evaporate or disperse within 24 hours. The sea surface area covered with small diesel fuel would range from 0.5 to 5 ha (1.2 to 12 ac), depending on sea state and weather conditions.

A small diesel fuel spill would not affect coastal air quality because the spill would not be expected to make landfall or reach coastal waters prior to natural dispersion (see **Section A.9.1**).

Impacts of a Large Oil Spill

Potential impacts of a large oil spill on air quality are expected to be consistent with those analyzed and discussed by BOEM (2012a, 2015, 2016b, 2017a).

A large oil spill could affect air quality by introducing VOCs into the atmosphere through evaporation from the slick. The extent and persistence of impacts would depend on the meteorological and oceanographic conditions at the time and the effectiveness of spill response measures. Real-time wind and current data from the project area would be available at the time of a spill and would be used to assess the fate and effects of VOCs released. Additional air quality impacts could occur if response measures included *in situ* burning of the floating oil. Burning would generate a plume of black smoke and result in emissions of NOx, SOx, CO, and PM as well as greenhouse gases. However, *in situ* burning would occur as a response measure only if authorized by the USEPA.

Based on the 30-day OSRA modeling (**Table 3**), Cameron Parish in Louisiana is the coastal area most likely to be affected (5% probability within 30 days). Based on the 60-day OSRA modeling estimates (**Table 4**), the potential shoreline contacts range from Cameron County, Texas, to Miami-Dade County, Florida. However, due to the lease area's distance from the nearest shoreline, most air quality impacts are likely to occur in offshore waters, and substantial impacts to onshore air quality are not expected.

C.1.2 Water Quality

There are no site-specific baseline water quality data for the lease area. Due to the lease location in deep, offshore waters, water quality is expected to be good, with low levels of contaminants. Deepwater areas in the northern Gulf of Mexico are relatively homogeneous with respect to temperature, salinity, and oxygen (BOEM, 2017a). Kennicutt (2000) noted that the deepwater region has little evidence of contaminants in the dissolved or particulate phases of the water column. However, there are localized occurrences of natural seepage of oil, gas, and brines in near-surface sediments and up through the water column. Within the northern Gulf of Mexico , there are localized areas (termed natural seeps) that release oil, gas, and brines from sub-surface deposits into near-surface sediments and up through the water column. Based on the site clearance letters for proposed wellsites, no natural seeps were noted in the vicinity of the proposed wellsites (Fugro Marine Geoservices, 2017).

IPFs that could affect water quality are effluent discharges associated with routine operations and two types of accidents (a small diesel fuel spill and a large oil spill). These IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of Effluent Discharges

Water-based drilling muds (WBM) and cuttings will be released at the seafloor during the initial well intervals before the marine riser is set, which allows their return to the surface vessel. Excess cement slurry will also be released at the seafloor during casing installation for the riserless portion of the drilling operations. Impacts, as discussed further below, will be to the immediate discharge area with little impact to water quality.

Cuttings wetted with SBMs will be treated and discharged overboard at the drillsite in accordance with all NPDES permit limitations and requirements. After discharge, WBM and SBM retained on cuttings would be expected to adhere tightly to the cuttings particles and, consequently, would not produce substantial turbidity as the cuttings sink through the water column (Neff et al., 2000). In general, turbid water can be expected to extend between a few hundred meters and several kilometers down current from the discharge point for drilling mud and cuttings (National Research Council, 1983, Neff, 1987). There will be no persistent impacts on water quality in the lease area. SBMs will be collected on the MODU and either re-used by the vendor or transported to Port Fourchon, Louisiana, for recycling or disposal at an approved facility.

Treated sanitary and domestic wastes, including those from support vessels, may have a slight transient effect on water quality in the immediate vicinity of these discharges. Treated sanitary and domestic wastes may have elevated levels of nutrients, organic matter, and chlorine but should dilute rapidly to undetectable levels within tens to hundreds of meters from the source. All NPDES permit limitations and requirements, as well as USCG regulations (as applicable), will be met; therefore, little or no impact on water quality from the overboard release of treated sanitary and domestic wastes is anticipated.

Deck drainage includes all effluents resulting from rain, deck washings, and runoff from curbs, gutters, and drains, including drip pans in work areas. Rainwater that falls on uncontaminated areas of the MODU will flow overboard without treatment. However, rainwater that falls on the deck of the drill floor and other areas such as chemical storage areas and places where equipment is exposed will be collected and oil and water separated prior to discharge to meet NPDES permit requirements. Based on adherence to permit limits and applicable regulations, little or no impact on water quality from deck drainage is anticipated.

Other discharges in accordance with the NPDES permit, such as desalination unit brine, BOP fluid, non-pollutant well treatment and workover fluids, ballast and bilge water, noncontact cooling water, and fire water are expected to dilute rapidly, resulting in little or no impact on water quality.

Impacts of a Small Diesel Fuel Spill

Potential impacts of a small diesel spill on water quality are expected to be consistent with those analyzed and discussed by BOEM (2012a, 2015, 2016b, 2017a). The probability of a small spill occuring would be minimized by Noble Energy's preventative measures that will be implemented during routine operations, including fuel transfers. In the unlikely event of a spill, implementation of Noble Energy's Regional OSRP will help mitigate and thus reduce potential impacts. **EP Section H** provides detail on spill response measures in addition to the summary information provided in the EIA.

The water-soluble fractions of diesel are dominated by two- and three-ringed polycyclic aromatic hydrocarbons (PAHs), which are moderately volatile (National Research Council, 2003b). The molecular weight of diesel oil constituents are light to intermediate and can be readily degraded by aerobic microbial oxidation. Diesel oil is much lighter than water (specific gravity is between 0.83 and 0.88, compared to 1.03 for seawater). When spilled on water, diesel oil spreads very quickly to a thin film of rainbow and silver sheens, except for marine diesel, which may form a thicker film of dull or dark colors. However, because diesel oil has a very low viscosity, it is readily dispersed into the water column when winds reach 5 to 7 knots or with breaking waves (NOAA, 2017a). It is possible for the diesel oil that is dispersed by wave action to form droplets that are small enough be kept in suspension and moved by the currents.

Diesel dispersed in the water column can adhere to suspended sediments, but this generally occurs only in coastal areas with high suspended solid loads (National Research Council, 2003b) and would not be expected to occur to any appreciable degree in offshore waters of the Gulf of Mexico.

The extent and persistence of water quality impacts from a small diesel fuel spill would depend on the meteorological and oceanographic conditions at the time and the effectiveness of spill response measures. It is estimated that more than 90% of a small diesel spill would evaporate or disperse within 24 hours (see **Section A.9.1**). The sea surface area covered with a very thin layer of diesel fuel would range from 0.5 to 5 ha (1.2 to 12 ac), depending on sea state and weather conditions. In addition to removal by evaporation, constiuents of diesel oil are readily and completely degraded by naturally occurring microbes (NOAA, 2006). Given the open ocean location of the lease area, the extent and duration of water quality impacts from a small spill are not expected to be significant.

A small diesel fuel spill would not substantially affect coastal water quality because the spill would not be expected to make landfall or reach coastal waters due to both response efforts that would be undertaken as well as natural attenuation (see **Section A.9.1**).

Impacts of a Large Oil Spill

Potential impacts of a large oil spill on water quality are expected to be consistent with those analyzed and discussed by BOEM (2012a, 2015, 2016b, 2017a). Additional air quality impacts could occur if response measures included *in situ* burning of the floating oil. Burning would generate a plume of black smoke and result in emissions of NOx, SOx, CO, and PM as well as greenhouse gases. However, *in situ* burning would occur only if authorized by the USEPA. Most of the spilled oil would be expected to form a slick at the surface, though small droplets in the water may adhere to suspended sediments and be removed from the water column (Operational Science Advisory Team, 2010). Information from the Macondo spill indicates that plumes of submerged oil droplets can be produced when subsea dispersants are applied at the wellhead (Camilli et al., 2010, Hazen et al., 2010, NOAA, 2011a, b, c). Subsea dispersants would be applied only after approval from the USEPA.

Analyses of the full set of samples associated with the Macondo spill have confirmed that the application of subsurface dispersants resulted in subsurface hydrocarbon plumes (Spier et al., 2013). A report by Kujawinski et al. (2011) indicates that chemical components of subsea dispersants used during the Macondo spill persisted for up to 2 months and were detected up to 186 miles (300 km) from the wellsite in water depths of 3,280 to 3,937 ft (1,000 to 1,200 m). Although dispersants were detected by laboratory analysis in 353 of the 4,114 water samples, concentrations were significantly below the chronic screening level for dispersants (BOEM, 2012a).

Hazen et al. (2010) studied the impacts and fate of deepwater oil. Initial studies suggested that the potential exists for rapid intrinsic bioremediation (bacterial degradation) of subsea dispersed oil in the water column by deep-sea indigenous microbial activity without significant oxygen depletion (Hazen et al., 2010), although other studies showed that oil bioremediation caused oxygen drawdown in deep waters (Kessler et al., 2011, Dubinsky et al., 2013). Additional studies investigated the effects of deepwater dissolved hydrocarbon gases (e.g., methane, propane, and ethane) and the microbial response to a deepwater oil spill. Results suggest deepwater dissolved hydrocarbon gases may promote rapid hydrocarbon respiration by low-diversity bacterial blooms, thus priming indigenous bacterial populations for rapid hydrocarbon degradation of subsea oil (Kessler et al., 2011, Du and Kessler, 2012, Valentine et al., 2014). A 2017 study identified water temperature, taxonomic composition of initial bacterial community, and dissolved nutrient levels as factors that may regulate oil degradation rates by deep-sea indigenous microbes (Liu et al., 2017).

The extent and persistence of impacts would depend on the meteorological and oceanographic conditions at the time and the effectiveness of spill response measures. Real-time wind and current data from the project area would be available at the time of a spill and would be used to assess the fate and effects of VOCs released. Weathering processes that affect spilled oil on the sea include adsorption (sedimentation), biodegradation, dispersion, dissolution, emulsification, evaporation, and photo oxidation. Most crude oil blends will emulsify quickly when spilled, creating a stable mousse that presents a more persistent cleanup and removal challenge (NOAA, 2017b).

Because of the lease area's distance from the nearest shoreline, it is expected that most water quality impacts would occur in offshore waters. Depending on the spill trajectory and the effectiveness of spill response measures, coastal water quality could be affected. Based on the 30-day OSRA modeling estimates (**Table 3**), nearshore waters and embayments of Cameron Parish, Louisiana, is the coastal area with the most potential for water quality to be affected. However, the 60-day OSRA estimates potential shoreline contacts ranging from Cameron County, Texas, to Miami-Dade County, Florida (**Table 4**).

C.2 Seafloor Habitats and Biota

According to BOEM (2016a), existing information for the deepwater Gulf of Mexico indicates that the seafloor is composed primarily of soft sediments; exposed hard substrate habitats and associated biological communities are rare. The water depth at the proposed wellsites ranges from approximately 4,015 to 4,165 ft (1,224 to 1,269 m). Based on the site clearance letter for proposed wellsites, no high-density deepwater benthic or chemosynthetic communities are located within 2,000 ft (610 m) of the proposed wellsite locations(Fugro Marine Geoservices, 2017).

C.2.1 Soft Bottom Benthic Communities

There are no site-specific benthic community data from the lease area. However, data from the Northern Gulf of Mexico Continental Slope Habitats and Benthic Ecology Study (Wei, 2006, Rowe and Kennicutt, 2009, Wei et al., 2010, Carvalho et al., 2013) can be used to describe typical baseline benthic communities that occur at similar water depths elsewhere in the region. **Table 5** summarizes data collected at nearby stations in water depths similar to the proposed activities area.

Table 5. Baseline benthic community data from stations near the lease area and in similar water depths sampled during the Northern Gulf of Mexico Continental Slope Habitats and Benthic Ecology Study. Adapted from: Wei (2006) and Rowe and Kennicutt (2009).

Station	Faunal Zone	Water Depth (m)	Abundance		
			Meiofauna (individuals m^{-2})	Macroinfauna (individuals m^{-2})	Megafauna (individuals ha^{-1})
C7	2E	1,072	542,119	3,293	625
MT3	2E	996	885,995	4,924	1,034

Meiofaunal and megafaunal abundances from Rowe and Kennicutt (2009); macroinfaunal abundance from Wei (2006).

Densities of meiofauna (animals passing through a 0.5-mm sieve but retained on a 0.062-mm sieve) at sampling stations in the vicinity of the lease area typically range from approximately 540,000 to 890,000 individuals m^{-2} (Rowe and Kennicutt, 2009). Nematodes, nauplii (crustacean larvae), and harpacticoid copepods were the three dominant meiofaunal groups, accounting for approximately 90% of total abundance.

The benthic macroinfauna is characterized by small mean individual sizes and low densities, both of which reflect the intrinsically low primary production in surface waters of the Gulf of Mexico continental slope (Wei, 2006). Based on an equation presented by Wei (2006) in which densities decrease exponentially with water depth, the macroinfaunal density at a water depth ranging from approximately 2,124 to 2,129 ft (647 to 649 m) is expected to be approximately 4,200 individuals m^{-2}; however, actual densities at the proposed project location are unknown. Macrofauna density at sampling stations in the vicinity of the lease area ranged from approximately 3,000 to 4,900 individuals m^{-2}.

Polychaetes typically are the most abundant macroinfaunal group on the northern Gulf of Mexico continental slope, followed by amphipods, tanaids, bivalves, and isopods. Carvalho et al. (2013) found polychaete abundance to be higher in the central region compared to the eastern and western regions. Wei (2006) recognized four depth-dependent faunal zones (1 through 4), two of which are divided horizontally. The lease area is located in Zone 2E. The most abundant species in Zone 2E were the polychaetes *Aricidea suecica*, *Litocorsa antennata*, *Paralacydonia paradoxa*, and *Tharyx marioni*; and the bivalve *Heterodonta* sp. D.

Megafaunal densities from nearby stations ranged from 625 to 1,034 individuals ha^{-1} (**Table 5**). Common megafauna included motile groups such as decapods, ophiuroids, holothurians, and demersal fishes, as well as sessile groups such as sponges and anemones. Common megafauna included motile groups such as decapods, ophiuroids, holothurians, and demersal fishes as well as sessile groups such as sponges and anemones.

Bacteria also are an important component in terms of biomass and cycling of organic carbon (Cruz-Kaegi, 1998). For example, in deep sea sediments, Main et al. (2015) observed that microbial oxygen consumption rates increased and bacterial biomass decreased with hydrocarbon contamination. Bacterial biomass at the depth range of the lease area typically is 1 to 3 g C m^{-2} in the top 6 in. (15 cm) of sediments (Rowe and Kennicutt, 2009).

The only IPFs that may affect benthic communities from this project are the physical disturbance to the seafloor around the wellbore where the bottom template and BOP are located, from seafloor effluent discharges, and potential effects from a large oil spill (WCD) resulting from a well blowout at the seafloor. Effluent discharges at the surface and a small diesel fuel spill would not affect benthic communities because both would float and dissipate on the sea surface. The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of Physical Disturbance to the Seafloor

In water depths such as those encountered in the lease area, the areal extent of seafloor impacts will be small compared to the lease area itself. DP MODUs disturb only the seafloor around the wellbore where the bottom template and BOP are located. Depending on the specific well configuration, this area is generally 0.25 ha (0.62 ac) per well (BOEM, 2012a).

Soft bottom communities are ubiquitous along the northern Gulf of Mexico continental slope (Gallaway, 1988, Gallaway et al., 2003, Rowe and Kennicutt, 2009), and impacts from the physical disturbance of the seafloor during this project will be localized and likely will have no significant impact on soft bottom benthic communities in the region due to distance of the wellsites from these communities.

Impacts of Effluent Discharges

Drilling muds and cuttings are the only effluents that are likely to affect benthic communities. During initial well interval(s) before the marine riser is set, cuttings and WBM will be released at the seafloor. Excess cement slurry also will be released at the seafloor during casing installation for the riserless portion of the drilling operations. Cement slurry components typically include cement mix and some of the same chemicals used in WBM (Boehm et al., 2001). The main impacts will be burial and smothering of benthic organisms within several hundred meters around the wellbore. Soft bottom sediments disturbed by cuttings, drilling muds, and cement slurry will eventually be recolonized through larval settlement and migration from adjacent areas. Because some deep-sea biota grow and reproduce slowly, recovery could require several years.

Discharges of washed SBM cuttings from the MODU may affect benthic communities, primarily within several hundred meters of the wellsites. The fate and effects of SBM cuttings have been reviewed by Neff et al. (2000), and monitoring studies have been conducted in the Gulf of Mexico by Continental Shelf Associates (2004, 2006). In general, washed cuttings with adhering SBMs tend to clump together and form thick cuttings piles close to the drillsite. Areas of deposited SBM cuttings may develop elevated organic carbon concentrations and anoxic conditions (Continental Shelf Associates, 2006). Where SBM cuttings accumulate in concentrations of approximately 1,000 mg kg^{-1} or higher, benthic infauna communities may be adversely affected due to both the toxicity of the base fluid and organic enrichment (with resulting anoxia) (Neff et al., 2000). Infauna numbers may increase and diversity may decrease as opportunistic species that tolerate low oxygen and high H_2S predominate (Continental Shelf Associates, 2006). As the base synthetic fluid is decomposed by microbes, the area will gradually return to pre-drilling conditions. Disturbed sediments will be recolonized through larval settlement and migration from adjacent areas.

The areal extent of impacts from drilling muds and cuttings discharges will be small; the typical effect radius is approximately 1,640 ft (500 m) around each wellsite. Although soft bottom communities are ubiquitous along the northern Gulf of Mexico continental slope (Gallaway, 1988, Gallaway et al., 2003, Rowe and Kennicutt, 2009), the impact radius of drilling discharges during this project is an extremely small footprint compared to the extensive geographic coverage of these communities and is not expected to have a significant regional impact on soft bottom benthic communities.

Impacts of a Large Oil Spill

The most likely effects on benthic communities of a subsea blowout of oil would be within a few hundred meters of the wellsite. BOEM (2012b) estimated that a severe subsurface blowout could resuspend and disperse sediments within a 984 ft (300 m) radius. While coarse sediments (sands) would probably settle at a rapid rate within 1,312 ft (400 m) of the blowout site, fine sediments (silts and clays) could be resuspended for more than 30 days and dispersed over a much wider area. Based on previous studies, surface sediments at the project area are assumed to largely be silt and clay (Rowe and Kennicutt, 2009).

While impacts on benthic communities from large oil spills are anticipated to be confined to the immediate vicinity of the wellhead, depending on the specific circumstances of the incident, additional benthic community impacts could extend beyond the immediate vicinity of the wellhead (BOEM, 2016b). During the Macondo spill, the use of subsea dispersants at the wellhead caused the formation of subsurface plumes (NOAA, 2011c). The subsurface plumes were reported in water depths of approximately 3,600 ft (1,100 m), extending at least 22 miles (35 km) from the wellsite and persisting for more than a month (Camilli et al., 2010). The subsurface oil plumes apparently resulted from the use of subsea dispersants at the wellhead (NOAA, 2011c, Spier et al., 2013). Montagna et al. (2013) mapped the benthic footprint of the Macondo spill and estimated that the most severe impacts to soft bottom benthic communities (e.g., reduction of faunal abundance and diversity) extended 4.8 miles (3 km) from the wellhead in all directions, covering an area of approximately 9.3 miles^2 (24 km^2). Moderate impacts were observed up to 10.6 miles (17 km) to the southwest and 5.3 miles (8.5 km) to the northeast of the wellhead, covering an area of 57 miles^2 (148 km^2). NOAA (2016b) documented a footprint of over 772 miles^2 (2,000 km^2) of impacts to benthic habitats surrounding the Macondo spill site. The analysis also identified a larger area of approximately 3.552 miles^2 (9,200 km^2) of potential exposure and uncertain impacts to benthic communities (NOAA, 2016b).

While the behavior and impacts of subsurface oil plumes are not well known, the Macondo findings indicate that benthic impacts could extend beyond the immediate vicinity of the wellsite, depending on the extent, trajectory, and persistence of the plume. Baguley et al. (2015) studied the meiofaunal benthic community response to the Macondo spill and noted that while nematode abundance increased with proximity to the Macondo wellhead, copepod abundance, relative species abundance, and diversity decreased. Baguley et al. (2015) hypothesized that the increase in nematode abundance with the proximity to the spill location could potentially represent a balance between organic enrichment and toxicity.

Oil contact could result in smothering or toxicity to benthic organisms. Any affected area would be recolonized by benthic organisms over a period of months to years (National Research Council, 1983).

C.2.2 High-Density Deepwater Benthic Communities

As defined by NTL 2009-G40, high-density deepwater benthic communities are features or areas that could support chemosynthetic communities, deepwater corals, and other associated hard bottom communities. Chemosynthetic communities were discovered in the central Gulf of Mexico in 1984 and have been studied extensively (MacDonald, 2002). Deepwater coral communities are also known from numerous locations in the Gulf of Mexico (Brooke and Schroeder, 2007, CSA International, 2007, Brooks et al., 2012). These communities occur almost exclusively on exposed authigenic carbonate rock created by a biogeochemical (microbial) process.

Monitoring programs on the Gulf of Mexico continental slope have shown that benthic impacts from drilling discharges typically are concentrated within approximately 1,640 ft (500 m) of the wellsite, although detectable deposits may extend beyond this distance (Continental Shelf Associates, 2004, Neff et al., 2005, Continental Shelf Associates, 2006). In water depths such as those encountered in the project area, DP drilling vessels disturb the seafloor only around the wellbore where the bottom template and BOP are located. Depending on the specific well configuration, this area is approximately 0.25 ha (0.62 ac) per well (BOEM, 2012a).

No high density deepwater benthic or chemosynthetic communities were found within 2,000 ft (610 m) of the proposed wellsite locations (Fugro Marine Geoservices, 2017). The nearest known high-density deepwater benthic community site is approximately 4,298 ft (1,310 m) miles (34 km) northwest from the proposed wellsites (MacDonald et al., 1995, U.S. Geological Survey, 2011, BOEM, nd).

The only IPF identified for this project that could affect high-density deepwater benthic communities is a large oil spill from a well blowout at the seafloor. A small diesel fuel spill would not affect benthic communities because the diesel fuel would float and dissipate on the sea surface. Physical disturbance and effluent discharge are not considered to be IPFs for deepwater benthic communities, because these communities are not known to be present within the area around the wellbore where the bottom template and BOP are located.

Impacts of a Large Oil Spill

A large oil spill caused by a seafloor blowout could cause direct physical alteration of the seafloor (e.g., formation of a caldera) within approximately 984 ft (300 m) of the wellhead (BOEM, 2012a). Based on the site clearance letters for proposed wellsites (Fugro Marine Geoservices, 2017), there is no evidence of the presence of high-density deepwater benthic or chemosynthetic communities within 2,000 ft (610 m) proposed wellsites. Therefore, this type of impact is expected to be avoided.

Additional benthic community impacts could extend beyond the immediate vicinity of the wellhead, depending on the specific circumstances (BOEM, 2016b). During the Macondo spill, subsurface plumes were reported at a water depth of approximately 3,600 ft (1,100 m), extending at least 22 miles (35 km) from the wellsite and persisting for more than a month (Camilli et al., 2010). The subsurface plumes apparently resulted from the use of subsea dispersants at the wellhead (NOAA, 2011c). While the behavior and impacts of subsurface plumes are not well known, a subsurface plume could have the potential to contact high-density deepwater benthic communities beyond the 984 ft (300 m) radius estimated by BOEM (2012a), depending on its extent, trajectory, and persistence (Spier et al., 2013). Oil plumes that contact sensitive benthic communities before degrading could potentially impact the resource (BOEM, 2017a). Potential impacts on sensitive resources would be an integral part of the decision and approval process for the use of dispersants, and such approval would be obtained from the USEPA prior to the use of dispersants.

Potential impacts of oil on high-density deepwater benthic communities are discussed in recent EISs (BOEM, 2012a, 2015, 2016b, 2017a). Although chemosynthetic communities live among hydrocarbon seeps, natural seepage is very consistent and occurs at low rates compared to the potential rates of oil release from a blowout. In addition, seep organisms also require unrestricted access to oxygenated water at the same time as exposure to hydrocarbon energy sources (MacDonald, 2002). Oil droplets or oiled sediment particles could come into contact with chemosynthetic organisms or deepwater corals. As discussed by BOEM (2012a, 2017a), impacts could include loss of habitat, biodiversity, and live coral coverage; destruction of hard substrate; change in sediment characteristics; and reduction or loss of one or more commercial and recreational fishery habitats. Sublethal effects could be long-lasting and affect the resilience of coral colonies to natural disturbances (e.g., elevated water temperature and diseases)

(BOEM, 2012a, 2015, 2016b, 2017a). Based on information learned from the Macondo spill, a few patches of habitats may be affected by a large oil spill, but the Gulf-wide ecosystem of live bottom communities would not be expected to suffer significant effects (BOEM, 2016b).

The potential for a large spill to affect deepwater corals can also be inferred based on the impacts of the Macondo spill during an October 2010 survey of deepwater coral habitats near the Macondo spill site (BOEMRE, 2010). Government and academic researchers were working at a site 4,600 ft (1,400 m) deep and approximately 7 miles (11 km) southwest of the Macondo wellhead when they observed dead and dying corals with sloughing tissue and discoloration. Much of the soft coral observed in an area measuring approximately 50 ft × 130 ft (15 m × 40 m) was covered by what appeared to be a brown flocculent substance. Of 40 large corals, 90% were heavily affected, showing dead or dying parts and discoloration. Another site 1,312 ft (400 m) farther away had a colony of stony corals similarly affected and partially covered with a similar brown substance. Based on hopanoid petroleum biomarkers from the brown flocculent substance, researchers concluded that the colony contained oil from the Macondo spill. The injured and dead corals were in an area where a subsea plume of oil had been documented during the spill in June 2010. Corals elsewhere in the Gulf of Mexico outside the area affected by the plume did not appear to be experiencing higher mortality. The research team concluded that the observed coral injuries likely resulted from exposure to the subsurface oil plume (White et al., 2012). Apparent recovery of some affected areas by March 2012 correlated negatively with the proportion of the coral covered with flocculent in late 2010 (Hsing et al., 2013). Fisher et al. (2014b) reported two additional coral areas affected by the Macondo spill, one 4 miles (6 km) south of the Macondo wellsite and the other 14 miles (22 km) to the southeast; the authors also hypothesized that other hard bottom sites probably were exposed to deepwater plumes, sinking oil residues from surface burning, or oil and dispersant contained in marine snow. In addition to direct impacts on corals and other sessile epifauna, the spill also affected macroinfauna associated with these hard bottom communities (Fisher et al., 2014a).

C.2.3 Designated Topographic Features

The lease area is not within or near a designated topographic feature or a no-activity zone as identified in NTL 2009-G39. The nearest designated Topographic Feature Stipulation Block is located approximately 42 miles (68 km) west of the lease area. There are no IPFs associated with routine operations that could cause impacts to designated topographic features.

Due to the distance from the lease area, it is unlikely that designated topographic features would be affected by accidental spills. A small diesel fuel spill would float and dissipate on the surface and would not reach these seafloor features. In the event of an oil spill from a well blowout, a surface slick would not contact these seafloor features. If a subsurface plume were to occur, impacts on these features would be unlikely due to the distance and the difference in water depth. Near-bottom currents in the region are predicted to flow along the isobaths (Nowlin et al., 2001) and typically would not be expected to carry a plume up onto the continental shelf edge. This assumption is consistent with the deposition patterns inferred by Valentine et al. (2014) for the subsurface plume from the Macondo spill. Felder et al. (2014) hypothesized that the Macondo spill may have affected two topographic features located 96 miles (155 km) and 168 miles (270 km) west of the Macondo site (Sackett Bank and Ewing Bank, respectively), but there was no definitive evidence of Macondo oil from either bank. Although a large oil spill could theoretically result in oil contacting topographic features, it is expected that most of the oil would rise to the surface and that the most heavily oiled sediments would likely be deposited before reaching these features (BOEM, 2012a). In the unlikely event that oil does contact topographic features, any contact with spilled oil would likely cause sublethal effects to benthic organisms because the distance between the spill source and topographic features would prevent concentrated oil from contacting any designated feature.

C.2.4 Pinnacle Trend Area Live Bottoms

The lease area is not covered by the Live Bottom (Pinnacle Trend) Stipulation. As defined by NTL 2009-G39, the nearest Pinnacle Stipulation Block is located approximately 125 miles (201 km) northeast of the lease area. There are no IPFs associated with routine operations that could cause impacts to pinnacle trend area live bottoms due to the distance from the lease area.

Due to their distance from the lease area, it is unlikely that pinnacle trend live bottom areas would be affected by an accidental spill. A small diesel fuel spill would float on the surface and would not reach these seafloor features. In the event of an oil spill from a well blowout, a surface slick would be unlikely to contact these seafloor features. If a subsurface plume were to occur, impacts on these features would be unlikely due to the difference in water depth. Near-bottom currents in the region are predicted to flow along the isobaths (Nowlin et al., 2001) and would not be expected to carry a plume up onto the continental shelf edge. This assumption is consistent with the deposition patterns inferred by Valentine et al. (2014) for the subsurface plume from the Macondo spill. Although there are mechanisms that could result in oil contacting these features, it is expected that most of the oil would rise to the surface and thereby reducing potential impacts to these features.

C.2.5 Eastern Gulf Live Bottoms

The lease area is not covered by the Live Bottom (Low-Relief) Stipulation, which pertains to seagrass communities and low-relief hard bottom reefs within the Eastern Gulf of Mexico Planning Area blocks in water depths of 328 ft (100 m) or less and portions of Pensacola and Destin Dome Area blocks in the Central Gulf of Mexico Planning Area. The nearest block covered by the Live Bottom Stipulation, as defined by NTL 2009-G39, is located approximately 164 miles (264 km) northeast of the lease area. There are no IPFs associated with routine operations that could cause impacts to eastern Gulf live bottom areas due to the distance from the lease area.

Because of their distance from the lease area, it is unlikely that Eastern Gulf live bottom areas would be affected by an accidental spill. A small diesel fuel spill would float and dissipate on the surface and would not reach these seafloor features. In the event of an oil spill from a well blowout, a surface slick would not likely contact these seafloor features. If a subsurface plume were to occur, impacts on these features would be unlikely due the difference in water depth. Near-bottom currents in the region are predicted to flow along the isobaths (Nowlin et al., 2001) and typically would not be expected to carry a plume up onto the continental shelf. This assumption is consistent with the deposition patterns inferred by Valentine et al. (2014) for the subsurface plume from the Macondo spill. Although there are mechanisms that could result in oil contacting these features, it is expected that most of the oil would rise to the surface thereby reducing potential impacts to benthic communities.

C.3 Threatened, Endangered, and Protected Species and Critical Habitat

This section discusses species listed as endangered or threatened under the Endangered Species Act (ESA). In addition, it includes all marine mammal species in the region, which are protected under the Marine Mammal Protection Act (MMPA).

Endangered or threatened species that may occur in the project area and along the northern Gulf Coast are listed in **Table 6**. The table also indicates the location of critical habitat (if designated in the Gulf of Mexico). Critical habitat is defined as (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation. The National Marine Fisheries Service (NMFS) has jurisdiction for ESA-listed marine mamamls (cetaceans), sea turtles in the marine environment, and fishes in the Gulf of Mexico. The USFWS has jurisdiction for ESA-listed birds, the West Indian manatee, and sea turtles on their nesting beaches.

In 2007, NMFS and the USFWS issued a Biological Opinion in response to ESA consultations with MMS for previous EISs (NMFS, 2007). Following the Macondo spill, on 30 July 2010, BOEM reinitiated ESA consultation with NMFS and the USFWS. Currently, BOEM, NMFS, and USFWS are in the process of collecting and awaiting additional information, which is being gathered as part of the Natural Resource Damage Assessment (NRDA) process in order to update the environmental baseline information as needed for this reinitiated Section 7 consultation. Consultation is ongoing at this time, and BOEM is acting as lead agency in the reinitiated consultation with BSEE involvement (BOEM, 2016b). BOEM and BSEE have developed an interim coordination and review process with NMFS and the USFWS for specific activities leading up to or resulting from upcoming lease sales. The purpose of this coordination is to ensure that NMFS and the USFWS have the opportunity to review post-lease exploration, development, and production activities prior to BOEM's approval to ensure that all approved plans and permits contain any necessary measures to avoid jeopardizing the existence of any ESA-listed species or precluding the implementation of any reasonable and prudent alternative measures. This interim coordination program remains in place while formal consultation and the development of a Biological Opinion are ongoing (BOEM, 2016b).

Coastal endangered or threatened species that may occur along the northern Gulf Coast include the West Indian manatee, Piping Plover, Whooping Crane, Gulf sturgeon, and four subspecies of beach mouse. Critical habitat has been designated for all of these species as indicated in **Table 6** and is discussed for each species in individual sections. The Bald Eagle and Brown Pelican, which are no longer federally listed as endangered or threatened, are discussed in **Section C.4.2**.

Table 6. Federally listed endangered and threatened species that could potentially occur in the lease area and along the northern Gulf Coast.

Species	Scientific Name	Status	Potential Presence		Critical Habitat Designated in Gulf of Mexico
			Lease Area	Coastal	
Marine Mammals					
Sperm whale	*Physeter macrocephalus*	E	X	--	None
Bryde's whale	*Balaenoptera edeni*[a]	C	X	--	None
West Indian manatee	*Trichechus manatus*[b]	T	--	X	Florida (Peninsular)
Sea Turtles					
Loggerhead turtle	*Caretta caretta*	T, E[c]	X	X	Nesting beaches and nearshore reproductive habitat in Mississippi, Alabama, and Florida (Panhandle); *Sargassum* habitat including most of the central and western Gulf of Mexico
Green turtle	*Chelonia mydas*	T	X	X	None
Leatherback turtle	*Dermochelys coriacea*	E	X	X	None
Hawksbill turtle	*Eretmochelys imbricata*	E	X	X	None
Kemp's ridley turtle	*Lepidochelys kempii*	E	X	X	None
Birds					
Piping Plover	*Charadrius melodus*	T	--	X	Coastal Texas, Louisiana, Mississippi, Alabama, and Florida (Panhandle)
Whooping Crane	*Grus americana*	E	--	X	Coastal Texas (Aransas National Wildlife Refuge)
Fishes					
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	T	--	X	Coastal Louisiana, Mississippi, Alabama, and Florida (Panhandle)
Invertebrates					
Elkhorn coral	*Acropora palmata*	T	--	X	The Florida Keys and the Dry Tortugas
Lobed star coral	*Orbicella annularis*	T	--	X	None
Mountainous star coral	*Orbicella faveolata*	T	--	X	None
Boulder star coral	*Orbicella franksi*	T	--	X	None
Terrestrial Mammals					
Beach mice (subspecies: Alabama, Choctawhatchee, Perdido Key, St. Andrew)	*Peromyscus polionotus*	E	--	X	Alabama and Florida (Panhandle) beaches

E = endangered; T = threatened; C = candidate; X = potentially present; -- = not present.

a Gulf of Mexico Bryde's whales are protected by the Marine Mammal Protection Act. There is currently a proposed rule to list this stock as 'endangered' under the Endangered Species Act.

b There are two subspecies of West Indian manatee: the Florida manatee (*T. m. latirostris*), which ranges from the northern Gulf of Mexico to Virginia, and the Antillean manatee (*T. m. manatus*), which ranges from northern Mexico to eastern Brazil. Only the Florida manatee subspecies is likely to be found in the northern Gulf of Mexico.

c The loggerhead turtle is composed of nine distinct population segments (DPSs). The only DPS that may occur in the project area (Northwest Atlantic DPS) is listed as threatened (76 *FR* 58868; 22 September 2011).

The sperm whale and five species of sea turtles are the only endangered or threatened species likely to occur in or near the lease area. The listed sea turtles include the leatherback turtle, Kemp's ridley turtle, hawksbill turtle, loggerhead turtle, and green turtle (Pritchard, 1997).

Effective 11 August 2014, NMFS has designated certain marine areas as critical habitat for the northwest Atlantic distinct population segment (DPS) of the loggerhead sea turtle (see **Section C.3.4**). No critical habitat has been designated in the Gulf of Mexico for the leatherback turtle, Kemp's ridley turtle, hawksbill turtle, green turtle, or the sperm whale. Five endangered mysticetes (blue whale, fin whale, humpback whale, North Atlantic right whale, and sei whale) have been reported in the Gulf of Mexico, but are considered rare or extralimital (Würsig et al., 2000). These species are not included in the most recent NMFS stock assessment reports (Waring et al., 2016, Hayes et al., 2017) nor in the most recent BOEM multisale EIS (BOEM, 2017a); therefore, they are not considered further in the EIA.

Four threatened coral species are known from the northern Gulf of Mexico: elkhorn coral (*Acropora palmata*), lobed star coral (*Orbicella annularis*), mountainous star coral (*Orbicella faveolata*), and boulder star coral (*Orbicella franksi*). None of these species are expected to be present in the lease area (See **Section C.3.9**).

There are no other endangered animals or plants in the Gulf of Mexico that are reasonably likely to be affected by either routine or accidental events. Other species occurring at certain locations in the Gulf of Mexico such as the smalltooth sawfish (*Pristis pectinata*) and Florida salt marsh vole (*Microtus pennsylvanicus dukecampbelli*) are remote from the lease area and highly unlikely to be affected.

C.3.1 Sperm Whale (Endangered)

The only endangered marine mammal likely to be present in or near the project area is the sperm whale (*Physeter macrocephalus*). Resident populations of sperm whales occur within the Gulf of Mexico. A species description is presented in the recovery plan for this species (NMFS, 2010b). Gulf of Mexico sperm whales are classified as an endangered species and a "strategic stock" by NMFS (Waring et al., 2016). A "strategic stock" is defined by the MMPA as a marine mammal stock that meets the following criteria:

- The level of direct human-caused mortality exceeds the potential biological removal level;
- Based on the best available scientific information, is in decline and is likely to be listed as a threatened species under the ESA within the foreseeable future; or
- Is listed as a threatened or endangered species under the ESA, or is designated as depleted under the MMPA.

Current threats to sperm whale populations worldwide are discussed in a final recovery plan for the sperm whale (NMFS, 2010b). Threats are defined as "any factor that could represent an impediment to recovery," and include fisheries interactions, anthropogenic noise, vessel interactions, contaminants and pollutants, disease, injury from marine debris, research, predation and natural mortality, direct harvest, competition for resources, loss of prey base due to climate change and ecosystem change, and cable laying. In the Gulf of Mexico, impacts from many of these threats are identified as either low or unknown (BOEM, 2012a).

In 2013, NMFS conducted a status review to consider designating the Gulf of Mexico population of the sperm whale as a DPS under the ESA. The designation would list the Gulf of Mexico population as a separate endangered or threatened population that is "significant to the species and faces additional unique threats to its survival." On 13 November 2013, NMFS concluded that the designation of a Gulf of Mexico DPS for sperm whales was not warranted (78 FR 68032).

The distribution of sperm whales in the Gulf of Mexico is correlated with mesoscale physical features such as eddies associated with the Loop Current (Jochens et al., 2008). Sperm whale populations in the north-central Gulf of Mexico are present throughout the year (Davis et al., 2000a). Results of a multi-year tracking study show female sperm whales are typically concentrated along the upper continental slope between the 656- and 3,280-ft (200- and 1,000m) depth contours (Jochens et al., 2008). Male sperm whales were more variable in their movements and were documented in water depths greater than 9,843 ft (3,000 m). Generally, groups of sperm whales sighted in the Gulf of Mexico during the MMS-funded Sperm Whale Seismic Study consisted of mixed-sex groups comprising adult females with juveniles, and groups of bachelor males. Typical group size for mixed groups was 10 individuals (Jochens et al., 2008). A review of sighting reports from seismic mitigation surveys in the Gulf of Mexico conducted over a 6-year period found a mean group size for sperm whales of 2.5 individuals (Barkaszi et al., 2012). In these mitigation surveys, sperm whales were the most common cetacean encountered. The Sperm Whale Seismic Study results also showed that sperm whales transit through the vicinity of the lease area. Movements of satellite-tracked individuals suggest that this area of the continental slope is within the home range of the Gulf of Mexico population (within the 95% utilization distribution) (Jochens et al., 2008).

IPFs potentially affecting sperm whales include MODU presence, noise, and lights; support vessel and helicopter traffic; and two types of accidents (a small diesel fuel spill and a large oil spill). Effluent discharges are likely to have negligible impacts on sperm whales due to rapid dispersion, the small area of ocean affected, the intermittent nature of the discharges, and the mobility of these marine mammals. Compliance with NTL BSEE-2015-G03 (see **Table 1**) will minimize the potential for marine debris-related impacts on sperm whales. The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of MODU Presence, Noise, and Lights

Noise from routine MODU activities has the potential to disturb sperm whales or mask the sounds whales would normally produce or hear. However, noise associated with drilling is relatively weak in intensity, and an individual animal's noise exposure would be transient. As discussed in **Section A.1**, sounds generated by an actively drilling MODU are maximum broadband (10 Hz to 10 kHz) energy of about 190 dB re 1 µPa m (Hildebrand, 2005).

Southall et al. (2007) lists sperm whales in the same hearing group (i.e., mid-frequency cetaceans) as dolphins, toothed whales, beaked whales, and bottlenose whales (estimated hearing range from 150 Hz to 160 kHz). Therefore, vessel-related noise is likely to be heard by sperm whales. Generally, most of the acoustic energy produced by sperm whales is present at frequencies below 10 kHz, although diffuse energy up to and past 20 kHz is common, with source levels up to 236 dB re 1 µPa m (Møhl et al., 2003). Generally, most of the acoustic energy from sperm whales is present at frequencies below 4 kHz, although diffuse energy up to and past 20 kHz has been reported, with source levels up to 236 dB re 1 µPa m. Other studies indicate sperm whales' wideband clicks contain energy between 0.1 and 20 kHz (Weilgart and Whitehead, 1993, Goold and Jones, 1995). Most observations of behavioral responses of marine mammals to anthropogenic sounds, in general, have been limited to short-term behavioral responses, which included the cessation of feeding, resting, or social interactions (NMFS, 2009a).

Animals can determine the direction from which a sound arrives based on cues, such as differences in arrival times, sound levels, and phases at the two ears. Thus, an animal's directional hearing capabilities have a bearing on its vulnerability to masking (National Research Council, 2003a). Behavioral changes for marine mammals such as the sperm whale to auditory masking sounds may include producing more calls, longer calls, or shifting the frequency of the calls (Holt et al., 2009, NMFS, 2009a).

It is expected that, due to the relatively stationary nature of the proposed activities, sperm whales would move away from the proposed operations area, and noise levels that could cause auditory injury would be avoided. However, observations of sperm whales near offshore oil and gas operations suggest an inconsistent response to anthropogenic marine sound (Jochens et al., 2008). Sounds produced during drilling operations are categorized as non-impulsive and produce sound pressure levels that may have greater amplitude, and of a similar frequency to the auditory signal received by sperm whales. NMFS analyzed the potential for impacts of drilling-related noise on sperm whales in its Biological Opinion for the Five-Year Oil and Gas Leasing Program in the Central and Western Planning Areas of the Gulf of Mexico (NMFS, 2007). The analysis noted that MODU activities produce low sound source levels and concluded that drilling is not expected to produce amplitudes sufficient to cause hearing or behavioral effects in sperm whales; therefore, these effects are insignificant (NMFS, 2007). Measurements of non-impulsive sources with DP thrusters in use during drilling, anchor handling, and construction operations have shown that received levels of 160dB re 1 µPa are not exceeded beyond 20 m from the operation (NOAA, 2016b).

There are other OCS facilities and activities near the lease area, and the region as a whole has a large number of similar noise sources. Noise associated with this project will contribute to an increase in the ambient noise environment of the Gulf of Mexico, but it is not expected in amplitudes sufficient to cause auditory injuries to sperm whales. The proposed activity may cause disturbance effects ; primarily avoidance or temporary displacement from the project area. Vessel lighting and presence are not identified as IPFs for sperm whales. MODU vessel lighting and presence are not identified as IPFs for sperm whales (NMFS, 2007, BOEM, 2012a, 2016b, 2017a).

Impacts of Support Vessel and Helicopter Traffic

Support vessel traffic has the potential to disturb sperm whales, and there is a risk of vessel strikes, which are identified as a threat in the recovery plan for this species (NMFS, 2010b). To reduce the potential for vessel strikes, BOEM issued BOEM-2016-G01, which recommends protected species identification training and that vessel operators and crews maintain a vigilant watch for marine mammals and slow down or stop their vessel to avoid striking protected species, and requires operators to report sightings of any injured or dead protected species. When whales are sighted, vessel operators and crews are required to attempt to maintain a distance of 300 ft (91 m) or greater whenever possible. Vessel operators are required to reduce vessel speed to 10 knots or less, when safety permits, when mother/calf pairs, pods, or large assemblages of cetaceans are observed near an underway vessel. Compliance with this NTL will minimize the likelihood of vessel strikes as well as reduce the chance of disturbing sperm whales.

NMFS (2007) analyzed the potential for vessel strikes and harassment of sperm whales. With implementation of the mitigation measures in NTL BOEM-2016-G01, NMFS concluded that the likelihood of collisions between vessels and sperm whales would be reduced to insignificant levels. NMFS concluded that the observed avoidance of passing vessels by sperm whales is an advantageous response to avoid a potential threat and is not expected to result in any significant effect on migration, breathing, nursing, breeding, feeding, or sheltering to individuals, or have any consequences at the population level. With implementation of the vessel strike avoidance measures requirement to maintain a distance of 300 ft (91 m) from sperm whales, NMFS concluded that the potential for harassment of sperm whales would be reduced to discountable levels.

Dependent on flight altitude, helicopter traffic also has the potential to disturb sperm whales. Smultea et al. (2008) documented responses of sperm whales offshore Hawaii to a fixed-wing aircraft flying at an altitude of 800 ft (245 m). A reaction to the initial pass of the aircraft was observed during 3 of 24 sightings (12%). All three reactions consisted of a hasty dive and occurred at less than 1,180 ft (360 m) lateral distance from the aircraft. Additional reactions were seen when the aircraft circled certain whales to make further observations. Based on other studies of cetacean responses to sound, the authors concluded that the observed reactions to brief overflights by the aircraft were short-term and limited to behavioral disturbances.

Helicopters used in support operations maintain a minimum altitude of 700 ft (213 m) while in transit offshore, 1,000 ft (305 m) over unpopulated areas or across coastlines, and 2,000 ft (610 m) over populated areas and sensitive habitats such as wildlife refuges and park properties. In addition, guidelines and regulations issued by NMFS under the authority of the Marine Mammal Protection Act specify that helicopters maintain an altitude of 1,000 ft (305 m) within 300 ft (91 m) of marine mammals. In the event that a whale is seen during transit, the helicopter will not approach or circle the animal. Although responses are possible, Smultea et al. (2008) and NMFS (2007) concluded that this altitude would minimize the potential for disturbing sperm whales. Therefore, no significant impacts are expected.

Impacts of a Small Diesel Fuel Spill

Potential spill impacts on marine mammals, including sperm whales, are discussed by NMFS (2007) and BOEM (2017a). Oil impacts on marine mammals are discussed by (Geraci and St. Aubin, 1990) and by the Marine Mammal Commission (MMC) (2011). For proposed activities in this EP, there are no unique site-specific issues with respect to spill impacts on sperm whales that were not analyzed in the previous documents.

The probability of a fuel spill will be minimized by Noble Energy's preventative measures that will be implemented during routine operations, including fuel transfer. In the unlikely event of a spill, implementation of Noble Energy's OSRP could mitigate and lessen the potential for impacts on sperm whales. Given the open ocean location of the lease area, the duration of a small spill and opportunity for impacts to occur would be very brief.

A small diesel fuel spill in offshore waters would produce a thin slick on the water surface and introduce concentrations of petroleum hydrocarbons and their degradation products. The extent and persistence of impacts would depend on the meteorological and oceanographic conditions at the time and the effectiveness of spill response measures. **Section A.9.1** discusses the likely fate of a small diesel fuel spill and indicates that more than 90% would evaporate or disperse naturally within 24 hours. Results of an ADIOS2 model run (see **Section A.9.1**) indicate that the area of the sea surface with diesel fuel on it would range from 0.5 to 5 ha (1.2 to 12 ac), depending on sea state and weather conditions.

Direct physical and physiological effects to sperm whale due to exposure to diesel fuel could include skin irritation, inflammation, or necrosis; chemical burns of skin, eyes, and mucous membranes; inhalation of toxic fumes; ingestion of oil directly or via contaminated prey; and stress from the activities and noise of response vessels and aircraft (MMC, 2011). However, due to the limited areal extent and short duration of water quality impacts from a small diesel fuel spill, as well as the mobility of sperm whales, no significant impacts are expected.

Impacts of a Large Oil Spill

Potential spill impacts on marine mammals, including sperm whales, are discussed by NMFS (2007) and BOEM (2017a). Oil impacts on marine mammals are discussed by Geraci and St. Aubin (1990) and by the MMC (2011). For this EP, there are no unique site-specific issues with respect to spill impacts on sperm whales.

Impacts of oil spills on sperm whales can include direct impacts from oil exposure as well as indirect impacts due to response activities and materials (e.g., vessel traffic, noise, and dispersants) (MMC, 2011). Direct physical and physiological effects can include skin irritation, inflammation, or necrosis; chemical burns of skin, eyes, and mucous membranes; inhalation of toxic fumes; ingestion of oil (and dispersants) directly or via contaminated prey; and stress from the activities and noise of response vessels and aircraft. The level of impact of oil exposure depends on the amount, frequency, and duration of exposure; route of exposure; and type or condition of petroleum compounds or chemical dispersants (Hayes et al., 2017). Complications from the previously listed exposures may lead to dysfunction of immune and reproductive systems, physiological stress, declining physical condition, and death. Behavioral responses can include displacement of animals from prime habitat, disruption of social structure, changing prey availability and foraging distribution or patterns, changing reproductive behavior/productivity, and changing movement patterns or migration (MMC, 2011). Ackleh et al. (2012) hypothesized that sperm whales may have temporarily relocated away from areas near the Macondo spill in 2010.

In the event of a large spill, the increased level of vessel and aircraft activity associated with spill response operations could disturb sperm whales and potentially result in vessel strikes, entanglement, or other injury or stress. Response vessels would operate in accordance with NTL BOEM-2016-G01 (see **Table 1**) to reduce the potential for striking or disturbing these animals.

C.3.2 West Indian Manatee (Threatened)

Most of the Gulf of Mexico manatee population is located in peninsular Florida (USFWS, 2001). Critical habitat has been designated in southwest Florida in Manatee, Sarasota, Charlotte, Lee, Collier, and Monroe Counties. Manatee sightings in Louisiana have increased as the species extends its presence farther west of Florida in the warmer months (Wilson, 2003). A species description is presented in the recovery plan for this species (USFWS, 2001).

IPFs that could affect manatees include support vessel and helicopter traffic and a large oil spill. A small diesel fuel spill in the lease area would be unlikely to affect manatees due to the distance from the nearest shoreline. As explained in **Section A.9.1**, a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to natural dispersion. Compliance with NTL BSEE-2015-G03 (see **Table 1**) will minimize the potential for marine debris-related impacts on manatees. The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of Support Vessel and Helicopter Traffic

Support vessel traffic has the potential to disturb manatees, and there is a risk of vessel strikes, which are identified as a threat in the recovery plan for this species (USFWS, 2001). Manatees are expected to be limited to inner shelf and coastal waters, and impacts are expected to be limited to transits of vessels and helicopters through these waters. To reduce the potential for vessel strikes, BOEM issued NTL BOEM-2016-G01, which recommends protected species identification training and that vessel operators and crews maintain a vigilant watch for marine mammals and slow down or stop their vessel to avoid striking protected species, and requires operators to report sightings of any injured or dead protected species. Compliance with this NTL will minimize the likelihood of vessel strikes, and no significant impacts on manatees are expected.

Dependent on flight altitude, helicopter traffic also has the potential to disturb manatees. Rathbun (1988) reported that manatees were disturbed more by helicopters than by fixed-wing aircraft; however, the helicopter was flown at relatively low altitudes of 66 to 525 ft (20 to 160 m). Helicopters used in support operations maintain a minimum altitude of 700 ft (213 m) while in transit offshore, 1,000 ft (305 m) over unpopulated areas or across coastlines, and 2,000 ft (610 m) over populated areas and sensitive habitats such as wildlife refuges and park properties. In addition, guidelines and regulations issued by NMFS under the authority of the Marine Mammal Protection Act specify that helicopters maintain an altitude of 1,000 ft (305 m) within 300 ft (91 m) of marine mammals. This mitigation measure will minimize the potential for disturbing manatees, and no significant impacts are expected.

Impacts of a Large Oil Spill

The OSRA results summarized in **Table 3** predict that Terrebonne and Plaquemines Parishes could be contacted within 10 days of a spill and other shorelines between Matagorda County, Texas, and Plaquemines Parish, Louisiana, could be contacted by a spill within 30 days. There is no manatee critical habitat designated in these areas, and the number of manatees potentially present is a small fraction of the population residing in peninsular Florida. The 60-day OSRA modeling (**Table 4**) predicts that shorelines between Cameron County, Texas (at the Texas/Mexico border), and Miami-Dade County, Florida, have a 1% to 13% conditional probability of contact within 60 days of a spill. This range includes some areas of manatee critical habitat in southwest Florida; however, the conditional probabilities of contacting these areas within 60 days of a spill is <0.5%.

In the event that manatees are exposed to oil, effects could include direct impacts from oil exposure as well as indirect impacts due to response activities and materials (e.g., vessel traffic, noise, and dispersants) (MMC, 2011). Direct physical and physiological effects can include asphyxiation, acute poisoning, lowering of tolerance to other stress, nutritional stress, and inflammation of infection (BOEM, 2017a). Indirect impacts include stress from the activities and noise of response vessels and aircraft. Complications from oil exposure may lead to dysfunction of immune and reproductive systems, physiological stress, declining physical condition, and death. Behavioral responses can include displacement of animals from prime habitat, disruption of social structure, change in prey availability and foraging distribution or patterns, change in reproductive behavior/productivity, and change in movement patterns or migration (MMC, 2011).

In the event that a large spill reaches coastal waters where manatees are present, the increased level of vessel and aircraft activity associated with spill response could disturb manatees and potentially result in vessel strikes, entanglement, or other injury or stress. Response vessels would operate in accordance with NTL BOEM-2016-G01 (see **Table 1**) to reduce the potential for striking or disturbing these animals, and therefore no significant impacts are expected.

C.3.3 Non-Endangered Marine Mammals (Protected)

Excluding the two endangered marine mammal species that were discussed in **Sections C.3.1** and **C.3.2**, there are 21 additional species of marine mammals that may be found in the Gulf of Mexico including 1 species of mysticete whale, the dwarf and pygmy sperm whales, 4 species of beaked whales, and 14 species of delphinid whales and dolphins. All marine mammals are protected species under the MMPA. The most common non-endangered cetaceans in the deepwater environment are odontocetes such as the pantropical spotted dolphin, spinner dolphin, and rough-toothed dolphin. A brief summary is presented in the following subsections; additional information on these groups is presented by BOEM (2017a).

Bryde's Whale. The Bryde's whale (*Balaenoptera edeni*) is the only year-round resident baleen whale in the northern Gulf of Mexico. In 2014, a petition was submitted to designate the northern Gulf of Mexico population as a DPS and list it as endangered under the ESA (NRDC, 2014). This petition received a 90-day positive finding by NMFS in 2015 and is currently under consideration for listing. The Bryde's whale (*Balaenoptera edeni*) is most frequently sighted along the 328 ft (100 m) isobath (Davis and Fargion, 1996, Davis et al., 2000a). Most sightings have been made in the DeSoto Canyon region and off western Florida, although there have been some in the west-central portion of the northeastern Gulf. Based on the available data, it is possible that Bryde's whales could occur in the lease area.

Dwarf and Pygmy Sperm Whales. At sea, it is difficult to differentiate dwarf sperm whales (*Kogia sima*) from pygmy sperm whales (*Kogia breviceps*), and sightings are often grouped together as *Kogia* spp. Both species have a worldwide distribution in temperate to tropical waters. In the Gulf of Mexico, both species occur primarily along the continental shelf edge and in deeper waters off the continental shelf (Mullin et al., 1991, Mullin, 2007, Waring et al., 2016). Either species could occur in the lease area.

Beaked Whales. Four species of beaked whales are known to occur in the Gulf of Mexico: Blainville's beaked whale (*Mesoplodon densirostris*), Sowerby's beaked whale (*Mesoplodon bidens*), and Gervais' beaked whale (*Mesoplodon europaeus*), and Cuvier's beaked whale (*Ziphius cavirostris*). Stranding records (Würsig et al., 2000) as well as passive acoustic monitoring in the Gulf of Mexico (Hildebrand et al., 2015) suggest that Gervais' beaked whale and Cuvier's beaked whale are the most common. Sowerby's beaked whale is considered extralimital, with only one document stranding in the Gulf of Mexico (Bonde and O'Shea, 1989). Blainville's beaked whales are rare, with only four documented strandings in the northern Gulf of Mexico (Würsig et al., 2000).

Due to the difficulties of at-sea identification, beaked whales in the Gulf of Mexico are identified either as Cuvier's beaked whales or are grouped into an undifferentiated species complex (*Mesoplodon* spp.). In the northern Gulf of Mexico, they are broadly distributed in water depths greater than 3,281 ft (1,000 m) over lower slope and abyssal landscapes (Davis et al., 2000a). Any of these species could occur in the lease area (Waring et al., 2016).

Delphinids. Fourteen species of delphinids are known to occur in the Gulf of Mexico: Atlantic spotted dolphin (*Stenella frontalis*), Clymene dolphin (*Stenella clymene*), pantropical spotted dolphin (*Stenella attenuata*), spinner dolphin (*Stenella longirostris*), striped dolphin (*Stenella coeruleoalba*), bottlenose dolphin (*Tursiops truncatus*), false killer whale (*Pseudorca crassidens*), killer whale (*Orcinus orca*), pygmy killer whale (*Feresa attenuata*), melon-headed whale (*Peponocephala electra*), short-finned pilot whale (*Globicephala macrorhynchus*), Risso's dolphin (*Grampus griseus*), Fraser's dolphin (*Lagenodelphis hosei*), and rough-toothed dolphin (*Steno bredanensis*). Any of these species could occur in the lease area (Waring et al., 2016). The most common non-endangered cetaceans in the deepwater environment of the northern Gulf of Mexico are the pantropical spotted dolphin, spinner dolphin, and rough toothed dolphin (Waring et al., 2016).

The bottlenose dolphin (*Tursiops truncatus*) is a common inhabitant of the northern Gulf of Mexico, particularly within continental shelf waters. There are two ecotypes of bottlenose dolphins, a coastal form and an offshore form, which are genetically isolated from each other (Waring et al., 2016). The offshore form of the bottlenose dolphin may occur within the lease area. Inshore populations of coastal bottlenose dolphins in the northern Gulf of Mexico are separated into 31 geographically distinct population units, or stocks, for management purposes by NMFS (Hayes et al., 2017).

IPFs that could affect non-endangered marine mammals include MODU presence, noise, and lights; support vessel and helicopter traffic; and two types of accidents (a small diesel fuel spill and a large oil spill). Effluent discharges are likely to have negligible impacts due to rapid dispersion, the small area of ocean affected, the intermittent nature of the discharges, and the mobility of these marine mammals. Compliance with NTL BSEE-2015-G03 (see **Table 1**) will minimize the potential for marine debris-related impacts. The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of MODU Presence, Noise, and Lights

Noise from routine drilling and well completion operations has the potential to disturb marine mammals. Most odontocetes (toothed whales and dolphins) use higher frequency sounds than those produced by OCS activities (Richardson et al., 1995). Noise intensity associated with drilling and well completion operations is relatively weak, and the noise exposure to an individual animal would be temporary. As discussed in **Section A.1,** noise impacts would be expected at greater distances when DP thrusters are in use than with vessel noise alone and are dependent on variables relating to sea state conditions, thruster type and usage. Three functional hearing groups are represented in the 21 non-endangered cetceans found in the Gulf of Mexico (NMFS, 2016). Eighteen of the 20 odonotocete species are considered to be in the mid-frequency functional hearing group, 2 species (*Kogia*) are in the high frequency functional hearing group, and 1 species (Bryde's whale) is in the low frequency functional hearing group (NMFS, 2016). Thruster and drilling noise will affect each group differently depending on the frequency bandwiths produced by operations.

For mid-frequency cetaceans exposed to a non-impulsive source, permanent threshold shifts are estimated to occur when the mammal has received a cumulative exposure level of 198 dB re 1 $\mu Pa^2 \cdot s$ over a 24 hour period. Simlarly, temporary threshold shifts are estimated to occur when a mammal has received a cummulative noise exposure level of 178 dB re 1 $\mu Pa^2 \cdot s$ over a 24 hour period. For low frequency cetaceans, specifically the Brydes whale, permant and temporary threshold shift onset is estimated to occur at 199 dB re 1 $\mu Pa^2 \cdot s$ and 179 re 1 $\mu Pa^2 \cdot s$, repectively.

Based on transmission loss calculations, open water propagation of noise produced by typical sources with DP thrusters in use during offshore operations, are not expected to produce received levels greater than 160 dB re 1 µPa beyond 25 m from the source. Due to the short propagation distance of high sound pressure levels, the transient nature of marine mammals and the stationary nature of the proposed activites, it is not expected that any marine mammals will receive exposure levels necessary for the onset of auditory threshold shifts.

Behaviorial criteria are currently being updated; therefore, the NOAA (2005) criteria are used in the interim to determine behavioral disturbance thresholds for marine mammals and are applied equally across all functional hearing groups. Received sound pressure levels of 120 dB re 1 µPa from a non-impulsive source are considered high enough to illicit a behaviorial reaction in some marine mammal species (NOAA, 2005). The 120 dB isolpleth may extend tens to hundreds of kilometers from the source depending on the propagation environment. There are other OCS facilities and activities near the lease area, and the region as a whole has a large number of similar sources. Marine mammal species in the northern Gulf of Mexico have been exposed to noise from anthropogenic sources for a long period of time and over large geographic areas and likely do not represent a naïve population with regard to sound (National Research Council, 2003a). Due to the limited scope, timing, and geographic extent of proposed activities, this project would represent a small, temporary contribution to the overall noise regime, and any short-term behaviorial impacts are not expected to be biologically significant to marine mammal populations.

Impacts of Support Vessel and Helicopter Traffic

Support vessel traffic has the potential to disturb marine mammals, and there is a risk of vessel strikes. Data concerning the frequency of vessel strikes are presented by BOEM (2012a). To reduce the potential for vessel strikes, BOEM issued NTL BOEM-2016-G01, which recommends protected species identification training and that vessel operators and crews maintain a vigilant watch for marine mammals and slow down or stop their vessel to avoid striking protected species, and requires operators to report sightings of any injured or dead protected species. Vessel operators and crews are required to attempt to maintain a distance of 300 ft (91 m) or greater when whales are sighted and 150 ft (45 m) when small (non-whale) cetaceans are sighted. When cetaceans are sighted while a vessel is underway, vessels must attempt to remain parallel to the animal's course and avoid excessive speed or abrupt changes in direction until the cetacean has left the area. Vessel operators are required to reduce vessel speed to 10 knots or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near an underway vessel, when safety permits. These mitigation measures are only effective during daylight hours, or in sea and weather conditions where cetaceans are sighted. Compliance with NTL BOEM-2016-G01 (see **Table 1**) will minimize the likelihood of vessel strikes as well as reduce the chance for disturbing marine mammals during these periods. If collisions occur during periods of poor visibility or at night, it is likely that it may result in the death of the cetacean. Impacts to non-listed cetaceans are not significant at the population (stock) level.

Aircraft traffic also has the potential to disturb marine mammals (Würsig et al., 1998). However, while flying offshore, helicopters maintain altitudes above 700 ft (213 m) during transit to and from the working area. In addition, guidelines and regulations issued by NMFS under the authority of the Marine Mammal Protection Act specify that helicopters maintain an altitude of 1,000 ft (305 m) within 300 ft (91 m) of marine mammals. Maintaining this altitude will minimize the potential for disturbing marine mammals, and no significant impacts are expected (BOEM, 2017a).

Impacts of a Small Diesel Fuel Spill

Potential spill impacts on marine mammals are discussed by BOEM (2017a). Oil impacts on marine mammals, in general, are discussed by Geraci and St. Aubin (1990). For this EP, there are no unique site-specific issues with respect to spill impacts on these animals.

The probability of a fuel spill will be minimized by Noble Energy's preventative measures that will be implemented during routine operations, including fuel transfer. In the unlikely event of a spill, implementation of Noble Energy's OSRP is expected to lessen the potential for impacts on marine mammals. **EP Section H** provides detail on spill response measures. Given the open ocean location of the lease area, the limited duration of a small spill and response efforts, it is expected that any impacts on marine mammals would be brief and minimal.

A small diesel fuel spill in offshore waters would produce a thin slick on the water surface and introduce concentrations of petroleum hydrocarbons and their degradation products. Direct physical and physiological effects of exposure to diesel fuel could include skin irritation, inflammation, or necrosis; chemical burns of skin, eyes, and mucous membranes; inhalation of toxic fumes; ingestion of oil directly or via contaminated prey; and stress from the activities and noise of response vessels and aircraft (MMC, 2011). The extent and persistence of impacts would depend on the meteorological and oceanographic conditions at the time and the effectiveness of spill response measures. As **Section A.9.1** discusses, a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to breaking up. Therefore, due to the limited areal extent and short duration of water quality impacts from a small diesel fuel spill as well as the mobility of marine mammals, no significant impacts are expected.

Impacts of a Large Oil Spill

Potential spill impacts on marine mammals are discussed by BOEM (2017a). For this EP, there are no unique site-specific issues.

Impacts of oil spills on marine mammals can include direct impacts from oil exposure as well as indirect impacts due to response activities and materials (e.g., vessel traffic, noise, and dispersants) (MMC, 2011, Takeshita et al., 2017). Direct physical and physiological effects can include skin irritation, inflammation, or necrosis; chemical burns of skin, eyes, and mucous membranes; inhalation of toxic fumes; ingestion of oil (and dispersants) directly or via contaminated prey. Complications of the above may lead to dysfunction of immune (DeGuise et al., 2017) and reproductive systems (Kellar et al., 2017), physiological stress, declining physical condition, and death (MMC, 2011). Indirect impacts can include stress from the activities and noise of response vessels and aircraft. Behavioral responses can include displacement of animals from prime habitat (McDonald et al., 2017), disruption of social structure, change in prey availability and foraging distribution or patterns, change in reproductive behavior/productivity, and change in movement patterns or migration (MMC, 2011).

Data from the Macondo spill, as analyzed and summarized by NOAA (2016b) indicate the scope of potential impacts from a large spill. Tens of thousands of marine mammals were exposed to oil, where they likely inhaled, aspirated, ingested, physically contacted, and absorbed oil components (NOAA, 2016b). Nearly all of the marine mammal stocks in the northern Gulf of Mexico were affected. The oil's physical, chemical, and toxic effects damaged tissues and organs, leading to a constellation of adverse health effects, including reproductive failure, adrenal disease, lung disease, and poor body condition (NOAA, 2016b). According to the National Wildlife Federation (2016a), nearly all of the 21 species of dolphins and whales that live in the northern Gulf of Mexico had demonstrable, quantifiable injuries. NMFS (2014a) documented 13 dolphins and whales stranded alive, and over 150 dolphins and whales were found dead during the oil spill response. Other affected species included dwarf and pygmy sperm whales, melon-headed whales, and spinner dolphins. Because of known low detection rates of carcasses (Williams et al., 2011), it is possible that the number of marine mammal deaths was significantly underestimated. Also, necropsies to confirm the cause of death could not be conducted for many of these marine mammals. Schwacke et al. (2014) reported that one year after the spill, many dolphins in Barataria Bay, Louisiana, had evidence of disease conditions associated with petroleum exposure and toxicity, including a decline in pregnancy success rate (Lane et al., 2015).

In the aftermath of the Macondo spill, an occurrence of an "unusual mortality event" (UME) of unprecedented size and duration that affectedmarine mammal stock areas in the Gulf of Mexico. The UME began in April 2010 and ended in July 2014 (NOAA, 2016c). Carmichael et al. (2012) hypothesized that the unusual number of bottlenose dolphin strandings in the northern Gulf of Mexico in 2010 and 2011 may have been associated with environmental perturbations including sustained cold weather and the Macondo spill in 2010 as well as large volumes of cold freshwater discharge in the early months of 2011. Schwacke et al. (2014) reported that 1 year after the Macondo spill, many dolphins in Barataria Bay, Louisiana, showed evidence of disease conditions associated with petroleum exposure and toxicity. Venn-Watson et al. (2015) performed histological studies to examine contributing factors and causes of deaths for stranded common bottlenose dolphins from Louisiana, Mississippi, and Alabama and found that the dead dolphins from the UME were more likely than those from other areas to have primary bacterial pneumonia and thin adrenal cortices. The adrenal gland and lung diseases were consistent with exposure to petroleum compounds, and the exposure to petroleum compounds during and after the Macondo spill are proposed as a cause.

In the event of a large spill, response activities that may impact marine mammals include increased vessel traffic, use of dispersants, and remediation activities (e.g., controlled burns, skimmers, boom) (BOEM, 2017a). The increased level of vessel and aircraft activity associated with spill response could disturb marine mammals, potentially resulting in behavioral changes. The large number of response vessels could result in vessel strikes, entanglement, injury, or stress. Response vessels would operate in accordance with NTL BOEM-2016-G01 to reduce the potential for striking or disturbing these animals, and therefore no significant impacts are expected. The application of dispersants is likely to reduce the chances of harmful impacts as the dispersants would remove oil from the surface, thereby reducing the risk of contact and rendering it less likely to adhere to skin, baleen plates, or other body surfaces (BOEM, 2017a). The use of trained observers during remediation activities will reduce the likelihood of capture and/or entrainment (BOEM, 2017a). It is expected that impacts to non-listed marine mammals from a oil spill response activities resulting in the death of individuals would be adverse but not significant at a population level.

C.3.4 Sea Turtles (Endangered/Threatened)

Five species of endangered or threatened sea turtles may be found near the lease area. Endangered species include the leatherback (*Dermochelys coriacea*), Kemp's ridley (*Lepidochelys kempii*), and hawksbill (*Eretmochelys imbricata*) turtles, while the North Atlantic

DPS of the green turtle (*Chelonia mydas*) is listed as threatened (81 FR 20057). The DPS of loggerhead turtles (*Caretta caretta*) that occurs in the Gulf of Mexico is listed as threatened, although other DPSs are endangered.

Critical habitat has been designated for the loggerhead turtle in the Gulf of Mexico as shown in **Figure 3**. Critical habitat in the northern Gulf of Mexico includes nesting beaches in Mississippi, Alabama, and the Florida Panhandle; nearshore reproductive habitat within 1 mile (1.6 km) seaward from these beaches; and a large area of *Sargassum* habitat that includes most of the Western and Central Planning Areas of and parts of the southern portion of the Eastern Planning Area (NMFS, 2014b).

Loggerhead turtles in the Gulf of Mexico are part of the Northwest Atlantic Ocean DPS (76 FR 58868). In July 2014, NMFS and the USFWS designated critical habitat for this DPS. The USFWS designation (79 FR 39756) includes nesting beaches in Jackson County, Mississippi; Baldwin County, Alabama; and Bay, Gulf, and Franklin Counties in the Florida Panhandle as well as several counties in southwest Florida and the Florida Keys (and other areas along the Atlantic coast). The NMFS designation (79 FR 39856) includes nearshore reproductive habitat within 1 miles (1.6 km) seaward of the mean high water line along these same nesting beaches. NMFS also designated a large area of shelf and oceanic waters, termed *Sargassum* habitat, in the Gulf of Mexico (and Atlantic Ocean) as critical habitat. *Sargassum* is a brown alga (Class Phaeophyceae) that takes on a planktonic, often pelagic existence after being removed from reefs during rough weather. Rafts of *Sargassum* serve as important foraging and developmental habitat for numerous fishes, and young sea turtles, including loggerhead turtles. NMFS designated three other categories of critical habitat as well; of these, two (migratory habitat and overwintering habitat) are along the Atlantic coast and the third (breeding habitat) is found in the Florida Keys and along the Florida east coast (NMFS, 2014b). The closest designated nearshore reproductive critical habitat for loggerhead sea turtles is approximately 212 miles (341 km) from the lease area. The lease area is located inside the designated *Sargassum* critical habitat for loggerhead sea turtles (**Figure 3**).

Leatherback and loggerhead turtles are the most likely species to be present near the lease area as adults. Green, hawksbill, and Kemp's ridley turtles are typically inner shelf and nearshore species, unlikely to occur near the lease area as adults. Hatchlings or juveniles of any of the sea turtle species may be present in deepwater areas, including the lease area, where they may be associated with *Sargassum* and other flotsam.

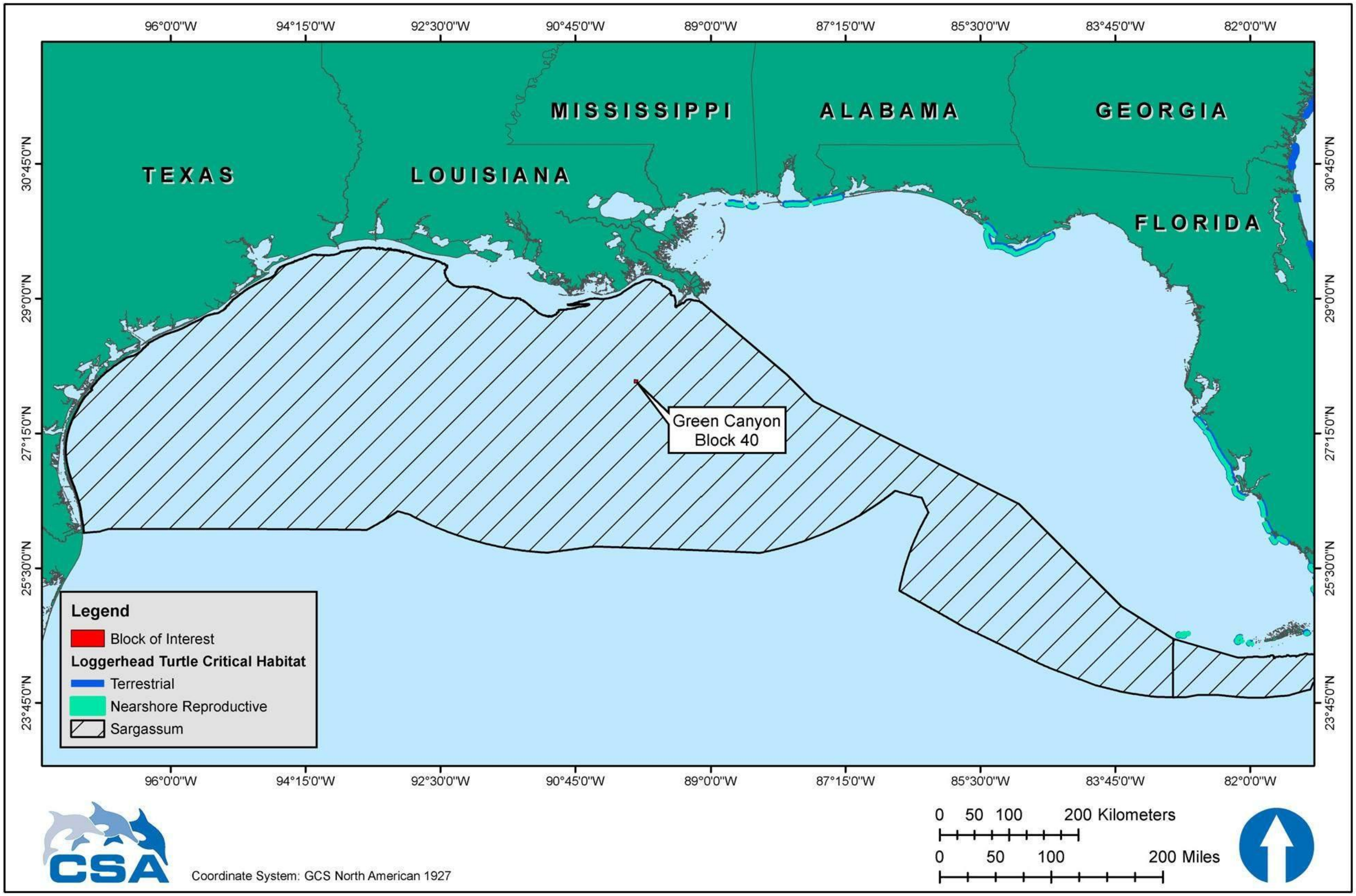

Figure 3. Location of loggerhead turtle designated critical habitat in relation to the lease area.

All five sea turtle species in the Gulf of Mexico are migratory and use different marine habitats according to their life stage. These habitats include high-energy beaches for nesting females and emerging hatchlings and pelagic convergence zones for hatchling and juvenile turtles. As adults, green, hawksbill, and loggerhead turtles forage primarily in shallow, benthic habitats. Leatherback turtles are the most pelagic of the sea turtles, feeding primarily on jellyfish.

Sea turtle nesting on the northern Gulf of Mexico coast can be summarized by species as follows:

- Loggerhead turtles – Loggerhead turtles nest in significant numbers along the Florida Panhandle (Florida Fish and Wildlife Conservation Commission, 2016a) and, to a lesser extent, from Texas through Alabama (NMFS and USFWS, 2008).

- Green and leatherback turtles – Green and leatherback turtles infrequently nest on Florida Panhandle beaches (Florida Fish and Wildlife Conservation Commission, 2016b, c).

- Kemp's ridley turtles – The critically endangered Kemp's ridley turtle nests almost exclusively on a 16 mile (26 km) stretch of coastline near Rancho Nuevo in the Mexican state of Tamaulipas (NMFS et al., 2011). A much smaller but growing population nests in Padre Island National Seashore, Texas, mostly as a result of reintroduction efforts (NMFS et al., 2011). A total of 353 Kemp's ridley turtle nests were counted on Texas beaches in 2017, an increase from the 185 counted in 2016, 159 counted in 2015, and 118 counted in 2014 (Turtle Island Restoration Network, 2017). Padre Island National Seashore along the coast of Willacy, Kenedy, and Kleberg Counties in southern Texas, is the most important nesting location for this species in the United States, although there have been occasional reports of Kemp's ridleys nesting in Alabama (Share the Beach, 2016).

- Hawksbill turtles – Hawksbill turtles typically do not nest anywhere near the project area, with most nesting in the region located in the Caribbean Sea and on the beaches of the Yucatán Peninsula (USFWS, 2016a).

IPFs that could affect sea turtles include MODU, noise, and lights; support vessel and helicopter traffic; and two types of accidents (a small diesel fuel spill and a large oil spill). Effluent discharges are likely to have negligible impacts on sea turtles due to rapid dispersion, the small area of ocean affected, and the intermittent nature of the discharges. Compliance with NTL BSEE-2015-G03 (see **Table 1**) will minimize the potential for marine debris-related impacts on sea turtles. The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of MODU Presence, Noise, and Lights

MODU activities produce a broad array of sounds at frequencies and intensities that may be detected by sea turtles (Samuel et al., 2005, Popper et al., 2014). Potential impacts may include behavioral disruption and temporary or permanent displacement from the area near the sound source. There is scarce information regarding hearing and acoustic thresholds for marine turtles. The currently accepted hearing and response estimates are derived from fish hearing data rather than from marine mammal hearing data in combination with the limited experimental data available (Popper et al., 2014). NMFS Biological Opinions (NMFS, 2015) list sea turtle underwater acoustic injury and behavioral thresholds at 207 dB re 1 µPa and 166 dB re 1 µPa, respectively. No distinction is made between impulsive and continuous sources for these thresholds. Based on transmission loss calculations, open water propagation of noise produced by typical sources with DP thrusters, are not expected to produce received levels greater than 160 dB re 1 µPa beyond 82 ft (25 m) from the source. Certain sea turtles, especially loggerheads, may be attracted to offshore structures (Lohoefener et al., 1990, Gitschlag et al., 1997) and, thus, may be more susceptible to impacts from sounds produced during routine operations. The most likely impacts would be short-term behavioral changes such as diving and evasive swimming, disruption of activities, or departure from the area. Due to the small impact area around the activties, limited number of sources, and short duration of activities, these short-term impacts are not expected to be biologically significant to sea turtle populations.

Artificial lighting can disrupt the nocturnal orientation of sea turtle hatchlings (Witherington, 1997, Tuxbury and Salmon, 2005). However, hatchlings may rely less on light cues when they are offshore than when they are emerging on the beach (Salmon and Wyneken, 1990). NMFS (2007) concluded that the effects of lighting from offshore structures on sea turtles are insignificant.

Impacts of Support Vessel and Helicopter Traffic

Noise generated from support vessel traffic has the potential to disturb sea turtles, and there is a risk of vessel strikes. Data show that vessel strike is one cause of sea turtle mortality in the Gulf of Mexico (Lutcavage et al., 1997). While adult sea turtles are visible at the surface during the day and in clear weather, they can be difficult to spot from a moving vessel when resting below the water surface, during nighttime, or during periods of inclement weather. To reduce the potential for vessel strikes, BOEM issued NTL BOEM-2016-G01, which recommends protected species identification training and that vessel operators and crews maintain a vigilant watch for sea turtles and slow down or stop their vessel to avoid striking protected species, and requires operators to report sightings of any injured or dead protected species. When sea turtles are sighted, vessel operators and crews are required to attempt to maintain a distance of 150 ft (45 m) or greater whenever possible. Compliance with this NTL (see **Table 1**) will minimize the likelihood of vessel strikes during periods of daylight and during sea and weahter conditions that permit sighting of turtles on the sea surface. If a project-related vessel strikes a sea turtle, it is likely that it will result in the death of the individual turtle. Lethal ship strike to these listed species is not likely but, if it occurs, is significant to the population (NMFS, 2007).

Noise generated from support helicopter traffic also has the potential to disturb sea turtles. However, while flying offshore, helicopters maintain altitudes above 700 ft (213 m) during transit to and from the working area. This altitude will minimize the potential for disturbing sea turtles, and no significant impacts are expected (NMFS, 2007, BOEM, 2012a).

Impacts of a Small Diesel Fuel Spill

Potential spill impacts on sea turtles are discussed by NMFS (2007) and BOEM (2017a). For this EP, there are no unique site-specific issues with respect to spill impacts on sea turtles.

The probability of a fuel spill will be minimized by Noble Energy's preventative measures that will be implemented during routine operations, including fuel transfer. In the unlikely event of a spill, implementation of Noble Energy's OSRP is expected to minimize potential impacts on sea turtles. **EP Section H** provides detail on spill response measures. Given the open ocean location of the lease area, the duration of a small spill and opportunity for impacts on turtles to occur would be brief.

A small diesel fuel spill in offshore waters would produce a thin slick on the water surface and introduce concentrations of petroleum hydrocarbons and their degradation products. Direct physical and physiological effects of exposure to diesel fuel could include skin irritation, inflammation, or necrosis; chemical burns of skin, eyes, and mucous membranes; inhalation of toxic fumes; ingestion of oil directly or via contaminated prey; and stress from the activities and noise of response vessels and aircraft (NMFS, 2014a). The extent and persistence of impacts would depend on the meteorological and oceanographic conditions at the time of the spill as well as the effectiveness of spill response measures. **Section A.9.1** discusses the likely fate of a small diesel fuel spill and indicates that more than 90% would evaporate or disperse naturally within 24 hours. The sea surface area covered with diesel fuel would range from 0.5 to 5 ha (1.2 to 12 ac), depending on sea state and weather conditions. Therefore, due to the limited areal extent and short duration of water quality impacts from a small diesel fuel spill, no significant impacts to sea turtles from direct or indirect exposure are expected.

<u>Loggerhead Critical Habitat – Nesting Beaches</u>. A small diesel fuel spill in the lease area would be unlikely to affect sea turtle nesting beaches due to the distance from the nearest shoreline. Loggerhead turtle nesting beaches and nearshore reproductive habitat designated as critical habitat are located in Mississippi, Alabama, and the Florida panhandle, at least 172 miles (277 km) from the lease area. As explained in **Section A.9.1**, a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to natural dispersion.

<u>Loggerhead Critical Habitat – *Sargassum*</u>. The lease area is within the *Sargassum* habitat portion of the loggerhead turtle critical habitat (**Figure 3**). A small diesel fuel spill could affect *Sargassum* and juvenile turtles by contaminating this habitat. Juvenile sea turtles could come into contact with or ingest oil, resulting in death, injury, or other sublethal effects. Effects of a small spill on *Sargassum* critical habitat for loggerhead turtles would be limited to the small area (0.5 to 5 ha [1.2 to 12 ac]) likely to be impacted by a small spill. An impact area of 5 ha (12 ac) would represent a negligible portion of the approximately 40,662,810 ha (100,480,000 ac) designated *Sargassum* critical habitat for loggerhead turtles in the northern Gulf of Mexico.

Impacts of a Large Oil Spill

Impacts of oil spills on sea turtles can include direct impacts from oil exposure as well as indirect impacts due to response activities and materials (e.g., vessel traffic, noise, and dispersants). Direct physical and physiological effects can include skin irritation, inflammation, or necrosis; chemical burns of skin, eyes, and mucous membranes; inhalation of toxic fumes and smoke (e.g., from *in situ* burning of oil); ingestion of oil (and dispersants) directly or via contaminated food; and stress from the activities and noise of response vessels and aircraft. Complications of the above may lead to dysfunction of immune and reproductive systems, physiological stress, declining physical condition, and death. Behavioral responses can include displacement of animals from prime habitat, disruption of social structure, change in food availability and foraging distribution or patterns, change in reproductive behavior/productivity, and change in movement patterns or migration (NOAA, 2010, NMFS, 2014a). In the unlikely event of a spill, implementation of Noble Energy's OSRP is expected to minimize the potential for these types of impacts on sea turtles. **EP Section H** provides detail on spill response measures.

Studies of oil effects on loggerhead turtles in a controlled setting (Lutcavage et al., 1995, NOAA, 2010) suggest that sea turtles show no avoidance behavior when they encounter an oil slick, and any sea turtle in an affected area would be expected to be exposed. Sea turtles' diving behaviors also put them at risk. Sea turtles rapidly inhale a large volume of air before diving and continually resurface over time, which may result in repeated exposure to volatile vapors and oiling (NMFS, 2007).

Results of the Macondo spill provide an indication of potential effects of a large oil spill on sea turtles. NOAA (2016b) estimates that between 4,900 and up to 7,600 large juvenile and adult sea turtles (Kemp's ridleys, loggerheads, and hardshelled sea turtles not identified to species), and between 56,000 and 166,000 small juvenile sea turtles (Kemp's ridleys, green turtles, loggerheads, hawksbills, and hardshelled sea turtles not identified to species) were killed by the Macondo spill. Impacts from a large oil spill resulting in the death of individual listed sea turtles would be significant to local populations.

Spill response activities could also kill sea turtles and interfere with nesting. NOAA (2016b) concluded that after the Macondo spill hundreds of sea turtles were likely killed by response activities such as increased boat traffic, dredging for berm construction, increased lighting at night near nesting beaches, and oil cleanup operations on nesting beaches. Nearly 35,000 hatchling sea turtles (loggerheads, Kemp's ridleys, and green turtles) were also injured by response activities (NOAA, 2016b). In addition, it is estimated that oil cleanup operations on Florida Panhandle beaches following the spill deterred adult female loggerheads from coming ashore and laying their eggs, resulting in a decrease of approximately 250 loggerhead nests in 2010 (NOAA, 2016b). Impacts from oil spill response activities resulting in the death of individual listed sea turtles would be significant to local populations.

Loggerhead Critical Habitat – Nesting Beaches. If spilled oil reaches sea turtle nesting beaches, nesting sea turtles and egg development could be affected (NMFS, 2007). An oiled beach could affect nest site selection or result in no nesting at all (e.g., false crawls). Upon hatching and successfully reaching the water, hatchlings are subject to the same types of oil spill exposure hazards as adults. Hatchlings that contact oil residues while crossing a beach can exhibit a range of effects, from acute toxicity to impaired movement and abnormal bodily functions (NMFS, 2007).

The 30-day OSRA results summarized in **Table 3** estimate that shorelines of Terrebonne and Plaquemines Parishes in Louisiana could be contacted within 10 days of a spill (1% conditional probability) and other shorelines in Louisiana and Texas shorelines that support limited sea turtle nesting could be contacted within 30 days (1% to 5% conditional probability). The 60-day OSRA modeling (**Table 4**) predicts the conditional probability of contacting Mississippi, Alabama, and Florida Panhandle shorelines that support significant loggerhead sea turtle nesting is 1% or less. The nearest nearshore reproductive critical habitat for the loggerhead turtle is 172 miles (277 km) from the lease area and is predicted by the 60-day OSRA model to have a 1% or less conditional probability of contact within 60 days of a spill.

Loggerhead Critical Habitat – *Sargassum*. The lease area is within the loggerhead turtle critical habitat designated as *Sargassum* habitat, which includes most of the Western and Central Planning Areas in the Gulf of Mexico and parts of the southern portion of the Eastern Planning Area (**Figure 3**) (NMFS, 2014b). Because of the large area covered by the designated *Sargassum* habitat for loggerhead turtles, a large spill could result in a substantial part of the *Sargassum* habitat in the northern Gulf of Mexico being oiled. However, the catastrophic 2010 Macondo spill affected approximately one-third of the *Sargassum* habitat in the northern Gulf of Mexico (BOEM, 2014a). It is extremely unlikely that the entire *Sargassum* critical habitat would be affected by a large spill. Because *Sargassum* is a floating, pelagic species, it would only be affected by impacts that occur near the surface.

The effects of oiling on *Sargassum* vary with spill severity, but moderate to heavy oiling that could occur during a large spill could cause complete mortality to *Sargassum* and its associated communities (BOEM, 2017a). *Sargassum* also has the potential to sink during a large spill, thus temporarily removing the habitat and possibly being an additional pathway of exposure to the benthic environment (Powers et al., 2013). Lower levels of oiling may cause sub-lethal affects, including a reduction in growth, productivity, and recruitment of organisms associated with *Sargassum*. The *Sargassum* algae itself could be less impacted by light to moderate oiling than associated organisms because of a waxy outer layer that might help protect it from oiling (BOEM, 2016b). *Sargassum* has a yearly seasonal cycle of growth and a yearly cycle of migration from the Gulf of Mexico to the western Atlantic. A large spill could affect a large portion of the annual crop of the algae; however, because of its ubiquitous distribution and seasonal cycle, recovery of the *Sargassum* community would be expected to occur within a short time period (BOEM, 2017a).

In the event of a large spill, the level of vessel and aircraft activity associated with spill response could disturb sea turtles and potentially result in vessel strikes, entanglement, or other injury or stress. Response vessels would operate in accordance with NTL BOEM-2016-G01 (see **Table 1**) to reduce the potential for striking or disturbing these animals; however, events leading to the death of individual sea turtles from spill response activities are expected to be significant to local populations.

C.3.5 Piping Plover (Threatened)

The Piping Plover (*Charadrius melodus*) is a migratory shorebird that overwinters along the southeastern U.S. and Gulf of Mexico coasts. This threatened species is in decline as a result of hunting, habitat loss and modification, predation, and disease (USFWS, 2003). Critical overwintering habitat has been designated, including beaches in Texas, Louisiana, Mississippi, Alabama, and Florida (**Figure 4**). Piping Plovers inhabit coastal sandy beaches and mudflats, feeding by probing for invertebrates at or just below the surface. They use beaches adjacent to foraging areas for roosting and preening (USFWS, nd).

IPFs potentially affecting Piping Plovers include helicopter traffic crossing over selected coastal habitats and a large oil spill. These IPFs with potential impacts listed in **Table 2** are discussed below. It is asumed that helicopters will maintain an altitude of 1,000 ft (305 m) over unpopulated areas or across coastlines. Therefore, it is not likely that the crossing of helicopters over coastlines will significantly impact overwintering Piping Plovers.

A small diesel fuel spill in the lease area would be unlikely to affect Piping Plovers because a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to natural dispersion (see **Section A.9.1**).

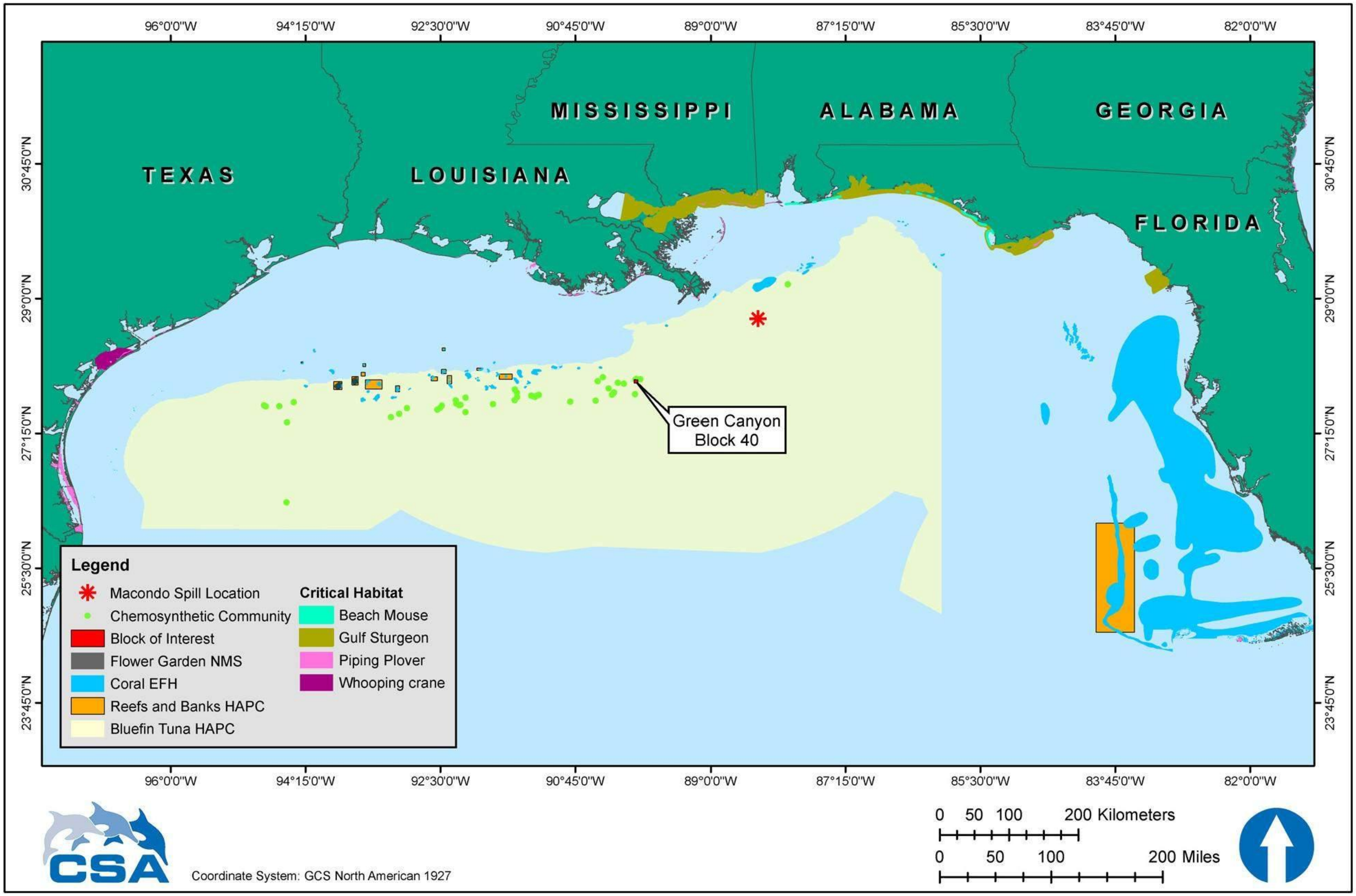

Figure 4. Location of selected environmental features in relation to the lease area. EFH = Essential Fish Habitat; HAPC = Habitat Area of Particular Concern; NMS= National Marine Sanctuary.

Impacts of a Large Oil Spill

The lease area is 79 miles (127 km) the nearest shoreline that is designed as critical habitat for Piping Plovers in Lafourche Parish, Louisiana (**Figure 4**). The 30-day OSRA modeling (**Table 3**) predicts that Piping Plover critical habitat in Terrebonne Parish Louisiana could be contacted within 10 days of a spill (1% conditional probability). The 60-day OSRA modeling (**Table 4**) predicts that during the spring, there is a 13% conditional probability that an oil spill from the lease area would reach a shoreline designated as critical habitat for the Piping Plover within 60 days of a spill. Piping Plovers could become physically oiled while foraging on oiled shores or secondarily contaminated through ingestion of oiled intertidal sediments and prey (BOEM, 2017a). Piping Plovers congregate and feed along tidally exposed banks and shorelines, following the tide out to allow foraging at the water's edge. It is possible that some deaths of Piping Plovers could occur, especially if spills occur during winter months when plovers are most common along the coastal Gulf or if spills contacted critical habitat. Impacts also could occur from vehicular traffic on beaches and other activities associated with spill cleanup. Noble Energy has extensive resources available to protect and rehabilitate wildlife in the event of a spill reaching the shoreline, as detailed in their Regional OSRP. Impacts resulting in the deaths of individual Piping Plovers may be significant to the local population, based on the number of individuals lost.

C.3.6 Whooping Crane (Endangered)

The Whooping Crane (*Grus americana*) is a large omnivorous wading bird listed as an endangered species. Three wild populations live in North America (National Wildlife Federation, 2016b). One population winters along the Texas coast at Aransas NWR and summers at Wood Buffalo National Park in Canada. This population represents the majority of the world's population of free-ranging Whooping Cranes, reaching a record estimated population of 431 during the 2016-2017 winter (USFWS, 2017). A non-migratory population was reintroduced in central Florida, and another reintroduced population summers in Wisconsin and migrates to the southeastern U.S. for the winter. Whooping Cranes breed, migrate, winter, and forage in a variety of habitats, including coastal marshes and estuaries, inland marshes, lakes, ponds, wet meadows and rivers, and agricultural fields (USFWS, 2007). Approximately 9,000 ha (22,240 ac) of salt flats on Aransas NWR and adjacent islands make up the principal wintering grounds of the Whooping Crane (**Figure 4**). Aransas NWR is designated as critical habitat for the species. A species description is presented by BOEM (2012a).

A large oil spill is the only IPF potentially affecting Whooping Cranes. A small diesel fuel spill in the lease area would be unlikely to affect Whooping Cranes due to the distance from Aransas NWR. As explained in **Section A.9.1**, a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to natural dispersion.

Impacts of a Large Oil Spill

The lease area is 396 miles (637 km) from the Aransas NWR in Aransas and Calhoun Counties, Texas, the nearest shoreline that is designed as critical habitat for Whooping Cranes. The 60-day OSRA modeling (**Table 4**) predicts that during the winter, there is a 4% conditional probability that an oil spill from the lease area would reach a shoreline designated as critical habitat for the Whooping Crane within 60 days of a spill. Whooping Cranes could physically oil themselves while foraging in oiled areas or secondarily contaminate themselves through ingestion of contaminated shellfish, frogs, and fishes. It is possible that some deaths of Whooping Cranes could occur, especially if spills occur during winter months when Whooping Cranes are most common along the Texas coast if the spill contacts their critical habitat in Aransas NWR. Impacts could also occur from vehicular traffic on beaches and other activities associated with spill cleanup. Noble Energy has extensive resources available to protect and rehabilitate wildlife in the event of a spill reaching the shoreline, as detailed in their OSRP. Impacts leading to the death of individual Whooping Cranes would be significant at a species level.

C.3.7 Gulf Sturgeon (Threatened)

The Gulf sturgeon (*Acipenser oxyrinchus desotoi*) is a threatened fish species that inhabits major rivers and inner shelf waters from the Mississippi River to the Suwannee River, Florida (Barkuloo, 1988, Wakeford, 2001). The Gulf sturgeon is anadromous and migrates from the sea upstream into coastal rivers to spawn in freshwater. The historic range of the species extended from the Mississippi River to Charlotte Harbor, Florida (Wakeford, 2001). This range has contracted to encompass major rivers and inner shelf waters from the Mississippi River to the Suwannee River, Florida. Populations have been depleted or even extirpated throughout this range by fishing, shoreline development, dam construction, water quality changes, and other factors (Barkuloo, 1988, Wakeford, 2001). These declines prompted the listing of the Gulf sturgeon as a threatened species in 1991. The best-known populations occur in the Apalachicola and Suwannee Rivers in Florida (Carr, 1996, Sulak and Clugston, 1998), the Choctawhatchee River in Alabama (Fox et al., 2000), and the Pearl River in Mississippi/Louisiana (Morrow et al., 1998). Rudd et al. (2014) reconfirmed the spatial distribution and movement patterns of Gulf Sturgeon by surgically implanting acoustic telemetry tags. Critical habitat in the Gulf extends from Lake Borgne, Louisiana (St. Bernard Parish), to Suwannee Sound, Florida (Levy County) (NMFS, 2014c) (**Figure 4**). A species description is presented by BOEM (2012a) and in the recovery plan for this species (USFWS et al., 1995).

A large oil spill is the only IPF that could affect Gulf sturgeon. There are no IPFs associated with routine project activities that could affect these fish. A small diesel fuel spill in the lease area would be unlikely to affect Gulf sturgeon because a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to natural dispersion (see explanation in **Section A.9.1**).

Impacts of a Large Oil Spill

Potential spill impacts on Gulf sturgeon are discussed by NMFS (2007) and BOEM (2012a). For this EP, there are no unique site-specific issues with respect to this species.

The lease area is approximately 162 miles (261 km) from the nearest Gulf sturgeon critical habitat in St Bernard Parish, Louisiana, and Hancock and Harrison Counties, Mississippi. The 30-day OSRA modeling (**Table 3**) predicts that a spill in the lease area has 0.5% or less conditional probability of contacting any coastal areas containing Gulf sturgeon critical habitat within 30 days of a spill. The 60-day OSRA modeling (**Table 4**) predicts that a spill in the lease areas has a 1% or less conditional probability of contacting any coastal areas containing Gulf sturgeon critical habitat within 60 days of a spill.

In the event of oil reaching Gulf sturgeon habitat, the fish could be affected by direct ingestion, ingestion of oiled prey, or the absorption of dissolved petroleum products through the gills. Based on the life history of this species, sub-adult and adult Gulf sturgeon would be most vulnerable to an estuarine or marine oil spill, and likely would be vulnerable only from

1 September through 30 April when the species is typically foraging in estuarine and shallow marine habitats (NMFS, 2007).

NOAA (2016b) estimated that 1,100 to 3,600 Gulf sturgeon were exposed to oil from the Macondo spill. Overall, 63% of the Gulf sturgeon from six river populations were potentially exposed to the spill. Although the number of dead or injured Gulf sturgeon was not estimated, laboratory and field tests indicated that Gulf sturgeon exposed to oil displayed both genotoxicity and immunosuppression, which can lead to malignancies, cell death, susceptibility to disease, infections, and a decreased ability to heal (NOAA, 2016b). Impacts resulting in the deaths of individual Gulf sturgeons may be significant to the local population, based on the number of individuals lost.

C.3.8 Beach Mice (Endangered)

Four subspecies of endangered beach mice (*Peromyscus polionotus*) occur on the barrier islands of Alabama and the Florida Panhandle: Alabama, Choctawhatchee, Perdido Key, and St. Andrew beach mice. Critical habitat has been designated for all four subspecies. **Figure 4** shows the combined critical habitat for all four subspecies. Species descriptions are provided by BOEM (2012a).

A large oil spill is the only IPF that could affect beach mice. There are no IPFs associated with routine project activities that could affect these animals due to the distance from shore and the lack of any onshore support activities near their habitat. A small diesel fuel spill in the lease area would not affect beach mice because a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to natural dispersion (see **Section A.9.1**).

Impacts of a Large Oil Spill

Potential spill impacts on beach mice are discussed by BOEM (2017a). For this EP, there are no unique site-specific issues with respect to these species that were not analyzed in these documents.

Beach mouse critical habitat in Baldwin County, Alabama, is approximately 195 miles (314 km) from the lease area. The 30-day OSRA results (**Table 3**) predict less than 0.5% conditional probability of oil contact with beach mouse critical habitat within 30 days of a spill. The 60-day OSRA modeling (**Table 4**) predicts that a spill in the lease area has a 1% or less conditional probability of reaching either the Alabama or Florida shorelines inhabited by beach mice within 60 days of a spill.

In the event of oil contacting these beaches, beach mice could experience several types of direct and indirect impacts. Contact with spilled oil could cause skin and eye irritation and subsequent infection; matting of fur; irritation of sweat glands, ear tissues, and throat tissues; disruption of sight and hearing; asphyxiation from inhalation of fumes; and toxicity from ingestion of oil and contaminated food. Indirect impacts could include reduction of food supply, destruction of habitat, and fouling of nests. Impacts could also occur from vehicular traffic and other activities associated with spill cleanup (BOEM, 2017a). However, any such impacts are unlikely due to the distance from shore and response actions that would occur in the event of a spill. Impacts leading to the death of individual beach mice would be significant at a species level.

C.3.9 Threatened Coral Species

Four threatened coral species are known from the northern Gulf of Mexico: elkhorn coral (*Acropora palmata*), lobed star coral (*Orbicella annularis*), mountainous star coral (*Orbicella faveolata*), and boulder star coral (*Orbicella franksi*). These species have been reported from the coral cap region of the Flower Garden Banks (NOAA, 2014) but are unlikely to be present as regular residents anywhere else in the northern Gulf of Mexico because they typically inhabit coral reefs in shallow, clear tropical, or subtropical waters. Other Caribbean coral species evaluated by NMFS in 2014 (79 FR 53852) either do not meet the criteria for ESA listing or are not known from the Flower Garden Banks. Critical habitat has been designated for elkhorn corals in the Florida Keys, but none has been designated for the other threatened coral species included above.

There are no IPFs associated with routine project activities that could affect threatened corals in the northern Gulf of Mexico. A small diesel fuel spill would not affect threatened coral species because the oil would float and dissipate on the sea surface. A large oil spill is the only relevant IPF.

Impacts of a Large Oil Spill

A large oil spill would be unlikely to reach coral reefs at the Flower Garden Banks or elkhorn coral critical habitat in the Florida Keys (Monroe County, Florida). The 60-day OSRA modeling (**Table 4**) does not predict oil contacting the Florida Keys within 60 days. A surface slick would not contact corals on the seafloor. If a subsurface plume were to occur, impacts on the Flower Garden Banks would be unlikely due to the distance and the difference in water depth. Near-bottom currents in the region are predicted to flow along the isobaths (Nowlin et al., 2001) and typically would not carry a plume up onto the continental shelf edge. Valentine et al. (2014) observed the spatial distribution of excess hopane, a crude oil tracer from Macondo spill sediment core samples, to be in the deeper waters and not transported up the shelf, thus confirming that near-bottom currents flow along the isobaths.

In the unlikely event that an oil slick reached reefs at the Flower Garden Banks or other Gulf of Mexico reefs, oil droplets or oiled sediment particles could come into contact with reef organisms or corals. As discussed by BOEM (2017a), impacts could include loss of habitat, biodiversity, and live coral coverage; destruction of hard substrate; change in sediment characteristics; and reduction or loss of one or more commercial and recreational fishery habitats. Sublethal effects could be long-lasting and affect the resilience of coral colonies to natural disturbances (e.g., elevated water temperature and diseases) (BOEM, 2017a).

Due to the distance betweenthe lease area and coral habitats, there is a low chance of oil contacting threatened coral habitat in the event of a spill, and no significant impacts on threatened coral species are expected.

C.4 Coastal and Marine Birds

C.4.1 Marine Birds

Marine birds include seabirds and other species that may occur in the pelagic environment of the project area (Clapp et al., 1982a, Clapp et al., 1982b, 1983, Peake, 1996, Hess and Ribic, 2000). Seabirds spend much of their lives offshore over the open ocean, except during breeding season when they nest on islands along the coast. Other waterbirds, such as waterfowl, marsh birds, and shorebirds may occasionally be present over open ocean areas. No endangered or threatened bird species are likely to occur at the project area. For a discussion of shorebirds and coastal nesting birds, see **Section C.4.2**.

Seabirds of the northern Gulf of Mexico were surveyed from ships during the GulfCet II program (Davis et al., 2000b). Hess and Ribic (2000) reported that terns, storm-petrels, shearwaters, and jaegers were the most frequently sighted seabirds in the deepwater area. From these surveys, four ecological categories of seabirds were documented in the deepwater areas of the Gulf: summer migrants (shearwaters, storm-petrels, boobies); summer residents that breed along the Gulf coast (Sooty Tern, Least Tern, Sandwich Tern, Magnificent Frigatebird); winter residents (gannets, gulls, jaegers); and permanent resident species (Laughing Gulls, Royal Terns, Bridled Terns) (Hess and Ribic, 2000). The GulfCet II study did not estimate bird densities; however, Powers (1987) indicated that seabird densities over the open ocean typically are less than 10 birds km^{-2}.

The distributions and relative densities of seabirds within the deepwater areas of the Gulf of Mexico, including the project area, vary temporally (i.e., seasonally) and spatially. In GulfCet II studies (Davis et al., 2000b), species diversity and density varied by hydrographic environment and by the presence and relative location of mesoscale features such as Loop Current eddies that may enhance nutrient levels and productivity of surface waters where these seabird species forage (Hess and Ribic, 2000).

Trans-Gulf migratory birds including shorebirds, wading birds, and terrestrial birds may also be present in the lease area. Migrant birds may use offshore structures and vessels for resting, feeding, or as temporary shelter from inclement weather. Some birds may be attracted to offshore structures and vessels because of the lights and the fish populations that aggregate around these structures (Russell, 2005).

IPFs that could affect marine and pelagic birds include MODU presence, noise, and lights; support vessel and helicopter traffic; and two types of accidents (a small diesel fuel spill and a large oil spill). Effluent discharges are likely to have negligible impacts on the birds due to rapid dispersion, the small area of ocean affected, the intermittent nature of the discharges, and the mobility of these animals. Compliance with NTL BSEE-2015-G03 (see **Table 1**) will minimize the potential for marine debris-related impacts on birds. The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of MODU Presence, Noise, and Lights

Birds migrating over water have been known to strike offshore structures, resulting in death or injury (Wiese et al., 2001, Russell, 2005). Mortality of migrant birds at tall towers and other land-based structures has been reviewed extensively, and the mechanisms involved in rig collisions appear to be similar. In some cases, migrants simply do not see a part of the rig until it is too late to avoid it. In other cases, navigation may be disrupted by noise or lighting (Russell, 2005). However, offshore structures may in some cases serve as suitable stopover habitats for trans-Gulf migrant species, particularly in spring (Russell, 2005).

Due to the limited scope and duration of MODU activities at each wellsite location as described in this EP, any impacts on populations of either seabirds or trans-Gulf migrant birds from activities described in this EP are not expected to be significant.

Impacts of Support Vessel and Helicopter Traffic

Support vessels and helicopters are unlikely to significantly disturb pelagic birds in areas of open offshore waters. It is likely that individual birds would experience, at most, only short-term behavioral disruption resulting from support vessel and helicopter traffic, and the impact would not be significant.

Impacts of a Small Diesel Fuel Spill

Potential spill impacts on marine birds are discussed by BOEM (2017a). For this EP, there are no unique site-specific issues with respect to spill impacts on these animals.

The probability of a fuel spill will be minimized by Noble Energy's preventative measures that will be implemented during routine operations, including fuel transfers. In the unlikely event of a spill, implementation of Noble Energy's OSRP could reduce the potential for impacts on marine and pelagic birds. **EP Section H** provides detail on spill response measures. Given the open ocean location of the lease area, the duration of a small spill and opportunity for impacts to occur would be very brief.

A small diesel fuel spill in offshore waters would produce a thin slick on the water surface and introduce concentrations of petroleum hydrocarbons and their degradation products. The extent and persistence of impacts would depend on the meteorological and oceanographic conditions at the time and the effectiveness of spill response measures. **Section A.9.1** discusses the likely fate of a small diesel fuel spill and indicates that more than 90% would evaporate or disperse naturally within 24 hours. The sea surface area covered with diesel fuel would range from 0.5 to 5 ha (1.2 to 12 ac), depending on sea state and weather conditions.

Birds exposed to oil on the sea surface could experience direct physical and physiological effects including skin irritation; chemical burns of skin, eyes, and mucous membranes; and inhalation of toxic fumes. Due to the limited areal extent and short duration of water quality impacts from a small diesel fuel spill, secondary impacts due to ingestion of oil via contaminated prey or reductions in prey abundance are unlikely. Due to the low densities of birds in open ocean areas, the small area affected, and the brief duration of the surface slick, no significant impacts on pelagic birds are expected.

Impacts of a Large Oil Spill

Potential spill impacts on marine and pelagic birds are discussed by BOEM (2017a). For this EP, there are no unique site-specific issues with respect to spill impacts on marine birds.

Pelagic seabirds could be exposed to oil from a spill at the project area. Hess and Ribic (2000) reported that terns, storm-petrels, shearwaters, and jaegers were the most frequently sighted seabirds in the deepwater Gulf of Mexico (> 656 ft [>200 m]). Powers (1987) indicated that seabird densities over the open ocean typically are less than 10 birds km^{-2}. The number of pelagic birds that could be affected in open offshore waters would depend on the extent and persistence of the oil slick.

Data following the Macondo spill provide relevant information about the species of pelagic birds that may be affected in the event of a large oil spill. Birds that have been treated for oiling include several pelagic species such as the Northern Gannet, Magnificent Frigatebird, and Masked Booby (USFWS, 2011). The Northern Gannet is among the species with the largest numbers of birds affected by the spill. NOAA reported that at least 93 resident and migratory bird species across all five Gulf Coast states were exposed to oil from the Macondo spill in multiple habitats, including offshore/open waters, island waterbird colonies, barrier islands, beaches, bays, and marshes (NOAA, 2016b). Exposure of marine birds to oil can result in adverse health with severity, depending on the level of oiling. Effects can range from plumage damage and loss of buoyancy from external oiling to more severe effects, such as organ damage, immune suppression, endocrine imbalance, reduced aerobic capacity, and death as a result of oil inhalation or ingestion (NOAA, 2016b). It is expected that impacts to marine birds from a large oil spill resulting in the death of individual birds would be adverse but not significant at population levels.

C.4.2 Coastal Birds

Threatened and endangered bird species (Piping Plover and Whooping Crane) were discussed in **Sections C.3.6** and **C.3.7**. The Brown Pelican (*Pelecanus occidentalis*) was delisted from federal endangered status in 2009 (USFWS, 2016b). However, this species remains listed as endangered by both Louisiana (State of Louisiana Department of Wildlife and Fisheries, 2005) and Mississippi (Mississippi Natural Heritage Program, 2015). The Brown Pelican was delisted as as a species of special concern by the State of Florida in 2017 (Florida Fish and Wildlife Conservation Commission, 2017). Brown Pelicans inhabit coastal habitats and forage within both coastal waters and waters of the inner continental shelf. Aerial and shipboard surveys, including GulfCet and GulfCet II (Davis et al., 2000b), indicate that Brown Pelicans do not occur in deep offshore waters (Fritts and Reynolds, 1981, Peake, 1996, Hess and Ribic, 2000). Nearly half the southeastern population of Brown Pelicans lives in the northern Gulf Coast, generally nesting on protected islands (USFWS, 2010a).

The Bald Eagle (*Haliaeetus leucocephalus*) was delisted from its threatened status in the lower 48 states on 28 June 2007. The Bald Eagle still receives protection under the Migratory Bird Treaty Act of 1918 and the Bald and Golden Eagle Protection Act of 1940 (USFWS, 2015). The Bald Eagle is a terrestrial raptor widely distributed across the southern U.S., including coastal habitats along the Gulf of Mexico. The Gulf Coast is inhabited by both wintering migrant and resident Bald Eagles (Johnsgard, 1990, Ehrlich et al., 1992).

Various species of non-endangered birds are also found along the northern Gulf Coast, including diving birds, shorebirds, marsh birds, wading birds, and waterfowl. Gulf Coast marshes and beaches also provide important feeding grounds and nesting habitats. Species that breed on beaches, flats, dunes, bars, barrier islands, and similar habitats include the Sandwich Tern, Wilson's Plover, Black Skimmer, Forster's Tern, Gull-Billed Tern, Laughing Gull, Least Tern, and Royal Tern (USFWS, 2010a). Additional information is presented by BOEM (2012a, 2017a).

IPFs that could affect coastal birds include support vessel and helicopter traffic and a large oil spill. A small diesel fuel spill in the lease area would be unlikely to affect shorebirds or coastal nesting birds, due to the lease area's distance from the nearest shoreline. As explained in **Section A.9.1**, a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to natural dispersion. Compliance with NTL BSEE-2015-G03 (see **Table 1**) will minimize the potential for marine debris-related impacts on shorebirds.

Impacts of Support Vessel and Helicopter Traffic

Support vessels and helicopters will transit coastal areas near Port Fourchon and Houma, Louisiana, where shorebirds and coastal nesting birds may be found. These activities could periodically disturb individuals or groups of birds within sensitive coastal habitats (e.g., wetlands that may support feeding, resting, or breeding birds).

Vessel traffic may disturb foraging and resting birds. Flushing distances vary among species and individuals (Rodgers and Schwikert, 2002). The disturbances will be limited to flushing birds away from vessel pathways; known distances are from 65 to 160 ft (20 to 49 m) for personal watercraft and 75 to 190 ft (23 to 58 m) for outboard-powered boats (Rodgers and Schwikert, 2002). Flushing distances may be similar or less for the support vessels to be used for Noble Energy's project, and some species such as gulls are attracted to boats. Support vessels will not approach nesting or breeding areas on the shoreline, so disturbances to nesting birds, eggs, and chicks are not expected. Vessel operators will use designated navigation channels and comply with posted speed and wake restrictions while transiting sensitive inland waterways. Due to the limited scope and short duration of support vessel activities, any short-term impacts are not expected to be biologically significant to coastal bird populations.

Aircraft traffic can cause some disturbance to birds onshore and offshore. Responses are highly dependent on the type of aircraft, bird species, activities that animals were previously engaged in, and previous exposures to overflights (Efroymson et al., 2000). Helicopters seem to cause the most intense responses when compared with other anthropogenic disturbances for some species (Bélanger and Bédard, 1989). Federal Aviation Administration (FAA) Advisory Circular No. 91-36D recommends that pilots maintain a minimum altitude of 2,000 ft (610 m) when flying over noise sensitive areas such as wildlife refuges, parks, and areas with wilderness characteristics. This is greater than the distance (slant range) at which aircraft overflights have been reported to cause behavioral effects on most species of birds studied (Efroymson et al., 2000). With the FAA guidelines in effect, it is likely that individual birds would experience, at most, only short-term behavioral disruption.

Impacts of Large Oil Spill

The OSRA results summarized in **Table 3** estimate that shorelines of Terrebonne and Plaquemines Parishes, Louisiana, could be contacted by a spill within 10 days. Other Texas and Louisiana shorelines that include habitat for shorebirds and coastal nesting birds could be affected within 30 days. The 60-day OSRA modeling (**Table 4**) predicts that shorelines between Cameron County, Texas (at the Texas/Mexico border), and Miami-Dade County, Florida, have up to a 13% probability of contact within 60 days of a spill.

Coastal birds can be exposed to oil as they float on the water surface, dive during foraging, or wade in oiled coastal waters. Oiled birds can lose the ability to fly, dive for food, or float on the water, which could lead to drowning (USFWS, 2010b) Oil interferes with the water repellency of feathers and can cause hypothermia in the right conditions. As birds groom themselves, they can ingest and inhale the oil on their bodies. Scavengers such as Bald Eagles and gulls can be exposed to oil by feeding on carcasses of contaminated fish and wildlife. While ingestion can kill animals immediately, more often it results in lung, liver, and kidney damage, which can lead to death (BOEM, 2017a). Bird eggs may be damaged if an oiled adult sits on the nest.

Data from the Macondo spill provide an indication of the potential impacts of a large spill on coastal bird populations. According to NOAA (2016b), an estimated 51,600 to 84,500 birds were killed by the spill, and the reproductive output lost as a result of breeding adult bird mortality was estimated to range from 4,600 to 17,900 fledglings that would have been produced in the absence of premature deaths of adult birds (NOAA, 2016b). Species with the largest numbers of estimated mortalities were American White Pelican, Black Skimmer, Black Tern, Brown Pelican, Laughing Gull, Least Tern, Northern Gannet, and Royal Tern (NOAA, 2016b).

Brown Pelicans are especially at risk from direct and indirect impacts from spilled oil within inner shelf and inshore waters, such as embayments. The range of this species is generally limited to these waters and surrounding coastal habitats. Brown Pelicans feed on mid-size fish that they capture by diving from above ("plunge diving") and then scooping the fish into their expandable gular pouch. This behavior makes them susceptible to plumage oiling if they feed in areas with surface oil or an oil sheen. They may also capture prey that has been physically contaminated with oil or has ingested oil. Issues for Brown Pelicans include direct contact with oil, disturbance from cleanup activities, and long-term habitat contamination (BOEM, 2012a).

The Bald Eagle also may be especially at risk from direct and indirect impacts from spilled oil. This species often captures fish within shallow water areas (snatching prey from the surface or wading into shallow areas to capture prey with their bill) and so may be susceptible to plumage oiling and, as with the Brown Pelican, they may also capture prey that has been physically contaminated with oil or has ingested oil (BOEM, 2012a). It is expected that impacts to coastal birds from a large oil spill resulting in the death of individual birds would be adverse but not significant at population levels.

C.5 Fisheries Resources

C.5.1 Pelagic Communities and Ichthyoplankton

Biggs and Ressler (2000) reviewed the biology of pelagic communities in the deepwater environment of the northern Gulf of Mexico. The biological oceanography of the region is dominated by the influence of the Loop Current, the surface waters of which are among the most oligotrophic in the world’s oceans. Superimposed on this low-productivity condition are productive "hot spots" associated with entrainment of nutrient-rich Mississippi River water and mesoscale oceanographic features. Anticyclonic and cyclonic hydrographic features play an important role in determining biogeographic patterns and controlling primary productivity in the northern Gulf of Mexico (Biggs and Ressler, 2000).

Most fishes inhabiting shelf or oceanic waters of the Gulf of Mexico have planktonic eggs and larvae (Ditty, 1986, Ditty et al., 1988, Richards et al., 1989, Richards et al., 1993). A study by Ross et al. (2012) on midwater fauna to characterize vertical distribution of mesopelagic fishes in selected deepwater areas in the Gulf of Mexico substantiated high species richness but general numerical domination by relatively few families and species.

IPFs potentially affecting pelagic communities and ichthyoplankton include MODU presence, noise, and lights; effluent discharges; water intakes; and two types of accidents (a small diesel fuel spill and a large oil spill).

Impacts of MODU Presence, Noise, and Lights

The MODU, as floating structures in the deepwater environment, will act as a fish aggregating device (FAD). In oceanic waters, the FAD effect would be most pronounced for epipelagic fishes such as tunas, dolphin, billfishes, and jacks, which are commonly attracted to fixed and drifting surface structures (Higashi, 1994, Relini et al., 1994, Holand, 1997). Positive fish associations with offshore rigs and platforms in the Gulf of Mexico are well documented (Gallaway and Lewbel, 1982, Wilson et al., 2003, Peabody and Wilson, 2006). The FAD effect could possibly enhance the feeding of epipelagic predators by attracting and concentrating smaller fish species. MODU noise could potentially cause masking in fishes, thereby reducing their ability to hear biologically relevant sounds (Radford et al., 2014).

The only defined acoustic threshold levels for continuous noise are given by Popper et al. (2014) and apply only to species of fish with swim bladders that provide some hearing (pressure detection) function. Popper et al. (2014) estimated threshold levels of 170 dB re 1 µPa acumulated over a 48-hour period for onset of recoverable injury and 158 dB re 1 µPa accumulated over a 12-hour period for onset temporary auditory threshold shifts. However, no consistent behavioral thresholds for fish have been established (Hawkins and Popper, 2014). Noise may also influence fish behaviors, such as predator-avoidance, foraging, reproduction, and intraspecific interactions (Picciulin et al., 2010, Bruintjes and Radford, 2013, McLaughlin and Kunc, 2015, Simpson et al., 2016). Fish aggregating is likely to occur to some degree due to the presence of the MODU, but the impacts would be limited in geographic scope and no population level impacts are expected.

Few data exist regarding the impacts of noise on pelagic larvae and eggs. Generally, it is believed that larval fish will have similar hearing sensitivities as adults, but may be more susceptible to barotrauma injuries associated with impulsive noise (Popper et al., 2014). Larval fish were experimentally exposed to simulated impulsive sounds by Bolle et al. (2012). The controlled playbacks produced cumulative exposures of 206 dB re 1 $\mu Pa^2 \cdot s$ but resulted in no increased mortality between the exposure and control groups. Non-impulsive noise sources are expected to be less injurious than impulsive noise. Based on transmission loss calculations, open water propagation of noise produced by typical sources with DP thrusters, are not expected to produce received levels greater than 160 dB re 1 µPa beyond 25 m from the source. Because of the limited propagation distances of high sound pressure levels and the periodic and transient nature of ichthyoplankton, no impacts to these life stages are expected.

Impacts of Effluent Discharges

Discharges of treated WBM- and SBM-associated cuttings will produce temporary, localized increases in suspended solids in the water column around the MODU. In general, turbid water can be expected to extend between a few hundred meters and several kilometers down current from the discharge point (National Research Council, 1983, Neff, 1987). NPDES permit limits and requirements will be met. Neff et al. (2005) reported that benthic communities in the Gulf of Mexico within 820 ft (250 m) of SBM discharge locations had reduced benthic faunal abundance and diversity.

Water-based drilling muds and cuttings will also be released at the seafloor during the initial well intervals before the marine riser is set to allow their return to the surface vessel. Excess cement slurry and BOP fluid will also be released at the seafloor. These discharges could smother or cover benthic communities in the vicinity of the discharge location. Impacts will be limited to the immediate area of the discharge, with little to no impact to fisheries resources.

Treated sanitary and domestic wastes may have a slight effect on the pelagic environment in the immediate vicinity of these discharges. These wastes may have elevated levels of nutrients, organic matter, and chlorine, but should dilute rapidly to undetectable levels within tens to hundreds of meters from the source. As a result of quick dilution, minimal impacts on water quality, plankton, and nekton are anticipated.

Deck drainage may have a slight effect on the pelagic environment in the immediate vicinity of these discharges. Deck drainage from contaminated areas will be passed through an oil-and-water separator prior to release, and discharges will be monitored for visible sheen. The discharges may have slightly elevated levels of hydrocarbons but should dilute rapidly to undetectable levels within tens to hundreds of meters from the source. Minimal impacts on water quality, plankton, and nekton are anticipated.

Other discharges in accordance with the NPDES permit, such as desalination unit brine, BOP fluid, non-pollutant well treatment and workover fluids, ballast and bilge water, noncontact cooling water, and fire water, are expected to dilute rapidly and have little or no impact on water column biota.

Impacts of Water Intakes

Seawater will be drawn from the ocean for once-through, non-contact cooling of machinery on the MODU. The MODU ultimately chosen for this project will be in compliance with all cooling water intake requirements of the NPDES permit to comply with Section 316(b) of the Clean Water Act.

The intake of seawater for cooling water will entrain plankton. The low intake velocity should allow most strong-swimming juvenile fishes and smaller adults to escape entrainment or impingement. However, drifting plankton would not be able to escape entrainment with the exception of a few fast-swimming larvae of certain taxonomic groups. The entrained organisms may be stressed or killed, primarily through changes in water temperature during the route from cooling intake structure to discharge structure and through mechanical damage (turbulence in pumps and condensers). Due to the limited scope and duration of proposed activities, any short-term impacts of entrainment are not expected to be significant on a population level for plankton or ichthyoplankton (BOEM, 2017a).

Impacts of a Small Diesel Fuel Spill

Potential spill impacts on fisheries resources are discussed by BOEM (2017a). For this EP, there are no unique site-specific issues with respect to spill impacts.

The probability of a fuel spill will be minimized by Noble Energy's preventative measures that will be implemented during routine operations, including fuel transfers between the supply vessel and MODU. In the unlikely event of a spill, implementation of Noble Energy's OSRP could mitigate the potential for impacts on pelagic communities, including ichthyoplankton. **EP Section H** provides detail on spill response measures. Given the open ocean location of the lease area, the duration of a small spill and opportunity for impacts to occur would be very brief.

A small diesel fuel spill in offshore waters would produce a thin slick on the water surface and introduce concentrations of petroleum hydrocarbons and their degradation products. The extent and persistence of impacts would depend on the meteorological and oceanographic conditions at the time and the effectiveness of spill response measures. **Section A.9.1** discusses the likely fate of a small diesel fuel spill and indicates that more than 90% would evaporate or disperse naturally within 24 hours. The sea surface area covered with diesel fuel would range from 0.5 to 5 ha (1.2 to 12 ac), depending on sea state and weather conditions.

A small diesel fuel spill could have localized impacts (i.e., hydrocarbon contamination) on phytoplankton, zooplankton, and nekton. Due to the limited areal extent and short duration of water quality impacts, a small diesel fuel spill would be unlikely to produce detectable impacts on pelagic communities.

Impacts of a Large Oil Spill

Potential spill impacts on pelagic communities and ichthyoplankton are discussed by . For this EP, there are no unique site-specific issues.

A large oil spill could directly affect water column biota including phytoplankton, zooplankton, ichthyoplankton, and nekton. A large spill that persisted for weeks or months would be more likely to affect these communities. While adult and juvenile fishes may actively avoid a large spill, planktonic eggs and larvae would be unable to avoid contact. Fish eggs and larvae are especially vulnerable to oiling because they inhabit the upper layers of the water column, and they will die if exposed to certain toxic fractions of spilled oil. Impacts could be greater if local-scale currents retained planktonic larval assemblages (and the floating oil slick) within the same water mass. Impacts to ichthyoplankton from a large spill would be greatest during spring and summer when shelf concentrations peak (BOEM, 2016b). Adult and juvenile fishes could also be impacted through the ingestion of oiled prey (USFWS, 2010b). It is expected that impacts to pelagic communites and ichthyoplankton from a large oil spill resulting in the death of individual fishes would be adverse but not significant at population levels.

C.5.2 Essential Fish Habitat

Essential Fish Habitat (EFH) is defined as the waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Under the Magnuson-Stevens Fishery Conservation and Management Act, as amended, federal agencies are required to consult on activities that may adversely affect EFH designated in Fishery Management Plans developed by the regional Fishery Management Councils.

The Gulf of Mexico Fishery Management Council (GMFMC) has prepared Fishery Management Plans for corals and coral reefs, shrimps, spiny lobster, reef fishes, coastal migratory pelagic fishes, and red drum. In 2005, the EFH for these managed species was redefined in Generic Amendment No. 3 to the various Fishery Management Plans (Gulf of Mexico Fishery Management Council, 2005). The EFH for most of these GMFMC-managed species is on the continental shelf in waters shallower than 600 ft (183 m). The shelf edge is the outer boundary for coastal migratory pelagic fishes, reef fishes, and shrimps. EFH for corals and coral reefs includes some shelf-edge topographic features located approximately 27 miles (43 km) west-northwest of the lease area.

Highly migratory pelagic fishes, which occur as transients in the lease area, are the only remaining group for which EFH has been identified in the deepwater Gulf of Mexico. Species in this group, including tunas, swordfishes, billfishes, and sharks are managed by NMFS. Highly migratory species with EFH in or near the lease area include the following species and life stages (NMFS, 2009b):

- Bigeye thresher shark (all)
- Blue marlin (juveniles, adults)
- Bluefin tuna (spawning, eggs, larvae, adults)
- Great hammerhead shark (all)
- Longfin mako shark (all)
- Oceanic whitetip shark (all)
- Sailfish (adults)
- Shortfin Mako (all)
- Silky shark (all)
- Skipjack tuna (spawning)
- Swordfish (larvae, juveniles, adults)
- Tiger shark (adults)
- Whale shark (all)
- White marlin (juveniles, adults)
- Yellowfin tuna (spawning, juveniles, adults)

Research indicates the central and western Gulf of Mexico may be important spawning habitat for Atlantic bluefin tuna (*Thunnus thynnus*), and NMFS (2009b) has designated a Habitat Area of Particular Concern (HAPC) for this species. The HAPC covers much of the deepwater Gulf of Mexico, including the lease area (**Figure 4**). The areal extent of the HAPC is approximately 115,830 miles^2 (300,000 km^2). The prevailing assumption is that Atlantic bluefin tuna follow an annual cycle of foraging in June through March off the eastern U.S. and Canadian coasts, followed by migration to the Gulf of Mexico to spawn in April, May, and June (NMFS, 2009b). The Atlantic bluefin tuna has also been designated as a species of concern (NMFS, 2011).

An amendment to the original EFH Generic Amendment was finalized in 2005 (Gulf of Mexico Fishery Management Council, 2005). One of the most significant proposed changes in this amendment reduced the extent of EFH relative to the 1998 Generic Amendment by removing the EFH description and identification from waters between 100 fathoms and the seaward limit of the Exclusive Economic Zone (EEZ). The Highly Migratory Species Fisheries Management Plan was amended in 2009 to update EFH and HAPC to include the bluefin tuna spawning area (NMFS, 2009b).

NTLs 2009-G39 and 2009-G40 provide guidance and clarification of regulations for biologically sensitive underwater features and areas and benthic communities that are considered EFH. As part of an agreement between BOEM and NMFS to complete a new programmatic EFH consultation for each new Five-Year Program, an EFH consultation was initiated between BOEM's Gulf of Mexico Region and NOAA's Southeastern Region during the preparation, distribution, and review of BOEM's 2017-2022 WPA/CPA Multisale EIS (BOEM, 2017a). The EFH assessment was completed and there is ongoing coordination among NMFS, BOEM, and BSEE, including discussions of mitigation (BOEM, 2016c).

Other HAPCs have been identified by the Gulf of Mexico Fishery Management Council (2005). These include the Florida Middle Grounds, Madison-Swanson Marine Reserve, Tortugas North and South Ecological Reserves, Pulley Ridge, and several individual reefs and banks of the northwestern Gulf of Mexico. (**Figure 4**). The nearest HAPC is Jakkula Bank, located approximately 96 miles (154 km) west of the lease area.

IPFs that could affect EFH include MODU presence, noise, and lights; effluent discharges; water intakes; and two types of accidents (a small diesel fuel spill and a large oil spill).

Impacts of MODU Presence, Noise, and Lights

The MODU, as a floating structure in the deepwater environment, will act as an FAD. In oceanic waters, the FAD effect would be most pronounced for epipelagic fishes such as tunas, dolphin, billfishes, and jacks, which are commonly attracted to fixed and drifting surface structures (Holland, 1990, Higashi, 1994, Relini et al., 1994). The FAD effect would possibly enhance feeding of epipelagic predators by attracting and concentrating smaller fish species. MODU noise could potentially cause acoustic masking for fishes, thereby reducing their ability to hear biologically relevant sounds (Radford et al., 2014). Noise may also influence fish behaviors such as predator avoidance, foraging, reproduction, and intraspecific interactions (Picciulin et al., 2010, Bruintjes and Radford, 2013, McLaughlin and Kunc, 2015).

The only defined acoustic threshold levels for continuous noise are given by Popper et al. (2014) and apply only to species of fish with swim bladders that provide some hearing (pressure detection) function. Popper et al. (2014) estimated threshold levels of 170 dB re 1 µPa acumulated over a 48-hour period for onset of recoverable injury and 158 dB re 1 µPa accumulated over a 12-hour period for onset temporary auditory threshold shifts. No consistent behavioral thresholds for fish have been established (Hawkins and Popper, 2014). Because the MODU is a temporary structure, any impacts on EFH for highly migratory pelagic fishes are considered minor.

Few data exist regarding the impacts of noise on pelagic larvae and eggs. Generally, it is believed that larval fish will have similar hearing sensitivities as adults, but may be more susceptible to barotrauma injuries associated with impulsive noise (Popper et al., 2014). Larval fish were experimentally exposed to simulated impulsive sounds by Bolle et al. (2012). The controlled playbacks produced cumulative exposures of 206 dB re 1 $\mu Pa^2 \cdot s$ but resulted in no increased mortality between the exposure and control groups. Non-impulsive noise sources are expected to be less injurious than impulsive noise. Based on transmission loss calculations, open water propagation of noise produced by typical sources with DP thrusters in use during offshore operations, are not expected to produce received levels greater than 160dB re 1 µPa beyond 25 m from the source. Because of the limited propagation distances of high sound pressure levels and the periodic and transient nature of ichthyoplankton, no impacts to these life stages are expected.

Impacts of Effluent Discharges

Effluent discharges affecting EFH by diminishing ambient water quality include sanitary and domestic wastes, deck drainage, desalination unit brine, BOP fluid, non-pollutant well treatment and workover fluids, uncontaminated ballast and bilge water, noncontact cooling water, fire water, water-based drilling muds and cuttings, cuttings wetted with synthetic-based muds, and excess cement. Impacts on water quality have been discussed previously. No significant impacts on EFH for highly migratory pelagic fishes are expected from these discharges if discharged according to NPDES permit conditions.

Impacts of Water Intakes

As noted previously, cooling water intake will cause entrainment and impingement of plankton, including fish eggs and larvae (ichthyoplankton). Due to the limited scope and relatively short duration of drilling activities, any short-term impacts on EFH for highly migratory pelagic fishes due to water intake are not expected to be biologically significant if operated in compliance with USEPA requirements.

Impacts of a Small Diesel Fuel Spill

Potential spill impacts on EFH are discussed by BOEM (2016c, 2017a). For this EP, there are no unique site-specific issues with respect to spill impacts.

The probability of a fuel spill will be minimized by Noble Energy's preventative measures that will be implemented during routine operations, including fuel transfer between the supply vessel and MODU. In the unlikely event of a spill, implementation of Noble Energy's OSRP could help diminish the potential for impacts on EFH. **EP Section H** provides detail on spill response measures. Given the open ocean location of the lease area, the duration of a small spill and opportunity for impacts to occur would be very brief.

A small diesel fuel spill in offshore waters would produce a thin slick on the water surface and introduce concentrations of petroleum hydrocarbons and their degradation products. The extent and persistence of impacts would depend on the meteorological and oceanographic conditions at the time and the effectiveness of spill response measures. **Section A.9.1** discusses the likely fate of a small diesel fuel spill and indicates that more than 90% would evaporate or disperse naturally within 24 hours. The sea surface area covered with diesel fuel would range from 0.5 to 5 ha (1.2 to 12 ac), depending on sea state and weather conditions.

A small diesel fuel spill could have localized impacts on EFH for highly migratory pelagic fishes, including tunas, swordfishes, billfishes, and sharks. These species occur as transients in the lease area. A spill would also produce short-term impact on surface and near-surface water quality in the HAPC for spawning bluefin tuna, which covers much of the deepwater Gulf of Mexico. The affected area would represent a negligible portion of the HAPC, which covers approximately 115,830 miles^2 (300,000 km^2) of the Gulf of Mexico.

A small diesel fuel spill would likely not affect EFH for corals and coral reefs, the nearest of which is located approximately 27 miles (43 km) west-northwest from the project area. A small diesel fuel spill would float and dissipate on the sea surface and would not contact these features.

Impacts of a Large Oil Spill

Potential spill impacts on EFH are discussed by BOEM (2016c, 2017a). For this EP, there are no unique site-specific issues with respect to EFH.

An oil spill in offshore waters would temporarily increase hydrocarbon concentrations on the water surface and potentially in the subsurface as well. Given the extent of EFH designations in the Gulf of Mexico (Gulf of Mexico Fishery Management Council, 2005, NMFS, 2009b), some impact on EFH would be unavoidable.

A large spill could affect the EFH for many managed species including shrimp, spiny lobster, reef fishes, coastal migratory pelagic fishes, and red drum. It would result in adverse impacts on water quality and water column biota including phytoplankton, zooplankton, and nekton. In coastal waters, sediments could be contaminated and result in persistent degradation of the seafloor habitat for managed demersal fish and shellfish species.

The lease area is within the HAPC for spawning Atlantic bluefin tuna (NMFS, 2009b). A large spill could temporarily degrade the HAPC due to increased hydrocarbon concentrations in the water column, with the potential for lethal or sublethal impacts on spawning tuna. Potential impacts would depend in part on the timing of a spill, as the species migrates to the Gulf of Mexico to spawn in April, May, and June (NMFS, 2009b).

The nearest feature designated as EFH for corals is located approximately 27 miles (43 km) west-northwest from the lease area. An accidental spill could reach or affect this feature, although near-bottom currents in the region are expected to flow along the isobaths (Nowlin et al., 2001, Valentine et al., 2014) and typically would not carry a plume up onto the continental shelf edge.

C.6 Archaeological Resources

C.6.1 Shipwreck Sites

Based on NTL 2011-JOINT-G01, the lease area is on BOEM's list of archaeology survey blocks (BOEM, 2011). No archaeological resources were noted in the site clearance letters for the proposed wellsites (Fugro Marine Geoservices, 2017).

Noble Energy will abide by the applicable requirements of NTL 2005-G07, which stipulate that work be stopped at the project site if any previously undetected archaeological resource is discovered after work has begun until appropriate surveys and evaluations have been completed. Because there are no known shipwreck sites in the lease area, there are no routine IPFs that are likely to affect shipwrecks. Impacts of a large oil spill are the only IPFs considered. A small diesel fuel spill would not affect shipwrecks because the oil would float and dissipate on the sea surface.

Impacts of a Large Oil Spill

BOEM (2012a) estimated that a severe subsurface blowout could resuspend and disperse sediments within a 984 ft (300 m) radius. Because there are no historic shipwrecks in the lease area, this impact would not be relevant.

Beyond this radius, there is the potential for impacts from oil, dispersants, and depleted oxygen levels (BOEM, 2017a). These impacts could include chemical contamination as well as alteration of the rates of microbial activity (BOEM, 2017a). During the Macondo spill, subsurface plumes were reported at a water depth of approximately 3,609 ft (1,100 m), extending at least 22 miles (35 km) from the wellsite and persisting for more than a month (Camilli et al., 2010). The subsurface plumes apparently resulted from the use of subsea dispersants at the wellhead (NOAA, 2011c). While the behavior and impacts of subsurface plumes are not well known, a subsurface plume could have the potential to contact shipwreck sites beyond the 984 ft (300 m) radius estimated by BOEM (2012a), depending on its extent, trajectory, and persistence (Spier et al., 2013). If oil from a subsea spill should come into contact with wooden shipwrecks on the seafloor, it could adversely affect their condition or preservation. Should there be any indication that potential shipwreck sites could be affected, in accordance with NTL 2005-G07, Noble Energy will immediately halt operations, take steps to ensure that the site is not disturbed in any way, and contact the BOEM Regional Supervisor, Leasing and Environment, within 48 hours of its discovery. Noble Energy would cease all operations within 1,000 ft (305 m) of the site until the Regional Supervisor provides instructions on steps to take to assess the site's potential historic significance and protect it.

A spill entering shallow coastal waters could conceivably contaminate an undiscovered shipwreck site. The 30-day OSRA modeling summarized in **Table 3** predicts that shorelines in Terrebonne and Plaquemines Parishes, Louisiana, could be contacted by a spill within 10 days (1% conditional probability). Other shorelines between Matagorda County, Texas, and Plaquemines Parish, Louisiana, could be contacted by a spill within 30 days (1% to 5% conditional probability). In addition, the 60-day OSRA modeling (**Table 4**) predicts that shorelines between Cameron County, Texas (at the Texas/Mexico border), and Miami-Dade County, Florida, have a 1% to 13% conditional probability of oil contact within 60 days of a spill. If an oil spill contacted a coastal historic site, such as a fort or a lighthouse, the impacts may be temporary and reversible (BOEM, 2017a).

C.6.2 Prehistoric Archaeological Sites

With a water depth at the proposed wellsites ranging from approximately 2,124 to 2,129 ft (647 to 649 m), the project area is well beyond the 197 ft (60 m) depth contour used by BOEM as the seaward extent for prehistoric archaeological site potential in the Gulf of Mexico. Because of this, the only relevant IPF is a large oil spill. A small diesel fuel spill would not affect prehistoric archaeological resources because the oil would float and dissipate on the sea surface.

Impacts of a Large Oil Spill

Because of the water depth and the lack of prehistoric archaeological sites found in the lease area, they would not be impacted by the physical effects of a subsea blowout. BOEM (2012a) estimated that a severe subsurface blowout could resuspend and disperse sediments within a 984 ft (300 m) radius.

Along the northern Gulf Coast, prehistoric sites occur frequently along the barrier islands and mainland coast and along the margins of bays and bayous (BOEM, 2012b). The 30-day OSRA modeling summarized in **Table 3** estimates that shorelines in Terrebonne and Plaquemines Parishes, Louisiana, could be contacted by a spill within 10 days (1% conditional probability). Other shorelines between Matagorda County, Texas, and Plaquemines Parish, Louisiana, could be contacted by a spill within 30 days (1% to 5% conditional probability). In addition, the 60-day OSRA modeling (**Table 4**) predicts that shorelines between Cameron County, Texas (at the Texas/Mexico border), and Miami-Dade County, Florida, have a 1% to 13% conditional probability of oil contact within 60 days of a spill. If a spill did reach a prehistoric site along these shorelines, it could coat fragile artifacts or site features and compromise the potential for radiocarbon dating organic materials in a site.Coastal prehistoric sites also could be damaged by spill cleanup operations (e.g., by destroying fragile artifacts and disturbing the provenance of artifacts and site features). BOEM (2017b) notes that some unavoidable direct and indirect impacts on coastal historic resources could occur, resulting in the loss of information.

C.7 Coastal Habitats and Protected Areas

Coastal habitats in the northeastern Gulf of Mexico that may be affected by oil and gas activities are described by BOEM (2016a, 2017a), and are tabulated in the OSRP. Coastal habitats inshore of the project area include coastal and barrier island beaches and dunes, wetlands, and submerged seagrass beds. Most of the northeastern Gulf of Mexico is fringed by coastal and barrier island beaches, with wetlands and submerged seagrass beds occurring in sheltered areas behind the barrier islands and in estuaries.

Due to the distance from shore, the only IPF associated with routine activities in the lease area that could affect beaches and dunes, wetlands, seagrass beds, coastal wildlife refuges, wilderness areas, or any other managed or protected coastal area is support vessel traffic. The support bases at Port Fourchon and Houma, Louisiana, are not in wildlife refuges or wilderness areas. Potential impacts of support vessel traffic are briefly addressed below.

A large oil spill is the only accidental IPF that could affect coastal habitats and protected areas. A small diesel fuel spill in the lease area would be unlikely to affect coastal habitats due to the lease area's distance from the nearest shoreline. As explained in **Section A.9.1**, a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to natural dispersion.

Impacts of Support Vessel Traffic

Support operations, including crew boats and supply boats as detailed in **EP Section K**, may have a minor incremental impact on coastal and barrier island beaches, wetlands, and protected areas. Over time with a large number of vessel trips, vessel wakes can erode shorelines along inlets, channels, and harbors, resulting in localized land loss. Impacts to beaches, wetlands, and protected areas will be minimized by following the speed and wake restrictions in harbors and channels.

Support operations, including crew boats and supply boats are not anticipated to have a significant impact on submerged seagrass beds. While submerged seagrass beds have the potential to be uprooted, scarred, or lost due to direct contact from vessels, use of navigation channels and adherence to local requirements and implemented programs will decrease the likelihood of impacts to submerged seagrass beds (BOEM, 2017a).

Impacts of a Large Oil Spill

Potential spill impacts on coastal habitats are discussed by BOEM (2017a). Coastal habitats inshore of the project area include coastal and barrier island beaches, wetlands, and submerged seagrass beds. For this EP, there are no unique site-specific issues with respect to coastal habitats.

The 30-day OSRA modeling (**Table 3**) indicates that shorelines in Terrebonne and Plaquemines Parishes, Louisiana, have a 1% conditional probability of oil contact within 10 days of a spill. Other shorelines between Matagorda County, Texas, and Plaquemines Parish, Louisiana, had a 1% to 5% conditional probability of shoreline contact within 30 days of a spill. The 60-day OSRA modeling (**Table 4**) predicts that shorelines between Cameron County, Texas (at the Texas/Mexico border), and Miami-Dade County, Florida, have a 1% to 13% conditional probability of oil contact within 60 days of a spill, with the highest probability occuring in Terrebonne Parish, Louisiana, in the spring (13% conditional probability).

The shorelines within the geographic range predicted by the 60-day OSRA modeling (**Table 4**) include extensive barrier beaches and wetlands, with submerged seagrass beds occurring in sheltered areas behind the barrier islands and in estuaries. NWRs and other protected areas along the coast are discussed by BOEM (2017a) and Noble Energy's OSRP. Based on the 30-day OSRA, coastal and near-coastal wildlife refuges, wilderness areas, and state and national parks within the geographic range of the potential shoreline contacts within 30 days are presented in **Table 7**.

Table 7. Wildlife refuges, wilderness areas, and state and national parks and preserves within the geographic range of 1% or greater conditional probability of shoreline contacts within 30 days based on the 30-day Oil Spill Risk Analysis model.

County or Parish, State	Wildlife Refuge, Wilderness Area, or State/National Park
Matagorda, Texas	Big Boggy National Wildlife Refuge
	Matagorda Bay Nature Park
	San Bernard National Wildlife Refuge
	West Moring Dock Park
Galveston, Texas	Anahuac National Wildlife Refuge
	Bolivar Flats Shorebird Sanctuary
	Fort Travis Seashore Park
	Galveston Island State Park
	Horseshoe Marsh Bird Sanctuary
	Mundy Marsh Bird Sanctuary
	R.A. Apffel Park
	Seawolf Park
Jefferson, Texas	McFaddin National Wildlife Refuge
	Sea Rim State Park
	Texas Point National Wildlife Refuge
Cameron, Louisiana	Sabine National Wildlife Refuge
	Rockefeller State Wildlife Refuge and Game Preserve
	Peveto Woods Sanctuary
Vermilion, Louisiana	Paul J. Rainey Wildlife Refuge and Game Preserve
	Rockefeller State Wildlife Refuge and Game Preserve
	State Wildlife Refuge
Terrebonne, Louisiana	Isles Dernieres Barrier Islands Refuge
	Pointe aux Chenes Wildlife Management Area
Lafourche, Louisiana	East Timbalier Island National Wildlife Refuge
	Pointe aux Chenes Wildlife Management Area
	Wisner Wildlife Management Area (Includes Picciola Tract)
Jefferson, Louisiana	Grand Isle State Park
Plaquemines, Louisiana	Breton National Wildlife Refuge
	Delta National Wildlife Refuge
	Pass a Loutre Wildlife Management Area

The level of impacts from oil spills on coastal habitats depends on many factors, including the oil characteristics, the geographic location of the landfall, and the weather and oceanographic conditions during the time of the spill (BOEM, 2017a). Oil that makes it to beaches may be either liquid weathered oil, an oil-and-water mousse, or tarballs. Oil is generally deposited on beaches in lines defined by wave action at the time of landfall. Oil that remains on the beach will thicken as its volatile components are lost. Thickened oil may form tarballs or aggregations that incorporate sand, shell, and other materials into its mass. Tar may be buried to varying depths under the sand. On warm days, both exposed and buried tarballs may liquefy and ooze. Oozing may also serve to expand the size of a mass as it incorporates beach materials. Oil on beaches may be cleaned up manually, mechanically, or both. Some oil can remain on the beach at varying depths and may persist for several years as it slowly biodegrades and volatilizes (BOEM, 2017a). Impacts associated with an extensive oiling of coastal and barrier island beaches from a large oil spill are expected to be adverse.

Coastal wetlands are highly sensitive to oiling and can be significantly affected because of the inherent toxicity of hydrocarbon and non-hydrocarbon components of the spilled substances (Beazley et al., 2012, Lin and Mendelssohn, 2012, Mendelssohn et al., 2012). Numerous variables such as oil concentration and chemical composition, vegetation type and density, season or weather, preexisting stress levels, soil types, and water levels may influence the impacts of oil exposure on wetlands. Light oiling could cause plant die-back, followed by recovery in a fairly short time. Vegetation exposed to oil that persists in wetlands could take years to recover (BOEM, 2017a). However, in a study in Barataria Bay, Louisiana, after the Macondo spill, Silliman et al. (2012) reported that vegetation in previously healthy marshes largely recovered to a pre-oiling state within 18 months. Oiled marshes that had prior accelerated rates of erosion experienced a bio-geomorphological feedback that further increased marsh loss to erosion and did not experience regrowth (Silliman et al., 2012). In addition to the direct impacts of oil, cleanup activities in marshes may accelerate rates of erosion and retard recovery rates (Lin et al., 2016, Turner et al., 2016, BOEM, 2017a). A recent review of the literature and new studies indicated that oil spill impacts to seagrass beds are often limited and may be limited to when oil is in direct contact with these plants (Fonseca et al., 2017).

Impacts associated with an extensive oiling of coastal wetland habitat from a large oil spill are expected to be significant.

C.8 Socioeconomic and Other Resources

C.8.1 Recreational and Commercial Fishing

Potential impacts to recreational and commercial fishing are analyzed by BOEM (2017a).

The main commercial fishing activity in deep waters of the northern Gulf of Mexico is pelagic longlining for tunas, swordfishes, and other billfishes (Continental Shelf Associates, 2002). Pelagic longlining has occurred historically in the project area, primarily during spring and summer.

Longline gear consists of monofilament line deployed from a moving vessel and generally allowed to drift for 4 to 5 hours. As the mainline is put out, baited leaders and buoys are clipped in place at regular intervals. It takes 8 to 10 hours to deploy a longline and approximately the same time to retrieve it. Longlines are often set near oceanographic features such as fronts or downwellings, with the aid of sophisticated onboard temperature sensors, depth finders, and positioning equipment. Vessels typically are 33 to 98 ft (10 to 30 m) long, and their trips last from 1 to 3 weeks. The main Gulf of Mexico homeports for longlining vessels are in Louisiana

(Dulac and Venice) and Florida (Destin, Madeira Beach, and Panama City) (Continental Shelf Associates, 2002).

It is unlikely that any commercial fishing activity other than longlining will occur in or near the project area due to the water depth at the project area. Benthic species targeted by commercial fishers occur on the upper continental slope, well inshore of the project area. Royal red shrimp (*Pleoticus robustus*) are caught by trawlers in water depths of approximately 820 to 1,804 ft (250 to 550 m). Tilefishes (primarily *Lophalotilus chamaeleonticeps*) are caught by bottom longlining in water depths from approximately 540 to 1,476 ft (165 to 450 m) (Continental Shelf Associates, 2002).

Most recreational fishing activity in the region occurs in water depths less than 656 ft (200 m) (Continental Shelf Associates, 1997, 2002). In deeper water, the main attraction to recreational fishers is petroleum rigs offshore Texas and Louisiana. Due to the project site's distance from shore, it is unlikely that recreational fishing activity is occurring in the lease area.

The only routine IPF potentially affecting fisheries and, therefore, commercial and recreational fishing, is MODU presence (including noise and lights). Potential accident IPFs that could affect fisheries are include both a small diesel fuel spill and a large oil spill.

Impacts of MODU Presence, Noise, and Lights

There is a slight possibility of pelagic longlines becoming entangled in the MODU. For example, in January 1999 a portion of a pelagic longline snagged on the acoustic Doppler current profiler of a drillship working in the Gulf of Mexico (Continental Shelf Associates, 2002). The line was removed without incident. Generally, longline fishers use radar and are aware of offshore structures and ships when placing their sets. Therefore, little or no impact on pelagic longlining is expected.

Because it is unlikely that any recreational fishing activity is occurring in the project area, no adverse impacts are anticipated. Other factors such as effluent discharges are likely to have negligible impacts on commercial or recreational fisheries due to rapid dispersion, the small area of ocean affected, and the intermittent nature of the discharges.

Impacts of a Small Diesel Fuel Spill

Pelagic longlining activities in the lease area, if any, could be interrupted in the event of a small diesel fuel spill. The sea surface area covered with diesel fuel would range from 0.5 to 5 ha (1.2 to 12 ac), depending on sea state and weather conditions (see **Section A.9.1**). Fishing activities could be interrupted due to the activities of response vessels operating in the lease area. A small diesel fuel spill would not affect coastal water quality because the spill would not be expected to make landfall or reach coastal waters prior to natural dispersion (see **Section A.9.1**).

The probability of a fuel spill will be minimized by Noble Energy's preventative measures that will be implemented during routine operations, including fuel transfers. In the unlikely event of a spill, implementation of Noble Energy's OSRP could potentially mitigate and reduce the potential for impacts. **EP Section H** provides detail on spill response measures. Given the open ocean location of the lease area, the duration of a small spill and opportunity for impacts to occur is expected to be very brief.

Impacts of a Large Oil Spill

Potential spill impacts on fishing activities are discussed by BOEM (2017a). For this EP, there are no unique site-specific issues with respect to this activity.

Pelagic longlining activities in the lease area and other fishing activities in the northern Gulf of Mexico could be interrupted in the event of a large oil spill. A spill may or may not result in fishery closures, depending on the duration of the spill, the oceanographic and meteorological conditions at the time, and the effectiveness of spill response measures. Data following the Macondo spill provide information about the maximum potential extent of fishery closures in the event of a large oil spill in the Gulf of Mexico (NMFS, 2010a). At its peak on 12 July 2010, closures encompassed 84,101 miles^2 (217,821 km^2), or 34.8% of the U.S. Gulf of Mexico EEZ. BOEM (2012a) notes that fisheries closures from a large spill event could have a negative effect on short-term fisheries catch and marketability.

According to BOEM (2012a, 2017a), the potential impacts on commercial and recreational fishing activities from an accidental oil spill are anticipated to be minimal because the potential for oil spills is very low, the most typical events are small and of short duration, and the effects are so localized that fishes are typically able to avoid the affected area. Fish populations may be affected by an oil spill event should it occur, but they would be primarily affected if the oil reaches the productive shelf and estuarine areas where many fishes spend a portion of their life cycle. The probability of an offshore spill affecting these nearshore environments is also low. Should a large oil spill occur, economic impacts on commercial and recreational fishing activities would likely occur, but are difficult to predict because impacts would differ by fishery and season (BOEM, 2017a).

C.8.2 Public Health and Safety

There are no IPFs associated with routine operations that are expected to affect public health and safety. A small diesel fuel spill would not have any impacts on public health and safety because it would affect only a small area of the open ocean. The lease area is approximately 75 miles (121 km) from the nearest shoreline and nearly all of the diesel fuel would evaporate or disperse naturally within 24 hours (see **Section A.9.1**). Impacts of a large oil spill are addressed below.

Impacts of a Large Oil Spill

In the event of a large spill from a blowout, the main safety and health concerns are those of the offshore personnel involved in the incident and those responding to the spill. The proposed activities will be covered by Noble Energy's Regional OSRP and the MODU's emergency response plans.

Depending on the spill rate and duration, the physical/chemical characteristics of the oil, meteorological and oceanographic conditions at the time, and the effectiveness of spill response measures, the public could be exposed to oil on the water and along the shoreline, including skin contact or breathing VOCs. Oil is a highly flammable material, and any smoke or vapors from an oil fire can cause irritation, and in large quantities may pose a health hazard.

Studies conducted after the Macondo spill provide relevant information about the types of health issues that may occur in the event of a large oil spill. Wildlife cleaning and rehabilitation workers have reported concerns including scrapes and cuts, itchy or red skin or rash, and symptoms of headache or feeling faint, dizzy, or fatigued (King and Gibbins, 2011). Hand, shoulder, or back pain was reported by some wildlife-cleaning workers as well. Awkward postures, repetitive motions, and heavy lifting tasks were noted by investigators as contributing to musculoskeletal symptoms. Personnel working on offshore vessels or providing direct oversight to offshore vessels, including USCG personnel, civilian contractors, and other responders who were exposed to oil and dispersants, had a 7 to 12 times higher prevalence of upper respiratory symptoms and cough than those not exposed (Centers for Disease Control and Prevention, 2010). Another potential occupational hazard for spill response workers in general was heat stress from work in a hot and humid environment (King and Gibbins, 2011). Initial symptoms from cleanup workers who sought medical care in Louisiana were typical of acute exposure to hydrocarbons or H_2S (e.g., headaches, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain) (Solomon and Janssen, 2010). Impacts associated with a large oil spill to public safety are expected to be adverse but not significant.

C.8.3 Employment and Infrastructure

There are no IPFs associated with routine operations that are expected to affect employment and infrastructure. The project involves support from drilling contractor and associated third-party services, and existing shorebase facilities in Louisiana. No new or expanded facilities will be constructed, and no new employees are expected to move permanently into the area. The project will have a negligible impact on socioeconomic conditions such as local employment and existing offshore and coastal infrastructure. A small diesel fuel spill that is dissipated within a few days would have little or no economic impact, as the spill response would use existing facilities, resources, and personnel. Impacts of a large oil spill on employment and infrastrucre are addressed below.

Impacts of a Large Oil Spill

Potential socioeconomic impacts of an oil spill are discussed by BOEM (2017a). For this EP, there are no unique site-specific issues with respect to employment and coastal infrastructure. A large spill could cause economic impacts in several ways: it could result in extensive fishery closures that put fishermen out of work; it could result in temporary employment as part of the response effort; it could result in adverse publicity that affects employment in coastal recreation and tourism industries; and it could result in another suspension of OCS drilling activities, including service and support operations that are an important part of local economies.

In addition to the analyses presented by BOEM (2012a), a study explored the economic impacts of the Macondo spill on oil and gas industry employment due to suspension of deepwater drilling (U.S. Department of Commerce, 2010). The study indicates that during the moratorium, the number of oil industry workers in the Gulf of Mexico fell by approximately 2,000 and may have indirectly caused a temporary loss of 8,000 to 12,000 jobs along the Gulf Coast. Total spending by drilling operators is estimated to have declined by $1.8 billion over a 6-month period; this direct reduction in spending affected employment in the industries that supply the Gulf drilling industry and in all other industries affected by declines in consumer and business spending (U.S. Department of Commerce, 2010).

As noted by BOEM (2012a), the short-term social and economic consequences for the Gulf Coast region should a large spill occur include the opportunity cost of employment and expenditures that could have gone to production or consumption rather the spill cleanup efforts. Nonmarket effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations could also occur in the short term. These negative, short-term social and economic consequences of a spill are expected to be modest in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities (BOEM, 2017a). Net employment impacts from a spill would not be expected to exceed 1% of baseline employment in any given year (BOEM, 2012a).

C.8.4 Recreation and Tourism

For this EP, there are no unique site-specific issues with respect to this recreation and tourism. There are no known recreational uses of the lease area. Recreational resources and tourism in coastal areas would not be affected by any routine activities due to the distance from shore. Compliance with NTL BSEE-2015-G03 (see **Table 1**) will minimize the chance of trash or debris being lost overboard from the MODU and subsequently washing up on beaches. A small diesel fuel spill in the lease area would be unlikely to affect recreation and tourism because, as explained in **Section A.9.1**, it would not be expected to make landfall or reach coastal waters prior to breaking up. Impacts of a large oil spill on recreation and tourism are discussed below.

Impacts of a Large Oil Spill

Potential impacts of an oil spill on recreation and tourism are discussed by BOEM (2017a). For this EP, there are no unique site-specific issues with respect to these impacts.

Impacts on recreation and tourism would vary depending on the duration of the spill and its fate including the effectiveness of response measures. A large spill that reached coastal waters and shorelines could adversely affect recreation and tourism by contaminating beaches and wetlands, resulting in negative publicity that encourages people to stay away. The 30-day OSRA modeling (**Table 3**) indicates that Terrebonne and Plaquemines Parishes in Louisiana are the areas most likely to be contacted within 10 days of a spill (1% conditional probability), while Cameron Parish is the area most likely to be contacted within 30 days of a spill (5% conditional probability). However, the 60-day OSRA modeling (**Table 4**) predicts that shorelines between Cameron County, Texas (at the Texas/Mexico border), and Miami-Dade County, Florida, have a 1% to 13% conditional probability of oil contact within 60 days of a spill.

According to BOEM (2017a), should an oil spill occur and contact a beach area or other recreational resource, it would cause some disruption during the impact and cleanup phases of the spill. However, these effects are also likely to be small in scale and of short duration, in part because the probability of an offshore spill contacting most beaches is small. In the unlikely event that a spill occurs that is sufficiently large to affect large areas of the coast and, through public perception, have effects that reach beyond the damaged area, effects to recreation and tourism could be significant (BOEM, 2017a).

Impacts of the Macondo spill on recreation and tourism provide some insight into the potential effects of a large spill. NOAA (2016b) estimated that the public lost 16,857,116 user days of fishing, boating, and beach-going experiences as a result of the spill. The U.S. Travel Association has estimated the economic impact of the Macondo spill on tourism across the Gulf Coast over a 3-year period at $22.7 billion (Oxford Economics, 2010). Hotels and restaurants were the most affected tourism businesses, but charter fishing, marinas, and boat dealers and sellers were among the others affected (Eastern Research Group, 2014).

C.8.5 Land Use

Land use along the northern Gulf Coast is discussed by BOEM (2017a). There are no routine IPFs that could affect land use. The project will use existing onshore support facilities in Louisiana. The land use at the existing shorebase sites is industrial. The project will not involve any new construction or changes to existing land use and therefore will not have any impacts. Levels of boat and helicopter traffic as well as demand for goods and services including scarce coastal resources will represent a small fraction of the level of activity occurring at the shorebases.

A large oil spill is the only relevant IPF on land use. A small diesel fuel spill would not have any impacts on land use, as the response would be staged out of existing shorebases and facilities.

Impacts of a Large Oil Spill

The initial response for a large oil spill would be staged out of existing facilities with no effect on land use. A large spill could have limited temporary impacts on land use along the coast if additional staging areas were needed. For example, during the Macondo spill, temporary staging areas were established in Louisiana, Mississippi, Alabama, and Florida for spill response and cleanup efforts. In the event of a large spill in the lease area, similar temporary staging areas could be needed. These areas would eventually return to their original use as the response is demobilized.

An accidental oil spill is not likely to significantly affect land use and coastal infrastructure in the region, in part because an offshore spill would have a small probability of contacting onshore resources. BOEM (2016b) states that landfill capacity would probably not be an issue at any phase of an oil spill event or the long-term recovery. In the case of the Macondo spill and response, the USEPA reported that existing landfills receiving oil spill waste had plenty of capacity to handle waste volumes; the wastes that were disposed of in landfills represented less than 7% of the total daily waste normally accepted at these landfills (USEPA, 2016).

C.8.6 Other Marine Uses

The lease area is not located within any USCG-designated fairway, shipping lane, or Military Warning Area. The site clearance letter for the proposed wellsites noted one existing wellsite within 3,000 ft (915 m) of the proposed wellsites. Several sonar contacts were identified within 2,000 ft (610 m) of the proposed wellsites (Fugro Marine Geoservices, 2017), but none were assigned archaeological voidance zones. Noble Energy will comply with BOEM requirements and lease stipulations to avoid impacts to other marine uses.

There are no IPFs from routine project activities that are likely to affect other marine uses of the lease area. A large oil spill is the only relevant accident-related IPF on other marine uses. A small diesel fuel spill would not have any impacts on other marine uses because spill response activities would be mainly within the lease area and the duration would be brief.

Impacts of a Large Oil Spill

In the event of a large spill requiring numerous response vessels, coordination would be required to manage the vessel traffic for safe operations and to ensure that no anchoring or seafloor-disturbing activities occur near the existing wells. Other OCS activities located nearby the location of a large spill may be temporarily interrupted, which could include evacuation of non-essential personnel. Noble Energy will comply with BOEM requirements and lease stipulations to avoid impacts on uses of the area by military vessels and aircraft.

C.9 Cumulative Impacts

For purposes of the National Environmental Policy Act, cumulative impact is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Any single activity or action may have a negligible impact(s) by itself, but when combined with impacts from other activities in the same area or time period, substantial impacts may result.

Prior Studies:

BOEM (2017a) prepared a multisale EIS in which it analyzed the environmental impact of activities that might occur in the multisale area. The level and types of activities planned in Noble Energy's EP are within the range of activities described and evaluated by BOEM in the 2017 to 2022 Programmatic Environmental Impact Statement (EIS) for the Outer Continental Shelf (OCS) Oil and Gas Leasing Program (BOEM, 2016a), and the Final EIS for Gulf of Mexico OCS Oil and Gas Lease Sales 2017-2022 (BOEM, 2017a). Past, present, and reasonably foreseeable activities are identified in the cumulative effects scenario of these documents, which are incorporated by reference. The proposed activities should not result in any additional impacts beyond those evaluated in the multisale and Final EISs.

Description of Activities Reasonably Expected to Occur in the Vicinity of Project Area:

Other exploration and development activities are ongoing in the vicinity of the proposed project area. Noble Energy does not anticipate other projects in the vicinity of the proposed project location beyond the types of projects analyzed in the lease sale and Supplemental EISs (BOEM, 2012a, b, 2013a, 2014a, 2015, 2016b, 2017a).

Cumulative Impacts of Activities in this EP:

The BOEM (2017a) Final EIS included a lengthy discussion of cumulative impacts, which analyzed the environmental and socioeconomic impacts from the incremental impacts of the 10 proposed lease sales, in addition to all activities (including non-OCS activities) projected to occur from past, proposed, and future lease sales. The following activities were considered in development of the EISs: exploration, delineation, and development of wells, platform installation, service-vessel trips, and oil spills. The EISs examined the potential cumulative effects on each specific resource for the entire Gulf of Mexico.

The level and type of activity proposed in Noble Energy's EP are within the range of activities described and evaluated in the recent lease sale EISs. The EIA incorporates and builds on these analyses by examining the potential impacts on physical, biological, and socioeconomic resources from the work planned in this EP along with other reasonably foreseeable activities expected to occur in the Gulf of Mexico. Thus, for all impacts, the incremental contribution of Noble Energy's proposed actions to the cumulative impacts in these prior analyses should not be significant.

D. Environmental Hazards

D.1 Geologic Hazards

Based on the site clearance letters, the proposed area is clear of constraining geological seafloor conditions (Fugro Marine Geoservices, 2017). See **EP Section C** for supporting geological and geophysical information.

D.2 Severe Weather

Under most circumstances, weather is not expected to have any effect on the proposed activities. Extreme weather, including high winds, strong currents, and large waves, was considered in the design criteria for the MODU under consideration for this project. High winds and limited visibility during a severe storm could disrupt support activities (vessel and helicopter traffic) and make it necessary to suspend some activities and potentially evacuate the MODU for safety reasons until the storm or weather event passes. In the event of a hurricane, procedures as outlined in the Hurricane Evacuation Plan would be adhered to. Evacuation in the event of a hurricane or other severe weather would increase the number and frequency of support vessel and helicopter trips to and from the project area.

D.3 Currents and Waves

Metocean conditions such as sea states, wind speed, and ocean currents will be continuously monitored. Under most circumstances, physical oceanographic conditions are not expected to have any effect on the proposed activities. Strong currents (e.g., caused by Loop Current eddies and intrusions) and large waves were considered in the design criteria for the MODU under consideration for this project. High waves during a severe storm could disrupt support activities (i.e., vessel and helicopter traffic) and make it necessary to suspend some activities on the MODU for safety reasons until the storm or weather event passes.

E. Alternatives

No formal alternatives were evaluated in the EIA for this EP. However, various technical and operational options, including the locations of the wellsites and the selection of the MODU, were considered by Noble Energy in developing the proposed action.

F. Mitigation Measures

The proposed action includes numerous mitigation measures required by laws, regulations, and BSEE and BOEM lease stipulations and NTLs. The project will comply with all applicable federal, state, and local requirements concerning air pollutant emissions, discharges to water, and solid waste disposal. All project activities will be conducted under guidance by Noble Energy's OSRP and Safety and Environmental Management System. Additional information can be found in **EP Section I**.

G. Consultation

No persons or agencies beyond those cited as Preparers (**Section H**) were consulted during the preparation of the EIA.

H. Preparers

The EIA was prepared by CSA Ocean Sciences Inc. Contributors included:

- John Tiggelaar (Project Scientist);
- Patrick Connelly (Project Scientist);
- Charles Hagens (Geospatial Analyst); and
- Kristen L. Metzger (Library and Information Services Director).

I. References

ABS Consulting Inc. 2016. 2016 Update of Occurrence Rates for Offshore Oil Spills. Prepared for the Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement. Contract # E15PX00045, Deliverable 7. https://www.bsee.gov/sites/bsee.gov/files/osrr-oil-spill-response-research//1086aa.pdf.

Ackleh, A.S., G.E. Ioup, J.W. Ioup, B. Ma, J.J. Newcomb, N. Pal, N.A. Sidorovskaia, and C. Tiemann. 2012. Assessing the Deepwater Horizon oil spill impact on marine mammal population through acoustics: endangered sperm whales. J. Acoust. Soc. Am. 131(3): 2306-2314.

Anderson, C.M., M. Mayes, and R. LaBelle. 2012. Update of Occurence Rates for Offshore Oil Spills. U.S. Department of the Interior, Bureau of Ocean Energy Management and Bureau of Safety and Environmental Enforcement. OCS Report BOEM 2012-069, BSEE 2012-069. http://www.boem.gov/uploadedFiles/BOEM/Environmental_Stewardship/Environmental_Assessment/Oil_Spill_Modeling/AndersonMayesLabelle2012.pdf

Baguley, J.G., P.A. Montagna, C. Cooksey, J.L. Hyland, H.W. Bang, C.L. Morrison, A. Kamikawa, P. Bennetts, G. Saiyo, E. Parsons, M. Herdener, and M. Ricci. 2015. Community Response of Deep-sea Soft sediment Metazoan Meiofauna to the Deepwater Horizon Blowout and Oil Spill. Mar. Ecol. Prog. Ser. 528: 127-140.

Barkaszi, M.J., M. Butler, R. Compton, A. Unietis, and B. Bennett. 2012. Seismic survey mitigation measures and marine mammal observer reports. New Orleans, LA. OCS Study BOEM 2012-015.

Barkuloo, J.M. 1988. Report on the Conservation Status of the Gulf of Mexico sturgeon, *Acipenser oxyrinchus desotoi*. U.S. Department of the Interior, U.S. Fish and Wildlife Service. Panama City, FL.

Beazley, M.J., R.J. Martinez, S. Rajan, J. Powell, Y.M. Piceno, L.M. Tom, G.L. Andersen, T.C. Hazen, J.D. Van Nostrand, J. Zhou, B. Mortazavi, and P.A. Sobecky. 2012. Microbial community analysis of a coastal salt marsh affected by the Deepwater Horizon oil spill. PLoS One 7(7): e41305.

Biggs, D.C., and P.H. Ressler. 2000. Water column biology. In: Deepwater Program: Gulf of Mexico Deepwater Information Resources Data Search and Literature Synthesis. Volume I: Narrative Report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2000-049.

Blackwell, S.B., and C.R. Greene Jr. 2003. Acoustic measurements in Cook Inlet, Alaska, during August 2001. Greeneridge Sciences, Inc., for NMFS, Anchorage, AK. 43 pp.

Boehm, P., D. Turton, A. Raval, D. Caudle, D. French, N. Rabalais, R. Spies, and J. Johnson. 2001. Deepwater program: Literature review, environmental risks of chemical products used in Gulf of Mexico deepwater oil and gas operations. Volume I: Technical report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2001-011.

Bureau of Ocean Energy Management. 2011. Archaeology Survey Blocks. http://www.boem.gov/Environmental-Stewardship/Archaeology/surveyblocks-pdf.aspx

Bureau of Ocean Energy Management. 2012a. Gulf of Mexico OCS Oil and Gas Lease Sales: 2012-2017. Western Planning Area Lease Sales 229, 233, 238, 246, and 248. Central Planning Area Lease Sales 227, 231, 235, 241, and 247. Final Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA BOEM 2012-019.

Bureau of Ocean Energy Management. 2012b. Gulf of Mexico OCS Oil and Gas Lease Sale: 2012. Central Planning Area Lease Sale 216/222. Final Supplemental Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA BOEM 2012-058.

Bureau of Ocean Energy Management. 2013a. Gulf of Mexico OCS Oil and Gas Lease Sales: 2013-2014. Western Planning Are Lease Sale 233. Central Planning Area 231. Final Supplemental Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA BOEM 2013-0118.

Bureau of Ocean Energy Management. 2013b. Gulf of Mexico OCS Oil and Gas Lease Sales: 2014 and 2016. Eastern Planning Area Lease Sales 225 and 226. Final Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA 2013-200

Bureau of Ocean Energy Management. 2014a. Gulf of Mexico OCS Oil and Gas Lease Sales: 2015-2017. Central Planning Area Lease Sales 235, 241, and 247. Final Supplemental Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA BOEM 2014-655.

Bureau of Ocean Energy Management. 2014b. Gulf of Mexico OCS Oil and Gas Lease Sales: 2014-2016. Western Planning Area Lease Sales 238, 246, and 248. Final Supplemental Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA BOEM 2013-0118.

Bureau of Ocean Energy Management. 2015. Gulf of Mexico OCS Oil and Gas Lease Sales: 2016 and 2017. Central Planning Area Lease Sales 241 and 247; Eastern Planning Area Lease Sale 226. Final Supplemental Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA BOEM 2015-033.

Bureau of Ocean Energy Management. 2016a. Outer Continental Shelf Oil and Gas Leasing Program: 2017-2022. Final Programmatic Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. OCS EIS/EIA BOEM 2016-060.

Bureau of Ocean Energy Management. 2016b. Gulf of Mexico OCS Oil and Gas Lease Sale: 2016. Western Planning Area Lease Sale 248. Final Supplemental Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA BOEM 2016-005.

Bureau of Ocean Energy Management. 2016c. Essential Fish Habitat Assessment for the Gulf of Mexico. U.S.D.o.t. Interior. New Orleans, LA. OCS Report BOEM 2016-016.

Bureau of Ocean Energy Management. 2017a. Gulf of Mexico OCS Oil and Gas Lease Sales: 2017-2025. Gulf of Mexico Lease Sales 249, 250, 251, 252, 253, 254, 256, 257, 259, and 261. Final Multisale Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA BOEM 2017-009.

Bureau of Ocean Energy Management. 2017b. Catastrophic Spill Event Analysis: High-Volume, Extended Duration Oil Spill Resulting from Loss of Well Control on the Gulf of Mexico Outer Continental Shelf. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS Report BOEM 2017-007.

Bureau of Ocean Energy Management. nd. Chemosynthetic Community Locations in the Gulf of Mexico. http://www.boem.gov/Chemo-Community-Locations-in-the-GOM/

Bureau of Ocean Energy Management, Regulation, and Enforcement. 2010. Federal & Academic Scientists Return from Deep-sea Research Cruise in Gulf of Mexico: Scientists Observe Damage to Deep-sea Corals. U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement. http://www.noaanews.noaa.gov/stories2010/20101104_coralcruise.html

Bolle, L.J., C.A.F. de Jong, S.M. Bierman, P.J.G. Van Beek, O.A. van Keeken, P.W. Wessels, C.J.G. van Damme, H.V. Winter, D. de Haan, and R.P.A. Dekeling. 2012. Common Sole Larvae Survive High Levels of Pile-Driving Sound in Controlled Exposure Experiments. PLoS One 7(3): e33052.

Bonde, R.K., and T.J. O'Shea. 1989. Sowerby's beaked whale (Mesoplodon bidens) in the Gulf of Mexico. J. Mammal. 70: 447-449.

Brooke, S., and W.W. Schroeder. 2007. State of deep coral ecosystems in teh Gulf of Mexico region: Texas to the Florida Straits, pp 271-306. In: S.E. Lumdsen, T.F. Hourigan, A.W. Bruckner and G. Dorr, The State of Deep Coral Ecosystems of the United STates. NOAA Technical Memo CRCP-3, Silver Spring, MD.

Brooks, J.M., C. Fisher, H. Roberts, E. Cordes, I. Baums, B. Bernard, R. Church, P. Etnoyer, C. German, E. Goehring, I. McDonald, H. Roberts, T. Shank, D. Warren, S. Welsh, and G. Wolff. 2012. Exploration and research of northern Gulf of Mexico deepwater natural and artificial hard-bottom habitats with emphasis on coral communities: Reefs, rigs, and wrecks — "Lophelia II" Interim report. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. PCS Study BOEM 2012-106.

Bruintjes, R., and A.N. Radford. 2013. Context-dependent impacts of anthropogenic noise on individual and social behaviour in a cooperatively breeding fish. Animal Behaviour 85(6): 1343-1349.

Bureau of Safety and Environmental Enforcement. 2016. Offshore Incident Statistics. U.S. Department of the Interior, Bureau of Safety and Environmental Enforcement. https://www.bsee.gov/stats-facts/offshore-incident-statistics

Camilli, R., C.M. Reddy, D.R. Yoerger, B.A. Van Mooy, M.V. Jakuba, J.C. Kinsey, C.P. McIntyre, S.P. Sylva, and J.V. Maloney. 2010. Tracking hydrocarbon plume transport and biodegradation at Deepwater Horizon. Science 330(6001): 201-204.

Carmichael, R.H., W.M. Graham, A. Aven, G. Worthy, and S. Howden. 2012. Were multiple stressors a 'perfect storm' for northern Gulf of Mexico bottlenose dolphins (*Tursiops truncatus*) in 2011? PLoS One 7(7): e41155.

Carr, A. 1996. Suwanee River sturgeon, pp 73-83. In: M.H. Carr, A Naturalist in Florida. Yale University Press, New Haven, CT.

Carvalho, R., C.-L. Wei, G.T. Rowe, and A. Schulze. 2013. Complex depth-related patterns in taxonomic and functional diversity of Polychaetes in the Gulf of Mexico. Deep Sea Research I 80: 66-77.

Centers for Disease Control and Prevention. 2010. Health Hazard Evaluation of Deepwater Horizon Response Workers. HETA 2010-0115. http://www.cdc.gov/niosh/hhe/pdfs/interim_report_6.pdf.

Clapp, R.B., R.C. Banks, D. Morgan-Jacobs, and W.A. Hoffman. 1982a. Marine birds of the southeastern United States and Gulf of Mexico. Part I. Gaviiformes through Pelicaniformes. U.S. Fish and Wildlife Service, Office of Biological Services. Washington, DC FWS/OBS-82/01.

Clapp, R.B., D. Morgan-Jacobs, and R.C. Banks. 1982b. Marine birds of the southeastern United States and Gulf of Mexico. Part II. Anseriformes. U.S. Fish and Wildlife Service, Office of Biological Services. Washington DC. FWS/OBS 82/20.

Clapp, R.B., D. Morgan-Jacobs, and R.C. Banks. 1983. Marine birds of the southeastern United States and Gulf of Mexico. Part III. Charadriiformes. U.S. Fish and Wildlife Service, Office of Biological Services. Washington, DC. FWS/OBS-83/30.

Continental Shelf Associates, Inc,. 1997. Characterization and trends of recreational and commercial fishing from the Florida Panhandle. U.S. Department of Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. USGS/BRD/CR 1997 0001 and OCS Study MMS 97 0020.

Continental Shelf Associates, Inc. 2002. Deepwater Program: Bluewater fishing and OCS activity, interactions between the fishing and petroleum industries in deepwaters of the Gulf of Mexico. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2002-078.

Continental Shelf Associates, Inc. 2004. Final Report: Gulf of Mexico Comprehensive Synthetic Based Muds Monitoring Program.

Continental Shelf Associates, Inc. 2006. Effects of oil and gas exploration and development at selected continental slope sites in the Gulf of Mexico. Volume II: Technical report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2006 045.

Cruz-Kaegi, M.E. 1998. Latitudinal variations in biomass and metabolism of benthic infaunal communities. Ph.D. Dissertation, Texas A&M University, College Station, TX

CSA International, Inc. 2007. Characterization of northern Gulf of Mexico deepwater hard-bottom communities with emphasis on Lophelia coral. M.M.S. U.S. Department of the Interior, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2007 044.

Daling, P.S., F. Leirvik, I.K. Almås, P.J. Brandvik, B.H. Hansen, A. Lewis, and M. Reed. 2014. Surface weathering and dispersability of MC252 crude oil. Mar. Poll. Bull. 15(87): 1-2.

Davis, R.W., and G.S. Fargion, (eds.). 1996. Distribution and abundance of cetaceans in the north-central and western Gulf of Mexico: Technical report. M.M.S. U.S. Department of the Interior, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 96-0026.

Davis, R.W., J.G. Ortega-Ortiz, C.A. Ribic, W.E. Evans, D.C. Biggs, P.H. Ressler, J.H. Wormuth, R.R. Leben, K.D. Mullin, and W. B. 2000a. Cetacean habitat in the northern Gulf of Mexico, pp 217-253. In: Cetaceans, sea turtles, and seabirds in the northern Gulf of Mexico: Distribution, abundance and habitat associations. Volume II: Technical report. U.S. Geological Survey, Biological Resources Division, USGS/BRD/CR 1999 0006 and U.S. Department of the Interior,, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2000-003.

Davis, R.W., W.E. Evans, and B. Würsig. 2000b. Cetaceans, sea turtles, and seabirds in the northern Gulf of Mexico: Distribution, abundance and habitat associations. Volume II: Technical Report. U.S. Geological Survey, Biological Resources Division, USGS/BRD/CR 1999 0006 and U.S. Department of the Interior,, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2000 003.

DeGuise, S., M. Levin, E. Gebhard, L. Jasperse, L.B. Hart, C.R. Smith, S. Venn-Watson, F.I. Townsend, R.S. Wells, B.C. Balmer, E.S. Zolman, T.K. Rowles, and L.H. Schwacke. 2017. Changes in immune functions in bottlenose dolphins in the northern Gulf of Mexico associated with the *Deepwater Horizon* oil spill. Endang Species Res 33: 291-303.

Ditty, J.G. 1986. Ichthyoplankton in neritic waters of the northern Gulf of Mexico off Louisiana: Composition, relative abundance, and seasonality. Fish. Bull. 84(4): 935-946.

Ditty, J.G., G.G. Zieske, and R.F. Shaw. 1988. Seasonality and depth distribution of larval fishes in the northern Gulf of Mexico above 26°00'N. Fish. Bull. 86(4): 811-823.

Du, M., and J.D. Kessler. 2012. Assessment of the spatial and temporal variability of bulk hydrocarbon respiration following the Deepwater Horizon oil spill. Environ Sci Technol 46: 10499-10507.

Dubinsky, E.A., M.E. Conrad, R. Chakraborty, M. Bill, S.E. Borglin, J.T. Hollibaugh, O.U. Mason, Y.M. Piceno, F.C. Reid, W.T. Stringfellow, L.M. Tom, T.C. Hazen, and G.L. Andersen. 2013. Succession of hydrocarbon-degrading bacteria in the aftermath of the *Deepwater Horizon* oil spill in the Gulf of Mexico. Environ Sci Technol 47.

Eastern Research Group, Inc. 2014. Assessing the impacts of the Deepwater Horizon oil spill on tourism in the Gulf of Mexico region. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study BOEM 2014-661.

Efroymson, R.A., W.H. Rose, S. Nemeth, and G.W. Sutter II. 2000. Ecological risk assessment framework for low altitude overflights by fixed-wing and rotary-wing military aircraft.

Ehrlich, P.R., D.S. Dobkin, and D. Wheye. 1992. Birds in Jeopardy: The Imperiled and Extinct Birds of the United States and Canada, including Hawaii and Puerto Rico. Palo Alto, CA, Stanford University Press.

Felder, C.R., B. Thoma, W.E. Schmidt, T. Sauvage, S.L. Self-Krayesky, and A. Christoserdov. 2014. Seaweeds and Decapod Crustaceans on Gulf Deep Banks after the Macondo Spill. BioScience 64(9): 808-819.

Fisher, C.R., A.W.J. Demopoulos, E.E. Cordes, I.B. Baums, H.K. White, and J.R. Borque. 2014a. Coral communities as indicators of ecosystem-level impacts of the Deepwater Horizon spill. BioScience 64: 796-807.

Fisher, C.R., P.Y. Hsing, C.L. Kaiser, D.R. Yoerger, H.H. Roberts, W.W. Shedd, E.E. Cordes, T.M. Shank, S.P. Berlet, M.G. Saunders, E.A. Larcom, and J.M. Brooks. 2014b. Footprint of Deepwater Horizon blowout impact to deep-water coral communities. Proc. Natl. Acad. Sci. USA 111(32): 11744-11749.

Florida Fish and Wildlife Conservation Commission. 2016a. Loggerhead nesting in Florida. http://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead/

Florida Fish and Wildlife Conservation Commission. 2016b. Green turtle nesting in Florida. http://myfwc.com/research/wildlife/sea-turtles/nesting/green-turtle/

Florida Fish and Wildlife Conservation Commission. 2016c. Leatherback nesting in Florida. http://myfwc.com/research/wildlife/sea-turtles/nesting/leatherback/

Florida Fish and Wildlife Conservation Commission. 2017. Florida's endangered and threatened species. http://myfwc.com/media/1515251/threatened-endangered-species.pdf

Fonseca, M., G.A. Piniak, and N. Cosentino-Manning. 2017. Susceptibility of seagrass to oil spills: A case study with eelgrass, *Zostera marina* in San Francisco Bay, USA. Mar. Poll. Bull. 115(1-2): 29-38.

Fox, D.A., J.E. Hightower, and F.M. Parauka. 2000. Gulf Sturgeon Spawning Migration and Habitat in the Choctawhatchee River System, Alabama–Florida. Trans. Am. Fish. Soc. 129(3): 811-826.

Fritts, T.H., and R.P. Reynolds. 1981. Pilot study of the marine mammals, birds, and turtles in OCS areas of the Gulf of Mexico. U.S. Department of the Interior, Fish and Wildlife Service, Biological Services Program. FWS/OBS 81/36.

Fugro Marine Geoservices, Inc. 2017. Wellsite Clearance Letters, Proposed Wellsite GC 40-F, GC 40-I, and GC 40-J, Katmai Prospect, Block 40, Green Canyon, Gulf of Mexico (OCS G-34536). 02.1602-1039-1.

Gallaway, B.J., and G.S. Lewbel. 1982. The ecology of petroleum platforms in the northwestern Gulf of Mexico: a community profile. U.S. Fish and Wildlife Service, Biological Services Program and U.S. Department of the Interior, Bureau of Land Management. Washington, D.C. FWS/OBS-82/27 and Open File Report 82-03. http://www.nwrc.usgs.gov/techrpt/82-27text.pdf

Gallaway, B.J., J.G. Cole, and R.G. Fechhelm. 2003. Selected Aspects of the Ecology of the Continental Slope Fauna of the Gulf of Mexico: A Synopsis of the Northern Gulf of Mexico Continental Slope Study, 1983-1988. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2003 072.

Gallaway, B.J., (ed.). 1988. Northern Gulf of Mexico Continental Slope Study, Final report: Year 4. Volume II: Synthesis report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 88-0053.

Geraci, J.R., and D.J. St. Aubin. 1990. Sea Mammals and Oil: Confronting the Risks. San Diego, CA, Academic Press.

Gitschlag, G., B. Herczeg, and T. Barcack. 1997. Observations of sea turtles and other marine life at the explosive removal of offshore oil and gas structures in the Gulf of Mexico. Gulf Research Reports 9(4): 247-262.

Goold, J.C., and S.E. Jones. 1995. Time and frequency domain characteristics of sperm whale clicks. J. Acoust. Soc. Am. 98: 1,279-271,291.

Gulf of Mexico Fishery Management Council. 2005. Generic Amendment Number 3 for addressing Essential Fish Habitat Requirements, Habitat Areas of Particular Concern, and adverse effects of fishing in the following Fishery Management Plans of the Gulf of Mexico: Shrimp fishery of the Gulf of Mexico, United States waters red drum fishery of the Gulf of Mexico, reef fish fishery of the Gulf of Mexico coastal migratory pelagic resources (mackerels) in the Gulf of Mexico and South Atlantic, stone crab fishery of the Gulf of Mexico, spiny lobster in the Gulf of Mexico and South Atlantic, coral and coral reefs of the Gulf of Mexico. Tampa, FL.

Hawkins, A.D., and A.N. Popper. 2014. Assessing the impact of underwwater sounds on fishes and other forms of marine life. Acoustics Today. Spring 2014**:** 30-41.

Hayes, S.A., E. Josephson, K. Maze-Foley, P.E. Rosel, B. Byrd, T.V.N. Cole, L. Engleby, L.P. Garrison, J. Hatch, A. Henry, S.C. Horstman, J. Litz, M.C. Lyssikatos, K.D. Mullin, C. Orphanides, R.M. Pace, D.L. Palka, M. Soldevilla, and F.W. Wenzel. 2017. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2016. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NE-241.

Hazen, T.C., E.A. Dubinsky, T.Z. DeSantis, G.L. Andersen, Y.M. Piceno, N. Singh, J.K. Jansson, A. Probst, S.E. Borglin, J.L. Fortney, W.T. Stringfellow, M. Bill, M.E. Conrad, L.M. Tom, K.L. Chavarria, T.R. Alusi, R. Lamendella, D.C. Joyner, C. Spier, J. Baelum, M. Auer, M.L. Zemla, R. Chakraborty, E.L. Sonnenthal, P. D'Haeseleer, H.Y. Holman, S. Osman, Z. Lu, J.D. Van Nostrand, Y. Deng, J. Zhou, and O.U. Mason. 2010. Deep-sea oil plume enriches indigenous oil-degrading bacteria. Science 330(6001): 204-208.

Hazen, T.C., R.C. Prince, and N. Mahmoudi. 2016. Marine oil biodegradation. Environ Sci Technol 50: 2121-2129.

Hess, N.A., and C.A. Ribic. 2000. Seabird ecology, pp 275-315. In: R.W. Davis, W.E. Evans and B. Würsig, Cetaceans, sea turtles, and seabirds in the northern Gulf of Mexico: Distribution, abundance and habitat associations. Volume II: Technical report. U.S. Geological Survey, Biological Resources Division, USGS/BRD/CR 1999 0006 and U.S. Department of the Interior, Minerals Management Service, New Orleans, LA.

Higashi, G.R. 1994. Ten years of fish aggregating device (FAD) design development in Hawaii. Bull. Mar. Sci. 55(2-3): 651-666.

Hildebrand, J.A. 2005. Impacts of anthropogenic sound, pp 101-124. In: J.E. Reynolds III, W.F. Perrin, R.R. Reeves, S. Montgomery and T.J. Ragen, Marine mammal research: conservation beyond crisis. Johns Hopkins University Press, Baltimore, MD.

Hildebrand, J.A. 2009. Anthropogenic and natural sources of ambient noise in the ocean. Mar. Ecol. Prog. Ser. 395: 5-20.

Hildebrand, J.A., S. Baumann-Pickering, K.E. Frasier, J.S. Trickey, K.P. Merkens, S.M. Wiggins, M.A. McDonald, L.P. Garrison, D. Harris, T.A. Marques, and L. Thomas. 2015. Passive acoustic monitoring of beaked whale densities in the Gulf of Mexico. Scientific Reports 5(16343).

Holand, P. 1997. Offshore Blowouts: Causes and Control. Houston, TX, Gulf Publishing Co.

Holland, K.N. 1990. Horizontal and vertical movements of yellowfin and bigeye tuna associated with fish aggregating devices. Fish. Bull. 88: 493-507.

Holt, M.M., D.P. Noren, V. Veirs, C.K. Emmons, and S. Veirs. 2009. Speaking up: Killer whales (Orcinus orca) increase their call amplitude in response to vessel noise. J. Acoust. Soc. Am. 125(1): 27-32.

Hsing, P.-Y., B. Fu, E.A. Larcom, S.P. Berlet, T.M. Shank, A.F. Govindarajan, A.J. Lukasiewicz, P.M. Dixon, and C.R. Fisher. 2013. Evidence of lasting impact of the Deepwater Horizon oil spill on a deep Gulf of Mexico coral community. Elementa: Science of the Anthropocene 1(1): 000012.

Intergovernmental Panel on Climate Change. 2014. Climate Change 2014: Impacts, Adaptation and Vulnerability. http://www.ipcc.ch/report/ar5/wg2/.

International Association of Oil & Gas Producers. 2010. Risk assessment data directory: Blowout frequencies. OGP Report No. 434 2. http://www.ogp.org.uk/pubs/434-02.pdf.

Ji, Z.-G., W.R. Johnson, C.F. Marshall, and E.M. Lear. 2004. Oil-Spill Risk Analysis: Contingency Planning Statistics for Gulf of Mexico OCS Activities. M.M.S. U.S. Department of the Interior, Gulf of Mexico OCS Region. New Orleans, LA. OCS Report MMS 2004 026.

Jochens, A., D.C. Biggs, D. Benoit-Bird, D. Engelhaupt, J. Gordon, C. Hu, N. Jaquet, M. Johnson, R.R. Leben, B. Mate, P. Miller, J.G. Ortega-Ortiz, A. Thode, P. Tyack, and B. Würsig. 2008. Sperm whale seismic study in the Gulf of Mexico: Synthesis report. M.M.S. U.S. Department of the Interior, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2008-006.

Johnsgard, P.A. 1990. Hawks, Eagles, and Falcons of North America; Biology and Natural History. Washington, D.C., Smithsonian Institute Press.

Kellar, N.M., T.R. Speakman, C.R. Smith, S.M. Lane, B.C. Balmer, M.L. Trego, K.N. Catelani, M.N. Robbins, C.D. Allen, R.S. Wells, E.S. Zolman, T.K. Rowles, and L.H. Schwacke. 2017. Low reproductive success rates of common bottlenose dolphins *Tursiops truncatus* in the northern Gulf of Mexico following the *Deepwater Horizon* distaster (2010-2015). Endang Species Res 33: 143-158.

Kennicutt, M.C. 2000. Chemical Oceanography, pp. 123 139. In: Continental Shelf Associates, Inc. Deepwater Program: Gulf of Mexico deepwater information resources data search and literature synthesis. Volume I: Narrative report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2000 049.

Kessler, J.D., D.L. Valentine, M.C. Redmond, M. Du, E.W. Chan, S.D. Mendes, E.W. Quiroz, C.J. Villanueva, S.S. Shusta, L.M. Werra, S.A. Yvon-Lewis, and T.C. Weber. 2011. A persistent oxygen anomaly reveals the fate of spilled methane in the deep Gulf of Mexico. Science 331: 312-315.

King, B.S., and J.D. Gibbins. 2011. Health hazard evaluation of Deepwater Horizon response workers. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Health Hazard Evaluation Report HETA 2010-0115 & 2010-0129-3138.

Kujawinski, E.B., M.C. Kido Soule, D.L. Valentine, A.K. Boysen, K. Longnecker, and M.C. Redmond. 2011. Fate of dispersants associated with the deepwater horizon oil spill. Environ. Sci. Technol. 45(4): 1298-1306.

Kyhn, L.A., J. Tougaard, and S. Sveegaard. 2011. Underwater noise from the drillship *Stena Forth* in Disko West, Baffin Bay, Greenland. http://www.dmu.dk/Pub/FR838.pdf 30 pp.

Lane, S.M., C.R. Smith, J. Mitchell, B.C. Balmer, K.P. Barry, T. McDonald, C.S. Mori, P.E. Rosel, T.K. Rowles, T.R. Speakman, F.I. Townsend, M.C. Tumlin, R.S. Wells, E.S. Zolman, and L.H. Schwacke. 2015. Reproductive outcome and survival of common bottlenose dolphins sampled in Barataria Bay, Louisiana, USA, following the *Deepwater Horizon* oil spill. Proc Biol Sci 282.

Lin, Q., and I.A. Mendelssohn. 2012. Impacts and recovery of the Deepwater Horizon oil spill on vegetation structure and function of coastal salt marshes in the northern Gulf of Mexico. Environ. Sci. Technol. 46(7): 3737-3743.

Lin, Q., I.A. Mendelssohn, S.A. Graham, A. Hou, J.W. Fleeger, and D.R. Deis. 2016. Response of salt marshes to oiling from the *Deepwater Hoirzon* spill: Implications for plant growth, soil-surface erosion, and shoreline stability. Science of the Total Environment 557-558: 369-377.

Liu, J., H.P. Bacosa, and Z. Liu. 2017. Potential environmental factors affecting oil-degrading bacterial populations in deep and surface waters of the northern Gulf of Mexico. Frontiers in Microbiology 7:2131.

Lohoefener, R., W. Hoggard, K.D. Mullin, C. Roden, and C. Rogers. 1990. Association of sea turtles with petroleum platforms in the north central Gulf of Mexico. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 90-0025.

Lutcavage, M.E., P.L. Lutz, G.D. Bossart, and D.M. Hudson. 1995. Physiologic and clinicopathologic effects of crude oil on loggerhead sea turtles. Arch. Environ. Contam. Toxicol. 28(4): 417-422.

Lutcavage, M.E., P. Plotkin, B. Witherington, and P.L. Lutz. 1997. Human impacts on sea turtle survival, pp pp. 387-409. In: P.L. Lutz and J.A. Musick, The Biology of Sea Turtles. CRC Press, Boca Raton, FL.

MacDonald, I.R., W.W. Schroeder, and J.M. Brooks. 1995. Northern Gulf of Mexico Chemosynthetic Ecosystems Study. Final Report. Volume II: Technical Report. OCS Study MMS 95-0022. 335 pp.

MacDonald, I.R.e. 2002. Stability and Change in Gulf of Mexico Chemosynthetic Communities. Volume II: Technical Report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2002-036.

Main, C.E., H.A. Ruhl, D.O.B. Jones, A. Yool, B. Thornton, and D.J. Mayor. 2015. Hydrocarbon contamination affects Deep-sea benthic oxygen uptake and microbial community composition. Deep Sea Research I 100: 79-87.

McCauley, R. 1998. Radiated underwater noise measured from the drilling rig Ocean General, rig tenders Pacific Ariki and Pacific Frontier, fishing vessel Reef Venture and natural sources in the Timor sea, northern Australia. Prepared for Shell Australia, Melbourne. 52pp. http://cmst.curtin.edu.au/local/docs/pubs/1998-19.pdf.

McDonald, T.L., F.E. Hornsby, T.R. Speakman, E.S. Zolman, K.D. Mullin, C. Sinclair, P.E. Rosel, L. Thomas, and L.H. Schwacke. 2017. Survival, density, and abundance of common bottlenose dolphins in Barataria Bay (USA) following the *Deepwater Horizon* oil spill. Endang Species Res 33: 193-209.

McKenna, M.F., D. Ross, S.M. Wiggins, and J.A. Hildebrand. 2012. Underwater radiated noise from modern commercial ships. J. Acoust. Soc. Am. 131: 92-103.

McLaughlin, K.E., and H.P. Kunc. 2015. Changes in the acoustic environment alter the foraging and sheltering behaviour of the cichlid *Amititlania nigrofasciata*. Behavioural processes 116: 75-79.

Mendelssohn, I.A., G.L. Andersen, D.M. Baltx, R.H. Caffey, K.R. Carman, J.W. Fleeger, S.B. Joyce, Q. Lin, E. Maltby, E.B. Overton, and L.P. Rozas. 2012. Oil impacts on coastal wetlands: Implications for the Mississippi River delta ecosystem after the Deepwater Horizon oil spill. BioScience 62(6): 562-574.

Mississippi Natural Heritage Program. 2015. Listed species of Mississippi. Museum of Natural Science, Mississippi Deptartment of Wildlife, Fisheries, and Parks. Jackson, MS. http://www.mdwfp.com/media/246709/t_e_2015.pdf

Marine Mammal Commission. 2011. Assessing the long-term effects of the BP Deepwater Horizon oil spill on marine mammals in the Gulf of Mexico: A statement of research needs. http://www.mmc.gov/wp-content/uploads/longterm_effects_bp_oilspil.pdf

Minerals Management Service. 2000. Gulf of Mexico Deepwater Operations and Activities: Environmental Assessment. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA MMS 2000 001.

Møhl, B., M. Wahlberg, and P.T. Madsen. 2003. The monopulsed nature of sperm whale clicks. J Acoust Soc Am 114(2): 1143-1154.

Montagna, P.A., J.G. Baguley, C. Cooksey, I. Hartwell, L.J. Hyde, J.L. Hyland, R.D. Kalke, L.M. Kracker, M. Reuscher, and A.C. Rhodes. 2013. Deep-sea benthic footprint of the *Deepwater Horizon* blowout. PLoS One 8(8): e70540.

Morrow, J.V.J., J.P. Kirk, K.J. Killgore, H. Rugillio, and C. Knight. 1998. Status and recovery of Gulf sturgeon in the Pearl River system, Louisiana-Mississippi. N. Am. J. Fish Manage. 18: 798-808.

Mullin, K.D., W. Hoggard, C. Roden, R. Lohoefener, C. Rogers, and B. Taggart. 1991. Cetaceans on the upper continental slope in the north-central Gulf of Mexico. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 91-0027.

Mullin, K.D. 2007. Abundance of cetaceans in the oceanic Gulf of Mexico based on 2003-2004 ship surveys. Available from: NMFS, Southeast Fisheries Science Center. Pascagoula, MS.

National Park Service. 2010. Breton Wilderness 300 km Radius. https://www.fws.gov/refuges/airquality/docs/Breton_WA300km.pdf

National Research Council. 1983. Drilling Discharges in the Marine Environment. Washington, DC.

National Research Council. 2003a. Ocean Noise and Marine Mammals. Washington, DC. 204 pp.

National Research Council. 2003b. Oil in the Sea III: Inputs, Fates, and Effects. Washington, DC. 182 pp. + app.

National Wildlife Federation. 2016a. Oil Spill Impacts on Marine Mammals. Website accessed 15 August 2016. http://www.nwf.org/What-We-Do/Protect-Habitat/Gulf-Restoration/Oil-Spill/Effects-on-Wildlife/Mammals.aspx

National Wildlife Federation. 2016b. Wildlife Library: Whooping Crane. Website accessed 4 April 2016. http://www.nwf.org/wildlife/wildlife-library/birds/whooping-crane.aspx

Nedwell, J.R., K. Needham, and B. Edwards. 2001. Report on measurements of underwater noise from the Jack Bates Drill Rig. Report No. 462 R 0202. Subacoustech Ltd., Southhampton, UK. 49 pp.

Nedwell, J.R., and B. Edwards. 2004. A review of measurements of underwater man-made noise carried out by Subacoustech Ltd, 1993 - 2003. Prepared by Subacoustech Report Reference: 565R00109, September 2004; prepared for ChevronTexaco Ltd, Total Final Elf Exploration UK PLC, DSTL, DTI, Shell UK.

Nedwell, J.R., and D. Howell. 2004. A review of offshore windfarm related underwater noise sources. Report No. 544 R 0308, 0308. Subacoustech Ltd., Southampton, UK. 63 pp.

Neff, J.M. 1987. Biological effects of drilling fluids, drill cuttings and produced waters, pp 469-538. In: D.F. Boesch and N.N. Rabalais, Long Term Effects of Offshore Oil and Gas Development. Elsevier Applied Science Publishers, London, UK.

Neff, J.M., S. McKelvie, and R.C. Ayers. 2000. Environmental impacts of synthetic based drilling fluids. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2000-064.

Neff, J.M., A.D. Hart, J.P. Ray, J.M. Limia, and T.W. Purcell (2005). An assessment of seabed impacts of synthetic based drilling-mud cuttings in the Gulf of Mexico. 2005 SPE/EPA/DOE Exploration and Production Environmental Conference, 7-9 March 2005, Galveston, TX. SPE 94086.

National Marine Fisheries Service. 2007. Endangered Species Act, Section 7 Consultation – Biological Opinion. Gulf of Mexico Oil and Gas Activities: Five Year Leasing Plan for Western and Central Planning Areas 2007-2012. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. St. Petersburg, FL. http://www.nmfs.noaa.gov/ocs/mafac/meetings/2010_06/docs/mms_02611_leases_2007_2012.pdf

National Marine Fisheries Service. 2009a. Sperm Whale (*Physeter macrocephalus*) 5-Year Review: Summary and Evaluation. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division. Silver Spring, MD.

National Marine Fisheries Service. 2009b. Final Amendment 1 to the Consolidated Atlantic Highly Migratory Species Fishery Management Plan Essential Fish Habitat. Highly Migratory Species Management Division, Office of Sustainable Fisheries. Silver Spring, MD. http://pbadupws.nrc.gov/docs/ML1219/ML12195A241.pdf

National Marine Fisheries Service. 2010a. Deepwater Horizon/BP oil spill: size and percent coverage of fishing area closures due to BP oil spill. http://sero.nmfs.noaa.gov/deepwater_horizon/size_percent_closure/index.html

National Marine Fisheries Service. 2010b. Final recovery plan for the sperm whale (*Physeter macrocephalus*). Silver Spring, MD. http://www.nmfs.noaa.gov/pr/pdfs/health/oil_impacts.pdf

National Marine Fisheries Service, U.S. Fish and Wildlife Service and Secretaría de Medio Ambiente y Recursos Naturales. 2011. Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*), Second Revision. http://www.nmfs.noaa.gov/pr/pdfs/recovery/kempsridley_revision2.pdf

National Marine Fisheries Service. 2011. Species of concern: Atlantic bluefin tuna, *Thunnus thynnus*. http://www.nmfs.noaa.gov/pr/pdfs/species/bluefintuna_detailed.pdf

National Marine Fisheries Service. 2014a. Sea turtles, dolphins, and whales and the Gulf of Mexico oil spill. http://www.nmfs.noaa.gov/pr/health/oilspill/gulf2010.htm

National Marine Fisheries Service. 2014b. Loggerhead Sea Turtle Critical Habitat in the Northwest Atlantic Ocean. http://www.nmfs.noaa.gov/pr/species/turtles/criticalhabitat_loggerhead.htm

National Marine Fisheries Service. 2014c. Gulf sturgeon (*Acipenser oxyrinchus desotoi*). http://www.nmfs.noaa.gov/pr/species/fish/gulfsturgeon.htm

National Marine Fisheries Service. 2016. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. NOAA Technical Memorandum NMFS-OPR-55.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 2008. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (*Caretta caretta*), Second Revision. http://www.nmfs.noaa.gov/pr/pdfs/recovery/turtle_loggerhead_atlantic.pdf

National Oceanic and Atmospheric Administration. 2005. Interim Sound Threshold Guidance. http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html

National Oceanic and Atmospheric Administration. 2006. Fact Sheet: Small Diesel Spills (500-5,000 gallons). NOAA Scientific Support Team, Hazardous Materials Response and Assessment Division. Seattle, WA.

National Oceanic and Atmospheric Administration. 2010. Oil and Sea Turtles. Biology, Planning, and Response. http://response.restoration.noaa.gov/sites/default/files/Oil_Sea_Turtles.pdf

National Oceanic and Atmospheric Administration. 2011a. Joint Analysis Group. Deepwater Horizon oil spill: Review of preliminary data to examine subsurface oil in the vicinity of MC252#1, May 19 to June 19, 2010. U.S. Department of Commerce, National Ocean Service. Silver Spring, MD. NOAA Technical Report NOS OR&R 25. http://service.ncddc.noaa.gov/rdn/www/media/documents/activities/jag-reports/NTR-NOS-ORR-25-082011.pdf

National Oceanic and Atmospheric Administration. 2011b. Joint Analysis Group, Deepwater Horizon oil spill: Review of R/V Brooks McCall data to examine subsurface oil. U.S. Department of Commerce, National Ocean Service. Silver Spring, MD. NOAA Technical Report NOS OR&R 24. http://service.ncddc.noaa.gov/rdn/www/media/documents/activities/jag-reports/NTR-NOS-ORR-24-062011.pdf

National Oceanic and Atmospheric Administration. 2011c. Joint Analysis Group, Deepwater Horizon oil spill: Review of preliminary data to examine oxygen levels in the vicinity of MC252#1 May 8 to August 9, 2010. U.S. Department of Commerce, National Ocean Service. Silver Spring, MD. NOAA Technical Report NOS OR&R 26. http://service.ncddc.noaa.gov/rdn/www/media/documents/activities/jag-reports/NTR-NOS-ORR-26-082011.pdf

National Oceanic and Atmospheric Administration. 2014. Flower Garden Banks National Marine Sanctuary. http://flowergarden.noaa.gov/about/cnidarianlist.html

National Oceanic and Atmospheric Administration. 2016a. ADIOS 2 (Automated Data Inquiry for Oil Spills). http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/response-tools/downloading-installing-and-running-adios.html

National Oceanic and Atmospheric Administration. 2016b. Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement. http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan/

National Oceanic and Atmospheric Administration. 2016c. Cetacean Unusual Mortality Event in Northern Gulf of Mexico (2010-2014). http://www.nmfs.noaa.gov/pr/health/mmume/cetacean_gulfofmexico.htm

National Oceanic and Atmospheric Administration. 2017a. Small Diesel Spills (500 - 5,000 gallons). O.o.R.a. Restoration. http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/small-diesel-spills.html

National Oceanic and Atmospheric Administration. 2017b. Oil Types. O.o.R.a. Restoration. http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/oil-types.html

Nowlin, W.D.J., A.E. Jochens, S.F. DiMarco, R.O. Reid, and M.K. Howard. 2001. Deepwater Physical Oceanography Reanalysis and Synthesis of Historical Data: Synthesis Report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2001-064.

Natural Resources Defense Council. 2014. A petition to list the Gulf of Mexico Bryde's whale (*Balaenoptera edeni*) as endangered under the Endangered Species Act. https://www.nrdc.org/sites/default/files/wil_14091701a.pdf

Operational Science Advisory Team. 2010. Summary report for sub-surface and sub sea oil and dispersant detection: Sampling and monitoring. Prepared for Paul F. Zukunft, U.S. Coast Guard Federal On Scene Coordinator, Deepwater Horizon MC252. http://www.restorethegulf.gov/sites/default/files/documents/pdf/OSAT_Report_FINAL_17DEC.pdf.

Oxford Economics. 2010. Potential impact of the Gulf oil spill on tourism. Report prepared for the U.S. Travel Association. http://www.mississippiriverdelta.org/blog/files/2010/10/Gulf_Oil_Spill_Analysis_Oxford_Economics_710.pdf.

Peabody, M.B., and C.A. Wilson. 2006. Fidelity of red snapper (*Lutjanus campechanus*) to petroleum platforms and artificial reefs in the northern Gulf of Mexico. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2006-005.

Peake, D.E. 1996. Bird surveys, pp. 271 304. In: R.W. Davis and G.S. Fargion (eds.), Distribution and abundance of cetaceans in the north central and western Gulf of Mexico, Final report. Volume II: Technical report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region New Orleans, LA. OCS Study MMS 96-0027.

Picciulin, M., L. Sebastianutto, A. Codarin, A. Farina, and E.A. Ferrero. 2010. In situ behavioural responses to boat noise exposure of Gobius cruentatus (Gmelin, 1789; fam. Gobiidae) and Chromis chromis (Linnaeus, 1758; fam. Pomacentridae) living in a Marine Protected Area. J. Exp. Mar. Biol. Ecol. 386(1): 125-132.

Popper, A.N., A.D. Hawkins, R.R. Fay, D. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, M.B. Halvorsen, S. Lokkeborg, P. Rogers, B.L. Southall, D. Zeddies, and W.N. Tavolga. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report. ASA S3/SC1.4 TR-2014 prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI.

Powers, K. 1987. Seabirds, pp 194-201. In: J.D. Milliman and W.R. Wright, The Marine Environment of the U.S. Atlantic Continental Slope and Rise. Jones and Bartlett Publishers, Inc, Boston/Woods Hole, MA.

Powers, S.P., F.J. Hernandez, R.H. Condon, J.M. Drymon, and C.M. Free. 2013. Novel pathways for injury from offshore oil spills: Direct, sublethal and indirect effects of the Deepwater Horizon oil spill on pelagic *Sargassum* communities. PLoS One 8(9): e74802.

Pritchard, P.C.H. 1997. Evolution, phylogeny, and current status, pp In: P.L. Lutz and J.A. Musick, The Biology of Sea Turtles. CFC Press, Boca Raton, FL.

Radford, A.N., E. Kerridge, and S.D. Simpson. 2014. Acoustic communication in a noisy world: Can fish compete with anthropogenic noise? . Behavioral Ecology 25: 1,022-021,030.

Rathbun, G.B. 1988. Fixed-wing airplane versus helicopter surveys of manatees. Mar. Mamm. Sci. 4(1): 71-75.

Relini, M., L.R. Orsi, and G. Relini. 1994. An offshore buoy as a FAD in the Mediterranean. Bull. Mar. Sci. 55(2-3): 1099-1105.

Richards, W.J., T. Leming, M.F. McGowan, J.T. Lamkin, and S. Kelley-Farga. 1989. Distribution of fish larvae in relation to hydrographic features of the Loop Current boundary in the Gulf of Mexico. ICES Mar. Sci. Symp. 191: 169-176.

Richards, W.J., M.F. McGowan, T. Leming, J.T. Lamkin, and S. Kelley-Farga. 1993. Larval fish assemblages at the Loop Current boundary in the Gulf of Mexico. Bull. Mar. Sci. 53(2): 475-537.

Richardson, W.J., C.R. Greene Jr., C.I. Malme, and D.H. Thomson. 1995. Marine Mammals and Noise. San Diego, CA, Acdemic Press.

Rodgers, J.A., and S.T. Schwikert. 2002. Buffer-Zone Distances to Protect Foraging and Loafing Waterbirds from Disturbance by Personal Watercraft and Outboard-Powered Boats. Conserv. Biol. 16(1): 216-224.

Ross, S.W., A.W.J. Demopoulos, C.A. Kellogg, C.L. Morrison, M.S. Nizinski, C.L. Ames, T.L. Casazza, D. Gualtieri, K. Kovacs, J.P. McClain, A.M. Quattrini, A.Y. Roa-Varón, and A.D. Thaler. 2012. Deepwater Program: Studies of Gulf of Mexico lower continental slope communities related to chemosynthetic and hard substrate habitats. U.S. Department of the Interior, U.S. Geological Survey. U.S. Geological Survey Open-File Report 2012-1032.

Rowe, G.T., and M.C. Kennicutt. 2009. Northern Gulf of Mexico Continental Slope Habitats and Benthic Ecology Study. Final Report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2009-039.

Rudd, M.B., R.N.M. Ahrens, W.E. Pine III, and S.K. Bolden. 2014. Empirical spatially explicit natural mortality and movement rate estimates for the threatened Gulf Sturgeon (*Acipenser oxyrinchus desotoi*). Can. J. Fish. Aquat. Sci. 71: 1407-1417.

Russell, R.W. 2005. Interactions between migrating birds and offshore oil and gas platforms in the northern Gulf of Mexico: Final Report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2005-009.

Salmon, M., and J. Wyneken. 1990. Do swimming loggerhead sea turtles (*Caretta caretta L.*) use light cues for offshore orientation? Mar. Fresh. Behav. Phy. 17(4): 233-246.

Samuel, Y., S.J. Morreale, C.W. Clark, C.H. Greene, and M.E. Richmond. 2005. Underwater, low-frequency noise in a coastal sea turtle habitat. J. Acoust. Soc. Am. 117(3): 1465-1472.

Schwacke, L.H., C.R. Smith, F.I. Townsend, R.S. Wells, L.B. Hart, B.C. Balmer, T.K. Collier, S. De Guise, M.M. Fry, L.J. Guillette, Jr., S.V. Lamb, S.M. Lane, W.E. McFee, N.J. Place, M.C. Tumlin, G.M. Ylitalo, E.S. Zolman, and T.K. Rowles. 2014. Response to comment on health of common bottlenose dolphins (Tursiops truncatus) in Barataria Bay, Louisiana following the deepwater horizon oil spill. Environ. Sci. Technol. 48(7): 4,209-204,211.

Share the Beach. 2016. Nesting season statistics. http://www.alabamaseaturtles.com/nesting-season-statistics/

Silliman, B.R., J. van de Koppel, M.W. McCoy, J. Diller, G.N. Kasozi, K. Earl, P.N. Adams, and A.R. Zimmerman. 2012. Degradation and resilience in Louisiana salt marshes after the BP-Deepwater Horizon oil spill. Proc. Nat. Acad. Sci. USA 109(28): 11234-11239.

Simpson, S.D., A.N. Radford, S.L. Nedelec, M.C. Ferrari, D.P. Chivers, M.I. McCormick, and M.G. Meekan. 2016. Anthropogenic noise increases fish mortality by predation. Nature Communications 7: 10544.

Smultea, M.A., J.R. Mobley Jr., D. Fertl, and G.L. Fulling. 2008. An unusual reaction and other observations of sperm whales near fixed wing aircraft. Gulf. Carib. Res. 20: 75-80.

Solomon, G.M., and S. Janssen. 2010. Health effects of the Gulf oil spill. JAMA 304(10): 1118-1119.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: initial scientific recommendation. Aquat. Mamm. 33: 411-521.

Spier, C., W.T. Stringfellow, T.C. Hazen, and M. Conrad. 2013. Distribution of hydrocarbons released during the 2010 MC252 oil spill in deep offshore waters. Environ. Pollut. 173: 224-230.

State of Louisiana Department of Wildlife and Fisheries. 2005. Chapter 4 - Conservation habits and species assessments. http://www.wlf.louisiana.gov/sites/default/files/pdf/document/32857-chapter-4-conservation-habitats-and-species-assessments/13_chapter_4_conservation_habitats__species_assessmen.pdf

Sulak, K.J., and J.P. Clugston. 1998. Early life history stages of Gulf sturgeon in the Suwanee River, Florida. Trans. Am. Fish. Soc. 127: 758-771.

Takeshita, R., L. Sullivan, C.R. Smith, T.K. Collier, A. Hall, T. Brosnan, T.K. Rowles, and L.H. Schwacke. 2017. The *Deepwater Horizon* oil spill marine mammal injury assessment. Endang Species Res 33: 95-106.

Tarr, M.A., P. Zito, E.B. Overton, G.M. Olson, P.L. Adhikari, and C.M. Reddy. 2016. Weathering of oil in the marine environment. Oceanography 29(3): 126-135.

Turner, R.E., G. McClenachan, and A.W. Tweel. 2016. Islands in teh oil: Quantifying salt marsh shoreline erosion after the *Deepwater Horizon* oiling. Mar. Poll. Bull. 110: 216-323.

Turtle Island Restoration Network. 2017. Kemp's Ridley Sea Turtle Count on the Texas Coast. https://seaturtles.org/turtle-count-texas-coast/

Tuxbury, S.M., and M. Salmon. 2005. Competitive interactions between artificial lighting and natural cues during seafinding by hatchling marine turtles. Biol. Conserv. 121: 311-316.

U.S. Department of Commerce, Economics and Statistics Administration. 2010. Estimating the effects of the deepwater drilling moratorium on the Gulf coast economy. Inter-agency economic report. http://www.esa.doc.gov/Reports/estimating-economic-effects-deepwater-drilling-moratorium-gulf-coast-econom

U.S. Geological Survey. 2011. Cold-water coral ecosystem studies: U.S. Gulf of Mexico. Website accessed 14 April 2016. http://fl.biology.usgs.gov/pdf/20100504Gulf_corals_v1.pdf

U.S. Environmental Protection Agency. 2016. Questions and answers about the BP oil spill in the Gulf Coast. http://archive.epa.gov/bpspill/web/html/qanda.html

U.S. Environmental Protection Agency. 2017. The green book nonattainment areas for criteria pollutants. https://www.epa.gov/green-book

U.S. Fish and Wildlife Service, Gulf States Marine Fisheries Commission and National Marine Fisheries Service. 1995. Gulf Sturgeon Recovery/Management Plan. U.S. Department of Interior, U.S. Fish and Wildlife Service, Southeast Region. Atlanta, GA. http://www.nmfs.noaa.gov/pr/pdfs/recovery/sturgeon_gulf.pdf

U.S. Fish and Wildlife Service. 2001. Florida manatee recovery plan (*Trichechus manatus latirostris*), Third Revision. U.S. Department of the Interior, Southeast Region. Atlanta, GA.

U.S. Fish and Wildlife Service. 2003. Recovery plan for the Great Lakes Piping Plover (*Charadrius melodus*). U.S. Department of the Interior. Fort Snelling, MN.

U.S. Fish and Wildlife Service. 2007. International Recovery Plan: Whooping Crane (*Grus americana*), Third Revision. U.S. Department of the Interior. Albequerque, NM.

U.S. Fish and Wildlife Service. 2010a. Bech-nesting birds of the Gulf. http://www.fws.gov/home/dhoilspill/pdfs/DHBirdsOfTheGulf.pdf

U.S. Fish and Wildlife Service. 2010b. Effects of oil on wildlife and habitat. http://www.fws.gov/home/dhoilspill/pdfs/DHJICFWSOilImpactsWildlifeFactSheet.pdf

U.S. Fish and Wildlife Service. 2011. FWS Deepwater Horizon Oil Spill Response. Bird Impact Data and Consolidated Wildlife Reports. Deepwater Horizon Bird Impact Data from the DOI-ERDC NRDA Database 12 May 2011. http://www.fws.gov/home/dhoilspill/pdfs/Bird%20Data%20Species%20Spreadsheet%2005122011.pdf

U.S. Fish and Wildlife Service. 2015. Bald and Golden Eage Information. http://www.fws.gov/birds/management/managed-species/bald-and-golden-eagle-information.php

U.S. Fish and Wildlife Service. 2016a. Hawksbill sea turtle (*Eretmochelys imbricata*). http://www.fws.gov/northflorida/SeaTurtles/Turtle%20Factsheets/hawksbill-sea-turtle.htm

U.S. Fish and Wildlife Service. 2016b. Find Endangered Species. http://www.fws.gov/endangered/

U.S. Fish and Wildlife Service. 2017. Whooping Crane Survey Results: Winter 2016-2017. https://www.fws.gov/uploadedFiles/Region_2/NWRS/Zone_1/Aransas-Matagorda_Island_Complex/Aransas/Sections/What_We_Do/Science/Whooping_Crane_Updates_2013/WHCR_Update_Winter_2016-2017.pdf

U.S. Fish and Wildlife Service. nd. All About Piping Plovers. http://www.fws.gov/plover/facts.html

Valentine, D.L., G.B. Fisher, S.C. Bagby, R.K. Nelson, C.M. Reddy, S.P. Sylva, and M.A. Woo. 2014. Fallout plume of submerged oil from Deepwater Horizon. Proc. Nat. Acad. Sci. USA 111(45): 906-915.

Venn-Watson, S., K.M. Colegrove, J. Litz, M. Kinsel, K. Terio, J. Saliki, S. Fire, R.H. Carmichael, C. Chevis, W. Hatchett, J. Pitchford, M.C. Tumlin, C. Field, S. Smith, R. Ewing, D. Fauquier, G. Lovewell, H. Whitehead, D. Rotstein, W.E. McFee, and E. Fougeres. 2015. Adrenal Gland and Lung Lesions in Gulf of Mexico Common Bottlenose Dolphins (Tursiops truncates) Found Dead following the Deepwater Horizon Oil Spill. PLoS One 10(5): e0126538.

Wakeford, A. 2001. State of Florida conservation plan for Gulf sturgeon (*Acipencer oxyrinchus desotoi*).

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E.e. Rosel. 2016. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2015. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. NOAA Tech. Memo. NMFS NE 238.

Wei, C.-L. 2006. The bathymetric zonation and community structure of deep-sea macrobenthos in the northern Gulf of Mexico. M.S. Thesis, Texas A&M University. http://repository.tamu.edu/handle/1969.1/4927

Wei, C.-L., G.T. Rowe, G.F. Hubbard, A.H. Scheltema, G.D.F. Wilson, I. Petrescu, J.M. Foster, M.K. Wickstein, M. Chen, R. Davenport, Y. Soliman, and Y. Wang. 2010. Bathymetric zonation of deep-sea macrofauna in relation to export of surface phytoplankton production. Mar. Ecol. Prog. Ser. 39: 1-14.

Weilgart, L., and H. Whitehead. 1993. Coda communication by sperm whales (*Physeter macrocephalus*) off the Galapagos Islands. Can. J. Zool. 71: 744-752.

White, H.K., P.Y. Hsing, W. Cho, T.M. Shank, E.E. Cordes, A.M. Quattrini, R.K. Nelson, R. Camilli, A.W.J. Demopoulos, C. German, J.M. Brooks, H. Roberts, W.W. Shedd, C.M. Reddy, and C. Fisher. 2012. Impact of the Deepwater Horizon oil spill on a deep-water coral community in the Gulf of Mexico. Proc. Nat. Acad. Sci. USA 109(50): 20303-20308.

Wiese, F.K., W.A. Montevecchi, G.K. Davoren, F. Huettmann, A.W. Diamond, and J. Linke. 2001. Seabirds at risk around offshore oil platforms in the north-west Atlantic. Mar. Poll. Bull. 42(12): 1285-1290.

Williams, R., E. Ashe, and P.D. O'Hara. 2011. Marine mammals and debris in coastal waters of British Columbia, Canada. Mar. Poll. Bull. 62(6): 1303-1316.

Wilson, C.A., A. Pierce, and M.W. Miller. 2003. Rigs and reefs: A comparison of the fish communities at two artificial reefs, a production platform, and a natural reef in the northern Gulf of Mexico. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2003-009.

Wilson, J. 2003. Manatees in Louisiana. Louisiana Conservationist July/August 2003: 7 pp.

Witherington, B. 1997. The problem of photopollution for sea turtles and other nocturnal animals, pp 303-328. In: J.R. Clemmons and R. Buchholz, Behavioral Approaches to Conservation in the Wild. Cambridge University Press, Cambridge, England.

Würsig, B., S.K. Lynn, T.A. Jefferson, and K.D. Mullin. 1998. Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. Aquat. Mamm. 24(1): 41-50.

Würsig, B., T.A. Jefferson, and D.J. Schmidly. 2000. The Marine Mammals of the Gulf of Mexico. College Station, TX, Texas A&M University Press.

Section O

Administrative Information

A. Exempted Information Description

The proposed bottom-hole locations of the planned wells have been removed from the public information copy of the EP as well as any discussions of the target objectives, geologic or geophysical data, and any interpreted geology.

B. Bibliography

The regional OSRP was reviewed and accepted under plan S-7696 for the Mississippi Canyon Blocks 948, 949, 992, and 993.