UNITED STATES GOVERNMENT June 21, 2019
MEMORANDUM

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

Subject: Public Information copy of plan

Control #	-	S-07957
Type	-	Supplemental Exploration Plan
Lease(s)	-	OCS-G08484 Block - 84 Mississippi Canyon Area OCS-G08797 Block - 85 Mississippi Canyon Area
Operator	-	Anadarko Petroleum Corporation
Description	-	Subsea Wells G, H, GG, HH, GGG and HHH
Rig Type	-	DP Semisubmersible and Drillship

Attached is a copy of the subject plan.

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

Chiquita Hill
Plan Coordinator

Site Type/Name	**Botm Lse/Area/Blk**	**Surface Location**	**Surf Lse/Area/Blk**
WELL/G	G08484/MC/84	5820 FNL, 890 FWL	G08797/MC/85
WELL/GG	G08484/MC/84	5770 FNL, 890 FWL	G08797/MC/85
WELL/GGG	G08484/MC/84	5870 FNL, 890 FWL	G08797/MC/85
WELL/H	G08484/MC/84	3995 FNL, 5615 FEL	G08484/MC/84
WELL/HH	G08484/MC/84	3995 FNL, 5715 FEL	G08484/MC/84
WELL/HHH	G08484/MC/84	3995 FNL, 5515 FEL	G08484/MC/84

SUPPLEMENTAL EXPLORATION PLAN
S-7957

ANADARKO PETROLEUM CORPORATION

MISSISSIPPI CANYON BLOCKS 84 & 85
OCS-G 08484 & 08797

PUBLIC COPY

RECORD OF CHANGE LOG

Submission Type	Date Sent to BOEM	Summary of Submission	Page Numbers
Initial	05/02/2019	Submit EP	All
Amendment	05/16/2019	WCD seismic survey info added	N/A
Amendment	05/28/2019	Updated engine loads	65-78
Final version of EP	6/12/19	Final copy of plan with all revisions included	All
Record of Change Log	6/12/19	Record of Change Log	1

SUPPLEMENTAL EXPLORATION PLAN
S-7957

ANADARKO PETROLEUM CORPORATION

MISSISSIPPI CANYON BLOCKS 84 & 85
OCS-G 08484 & 08797

PUBLIC COPY

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Amendment	05/28/2019	Updated engine loads	65-79
Final version of EP	6/12/19	Final copy of plan with all revisions included	All
Record of Change Log	6/12/19	Record of Change Log	1

PUBLIC

SUPPLEMENTAL EXPLORATION PLAN

MISSISSIPPI CANYON BLOCKS 84 and 85
OCS-G 08484 and 08797

OFFSHORE, ALABAMA

Unit No. 754396002

Anadarko Petroleum Corporation
1201 Lake Robbins Drive
The Woodlands, Texas 77380
Contact: Jill Wiederhold
Jill.wiederhold@anadarko.com
(832) 636-1554

1 – Hard Copy Confidential
1 – CD Confidential
1 – Hard Copy Public Information
1 – CDs Public Information

May, 2019

SUPPLEMENTAL EXPLORATION PLAN
LEASE OCS-G 08484 and 08797
MISSISSIPPI CANYON BLOCKS 84 and 85

A
PLAN CONTENTS

(a) Plan Information Form

Under this Supplemental Exploration Plan (EP), Anadarko Petroleum Corporation (Anadarko) proposes to drill and complete six wells, MC 84 G, GG, GGG, H, HH, and HHH, all within Mississippi Canyon Blocks 84 and 85.

The wells will conduct operations using either a Dynamically Positioned (DP) Drillship or DP Semisubmersible drilling rig. Drilling and completion operations for the proposed well locations will utilize a Subsea BOP stack. OCS Plan Information Form BOEM-137 is enclosed as **Attachment A-1.**

(b) Location

Enclosed as **Attachment A-2** is a well location plat at a scale of 1 inch = 2000 feet that depicts the surface location and water depth of the proposed wells.

(c) Safety and Pollution Prevention Features

Safety features on the drilling unit will include well control, pollution prevention, safe welding procedures, and blowout prevention equipment as described in Title 30 CFR Part 250, Subparts C, D, E, G and O; and as further clarified by BOEM Notices to Lessees, and applicable regulations of the Environmental Protection Agency and the U.S. Coast Guard. The appropriate life rafts, life jackets, ring buoys, etc., as prescribed by the U.S. Coast Guard, will be maintained on the facility at all times.

(d) Storage Tanks and Production Vessels

The Mississippi Canyon Blocks 84 and 85 wells will conduct operations with either a DP drillship or DP semisubmersible unit. The storage tanks represented below reflect the largest tank capacities from MODU's under contract. Another MODU or vessel may be utilized during operations, but will have a total storage tank capacity equal to or less than the following:

Type of Facility	Type Of Storage Tank	Tank Capacity	Number Of Tanks	Total Capacity	Fluid Gravity (Api)	Total Capacity of all Tanks for Rig Type
Drillship	Hydrocarbons/Fuel Oil Storage Tank	5,514 bbls	2	11,028 bbls	No. 2 Diesel/ varies	**12 tanks total= 62,874 bbls**
	Hydrocarbons/Fuel Oil Storage Tank	12,458 bbls	2	24,916 bbls	No. 2 Diesel/ varies	
	Hydrocarbons/Fuel Oil Storage Tank	12,065 bbls	2	24,130 bbls	No. 2 Diesel/ varies	
	Fuel Oil Settling Tanks	640 bbls	2	1,280 bbls	No. 2 Diesel	

	Fuel Oil Service Tanks	480 bbls	3	1,440 bbls	No. 2 Diesel	
	Fuel Oil Emergency Generator Tank	80 bbls	1	80 bbls	No. 2 Diesel	
DP Semi	Hydrocarbon/Fuel Oil Hull Tanks	4,541 bbls	2	9,082 bbls	No. 2 Diesel/ varies	**7 tanks total= 16,689 bbls**
	Hydrocarbon/Fuel Oil Hull Tanks	3,392 bbls	2	6,784 bbls	No. 2 Diesel/ varies	
	Fuel Oil Deck Day Tank	629 bbls	1	629 bbls	No. 2 Diesel	
	Fuel Oil Deck Settling Tank	164 bbls	1	164 bbls	No. 2 Diesel	
	Fuel Oil Emergency Generator	30 bbls	1	30 bbls	No. 2 Diesel	

(e) Pollution Prevention Measures

The drilling rig utilized for these operations will comply with all applicable regulations regarding pollution prevention and control. The rig has a Shipboard Oil Pollution Emergency Plan (SOPEP), which is reviewed and approved annually by the American Bureau of Shipping (ABS). The SOPEP is provided to assist employees in dealing with an unexpected discharge of oil. Its primary purpose is to set in motion the necessary actions to stop or minimize the discharge of oil and to mitigate its effects. Effective planning ensures that the necessary actions are taken in a structured, logicalm and timely manner.

Pollution prevention measures include installation of curbs, gutters, drip pans, and drains on deck areas to collect all contaminants and debris. Most deck drains and some of the joints at the edge of the rig floor go overboard or into the moonpool, respectively. To prevent ocean discharge from the drains there is a dedicated drip pan under the rotary table. The pipe racks, mud pump room, sack store, and drill floor drains go to a holding tank, which is served by a dedicated oily water separator. The well test area, engine room, and other major machinery spaces drains all go to slops tanks, which are served by a large general-service, oily water separator. The containment devices are temporary. They are not meant for permanent storage of waste. On the rare occasion that they contain wastes, they are pumped, mopped, or cleaned within a short period of time. The chances of damage to a containment structure during such time as it contains wastes are exceedingly small.

(f) Additional Pollution Prevention Measures

No additional measures are proposed under this plan. The activities proposed in this plan are not located offshore Florida.

(g) Description of Previously Approved Lease Activities

Anadarko has previously approved well locations in Mississippi Canyon Block 84 and 85.

Approval was granted for the following well locations under the Supplemental Exploration Plan (filed by FMOG) for Mississippi Canyon Blocks 84 & 85 (Plan Control No. S-7638) approved on June 11, 2014:

Well Location	Status of Well Location	Potential Future Operations
MC 84 “A”	Location used to drill MC 84 #SS005 ST01	Well completed and placed on production
MC 84 “B”	Approved well location for future utility	Future drill location

Approval was granted for the following well locations under the Supplemental Exploration Plan (filed by FMOG) for Mississippi Canyon Blocks 84 and 85 (Plan Control No. S-7724) approved on April 30, 2015:

Well Location	Status of Well Location	Potential Future Operations
MC 84 “C”	Location used to drill MC 84 #SS006	Well TA’d. Will potentially re-enter and conduct future ops.
MC 84 “D”	Location used to drill MC 84 #SS007 BP01	Well TA’d. Will potentially re-enter and conduct future ops.
MC 85 “E”	Previously submitted well location cancelled by FMOG.	N/A
MC 84 “F”	Approved well location for future utility	Future drill location

Approval was granted for the following well locations under the Supplemental Exploration Plan for Mississippi Canyon Block 84 (Plan Control No. S-7828) approved on February 9, 2017:

Well Location	Status of Well Location	Potential Future Operations
MC 84 “F”	Location used to drill MC 84 #SS008	Well completed and placed on production
MC 84 “FF”	Approved well location for future utility	Future drill location
MC 84 “FFF”	Approved well location for future utility	Future drill location
MC 84 #006	Currently TA’d	Potential future sidetrack
MC 84 #007	Currently TA’d	Potential future sidetrack

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: ☒ Exploration Plan (EP) ☐ Development Operations Coordination Document (DOCD)

Company Name: Anadarko Petroleum Corporation	BOEM Operator Number: 00981
Address:	Contact Person: Jill Wiederhold
1201 Lake Robbins Drive	Phone Number: 832-636-1554
The Woodlands, TX 77380	E-Mail Address: jill.wiederhold@anadarko.com

If a service fee is required under 30 CFR 550.125(a), provide the Amount paid $7346.00 Receipt No. 75738537855

Project and Worst Case Discharge (WCD) Information

Lease(s): OCS-G 08484 & 08797 Area: MC Block(s): 84 & 85 Project Name (If Applicable): King North

Objective(s) ☒ Oil ☒ Gas ☐ Sulphur ☐ Salt Onshore Support Base(s): Fourchon, LA

Platform/Well Name: MC 84 "H" Total Volume of WCD: 394,798 BOPD API Gravity: 33.0

Distance to Closest Land (Miles): 67 Volume from uncontrolled blowout: 24,082,678 bbls

Have you previously provided information to verify the calculations and assumptions for your WCD?	☒ Yes	☐ No
If so, provide the Control Number of the EP or DOCD with which this information was provided	S-7724 (FMOG Plan)	
Do you propose to use new or unusual technology to conduct your activities?	☐ Yes	☒ No
Do you propose to use a vessel with anchors to install or modify a structure?	☐ Yes	☒ No
Do you propose any facility that will serve as a host facility for deepwater subsea development?	☐ Yes	☒ No

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

Proposed Activity	Start Date	End Date	No. of Days
Drill, Complete, & Conduct Flowtest Well Location MC 84 G	11/1/2019	01/25/2020	85
Drill, Complete, & Conduct Flowtest Well Location MC 84 H	01/26/2020	04/20/2020	85
Drill, Complete, & Conduct Flowtest Well Location MC 84 GG	1/1/2021	03/27/2021	85
Drill, Complete, & Conduct Flowtest Well Location MC 84 HH	03/28/2021	06/21/2021	85
Drill, Complete, & Conduct Flowtest Well Location MC 84 GGG	01/01/2022	03/27/2022	85
Drill, Complete, & Conduct Flowtest Well Location MC 84 HHH	03/28/2022	06/21/2022	85

Description of Drilling Rig

☐ Jackup	☒ Drillship
☐ Gorilla Jackup	☐ Platform rig
☐ Semisubmersible	☐ Submersible
☒ 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)

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): MC 84 "G"	Previously reviewed under an approved EP or DOCD?		Yes		No X

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.	N/A

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): N/A	For structures, volume of all storage and pipelines (Bbls): N/A	API Gravity of fluid	N/A

	Surface Location	**Bottom-Hole Location (For Wells)**	**Completion (For multiple completions, enter separate lines)**
Lease No.	OCS G-08797	OCS	OCS OCS
Area Name	Mississippi Canyon		
Block No.	85		
Blockline Departures (in feet)	N/S Departure: F____ L 5820 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 890 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: 1331450	X:	X: X: X:
	Y: 10496100	Y:	Y: Y: Y:
Latitude/ Longitude	Latitude 28.9189799	Latitude	Latitude Latitude Latitude
	Longitude -87.9660757	Longitude	Longitude Longitude Longitude

Water Depth (Feet): 5,179'	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): MC 84 "GG"	Previously reviewed under an approved EP or DOCD?		Yes		No X

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.	N/A

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): N/A	For structures, volume of all storage and pipelines (Bbls): N/A	API Gravity of fluid	N/A

	Surface Location	**Bottom-Hole Location (For Wells)**	**Completion (For multiple completions, enter separate lines)**
Lease No.	OCS G-08797	OCS	OCS OCS
Area Name	Mississippi Canyon		
Block No.	85		
Blockline Departures (in feet)	N/S Departure: F____ L 5770 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 890 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: 1331450	X:	X: X: X:
	Y: 10496150	Y:	Y: Y: Y:
Latitude/ Longitude	Latitude 28.9191175	Latitude	Latitude Latitude Latitude
	Longitude -87.966077	Longitude	Longitude Longitude Longitude

Water Depth (Feet): 5,179'	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): MC 84 "GGG"	Previously reviewed under an approved EP or DOCD?		Yes		No X

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.	N/A

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): N/A	For structures, volume of all storage and pipelines (Bbls): N/A	API Gravity of fluid	N/A

	Surface Location	**Bottom-Hole Location (For Wells)**	**Completion (For multiple completions, enter separate lines)**
Lease No.	OCS G-08797	OCS	OCS OCS
Area Name	Mississippi Canyon		
Block No.	85		
Blockline Departures (in feet)	N/S Departure: F____ L 5870 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 890 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: 1331450	X:	X: X: X:
	Y: 10496050	Y:	Y: Y: Y:
Latitude/ Longitude	Latitude 28.9188424	Latitude	Latitude Latitude Latitude
	Longitude -87.9660744	Longitude	Longitude Longitude Longitude

Water Depth (Feet): 5,179'	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): MC 84 "H"	Previously reviewed under an approved EP or DOCD?		Yes		No X

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.	N/A

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): N/A	For structures, volume of all storage and pipelines (Bbls): N/A	API Gravity of fluid	N/A

	Surface Location	**Bottom-Hole Location (For Wells)**	**Completion (For multiple completions, enter separate lines)**
Lease No.	OCS G-08484	OCS	OCS OCS
Area Name	Mississippi Canyon		
Block No.	84		
Blockline Departures (in feet)	N/S Departure: F____ L 3995 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 5615 FEL	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: 1324945	X:	X: X: X:
	Y: 10497925	Y:	Y: Y: Y:
Latitude/ Longitude	Latitude 28.9238528	Latitude	Latitude Latitude Latitude
	Longitude -87.9864606	Longitude	Longitude Longitude Longitude

Water Depth (Feet): 5,093'	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): MC 84 "HH"	Previously reviewed under an approved EP or DOCD?		Yes		No X

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.	N/A

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): N/A	For structures, volume of all storage and pipelines (Bbls): N/A	API Gravity of fluid	N/A

	Surface Location	**Bottom-Hole Location (For Wells)**	**Completion (For multiple completions, enter separate lines)**
Lease No.	OCS G-08484	OCS	OCS OCS
Area Name	Mississippi Canyon		
Block No.	84		
Blockline Departures (in feet)	N/S Departure: F____ L 3995 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 5715 FEL	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: 1324845	X:	X: X: X:
	Y: 10497925	Y:	Y: Y: Y:
Latitude/ Longitude	Latitude 28.9238505	Latitude	Latitude Latitude Latitude
	Longitude -87.9637732	Longitude	Longitude Longitude Longitude

Water Depth (Feet): 5,093'	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 =	
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			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): MC 84 "HHH"	Previously reviewed under an approved EP or DOCD?		Yes		No X

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.	N/A

Do you plan to use a subsea BOP or a surface BOP on a floating facility to conduct your proposed activities?	X	Yes		No

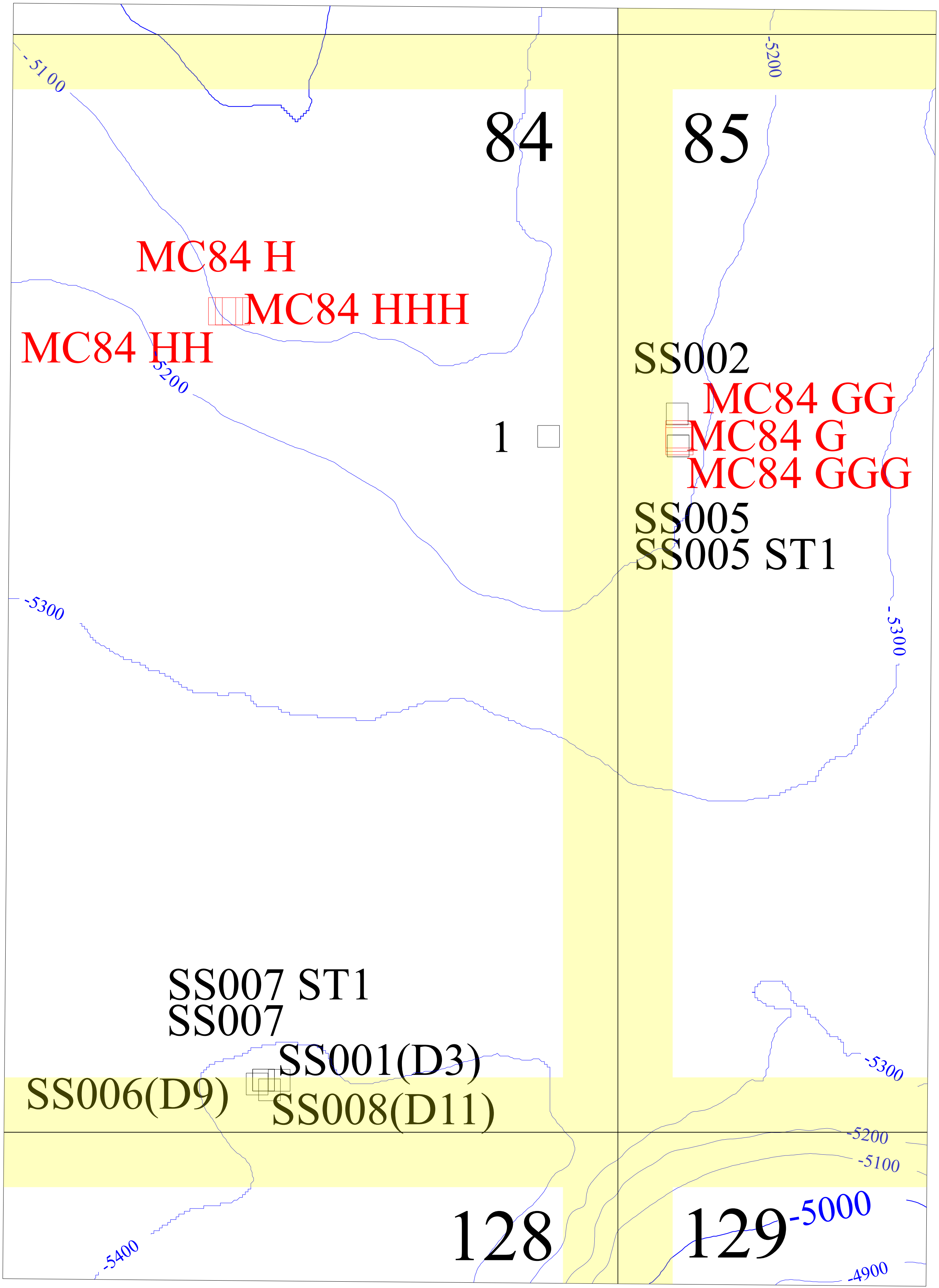
WCD info	For wells, volume of uncontrolled blowout (Bbls/day): N/A	For structures, volume of all storage and pipelines (Bbls): N/A	API Gravity of fluid	N/A

	Surface Location	**Bottom-Hole Location (For Wells)**	**Completion (For multiple completions, enter separate lines)**
Lease No.	OCS G-08484	OCS	OCS OCS
Area Name	Mississippi Canyon		
Block No.	84		
Blockline Departures (in feet)	N/S Departure: F____ L 3995 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 5515 FEL	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: 1325045	X:	X: X: X:
	Y: 10497925	Y:	Y: Y: Y:
Latitude/ Longitude	Latitude 28.923855	Latitude	Latitude Latitude Latitude
	Longitude -87.9861479	Longitude	Longitude Longitude Longitude

Water Depth (Feet): 5,093'	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 =	



N

1:24000
1" = 2000'

0 1
MILES

NAD27 / BLM 16N (ftUS) (EPSG 32066)

Transverse Mercator
Clarke 1866 spheroid
Natural origin: [87 00 00W, 0 00 00N]

Anadarko Petroleum Corporation

MC 84
OCS-G 08484

King North
Exploration Plan
Public Plat
C.I. = 100'

Author : David Ju; Jordan Dubuisson

Date : March 6, 2019

Scale : 1:24000

For internal information only. Depicted information is subjective and its accuracy has not been verified. Printed or saved versions may be outdated. Depictions and information are intended to be confidential, and may be subject to legal restrictions or protections. For questions regarding appropriate use contact Bobby Killion in ITS Global Geoscience Systems.

Well Number	X Coordinate (feet)	Y Coordinate (feet)	Latitude	Longitude	FNL/FSL	FWL/FEL	Block	Wellsite Clearance
MC84 G	1331450	10496100	28.9189799	-87.9660757	5820 FNL	890 FWL	85	Proposed Well "MC85 G"
MC84 GG	1331450	10496150	28.9191175	-87.966077	5770 FNL	890 FWL	85	Proposed Well "MC85 GG"
MC84 GGG	1331450	10496050	28.9188424	-87.9660744	5870 FNL	890 FWL	85	Proposed Well "MC85 GGG"
MC84 H	1324945	10497925	28.9238528	-87.9864606	3995 FNL	5615 FEL	84	Proposed Well "MC84 H"
MC84 HH	1324845	10497925	28.9238505	-87.9637732	3995 FNL	5715 FEL	84	Proposed Well "MC84 HH"
MC84 HHH	1325045	10497925	28.923855	-87.9861479	3995 FNL	5515 FEL	84	Proposed Well "MC84 HHH"

B
GENERAL INFORMATION

(a) Applications and Permits

Prior to beginning exploration operations the following application(s) will be submitted for approval:

Application/Permit	Issuing Agency	Status
Permits to Drill	BSEE Bureau of Safety and Environmental Enforcement (BSEE)	To be submitted

(b) Drilling Fluids

Type of Drilling Fluid	Estimated Volume Per Well
Water-based (NaCl saturated, seawater, freshwater, barite) for Pump and Dump	35,000 bbls per well**
Synthetic-based (internal olefin, ester)	15,000 bbls per well
Oil-based	NA

***The actual volume ordered out will be an estimated 35,000 bbls/well of mud. Once on location this volume will be cut back and mixed with seawater to different desired mud weights which will increase the volume that is discharged at the seafloor. The estimated volume that will be discharged at the seafloor will be approximately 65,000 bbls/well (NOTE: there will be six wells drilled for a total of 390,000 bbls).*

(c) New or Unusual Technology

Anadarko does not propose to use any new or unusual technology to drill the well proposed in this plan.

(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 part 256, subpart I; NTL No. 2015-N04, "General Financial Assurance," and National NTL No. 2016-N01 "Requiring Additional Security".

(e) Oil Spill Financial Responsibility (OSFR)

Anadarko Petroleum Corporation (Company Number 00981) has demonstrated oil spill financial responsibility for the facilities proposed in this EP according to 30 CFR Part 253, and NTL No. 2008-N05, "Guidelines for Oil Spill Financial Responsibility for Covered Facilities".

(f) Deepwater Well Control Statement

Anadarko Petroleum Corporation (Company Number 00981) has the financial capability to drill a relief well and conduct other emergency well control operations if required.

(g) Blowout Scenario

Anadarko prepared this blowout scenario pursuant to guidance provided in NTL No. 2015-N01. The Mississippi Canyon Block 84 Location "H" is addressed in this blowout scenario since it is the proposed location with the highest potential worst case discharge (WCD). A similar approach would be taken in the event of a blowout from the other wells proposed in Mississippi Canyon Blocks 84 and 85. Based on

NTL No. 2015-N01 guidance, the maximum hydrocarbon discharge from Mississippi Canyon Block 84 Location “H” is calculated to be 394,798 BOPD.

Purpose

This information provides a generic blowout scenario, additional information regarding any potential oil spill, the measures Anadarko will take to prevent a blowout, and if necessary, promptly respond to manage a blowout scenario if one occurs. The following information is pursuant with 30 CFR 550.213(g), 550.219, 550.250 and NTL No. 2015-N01.

Background

Anadarko prepared this blowout scenario pursuant to guidance provided in NTL No. 2015-N01. Mississippi Canyon Block 84 Location “H” is addressed in this blowout scenario since it is the location with the highest potential worst case discharge (WCD). Based on NTL No. 2015-N01 guidance, the maximum hydrocarbon discharge for Mississippi Canyon Block 84 Location “H” is calculated to be **394,798 BOPD.**

Information Requirements

Blowout Scenario

The objectives are drilled utilizing a MODU rig with a marine riser and sub-sea BOP. A typical sub-sea wellhead system, conductor, surface and intermediate casing program will be used. A hydrocarbon influx occurs, followed by a well control event from the objective sands. The sub-sea BOP and marine riser fails and a blow-out at the seabed occurs. Exposed sands in the primary objective are the WCD scenario.

Estimated Flow Rate of the Potential Blowout

Category	EP
Type of Activity	Drilling
Facility Location (area/block)	MC 84 “H”
Facility Designation	MODU
Distance to Nearest Shoreline (miles)	67 miles
Uncontrolled Blowout (volume per day)	394,798 bbl
Type of Fluid(s)	Crude Oil

a) Potential for the well to bridge over:

Formation collapse and bridging is expected in a blowout scenario, sanding would occur. Complete bridging is expected within four days.

Mechanical collapse of the reservoirs in the open-hole section of the wellbore was not considered in determining WCD. During a worst case discharge event, the open hole portion of the well will be exposed to a substantial underbalance condition. Due to the unconsolidated nature of the formations contributing flow and the relatively weak remaining exposed sediments, a significant quantity sand and heaving shale will enter the flowstream. The presence of sediments in the flowstream are excluded from Anadarko’s discharge calculations and assumes no bridging will occur, however, bridging is likely to occur.

b) Likelihood and measures taken for surface and/or sub-sea intervention to stop the blowout:

The likelihood of surface intervention to stop a blowout is high. In addition to the surface intervention equipment the contracted MODU will have the equipment / ability to perform the following:

- ROV Secondary BOP Control System: The BOP is confirmed to have a ROV Intervention Panel and circuits that have the following attributes:
    - ROV Intervention is capable of Opening and Closing each Shear Ram, Ram Locks, One Pipe Ram and Disconnect the LMRP, all under MASP conditions.
    - ROV Intervention is to be tested during the initial stump test and during the initial BOP latch up.
    - BOP panels also can be operated by an ROV from an independent supply boat in the event of a loss-of-rig scenario.
- Deadman/Autoshear Function: The rig is equipped with an automated sequence that closes the blind shear rams in the event of any of the following scenarios:
    - Inadvertent disconnect of the LMRP
    - Loss of both hydraulic pressure and electrical supply from the surface BOP control system
    - No human interface is required once these systems are armed.

c) Availability of a rig to drill a relief well:

Per the preliminary Mutual Aid agreements that are being worked between E&P Operators in the Gulf of Mexico, Anadarko will select from the best rig option available in the Gulf of Mexico fleet if and when it is required for relief well work. A rig that could be used to drill a relief well is the Diamond Ocean Blackhawk Drillship, which is a drillship capable of drilling in 12,000 ft. of water without any constraints. The rig is currently under contract to Anadarko.

There are no nearby platforms from which to drill a relief well.

It is not feasible to drill a relief well from land.

d) Rig constraints:

The minimum capability for a Drilling Rig, is to be able to drilling in 5,000 ft. of water, and a 15k BOP Stack to drill a relief well. The Diamond Ocean Blackhawk Drillship meets these requirements.

e) Time taken to mobilize a rig and drill a relief well:

An estimate of 7-21 days is required to suspend operations on a deepwater GOM well and begin drilling the relief well. This assumes 0-14 days to suspend current operations on an existing well and 7 days to mobilize and be ready to spud the relief well. The estimated time to drill the relief well to a blowout originating from the target zone is 25-40 days, for a total estimated time of 32-61 days from time of blowout to finishing the relief well.

f) Assumptions and calculations used in approved or proposed Oil Spill Response Plan:

- The maximum total volume during a blowout could potentially be 24,082,678 bbl. assuming 61 days for the maximum duration of a blowout, multiplied by the worst case daily uncontrolled blowout volume of 394,798 bbl.

g) Measures taken to enhance ability to prevent a blowout:

- **Well Design**: Anadarko utilizes a systematic well design process for the planning and construction of a well operation. This process taps into the vast depth of experience Anadarko possesses in the Deep Water drilling arena and involves a multi-team peer review of the well design, shallow hazards, and formation pressure hazards expected during drilling. This process minimizes the potential for an unplanned well control event that could lead to a blowout. This process will also include a Registered Professional Engineer review and approval of the final casing design and cementing program.
  A detailed pre-drill assessment of formation pressure provided by Anadarko's Geological and Geophysical team, along with third-party consultants, allows for a mud program that provides an overbalanced mud weight for the safe drilling of the well. For an exploration well, this may also include taking formation pressures to confirm the actual formation pressure during the well construction process to minimize the risk of an unplanned well control event. The pore pressure environment is understood due to the nearby offset wells.

  The well construction process also requires a systematic review and management acceptance of the start-up preparation work for the rig and crews and the third-party technical audit work on the rig and the rig's well control equipment. This measures the rig's ability to handle an unplanned well control event and provide assurance that the rig can successfully mitigate a loss of well control event and prevent it from becoming a blowout scenario.

- **Barrier Philosophy**: For all well designs, Anadarko requires and uses a redundant barrier philosophy—that being two independent tested barriers including one mechanical barrier—across each flow path during well operations.
  For the final casing string (or liner if it is the final string), there shall be one mechanical barriers in addition to cement inside the wellbore.

  It is also standard practice to conduct pressure testing, in accordance with the law, to confirm integrity on all relevant barriers.

  In addition, all intermediate and production casings returned to the wellhead will be locked down before subsequent wellbore construction is proceeded.

- **BOP and Well Control Equipment**: The rig will have an 18-3/4" 15k psi BOP with primary and secondary BOP control systems. The BOP will have been completely recertified compliant to OEM specifications by a qualified third-party. Prior to commencement of operations, independent third-party verification will be obtained that the sub-sea BOP is designed for the specific equipment on the rig and this specific well design. 250.731(c) and (d).
- **BOP and Well Control Equipment Testing**: To ensure effectiveness of the BOP and well control equipment, a testing program will be conducted prior to running the BOP and then during the well operations. This testing program will provide compliance with current federal regulations for pressure and function testing and will also provide periodic assurance on the performance of

both primary and secondary BOP control systems including actual interface operations with the ROV and the ROV panel.

- **Well Control Training and Drills**: Anadarko requires that key nominated onshore and offshore positions, including rig contractor personnel, hold a WellCAP or equivalent well control training certificate, renewable every two years for the type of floating drilling operation being conducted. Anadarko also monitors compliance for its personnel with the federal regulations and Sub-Part O for well control training.

  A comprehensive program of well control drills will be conducted offshore to ensure readiness to identify and then manage a well control situation and thereby minimize the potential for a well control event to lead to a blowout scenario.

h) Arrangements for drilling a relief well:

- Anadarko maintains a master agreement with Wild Well Control, Inc. for advice, management, engineering, well kick pre- and post-modeling, and resource support for an unplanned loss-of-well-control event. If any well control event occurs, Wild Well Control, Inc. would be contacted and mobilized if required to support Anadarko's operational team, both in the onshore and offshore locations.
- The conceptual relief well design is similar to the design of the Mississippi Canyon Block 84 #08 ST00 BP00 well, in that casing weights, grades, and setting points would be very similar. Site clearance letters for surface locations will be completed and deemed acceptable for drilling prior to any drilling operations. Depending on the nature of the blowout scenario, well geometry, and total depth required to intersect the blowout, previously submitted surface locations and/or additional surface locations would be submitted and all reviewed for best suitability for the location of the relief well if needed. The conceptual well design is not anticipated to take over 2 days to finalize upon initialization.
- Anadarko's philosophy is to carry adequate inventory in stock to drill a complete well(s) from surface to TD. Back-up long-lead equipment equivalent to the original well design will be carried in stock to allow a rapid response. This includes a spare deepwater sub-sea wellhead system and the large OD casing (36", 28", 22", 18", 16", 14", and 13-5/8") and connectors required. Smaller OD casing (9 7/8"and 7 3/4") is considered widely available on the ground in the GOM and would be resourced out of existing inventory or from suppliers as required.
- Existing service agreements will be in place for support services, including drilling fluids, casing running, cementing, ROVs, solids control, mud logging, directional drilling, LWD/MWD, logging, boats, and helicopters.
- Specialist services for range finding to drill the relief well in close proximity to the original wellbore at the reservoir depth will be provided through Vector Magnetics LLC. Sperry Drilling/Halliburton and Baker Hughes have in-house personnel to supplement Vector Magnetics LLC under our existing directional drilling agreements.

C
GEOLOGICAL AND GEOPHYSICAL INFORMATION

(a) Geological Description

Discussions regarding geologic information are considered proprietary and have been omitted from this public copy of the EP, along with the attachments.

(b) Structure Contour Maps

Current structure maps drawn to the top of each productive hydrocarbon sand showing the entire lease block, the surface locations of each well and locations of geological cross-sections, are enclosed as **Attachment C-1.**

(c) Interpreted 2-D and/or 3-D Seismic Lines

Interpreted seismic lines are enclosed as **Attachment C-2.**

(d) Geological Structure Cross-Sections

Interpreted geological structure cross-sections showing the location and depth of each proposed well are enclosed as **Attachment C-3.**

(e) Shallow Hazards Report

A shallow hazards survey was conducted by C&C Technologies. The shallow hazards report was previously provided with Exploration Plan (Control No. S-7638), approved June 11, 2014.

(f) Shallow Hazards Assessment

Shallow Hazards Site Clearance (SC) Letters for the proposed well locations in Mississippi Canyon Blocks 84 and 85 are enclosed as **Attachment C-4.**

(g) High-resolution Seismic Lines

High resolution seismic lines are enclosed as **Attachment C-5.**

(h) Stratigraphic Column

A generalized stratigraphic column depicting the wells from the seafloor to total depth is included as **Attachment C-6.**

(i) Time Vs. Depth Tables

The proposed activities under this EP are not considered to be in areas where there is no well control. Therefore, a seismic travel time versus depth table is not required per NTL No. 2008-G04.

Anadarko
Petroleum Corporation

SITE CLEARANCE LETTER

PROPOSED WELL “G”
BLOCK 85, MISSISSIPPI CANYON AREA

OCEANEERING®

Oceaneering Document Number:	198110-OII-RPT-WCL-01	Survey Dates:	Sep 2007
Client Document Number:	N/A	Location:	MC85
Client:	Anadarko Petroleum Corporation	Vessel:	M/V *Moana Wave*

REVISION HISTORY

Rev	Reason For Issue	Author	Reviewed	Approved	Rev Date
A	Client Review	C Baker	S Comiskey	C Baker	8Mar2019
0	Client Review	C Baker	S Comiskey	C Baker	13Mar2019

Signature Box

Christopher Baker

Christopher Baker
Geohazards Specialist

Anadarko Petroleum Corporation
1201 Lake Robbins Drive
The Woodlands, TX 77380

ATTN: Jordan Dubuisson

Site Clearance Letter
Proposed Well “G”
Block 85 (OCS-G-08797), Mississippi Canyon Area

INTRODUCTION

Anadarko Petroleum Corporation (Anadarko) contracted Oceaneering International, Inc. (OII) to prepare a well site clearance letter for the proposed location of Well “G” in Block 85 (OCS-G-08797), Mississippi Canyon Area (MC), Gulf of Mexico. The data used for this site clearance letter include high-resolution geophysical data sets collected by OII’s *O-Surveyor III* Autonomous Underwater Vehicle (AUV) in 2007 and an exploration-quality 3D seismic data volume originally provided to OII by Freeport McMoRan (FMOG). OII completed the geohazard assessment report titled “*3D Seismic Shallow Geohazard Report, King Field, Blocks 84, 85, and 128, Mississippi Canyon Area*” in July 2013 and the archeological assessment report titled “*Archaeological Assessment, King Field, Blocks 84, 85, and 129, Mississippi Canyon Area*” in August 2013. This site clearance letter is based on findings provided within those reports.

This letter provides a top-hole drilling prognosis and addresses seafloor conditions within a 2,000-foot radius centered at the proposed Well “G” location. The depth limit of the investigation is approximately 2.0 seconds of two-way traveltime, approximately 5,000 feet below seafloor (BSF), or to the top of the salt/sediment interface. This letter complies with the Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE) guidelines provided in Notice to Lessees (NTL) No. 2008-G05 (Shallow Hazards Program), NTL No. 2005-G07 (Archaeological Resource Surveys and Reports), and NTL No. 2009-G40 (Deepwater Benthic Communities).

WELL LOCATION

The coordinates and calls for the proposed Well “G” surface location are tabulated below:

Table 1. Proposed Well “G” Surface Location

Well	Easting (feet)	Northing (feet)	Latitude	Longitude	Calls From MC85	
“G”	1,331,450.00	10,496,100.00	28° 55' 08.328” N	87° 57' 57.873” W	5,820′ FNL	890′ FWL

Two additional proposed well locations are also included within the 2,000-foot vicinity, and are listed as proposed wells “GG” and “GGG.” The locations and coordinates for those 2 wells are listed below.

Table 2. Proposed Well “GG” and “GGG” Surface Locations

Well	Easting (feet)	Northing (feet)	Latitude	Longitude	Calls From MC85	
“GG”	1,331,450.00	10,496,150.00	28° 55' 08.823” N	87° 57' 57.877” W	5,770′ FNL	890′ FWL
“GGG”	1,331,450.00	10,496,050.00	28° 55' 07.328” N	87° 57' 57.868” W	5,870′ FNL	890′ FWL

The geodetic datum used for this project is the North American Datum of 1927 (NAD27) with the Clarke 1866 Ellipsoid. The datum is projected using the Universal Transverse Mercator (UTM), Zone 16 North (16N) with a central meridian at 93° 00’W, a false easting of 1,640,416.67 feet at the central meridian, and a false northing of 0.00 feet at 00° 00’N. All coordinates given are presented in this projection within this letter and on the maps (Sheets 1 through 6). All grid units, as well as scales and measurements, are in U.S. Survey Feet.

The proposed Well “G” surface location and the 2,000-foot radius circle centered at the surface location are displayed on the Color Shaded Bathymetry Map (Sheet 1), Seafloor Gradient Map (Sheet 2), Side Scan Sonar Mosaic Map (Sheet 3), Seafloor Amplitude Map (Sheet 4), and Hazards Map (Sheet 5).

SURVEY METHODS

AUV Survey Data

OII’s *O-Surveyor III* AUV provided multibeam bathymetric mapping, high-resolution side scan sonar imagery, and subbottom profiles collected at an altitude of 40 meters above the seafloor. Geophysical instruments integrated into the *O-Surveyor III* AUV and used for the survey include a Kongsberg EM 2000 Multibeam Echosounder (200 kHz), EdgeTech DF4500 Full Spectrum Chirp Dual Frequency Side Scan Sonar (230 kHz), and EdgeTech DW106 Chirp Subbottom Profiler (1.5 – 4.5 kHz). All the raw digital data were logged utilizing OII’s proprietary software. The multibeam system delivered a 3-meter gridded dataset with relative vertical accuracies within 20 centimeters. The theoretical vertical resolution with the subbottom profiling system is estimated at 8 centimeters with upwards of 100 meters of subbottom being resolved in some areas.

The 2007 AUV survey grid consisted of north-south primary tracklines (Lines 103 – 113) and east-west tie lines (Lines 201 – 202). Primary tracklines were spaced at 200 meter (656 feet) intervals, while the tie lines were surveyed at 900 meter (2,953 foot) line spacing. Navigation fixes were annotated at 125-meter (410-foot) intervals along all survey lines. The survey grid provided overlapping side scan sonar and multibeam echosounder coverage and representative sampling with the subbottom profiler system.

3D Seismic Data

The exploration-quality 3D seismic data used for this site clearance assessment were provided in SEG-Y format and loaded into IHS’ Kingdom Suite 2D/3DPak for interpretation. The amplitude traces were processed at a 2-millisecond sample rate and was interpreted to 2 seconds BSF or to the top of the salt/sediment interface. The 3D data volume inlines run northwest-southeast while the crosslines run southwest-northeast. The inlines and crosslines are spaced at 41.01 foot (12.5 meter) intervals.

The 3D seismic data are zero phase, and the seafloor reflector is represented by a strong, positive amplitude peak flanked by troughs with absolute amplitude values of less than one-half of the peak value. The seismic data provided adequate screening of the regional seafloor and shallow geologic conditions and large-scale geohazards, such as but not including or limited to, faults, salt, high acoustic impedance, and stratigraphic horizons. Figure 1 consists of a wavelet and an amplitude spectrum showing the frequency content versus the amplitudes of the data collected at the proposed well site.

BATHYMETRY AND SEAFLOOR GRADIENTS

The water depth at the proposed location of Well “G” is 5,179 feet below mean sea level (MSL). Within the 2,000-foot radius, seafloor depths range from 5,116 feet MSL in the northwest to 5,259 feet MSL downslope in the east (Sheet 1). The proposed well is situated on a smooth, east-southeast deepening seafloor at a 2° average gradient.

SEAFLOOR SEDIMENTS AND HAZARDS

Side scan imagery within the 2,000-foot radius exhibit primarily low to moderate acoustic reflectivity (Sheet 3). The 3D seafloor amplitude image displays a range of low to moderate acoustic amplitudes and agrees well with the sonar images (Sheets 3 and 4). These low to moderate acoustic reflectivity and seafloor amplitudes indicate finely textured seabed sediments likely comprised of hemipelagic clay (very soft silty clay).

POTENTIAL DEEPWATER BENTHIC COMMUNITIES

High-amplitude seismic seafloor anomalies are a potential indicator of carbonates and benthic community habitats. The review of 3D seismic and AUV data identified no high negative or positive amplitude anomalies associated with fluid expulsion or mounded carbonates representing potential high-density deepwater benthic habitats. The proposed well “G” location appears to be clear of potential deepwater benthic communities and the impacts on potential deepwater benthic communities is considered negligible.

MAN-MADE HAZARDS

A review of company and BOEM/BSEE databases indicates 2 existing wells, 9 existing pipelines, and numerous jumpers and leads within 2,000 feet of the proposed Well “G” location (Sheets 1 – 5; Table 3).

Table 3. Existing infrastructure near the proposed Well “G”

Well	
Name	**Block**
OCS-G-08797 Well No. SS-2	MC85
OCS-G-08484 Well No. SS-5	MC85
Pipelines	
Name	**Block**
S-16085 Anadarko 6”	MC85
S-19431 Anadarko 6”	MC85
S-19420 Anadarko 4”	MC85
S-14091 Anadarko 4” Umb	MC85
S-14089 Anadarko 6” Casing S-14090 Anadarko 10” Casing	MC85
S-13386 Anadarko 8” S-13387 Anadarko 12” Casing	MC85
S-13388 Anadarko 4”	MC85
S-16086 Anadarko 5”	MC85
S-13384 Anadarko 2”	MC85

The side scan sonar data revealed 5 unidentified sonar contacts within the 2,000-foot vicinity. The closest sonar contact (Sonar Contact No. 2) is located 1,300 feet northwest of the proposed well location. The lengths of the 5 sonar targets range from 7 to 10 feet, with widths ranging from 3 to 10 feet, and none exhibiting any measurable height off bottom. All unidentified sonar contacts should be noted and avoided as appropriate. None of the sonar contacts are recommended for avoidance based on archaeological potential.

SUBSURFACE GEOHAZARDS AND STRATIGRAPHY

OII’s AUV subbottom profiles provided high-resolution data of the upper 300 feet BSF. The profiles are characterized as continuous, well-defined bottom echoes with parallel stratified subsurface reflectors of varying amplitudes (Figure 2).

Three NW-SE oriented buried faults are noted within the 2,000-foot radius, with the closest mapped 560 feet southwest of the proposed well. These faults are buried between 633 and 4,400 feet below mudline and are downthrown to the southwest. The proposed bore path does not intersect any of the buried faults (Figures 3 and 4).

3D seismic data were used to assess subsurface geology deeper than the AUV penetration. Six stratigraphic units (Units A to F), each consisting of one or more distinctive sequences, were interpreted within the study area to 2.0 seconds of two-way travel time below the seabed. A time-series for the sediment column was obtained at MC84 Well No. 1. The following polynomial equation was derived from the Total Vertical Depth (TVD) and the corresponding two-way traveltime (TWT) using the time-depth values to calculate depths below the sea level:

$$\mathbf{D = 312.76T^2 + 1{,}651.4T}$$

Where **D** = depth below seafloor in feet and **T** = two-way traveltime below seafloor in seconds.

Seven horizons mark the upper and/or lower contacts of each of the successive units. For each unit, interval amplitudes were examined by extracting the greatest positive amplitude values within envelopes from 10 milliseconds below the top of the unit to 10 milliseconds above the base the unit. High amplitude anomalies, commonly termed bright spots, are interpreted as potential fluid saturation regions usually associated with porous sands.

Unit A (Seafloor to Horizon 1)

Unit A consists predominantly of low to moderate amplitude, parallel, continuous reflectors that are 218 feet thick at the proposed Well “G” location. These reflection patterns are likely comprised of hemipelagic clay laid down as a drape deposit.

Unit B (Horizon 1 to Horizon 2)

Unit B consists of low to moderate amplitude, continuous reflectors overlying low to moderate semi-continuous to chaotic reflectors. The center of the unit is characterized by a moderate to high amplitude continuous reflector indicative of a possible sand sheet. The unit is 382 feet thick at the proposed well location. The reflection patterns at the top of Unit B are likely comprised of hemipelagic clay, laid down as a drape deposit, while the bottom of the unit is comprised of thick interbedded mud-prone mass movement deposits and sandy channel fill.

Unit C (Horizon 2 to Horizon 3)

Unit C consists of primarily low amplitude, continuous, parallel reflectors and is 325 feet thick at the proposed Well “G” location. Unit C is interpreted as mostly fine-grained channel fill with some interbedded channel/overbank deposits.

Unit D (Horizon 3 to Horizon 4)

Unit D consists of variable amplitude, semi-continuous to chaotic reflectors and is 1,266 feet thick at the proposed well location. These reflection patterns are interpreted as clay-prone mass transport deposits with interbedded sandy channel fill. High amplitude anomalies indicative of shallow gas were identified throughout Unit D, with several located within the 2,000-foot vicinity. The closest amplitude anomaly is located 135 feet northeast of the proposed well. The poorly consolidated sand-prone sequences near the top of the unit are lying below a potential clay seal and may represent a low to moderate shallow water flow hazard. This shallow water flow potential may be lower since the wells drilled in the immediate vicinity did not report any shallow water flow events.

Unit E (Horizon 4 to Horizon 5)
Unit E consists of low to moderate amplitude, sub-parallel to chaotic reflectors and is 1,261 feet thick at the proposed well location. The sediments in Unit E are interpreted as interbedded channel fills and clay-prone mass transport deposits.

Unit F (Horizon 5 to Horizon 6)
Unit F consists of low to moderate amplitude, sub-parallel to chaotic reflectors and is 1,361 feet thick at the proposed Well "G" location. The sediments within the unit are interpreted as mostly clay-prone mass transport deposits with interbedded channel fills.

SHALLOW GAS

Anomalies of very high amplitude are interpreted as potential regions of fluid/gas saturation usually associated with porous sands. The risk of shallow gas is interpreted based on seismic amplitude levels with geologic settings taken into account. The gas risk is assessed as being at one of the following levels:

- **Negligible:** No amplitude anomalies or other gas indicators present.
- **Low risk of gas:** Generally indicated by increased amplitude (2 – 3 times background level) and phase reversal. This may also include diffuse areas of gas blanking.
- **Moderate risk of gas:** Generally indicated by high amplitude (3 – 4 times background level) and phase reversal.
- **High risk of gas:** Generally indicated by the highest amplitudes (in excess of 4 times background level), phase reversal, and a combination of other attributes indicative of the presence of gas, particularly velocity pull-down and masking of underlying sediments. Stratigraphic and structural settings may also be taken into account.

Seismic amplitude anomalies are displayed on the Hazards Map (Sheet 5). Within the 2,000-foot radius, the risk of shallow gas for Unit A is considered negligible, while Units B, C, E, and F exhibit a low risk of gas. Unit D exhibits a low to moderate risk of gas (Figure 5).

SHALLOW WATER FLOW

Sands with shallow water flow (SWF) potential often lie below a seal that prevents dewatering and compaction after deposition and form in unconsolidated and overpressured sands. The pressure rises with overburden causing a potentially hazardous condition for drilling operations. Some SWF intervals have proven difficult or impossible to detect on seismic profiles. Several factors may contribute to shallow water flows, including high porosity and permeability, sand-prone aquifer, mechanism to pressurize, and seal. Additional details are described below:

- **Water depth and depth of burial:** Significant water depths (> 500 feet below sea level) are required for the overpressure to occur. The seal must be deeply buried (> 500 feet below the seafloor) to become sufficiently strong.
- **High deposition rates:** Sedimentation rate needs to be greater than 1,500 feet/myr to effectively seal in sands. Sedimentation rates are expected to be high within a salt withdrawal basin. Rapid burial leads to pressure disequilibrium. In addition, if these sediment 'packets' were formed through

a sequence of turbidites or gravity flow, there is an increased likelihood of water saturation and overpressure (pore pressure rapidly increased and sealed by an impervious layer).

- **Suitably porous sediments:** The sediment packets comprising the risk of shallow water flow are believed to contain clastic material and are thus porous.
- **Impermeable seal:** The overlying sediments are comprised of a clay facies.

According to the BOEM/BSEE, the nearest reported shallow water flow event was in DC177, approximately 10 miles southeast from the proposed well site and was categorized as a low severity flow. This SWF event is listed as occurring 1,915 feet BSF, which correlates within Unit D of this assessment.

The assessment of seismic profiles suggest the risk of SWF for Units A and B are negligible, while Units C, E, and F exhibit a low risk of SWF. Unit D exhibits a low risk with a moderate risk near the top of the unit. Due to the unpredictable nature of SWF, it is advised that caution be executed for any drilling operations through these sediments.

GAS HYDRATES

Gas hydrates are an ice crystalline form of gas hydrocarbons in deepwater marine environments where the conditions of pressure and temperature are favorable. The hydrate stability zone is the depth interval between the seafloor and the point where the hydrate is no longer stable in form. The thermal gradient of the seabed soils determines the depth of the hydrate stability zone base. The acoustic impedance contrast caused by the hydrate and free gas trapped at the base of the hydrate stability zone forms a bottom simulating reflector (BSR) on seismic profiles. Bottom simulating reflectors often cross cut the normal seismic stratigraphy, much like a bottom multiple.

The areas where seafloor gas hydrates accumulate in the near-surface sediments of the Gulf of Mexico are generally unfavorable sites for drilling operations. Irregular seafloor topography, gas seeps, gas chimneys, seafloor hydrates and benthic communities may all be found in close association. There was no indication of gas hydrates, associated geologic feature, or any obvious BSRs near the proposed well.

CONCLUSIONS

The seafloor at the proposed Well “G” location is at a depth of 5,179 feet MSL and slopes east-southeast on a smooth seafloor at a gradient of 2°.

The review of 3D seismic and AUV data identified no seafloor high negative or positive amplitude anomalies associated with fluid expulsion or mounded carbonates representing potential high-density deepwater benthic habitats.

Three subsurface faults, oriented NW-SE and buried between 633 and 4,400 feet BSF and downthrown to the southwest, are located within the 2,000-foot vicinity. The proposed wellbore does not intersect any of these buried faults.

There are 2 wells and 9 pipelines within the 2,000-foot vicinity, as well as numerous jumpers and flying leads. Additionally, 5 sonar contacts were identified in the 2,000-foot vicinity. None of the unidentified sonar contacts are recommended for investigation or avoidance based on potential archaeological significance.

The risk of shallow gas for Unit A is considered negligible, while Units B, C, E, and F exhibit a low risk of gas. Unit D exhibits a low to moderate risk of gas.

The risk of SWF for Units A and B are negligible, while Units C, E, and F exhibit a low risk of SWF. Unit D exhibits a low risk with a moderate risk near the top of the unit. Due to the unpredictable nature of SWF, it is advised that caution be executed for any drilling operations through these sediments.

There was no indication of gas hydrates, associated geologic features, or any obvious BSRs at the proposed drill center.

Oceaneering appreciates this opportunity to be of service. Please contact us if you have any questions concerning this assessment.

Sincerely,

Christopher Baker

Christopher Baker
Geohazards Specialist

Enclosures
Figure 1. Extracted wavelet and power spectrum at proposed Well “G”.
Figure 2. AUV subbottom profile of Line 117 showing hi-res stratigraphy near the proposed Well “G”.
Figure 3. 3D seismic inline 7651 through the proposed Well “G”.
Figure 4. 3D seismic inline 6482 through the proposed Well “G”.
Figure 5. Top-Hole Prognosis Chart for the proposed Well “G”.

Sheet 1. Color Shaded Bathymetry Map
Sheet 2. Seafloor Gradient Map
Sheet 3. Side Scan Sonar Mosaic Map
Sheet 4. Seafloor Amplitude Map
Sheet 5. Hazards Map

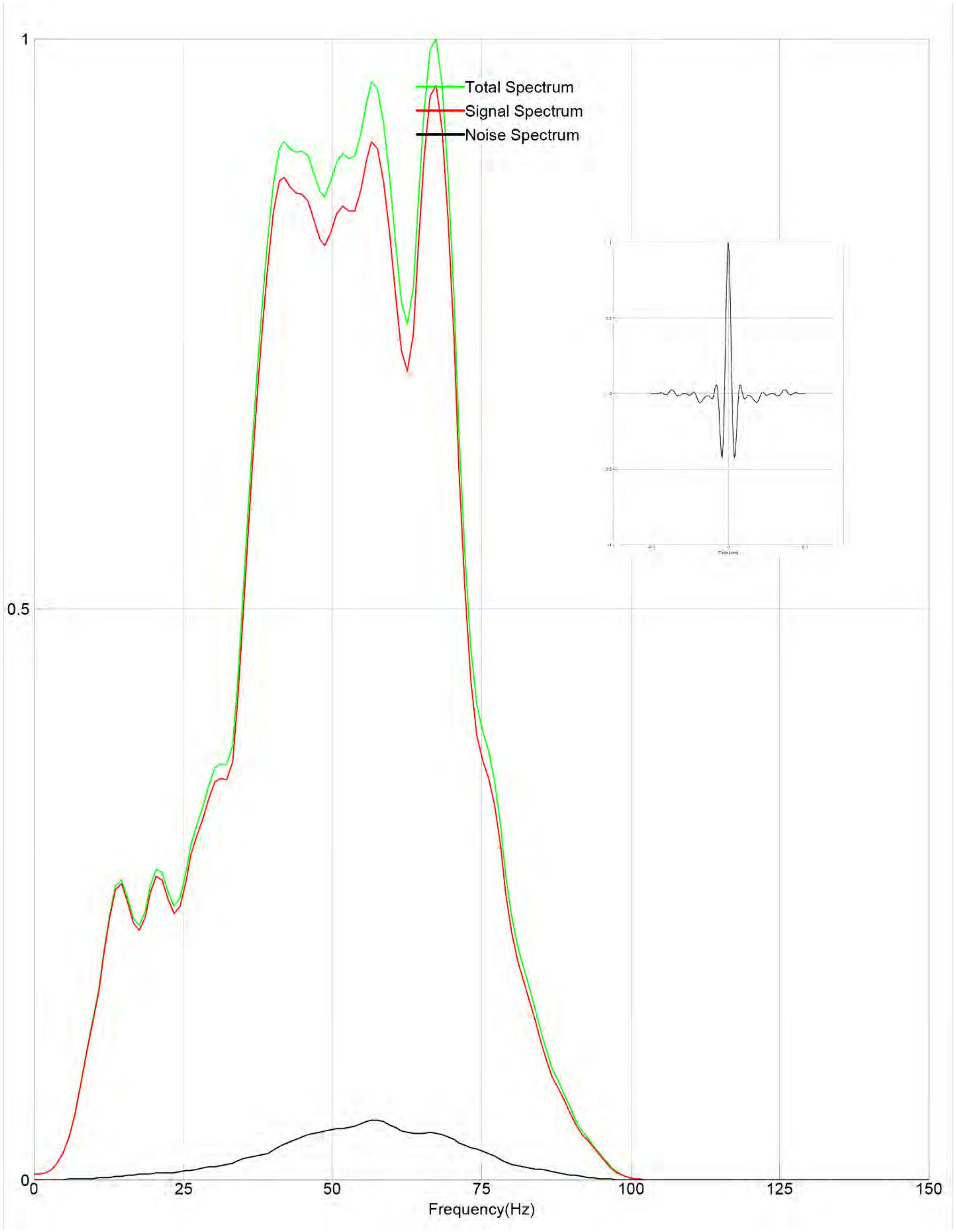


Figure 1. Extracted wavelet and power spectrum at the proposed Well "G".

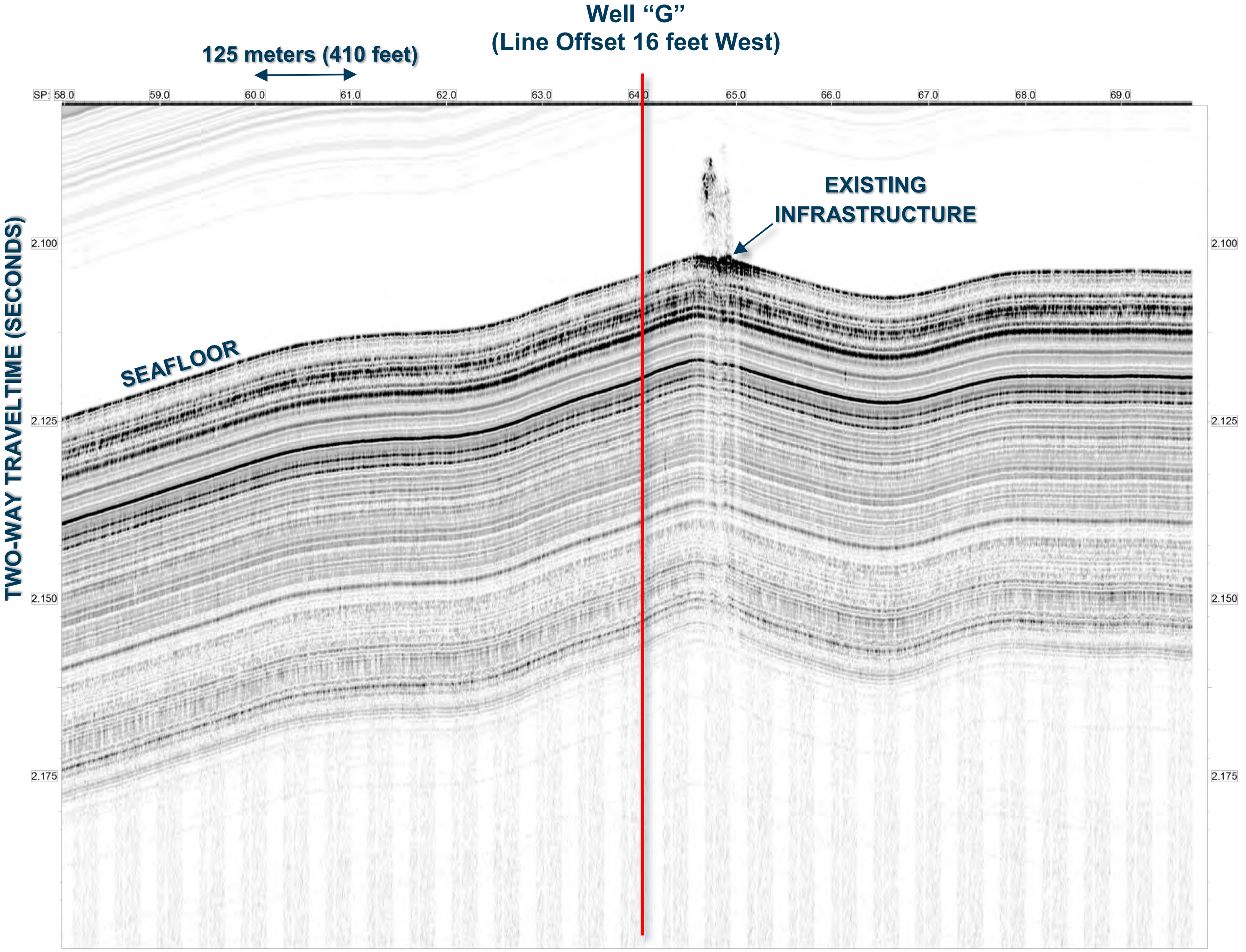


Figure 2. AUV Subbottom profiler data through the proposed Well “G” (Line 108)

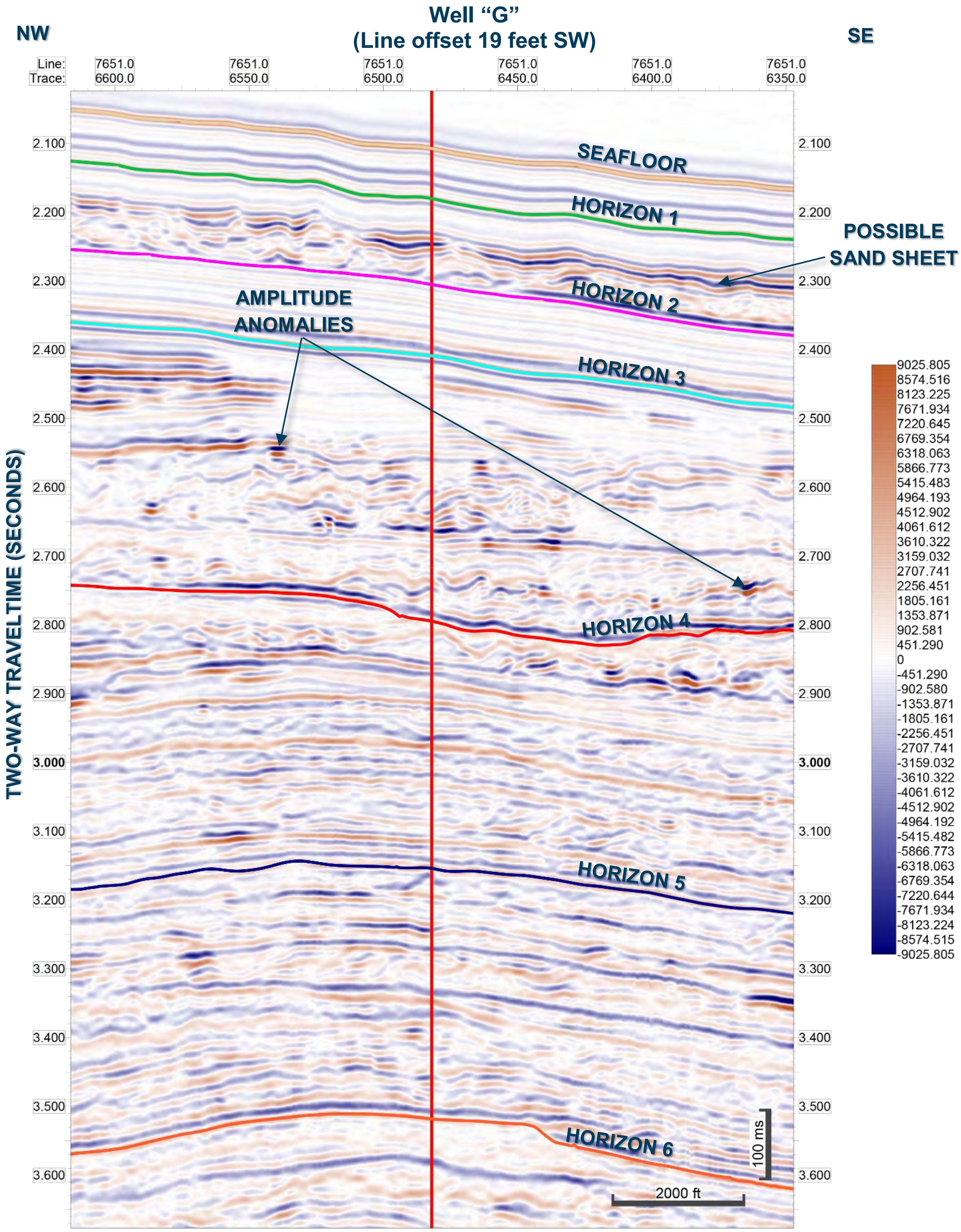


Figure 3. 3D seismic inline 7651 through the proposed Well "G"

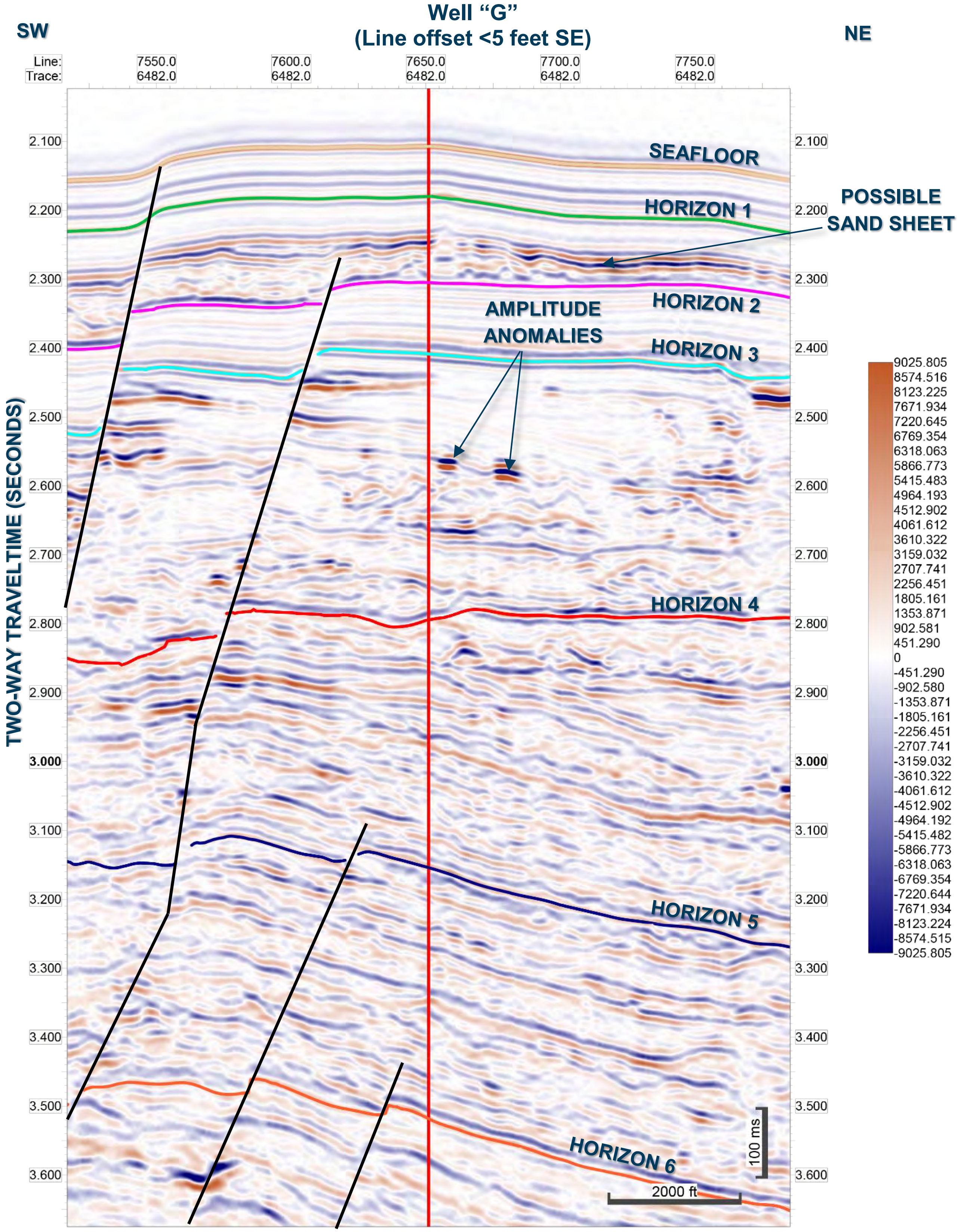
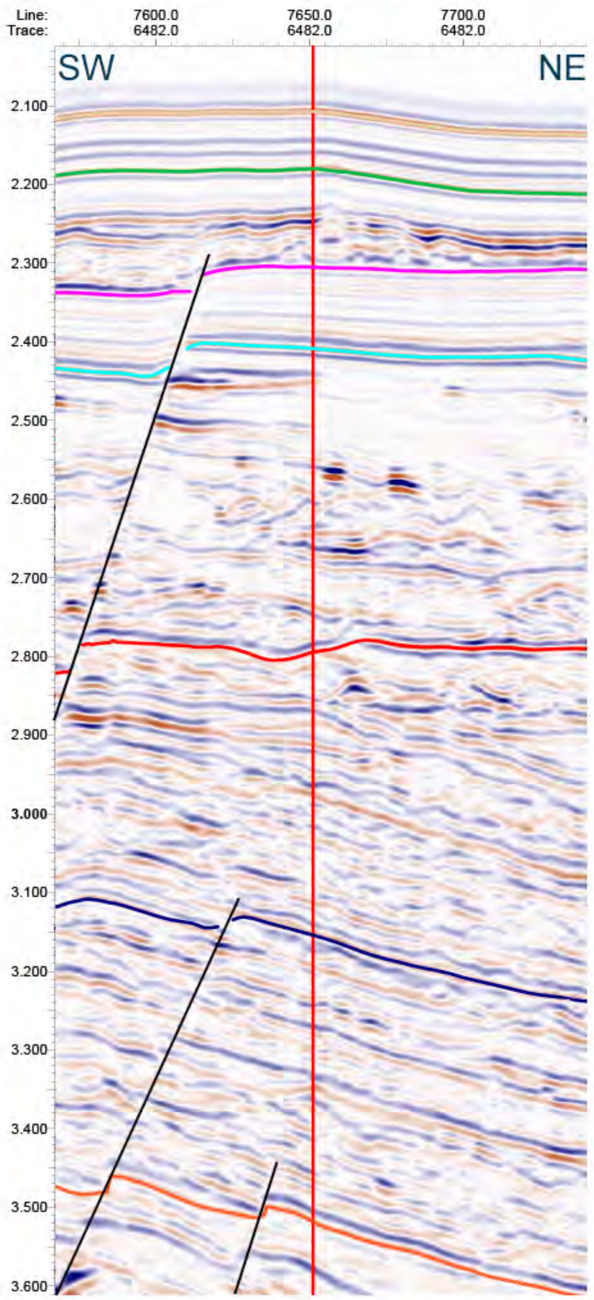


Figure 4. 3D seismic crossline 6482 through the proposed Well "G"

Proposed Well "G" Location
MC85 (OCS-G-08797)
X: 1,331,450.00' Y: 10,496,100.00'
Crossline 6482 (offset <5 feet southeast)

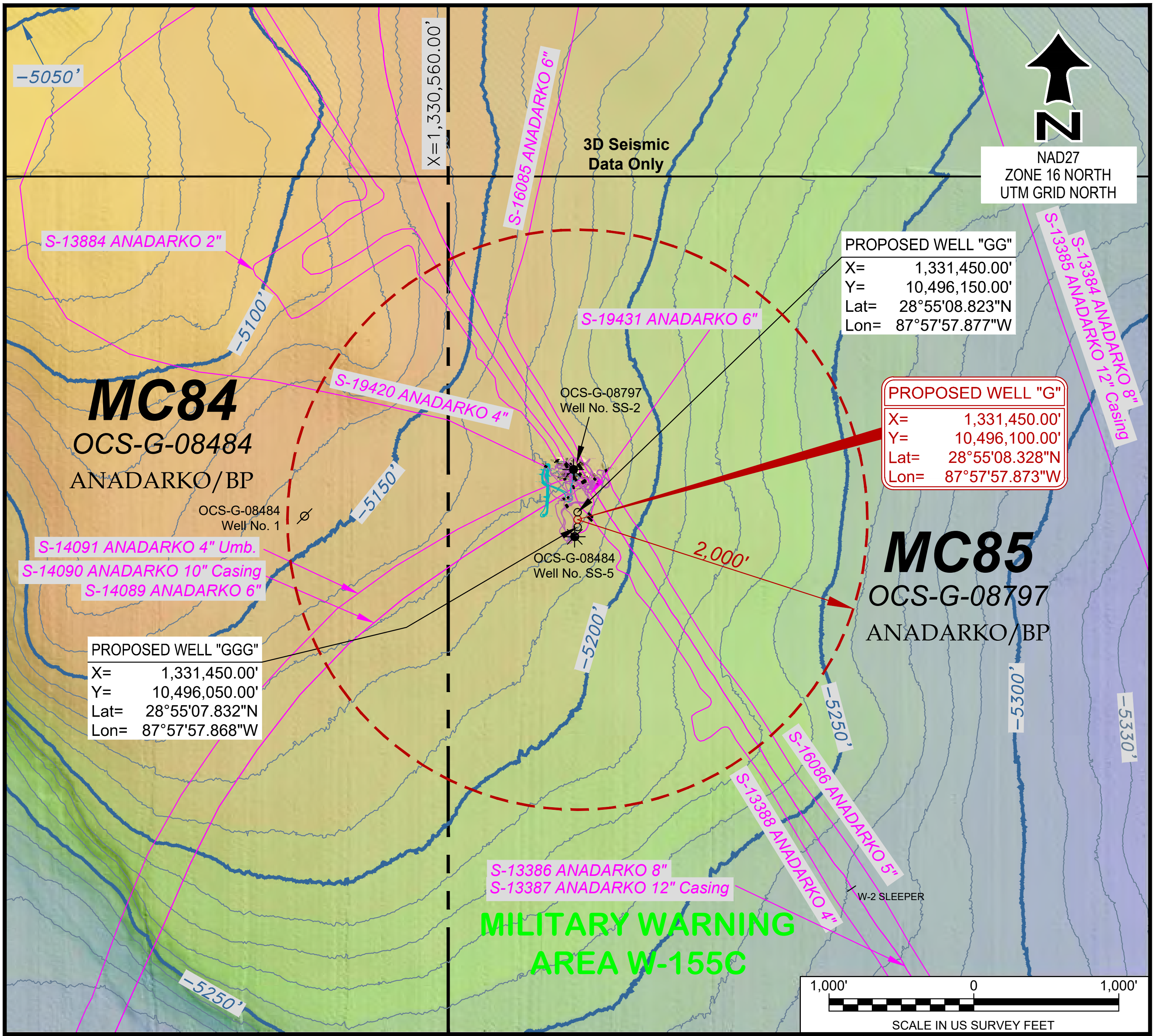


Note: Subsurface depths based on T-D equation
$D = 312.76T^2 + 1,651.4T$

Subsurface Sequence (Well Intersect)		Water Flow and Gas Potential		Depth BML (feet)	Depth MSL (feet)	TWT BSL (sec)	Interval Thickness (feet)	Lithology Description
Unit	Horizon	Gas	Water Flow					
	Seafloor				5,179	2.107		
A	Horizon 1	🟦	🟦	218	5,397	2.180	218	Drape deposit of hemipelagic clays.
B	Horizon 2	🟩	🟦	600	5,779	2.305	382	Upper unit consists of hemipelagic clays, while the base of the unit is mostly clay-prone mass transport deposits. The middle of the unit is a coarse-grained possible sand sheet.
C	Horizon 3	🟩	🟩	925	6,104	2.409	325	Fine-grained channel fill with some interbedded channel/overbank deposits.
D	Horizon 4	🟩 🟨 🟩	🟨 🟩	2,191	7,370	2.795	1,266	Clay-prone mass transport deposuits with interbedded sand channel fills. Poorly consolidated sand-prone sequences at the top of the unit are lying below a clay seal and may represent low to medium shallow water flow hazard. Medium amplitude reflectors with some phase reversal indicate a low to moderate risk of gas
E	Horizon 5	🟩	🟩	3,452	8,631	3.154	1,261	Interbedded clay-prone mass transport deposits and sandy channel fills.
F	Horizon 6	🟩	🟩	4,812	9,991	3.518	1,361	Interbedded clay-prone mass transport deposits and sandy channel fills.
	Depth of study							

Negligible: 🟦 Low: 🟩
Moderate: 🟨 High: 🟥

Figure 5. Top-Hole Prognosis Chart for the proposed Well "G".



✷ Seafloor surface location of existing well	⌀ Seafloor surface location of permanently abandoned well	— Existing pipeline, umbilical, or groundbed

Multibeam Processing Sequence

- Water column velocity and density corrections applied
- Tide corrections applied using Goddard Ocean Tide Model GOT99.2
- Bin size = 3 meters (9.84 feet)
- Median filter applied
- Produced gridded-binned dataset using weighted-neighbor algorithm
- Search radius = 9 meters (29.53 feet)
- Contour interval = 10 feet
- Zero datum = Mean Sea Level

Color shaded image

Sun azimuth = 45°
Sun elevation = 30°

Shallower — Deeper

Anadarko Petroleum Corporation

PROPOSED WELL "G"

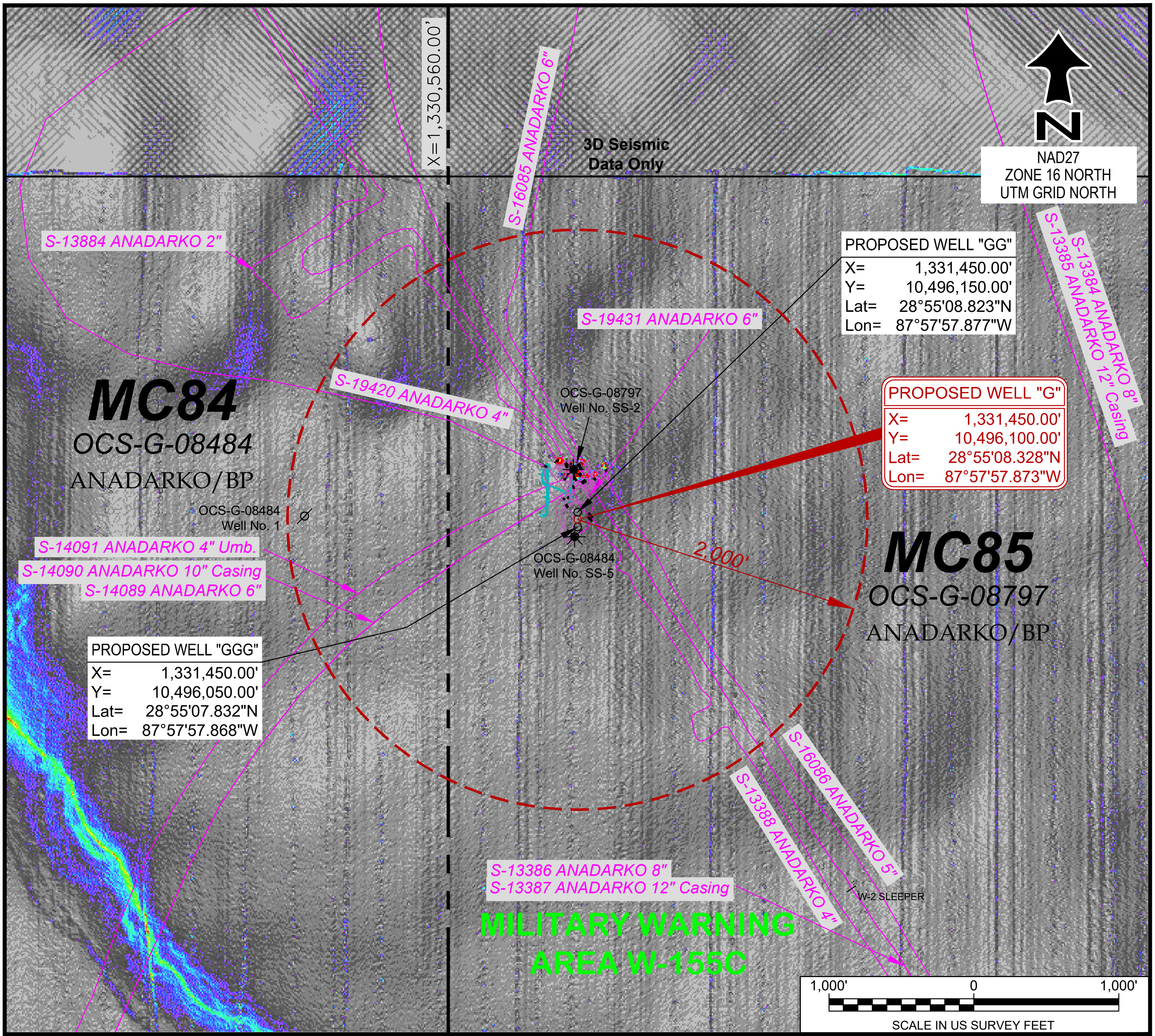
COLOR SHADED BATHYMETRY MAP

Block 85, Mississippi Canyon Area

PREPARED BY: OCEANEERING®

OCEANEERING INTERNATIONAL, INC.
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000

JOB: 198110	DRW: J. Guidry	DATE: MARCH 12, 2019	
CKD: D. Pierrottie	APP: C. Baker	SHEET 1 of 5	REV. 0
DOC: 198110-OII-DRW-CLR-001-01			

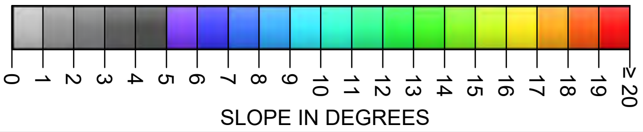


✷	Seafloor surface location of existing well	⌀	Seafloor surface location of permanently abandoned well	―	Existing pipeline, umbilical, or groundbed

Gradient is the first order derivative of the multibeam data.

Multibeam Processing Sequence

- Water column velocity and density corrections applied
- Tide corrections applied using Goddard Ocean Tide Model GOT99.2
- Bin size = 3 meters (9.84 feet)
- Search radius = 9 meters (29.53 feet)



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Petroleum Corporation

PROPOSED WELL "G"
SEAFLOOR GRADIENT MAP
Block 85, Mississippi Canyon Area

PREPARED BY:

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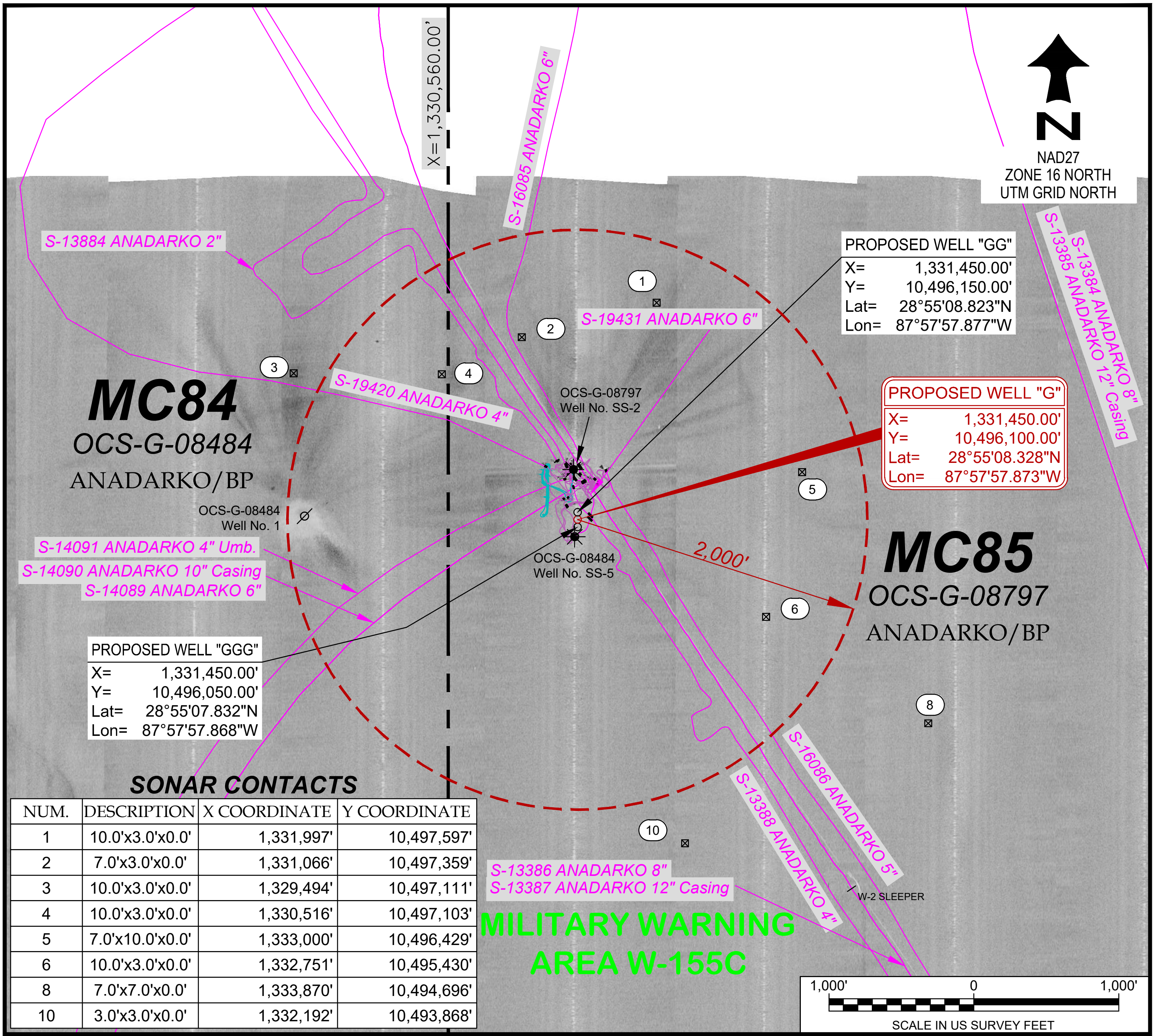
JOB: 198110	DRW: J. Guidry	DATE: MARCH 12, 2019	
CKD: D. Pierrottie	APP: C. Baker	SHEET 2 of 5	REV. 0
DOC: 198110-OII-DRW-CLR-001-02			



PROPOSED WELL "GG"
X= 1,331,450.00'
Y= 10,496,150.00'
Lat= 28°55'08.823"N
Lon= 87°57'57.877"W

PROPOSED WELL "G"
X= 1,331,450.00'
Y= 10,496,100.00'
Lat= 28°55'08.328"N
Lon= 87°57'57.873"W

PROPOSED WELL "GGG"
X= 1,331,450.00'
Y= 10,496,050.00'
Lat= 28°55'07.832"N
Lon= 87°57'57.868"W

SONAR CONTACTS

NUM.	DESCRIPTION	X COORDINATE	Y COORDINATE
1	10.0'x3.0'x0.0'	1,331,997'	10,497,597'
2	7.0'x3.0'x0.0'	1,331,066'	10,497,359'
3	10.0'x3.0'x0.0'	1,329,494'	10,497,111'
4	10.0'x3.0'x0.0'	1,330,516'	10,497,103'
5	7.0'x10.0'x0.0'	1,333,000'	10,496,429'
6	10.0'x3.0'x0.0'	1,332,751'	10,495,430'
8	7.0'x7.0'x0.0'	1,333,870'	10,494,696'
10	3.0'x3.0'x0.0'	1,332,192'	10,493,868'

✷ Seafloor surface location of existing well	⌀ Seafloor surface location of permanently abandoned well	─ Existing pipeline, umbilical, or groundbed	⊠ ⑩ Sonar contact & reference number (Job # 072372)

SONAR MOSAIC

Dark returns represent higher seafloor reflectivity.

Anadarko Petroleum Corporation

PROPOSED WELL "G"
SIDE SCAN SONAR MOSAIC MAP
Block 85, Mississippi Canyon Area

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LAFAYETTE, LA 70508
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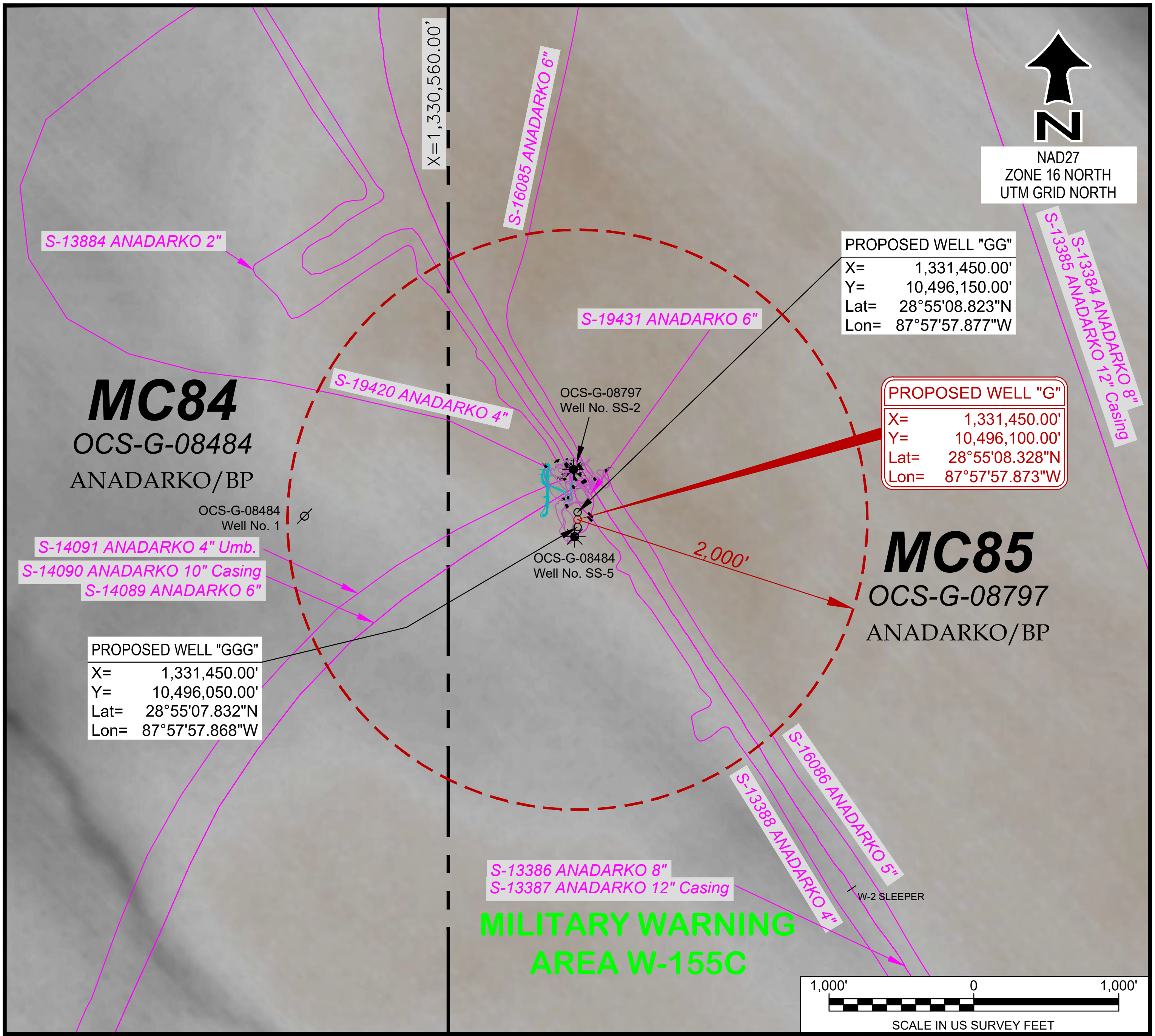
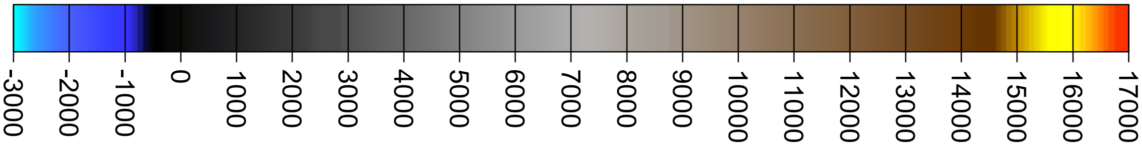
JOB: 198110	DRW: J. Guidry	DATE: MARCH 12, 2019
CKD: D. Pierrottie	APP: C. Baker	SHEET 3 of 5 — REV. 0
DOC: 198110-OII-DRW-CLR-001-03		



✷	Seafloor surface location of existing well	∅	Seafloor surface location of permanently abandoned well	—	Existing pipeline, umbilical, or groundbed



SEAFLOOR AMPLITUDE
3D SEISMIC

Anadarko
Petroleum Corporation

PROPOSED WELL "G"
SEAFLOOR AMPLITUDE MAP
Block 85, Mississippi Canyon Area

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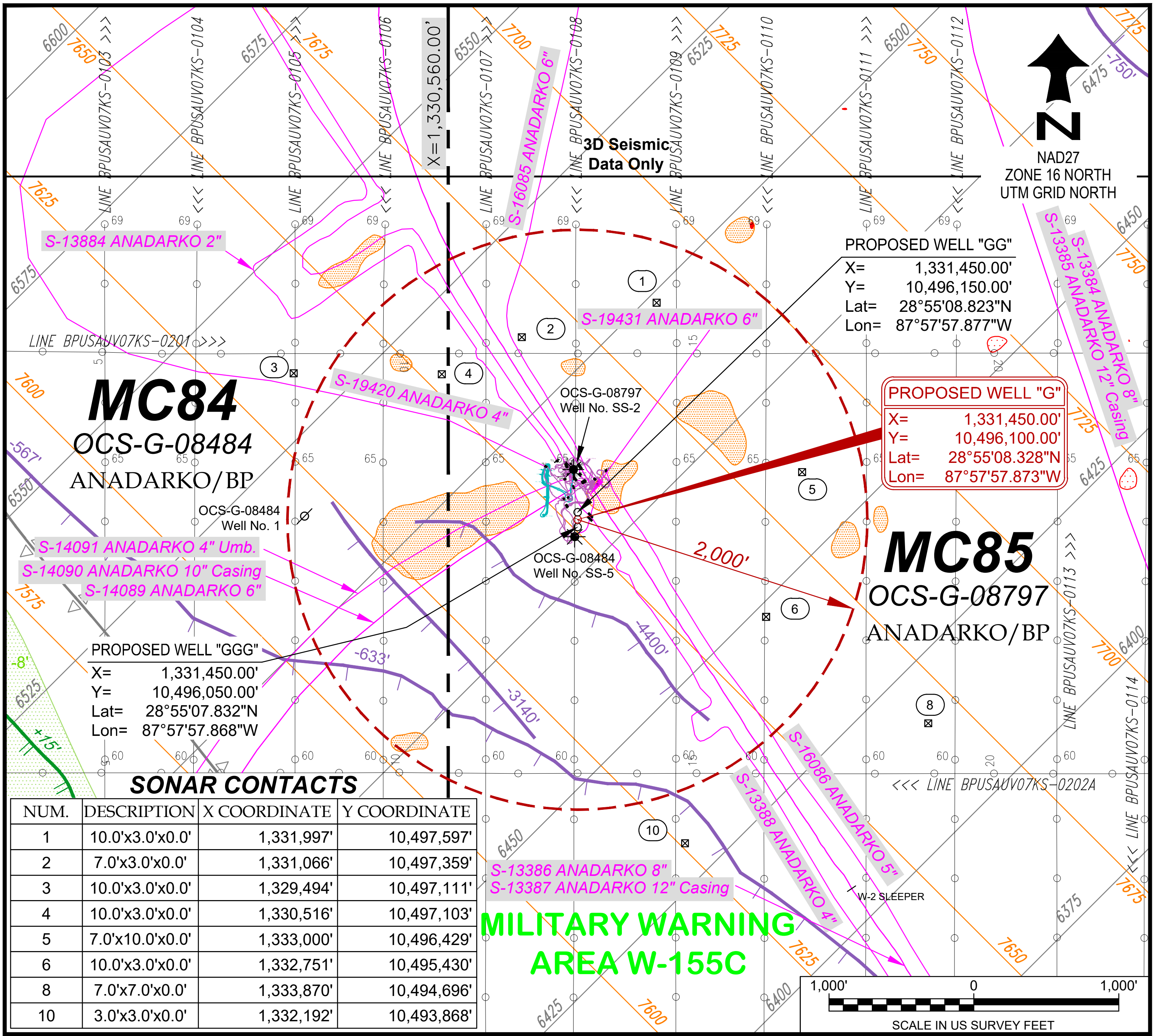
JOB: 198110	DRW: J. Guidry	DATE: MARCH 12, 2019	
CKD: D. Pierrottie	APP: C. Baker	SHEET 4 of 5	REV. 0
DOC: 198110-OII-DRW-CLR-001-04			



SONAR CONTACTS

NUM.	DESCRIPTION	X COORDINATE	Y COORDINATE
1	10.0'x3.0'x0.0'	1,331,997'	10,497,597'
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10	3.0'x3.0'x0.0'	1,332,192'	10,493,868'

✷	Seafloor surface location of existing well	⌀	Seafloor surface location of permanently abandoned well	—	Existing pipeline, umbilical, or groundbed	10 LINE BPUSAUV07KS-0101 >>>	AUV navigation trackline with name, direction run, fix, and fix number (Job # 072372)
7600	Inline and inline number for 3D seismic data - Sp = 312.5 meters (1025.25 feet)	6600	Crossline and crossline number for 3D seismic data - Spacing = 312.5 meters (1025.25 feet)	☒ 10	Sonar contact & reference number (Job # 072372)	-8'	Mass transport deposits with depth below seafloor
+15'	Normal scarp from 3D data wtih seafloor displacement (Hachures on downthrown side)		Normal ridge from 3D data	-4400'	Normal fault from 3D data with depth of burial (Hachures on downthrown side)		Unit B seismic amplitude anomaly 2,102 to 2,652 milliseconds (15 to 1,080 feet) below sea level
	Unit D seismic amplitude anomaly 2,329 to 3,152 milliseconds (539 to 2,934 feet) below sea level						

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Petroleum Corporation

PROPOSED WELL "G"
SEAFLOOR & SUBSURFACE FEATURES MAP
Block 85, Mississippi Canyon Area

PREPARED BY: **OCEANEERING**®

OCEANEERING INTERNATIONAL, INC.
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LAFAYETTE, LA 70508
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JOB: 198110	DRW: J. Guidry	DATE: MARCH 12, 2019	
CKD: D. Pierrottie	APP: C. Baker	SHEET 5 of 5	REV. 0
DOC: 198110-OII-DRW-CLR-001-05			

Anadarko
Petroleum Corporation

SITE CLEARANCE LETTER

PROPOSED WELL “H”
BLOCK 84, MISSISSIPPI CANYON AREA

OCEANEERING®

Oceaneering Document Number:	198110-OII-RPT-WCL-02	Survey Dates:	Sep 2007
Client Document Number:	N/A	Location:	MC84
Client:	Anadarko Petroleum Corporation	Vessel:	M/V *Moana Wave*

REVISION HISTORY

Rev	Reason For Issue	Author	Reviewed	Approved	Rev Date
A	Client Review	C Baker	S Comiskey	C Baker	8Mar2019
0	Client Review	C Baker	S Comiskey	C Baker	13Mar2019

Signature Box

Christopher Baker

Christopher Baker
Geohazards Specialist

Anadarko Petroleum Corporation
1201 Lake Robbins Drive
The Woodlands, TX 77380

ATTN: Jordan Dubuisson

Site Clearance Letter
Proposed Well “H”
Block 84 (OCS-G-08484), Mississippi Canyon Area

INTRODUCTION

Anadarko Petroleum Corporation (Anadarko) contracted Oceaneering International, Inc. (OII) to prepare a well site clearance letter for the proposed location of Well “H” in Block 84 (OCS-G-08484), Mississippi Canyon Area (MC), Gulf of Mexico. The data used for this site clearance letter include high-resolution geophysical data sets collected by OII’s *O-Surveyor III* Autonomous Underwater Vehicle (AUV) in 2007 and an exploration-quality 3D seismic data volume originally provided to OII by Freeport McMoRan (FMOG). OII completed the geohazard assessment report titled “*3D Seismic Shallow Geohazard Report, King Field, Blocks 84, 85, and 128, Mississippi Canyon Area*” in July 2013 and the archeological assessment report titled “*Archaeological Assessment, King Field, Blocks 84, 85, and 129, Mississippi Canyon Area*” in August 2013. This site clearance letter is based on findings provided within those reports.

This letter provides a top-hole drilling prognosis and addresses seafloor conditions within a 2,000-foot radius centered at the proposed Well “H” location. The depth limit of the investigation is approximately 2.0 seconds of two-way traveltime, approximately 5,000 feet below seafloor (BSF), or to the top of the salt/sediment interface. This letter complies with the Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE) guidelines provided in Notice to Lessees (NTL) No. 2008-G05 (Shallow Hazards Program), NTL No. 2005-G07 (Archaeological Resource Surveys and Reports), and NTL No. 2009-G40 (Deepwater Benthic Communities).

WELL LOCATION

The coordinates and calls for the proposed Well “H” surface location are tabulated below:

Table 1. Proposed Well “H” Surface Location

Well	Easting (feet)	Northing (feet)	Latitude	Longitude	Calls From MC84	
“H”	1,324,945.00	10,497,925.00	28° 55' 25.870” N	87° 59' 11.258” W	3,995′ FNL	5,615′ FEL

Two additional proposed well locations are also included within the 2,000-foot vicinity, and are listed as proposed wells “GG” and “GGG.” The locations and coordinates for those 2 wells are listed below.

Table 2. Proposed Well “HH” and “HHH” Surface Locations

Well	Easting (feet)	Northing (feet)	Latitude	Longitude	Calls From MC85	
“HH”	1,324,845.00	10,497,925.00	28° 55' 25.862” N	87° 59' 12.384” W	3,995′ FNL	5,715′ FEL
“HHH”	1,325,045.00	10,497,925.00	28° 55' 25.878” N	87° 59' 10.132” W	3,995′ FNL	5,515′ FEL

The geodetic datum used for this project is the North American Datum of 1927 (NAD27) with the Clarke 1866 Ellipsoid. The datum is projected using the Universal Transverse Mercator (UTM), Zone 16 North (16N) with a central meridian at 93° 00’W, a false easting of 1,640,416.67 feet at the central meridian, and a false northing of 0.00 feet at 00° 00’N. All coordinates given are presented in this projection within this letter and on the maps (Sheets 1 through 6). All grid units, as well as scales and measurements, are in U.S. Survey Feet.

The proposed Well “H” surface location and the 2,000-foot radius circle centered at the surface location are displayed on the Color Shaded Bathymetry Map (Sheet 1), Seafloor Gradient Map (Sheet 2), Side Scan Sonar Mosaic Map (Sheet 3), Seafloor Amplitude Map (Sheet 4), and Hazards Map (Sheet 5).

SURVEY METHODS

AUV Survey Data

OII’s *O-Surveyor III* AUV provided multibeam bathymetric mapping, high-resolution side scan sonar imagery, and subbottom profiles collected at an altitude of 40 meters above the seafloor. Geophysical instruments integrated into the *O-Surveyor III* AUV and used for the survey include a Kongsberg EM 2000 Multibeam Echosounder (200 kHz), EdgeTech DF4500 Full Spectrum Chirp Dual Frequency Side Scan Sonar (230 kHz), and EdgeTech DW106 Chirp Subbottom Profiler (1.5 – 4.5 kHz). All the raw digital data were logged utilizing OII’s proprietary software. The multibeam system delivered a 3-meter gridded dataset with relative vertical accuracies within 20 centimeters. The theoretical vertical resolution with the subbottom profiling system is estimated at 8 centimeters with upwards of 100 meters of subbottom being resolved in some areas.

The 2007 AUV survey grid consisted of north-south primary tracklines (Lines 112 – 119) and east-west tie lines (Lines 201 – 202). Primary tracklines were spaced at 200 meter (656 feet) intervals, while the tie lines were surveyed at 900 meter (2,953 foot) line spacing. Navigation fixes were annotated at 125-meter (410-foot) intervals along all survey lines. The survey grid provided overlapping side scan sonar and multibeam echosounder coverage and representative sampling with the subbottom profiler system.

3D Seismic Data

The exploration-quality 3D seismic data used for this site clearance assessment were provided in SEG-Y format and loaded into IHS’ Kingdom Suite 2D/3DPak for interpretation. The amplitude traces were processed at a 2-millisecond sample rate and was interpreted to 2 seconds BSF or to the top of the salt/sediment interface. The 3D data volume inlines run northwest-southeast while the crosslines run southwest-northeast. The inlines and crosslines are spaced at 41.01 foot (12.5 meter) intervals.

The 3D seismic data are zero phase, and the seafloor reflector is represented by a strong, positive amplitude peak flanked by troughs with absolute amplitude values of less than one-half of the peak value. The seismic data provided adequate screening of the regional seafloor and shallow geologic conditions and large-scale geohazards, such as but not including or limited to, faults, salt, high acoustic impedance, and stratigraphic horizons. Figure 1 consists of a wavelet and an amplitude spectrum showing the frequency content versus the amplitudes of the data collected at the proposed well site.

BATHYMETRY AND SEAFLOOR GRADIENTS

The water depth at the proposed location of Well “H” is 5,093 feet below mean sea level (MSL). Within the 2,000-foot radius, seafloor depths range from 5,028 feet MSL in the northeast to 5,251 feet MSL downslope in the southwest (Sheet 1). The proposed well is situated on a smooth, southwest deepening seafloor at a 2.5° average gradient.

Two fault scarps are located to the east and south of the proposed well and exhibit gradients of up to 16° along the scarp walls.

SEAFLOOR SEDIMENTS AND HAZARDS

Side scan imagery within the 2,000-foot radius exhibit primarily low to moderate acoustic reflectivity (Sheet 3). The 3D seafloor amplitude image displays a range of low to moderate acoustic amplitudes and agrees well with the sonar images (Sheets 3 and 4). These low to moderate acoustic reflectivity and seafloor amplitudes indicate finely textured seabed sediments likely comprised of hemipelagic clay (very soft silty clay).

Two surface faults are located within the 2,000 foot radius of the proposed well. These faults are NW-SE trending faults downthrown to the west and southwest and exhibit seafloor offsets of 10 – 15 feet. Both faults are located greater than 1,100 feet from the well (Sheet 5).

POTENTIAL DEEPWATER BENTHIC COMMUNITIES

High-amplitude seismic seafloor anomalies are a potential indicator of carbonates and benthic community habitats. The review of 3D seismic and AUV data identified no high negative or positive amplitude anomalies associated with fluid expulsion or mounded carbonates representing potential high-density deepwater benthic habitats. The proposed well “H” location appears to be clear of potential deepwater benthic communities and the impacts on potential deepwater benthic communities is considered negligible.

MAN-MADE HAZARDS

A review of company and BOEM/BSEE databases indicates no existing infrastructure 2,000 feet of the proposed Well “H” location (Sheets 1 – 5).

The side scan sonar data revealed no unidentified sonar contacts within the 2,000-foot vicinity. Therefore, there are no sonar contacts recommended for avoidance based on archaeological potential.

SUBSURFACE GEOHAZARDS AND STRATIGRAPHY

OII’s AUV subbottom profiles provided high-resolution data of the upper 300 feet BSF. The profiles are characterized as continuous, well-defined bottom echoes with parallel stratified subsurface reflectors of varying amplitudes (Figure 2).

One NW-SE oriented buried fault is noted 1,830 feet northeast of the proposed well. This fault is buried 567 feet BSF and is downthrown to the southwest. The proposed bore path will intersect this buried fault at approximately 3,616 feet BSF (Figure 5).

3D seismic data were used to assess subsurface geology deeper than the AUV penetration. Six stratigraphic units (Units A to F), each consisting of one or more distinctive sequences, were interpreted within the study area to 2.0 seconds of two-way travel time below the seabed. A time-series for the sediment column was obtained at MC84 Well No. 1. The following polynomial equation was derived from the Total Vertical Depth (TVD) and the corresponding two-way traveltime (TWT) using the time-depth values to calculate depths below the sea level:

$$\mathbf{D = 312.76T^2 + 1{,}651.4T}$$

Where **D** = depth below seafloor in feet and **T** = two-way traveltime below seafloor in seconds.

Seven horizons mark the upper and/or lower contacts of each of the successive units. For each unit, interval amplitudes were examined by extracting the greatest positive amplitude values within envelopes from 10 milliseconds below the top of the unit to 10 milliseconds above the base the unit. High amplitude anomalies, commonly termed bright spots, are interpreted as potential fluid saturation regions usually associated with porous sands.

Unit A (Seafloor to Horizon 1)
Unit A consists predominantly of low to moderate amplitude, parallel, continuous reflectors that are 211 feet thick at the proposed Well "H" location. These reflection patterns are likely comprised of hemipelagic clay laid down as a drape deposit.

Unit B (Horizon 1 to Horizon 2)
Unit B consists of low to moderate amplitude, continuous reflectors overlying low to moderate semi-continuous to chaotic reflectors. The center of the unit is characterized by a moderate to high amplitude continuous reflector indicative of a possible sand sheet. The unit is 391 feet thick at the proposed well location. The reflection patterns at the top of Unit B are likely comprised of hemipelagic clay, laid down as a drape deposit, while the bottom of the unit is comprised of thick interbedded mud-prone mass movement deposits and sandy channel fill.

Unit C (Horizon 2 to Horizon 3)
Unit C consists of primarily low amplitude, continuous, parallel reflectors and is 329 feet thick at the proposed Well "H" location. Unit C is interpreted as mostly fine-grained channel fill with some interbedded channel/overbank deposits.

Unit D (Horizon 3 to Horizon 4)
Unit D consists of variable amplitude, semi-continuous to chaotic reflectors and is 1,234 feet thick at the proposed well location. These reflection patterns are interpreted as clay-prone mass transport deposits with interbedded sandy channel fill. High amplitude anomalies indicative of shallow gas were identified within Unit D located 300 feet north of the proposed well. The poorly consolidated sand-prone sequences near the top of the unit are lying below a potential clay seal and may represent a low to moderate shallow water flow hazard. This shallow water flow potential may be lower since the wells drilled in the immediate vicinity did not report any shallow water flow events.

Unit E (Horizon 4 to Horizon 5)
Unit E consists of low to moderate amplitude, sub-parallel to chaotic reflectors and is 1,451 feet thick at the proposed well location. The sediments in Unit E are interpreted as interbedded channel fills and clay-prone mass transport deposits. A small amplitude anomalies indicative of shallow gas was identified within Unit E 1,460 feet south-southwest of the proposed well.

Unit F (Horizon 5 to Horizon 6)
Unit F consists of low to moderate amplitude, sub-parallel to chaotic reflectors and is 1,418 feet thick at the proposed Well "H" location. The sediments within the unit are interpreted as mostly clay-prone mass transport deposits with interbedded channel fills. A buried fault intersects the proposed wellbore at the boundary between Horizons 5 and 6 at approximately 3,616 feet BSF.

SHALLOW GAS

Anomalies of very high amplitude are interpreted as potential regions of fluid/gas saturation usually associated with porous sands. The risk of shallow gas is interpreted based on seismic amplitude levels with geologic settings taken into account. The gas risk is assessed as being at one of the following levels:

- **Negligible:** No amplitude anomalies or other gas indicators present.
- **Low risk of gas:** Generally indicated by increased amplitude (2 – 3 times background level) and phase reversal. This may also include diffuse areas of gas blanking.
- **Moderate risk of gas:** Generally indicated by high amplitude (3 – 4 times background level) and phase reversal.
- **High risk of gas:** Generally indicated by the highest amplitudes (in excess of 4 times background level), phase reversal, and a combination of other attributes indicative of the presence of gas, particularly velocity pull-down and masking of underlying sediments. Stratigraphic and structural settings may also be taken into account.

Seismic amplitude anomalies are displayed on the Hazards Map (Sheet 5). Within the 2,000-foot radius, the risk of shallow gas for Unit A is considered negligible, while Units B, C, E, and F exhibit a low risk of gas. Unit D exhibits a low to moderate risk of gas (Figure 5).

SHALLOW WATER FLOW

Sands with shallow water flow (SWF) potential often lie below a seal that prevents dewatering and compaction after deposition and form in unconsolidated and overpressured sands. The pressure rises with overburden causing a potentially hazardous condition for drilling operations. Some SWF intervals have proven difficult or impossible to detect on seismic profiles. Several factors may contribute to shallow water flows, including high porosity and permeability, sand-prone aquifer, mechanism to pressurize, and seal. Additional details are described below:

- **Water depth and depth of burial:** Significant water depths (> 500 feet below sea level) are required for the overpressure to occur. The seal must be deeply buried (> 500 feet below the seafloor) to become sufficiently strong.
- **High deposition rates:** Sedimentation rate needs to be greater than 1,500 feet/myr to effectively seal in sands. Sedimentation rates are expected to be high within a salt withdrawal basin. Rapid burial leads to pressure disequilibrium. In addition, if these sediment 'packets' were formed through a sequence of turbidites or gravity flow, there is an increased likelihood of water saturation and overpressure (pore pressure rapidly increased and sealed by an impervious layer).
- **Suitably porous sediments:** The sediment packets comprising the risk of shallow water flow are believed to contain clastic material and are thus porous.
- **Impermeable seal:** The overlying sediments are comprised of a clay facies.

According to the BOEM/BSEE, the nearest reported shallow water flow event was in DC177, approximately 10 miles southeast from the proposed well site and was categorized as a low severity flow. This SWF event is listed as occurring 1,915 feet BSF, which correlates within Unit D of this assessment.

The assessment of seismic profiles suggest the risk of SWF for Units A and B are negligible, while Units C, E, and F exhibit a low risk of SWF. Unit D exhibits a low risk with a moderate risk near the top of the unit. Due to the unpredictable nature of SWF, it is advised that caution be executed for any drilling operations through these sediments.

GAS HYDRATES

Gas hydrates are an ice crystalline form of gas hydrocarbons in deepwater marine environments where the conditions of pressure and temperature are favorable. The hydrate stability zone is the depth interval between the seafloor and the point where the hydrate is no longer stable in form. The thermal gradient of the seabed soils determines the depth of the hydrate stability zone base. The acoustic impedance contrast caused by the hydrate and free gas trapped at the base of the hydrate stability zone forms a bottom simulating reflector (BSR) on seismic profiles. Bottom simulating reflectors often cross cut the normal seismic stratigraphy, much like a bottom multiple.

The areas where seafloor gas hydrates accumulate in the near-surface sediments of the Gulf of Mexico are generally unfavorable sites for drilling operations. Irregular seafloor topography, gas seeps, gas chimneys, seafloor hydrates and benthic communities may all be found in close association. There was no indication of gas hydrates, associated geologic feature, or any obvious BSRs near the proposed well.

CONCLUSIONS

The seafloor at the proposed Well “H” location is at a depth of 5,093 feet MSL and slopes southwest on a smooth seafloor at a gradient of 2.5°.

Two NW-SE trending surface faults are located within the 2,000 foot radius of the proposed well. These faults are downthrown to the west and southwest and exhibit seafloor offsets of 10 – 15 feet. Both faults are located greater than 1,100 feet from the well.

The review of 3D seismic and AUV data identified no seafloor high negative or positive amplitude anomalies associated with fluid expulsion or mounded carbonates representing potential high-density deepwater benthic habitats.

One NW-SE oriented buried fault is noted 1,830 feet northeast of the proposed well. This fault is buried 567 feet BSF and is downthrown to the southwest. The proposed bore path will intersect this buried fault at approximately 3,616 feet BSF.

There is no existing infrastructure within 2,000 feet of the proposed Well “H” location. The side scan sonar data revealed no unidentified sonar contacts within the 2,000-foot vicinity. Therefore, there are no sonar contacts recommended for avoidance based on archaeological potential.

The risk of shallow gas for Unit A is considered negligible, while Units B, C, E, and F exhibit a low risk of gas. Unit D exhibits a low to moderate risk of gas.

The risk of SWF for Units A and B are negligible, while Units C, E, and F exhibit a low risk of SWF. Unit D exhibits a low risk with a moderate risk near the top of the unit. Due to the unpredictable nature of SWF, it is advised that caution be executed for any drilling operations through these sediments.

There was no indication of gas hydrates, associated geologic features, or any obvious BSRs at the proposed drill center.

Oceaneering appreciates this opportunity to be of service. Please contact us if you have any questions concerning this assessment.

Sincerely,

Christopher Baker

Christopher Baker
Geohazards Specialist

Enclosures

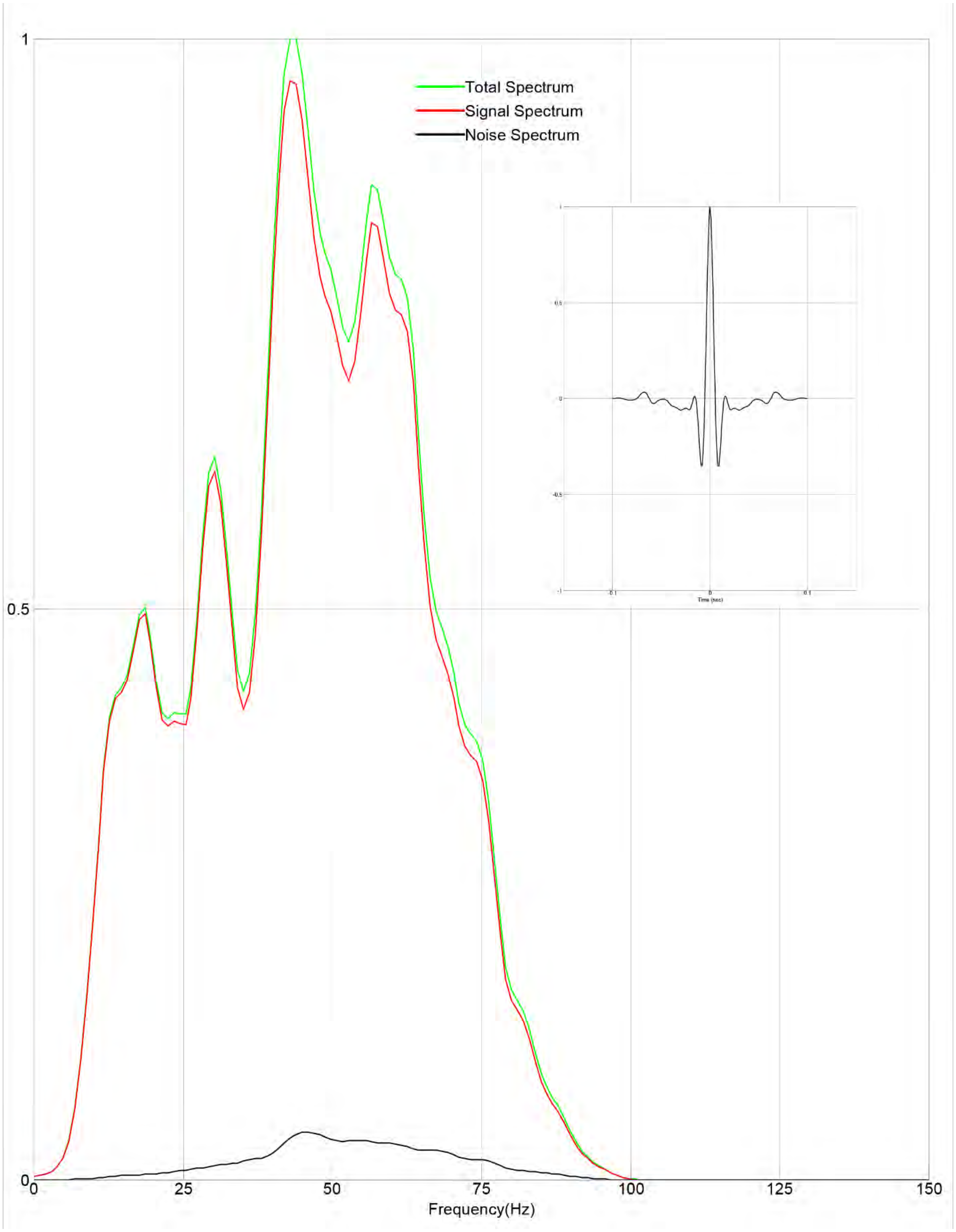


Figure 1. Extracted wavelet and power spectrum at the proposed Well “H”.

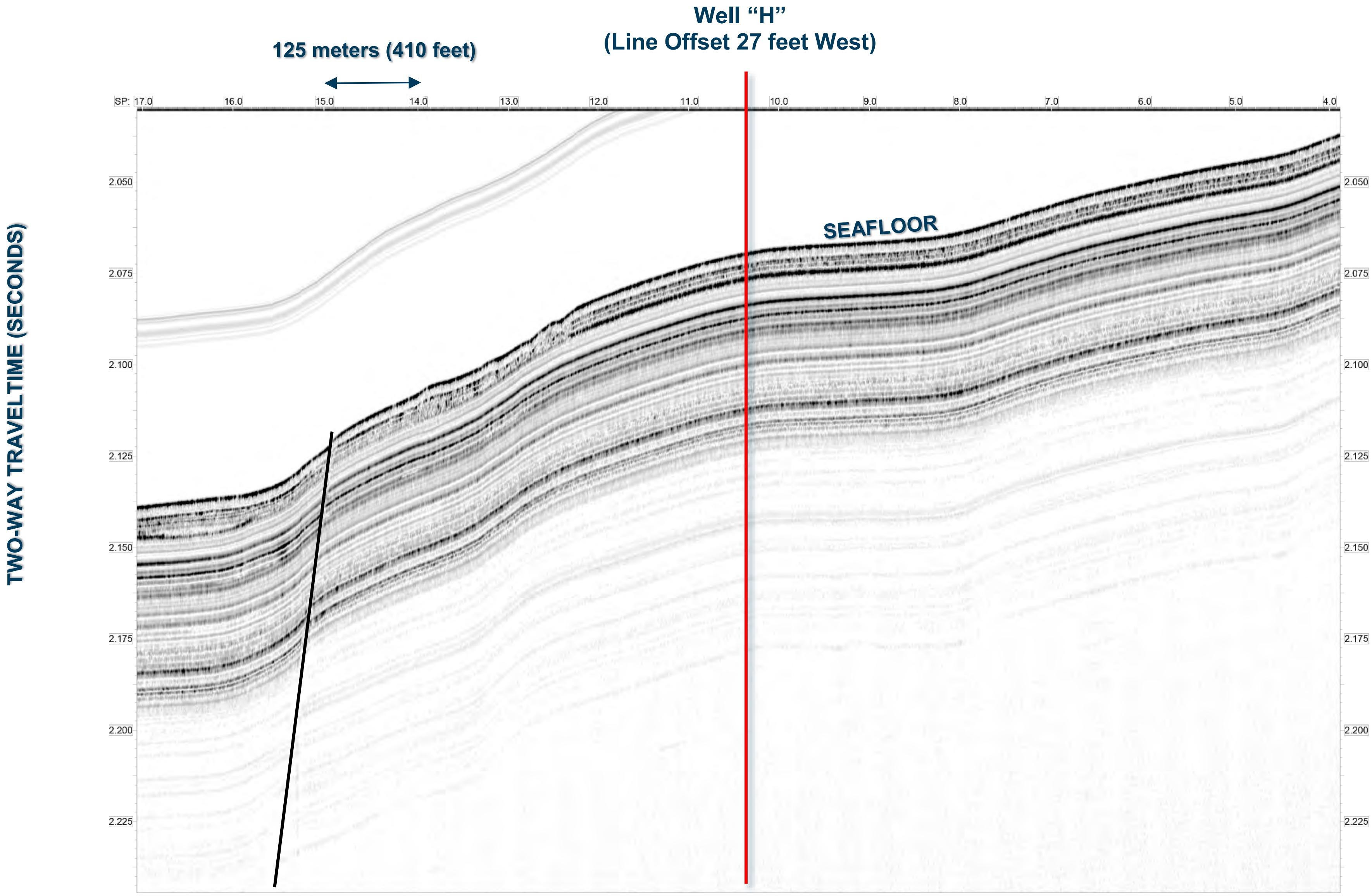


Figure 2. AUV Subbottom profiler data through the proposed Well “H” (Line 117)

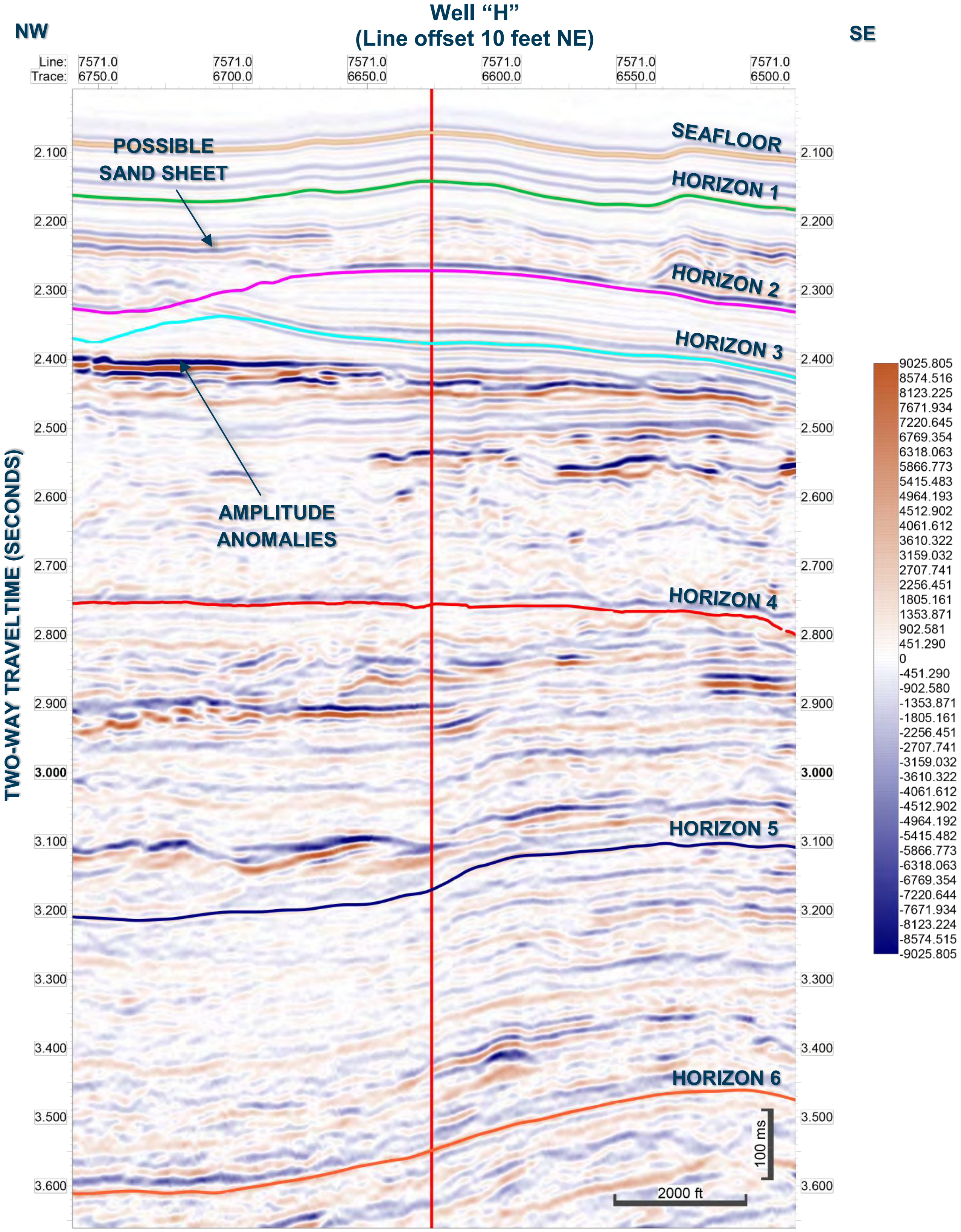


Figure 3. 3D seismic inline 7571 through the proposed Well “H”

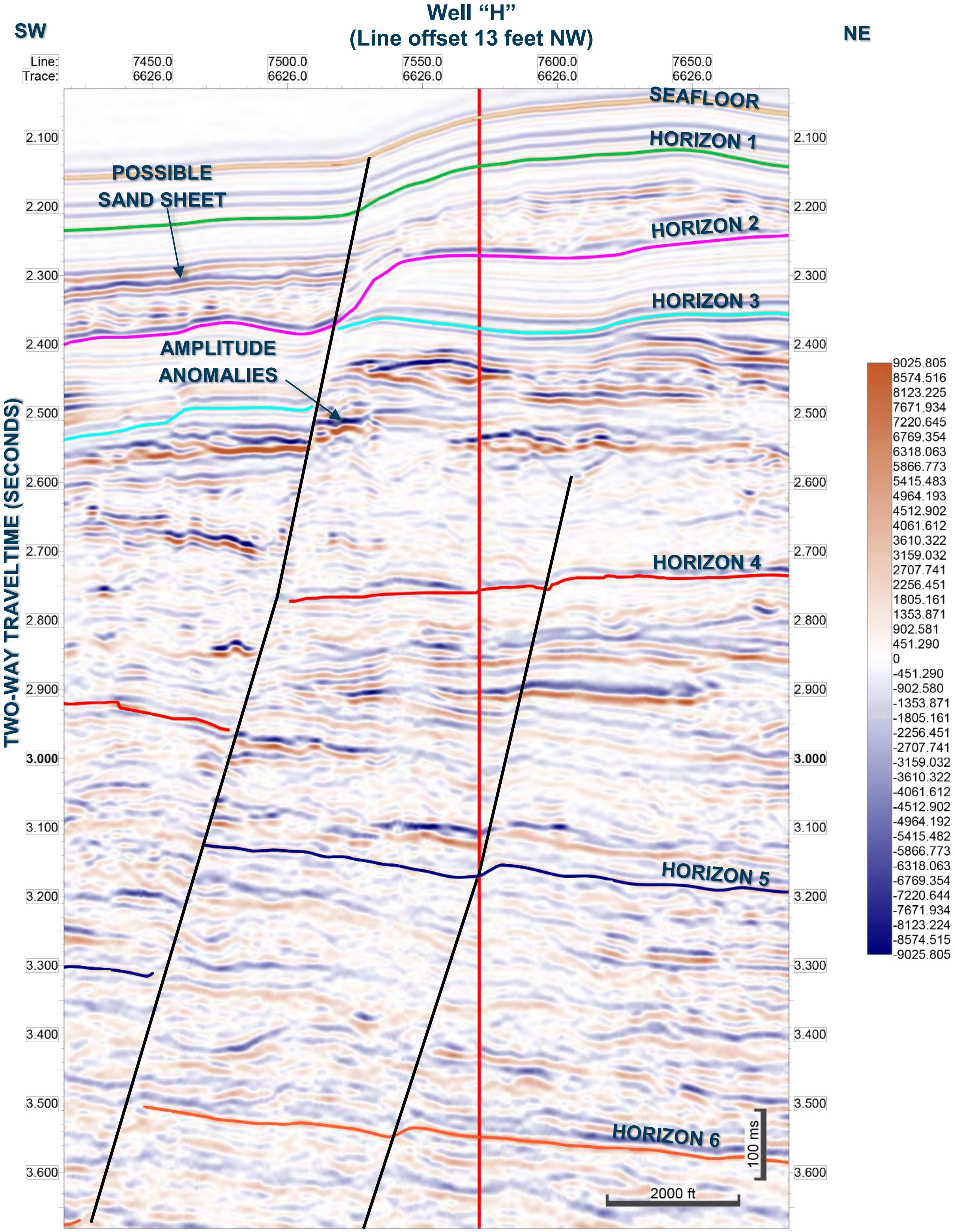
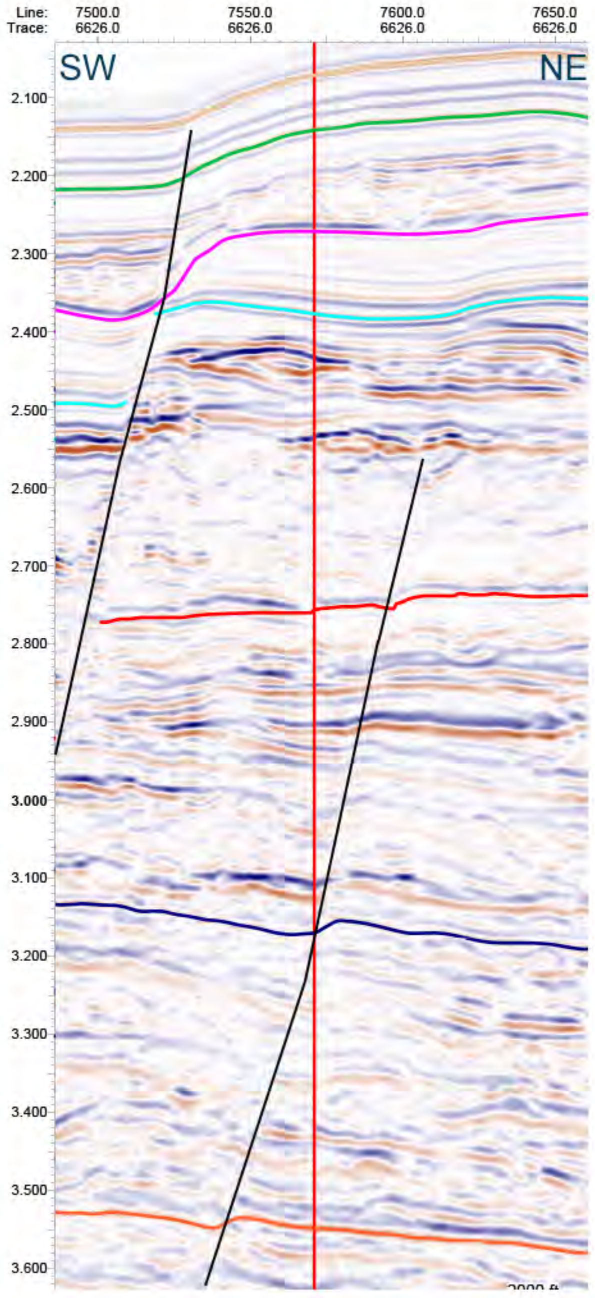


Figure 4. 3D seismic crossline 6626 through the proposed Well “H”

Proposed Well "H" Location
MC84 (OCS-G-08484)
X: 1,324,945.00' Y: 10,497,925.00'
Crossline 6626 (offset 10 feet northeast)

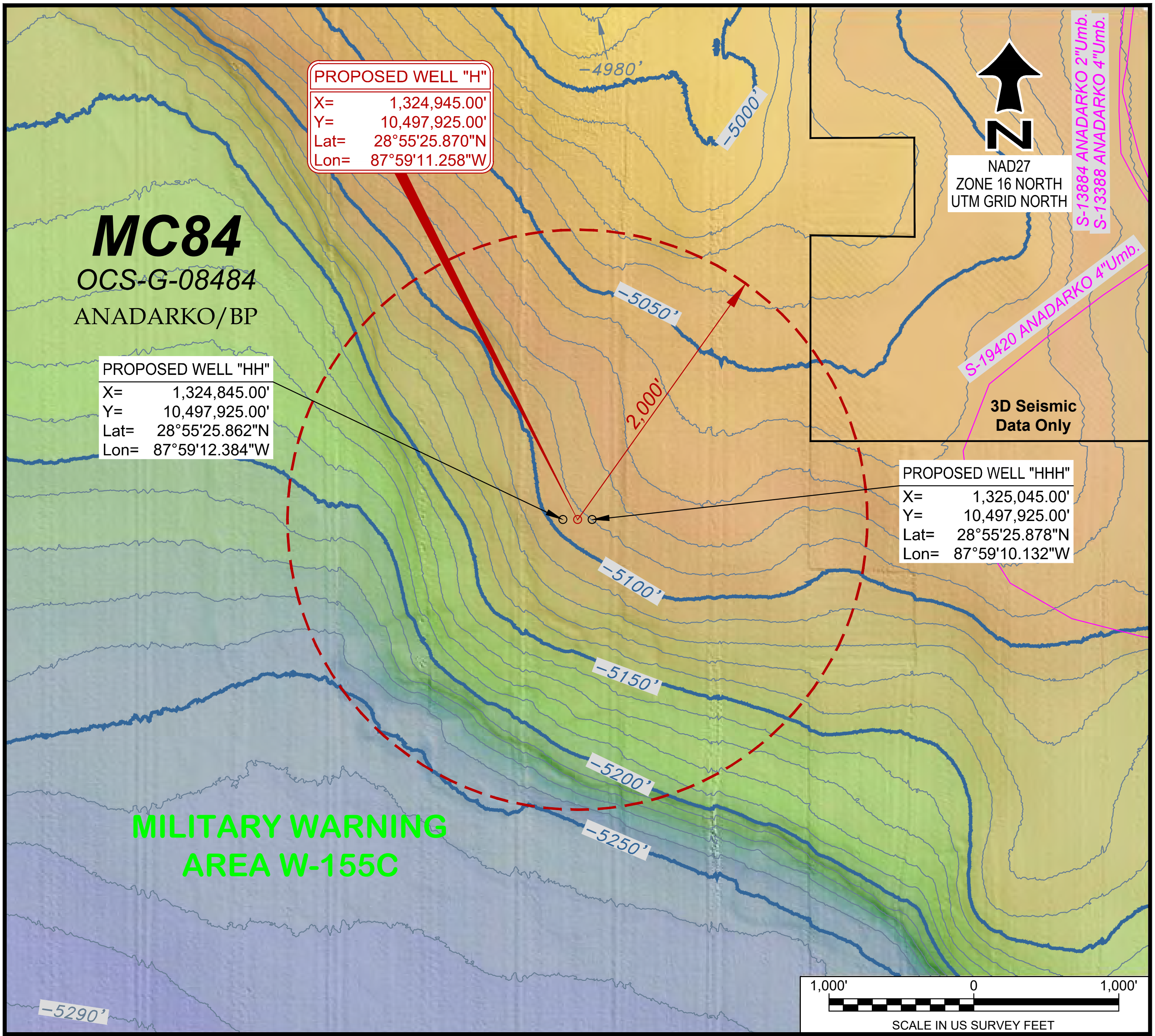


Note: Subsurface depths based on T-D equation
$D = 312.76T^2 + 1,651.4T$

Subsurface Sequence (Well Intersect)		Water Flow and Gas Potential		Depth BML (feet)	Depth MSL (feet)	TWT BSL (sec)	Interval Thickness (feet)	Lithology Description
Unit	Horizon	Gas	Water Flow					
	Seafloor				5,093	2.071		
A	Horizon 1	◼	◼	211	5,304	2.142	211	Drape deposit of hemipelagic clays.
B	Horizon 2	🟩	◼	602	5,695	2.271	391	Upper unit consists of hemipelagic clays, while the base of the unit is mostly clay-prone mass transport deposits. The middle of the unit is a coarse-grained possible sand sheet.
C	Horizon 3	🟩	🟩	931	6,025	2.377	329	Fine-grained channel fill with some interbedded channel/overbank deposits.
D	Horizon 4	🟩 🟨 🟩	🟨 🟩	2,165	7,259	2.756	1,234	Clay-prone mass transport deposuits with interbedded sand channel fills. Poorly consolidated sand-prone sequences at the top of the unit are lying below a clay seal and may represent low to medium shallow water flow hazard. Medium amplitude reflectors with some phase reversal indicate a low to moderate risk of gas.
E	Horizon 5	🟩	🟩	3,616	8,710	3.170	1,451	Interbedded clay-prone mass transport deposits and sandy channel fills.
F	Fault Horizon 6	🟩	🟩	5,035	10,128	3.548	1,418	Interbedded clay-prone mass transport deposits and sandy channel fills. A buried fault intersects the proposed wellbore at 3,616 feet BML.
	Depth of study							

Negligible: ◼ Low: 🟩
Moderate: 🟨 High: 🟥

Figure 5. Top-Hole Prognosis Chart for the proposed Well "H".



—	Existing pipeline, umbilical, or groundbed

Multibeam Processing Sequence

- Water column velocity and density corrections applied
- Tide corrections applied using Goddard Ocean Tide Model GOT99.2
- Bin size = 3 meters (9.84 feet)
- Median filter applied
- Produced gridded-binned dataset using weighted-neighbor algorithm
- Search radius = 9 meters (29.53 feet)
- Contour interval = 10 feet
- Zero datum = Mean Sea Level

Color shaded image

Sun azimuth = 45°

Sun elevation = 30°

Shallower Deeper

Anadarko Petroleum Corporation

PROPOSED WELL "H"

COLOR SHADED BATHYMETRY MAP

Block 84, Mississippi Canyon Area

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LAFAYETTE, LA 70508
(337) 210-0000

JOB: 198110	DRW: J. Guidry	DATE: MARCH 12, 2019	
CKD: D. Pierrottie	APP: C. Baker	SHEET 1 of 5	REV. 0
DOC: 198110-OII-DRW-CLR-002-01			

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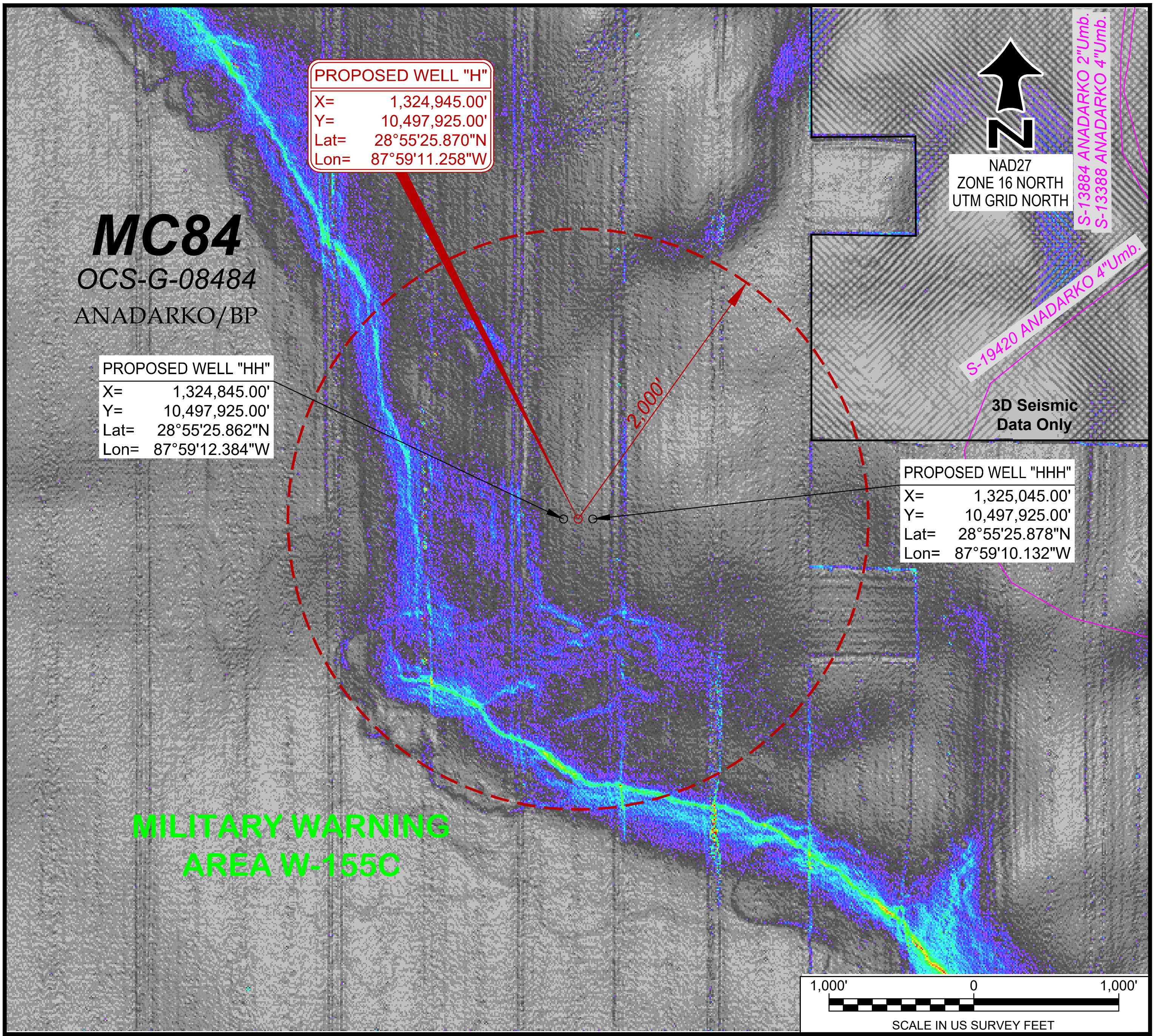


PROPOSED WELL "H"

X=	1,324,945.00'
Y=	10,497,925.00'
Lat=	28°55'25.870"N
Lon=	87°59'11.258"W

PROPOSED WELL "HH"

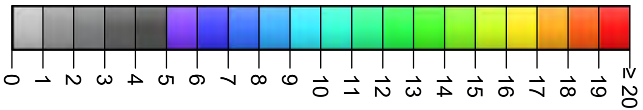
X=	1,324,845.00'
Y=	10,497,925.00'
Lat=	28°55'25.862"N
Lon=	87°59'12.384"W

PROPOSED WELL "HHH"

X=	1,325,045.00'
Y=	10,497,925.00'
Lat=	28°55'25.878"N
Lon=	87°59'10.132"W

Existing pipeline, umbilical, or groundbed

Gradient is the first order derivative of the multibeam data.



SLOPE IN DEGREES

Multibeam Processing Sequence

- Water column velocity and density corrections applied
- Tide corrections applied using Goddard Ocean Tide Model GOT99.2
- Bin size = 3 meters (9.84 feet)
- Search radius = 9 meters (29.53 feet)

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PROPOSED WELL "H"
SEAFLOOR GRADIENT MAP
Block 84, Mississippi Canyon Area

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JOB: 198110	DRW: J. Guidry	DATE: MARCH 12, 2019	
CKD: D. Pierrottie	APP: C. Baker	SHEET 2 of 5	REV. 0
DOC: 198110-OII-DRW-CLR-002-02			

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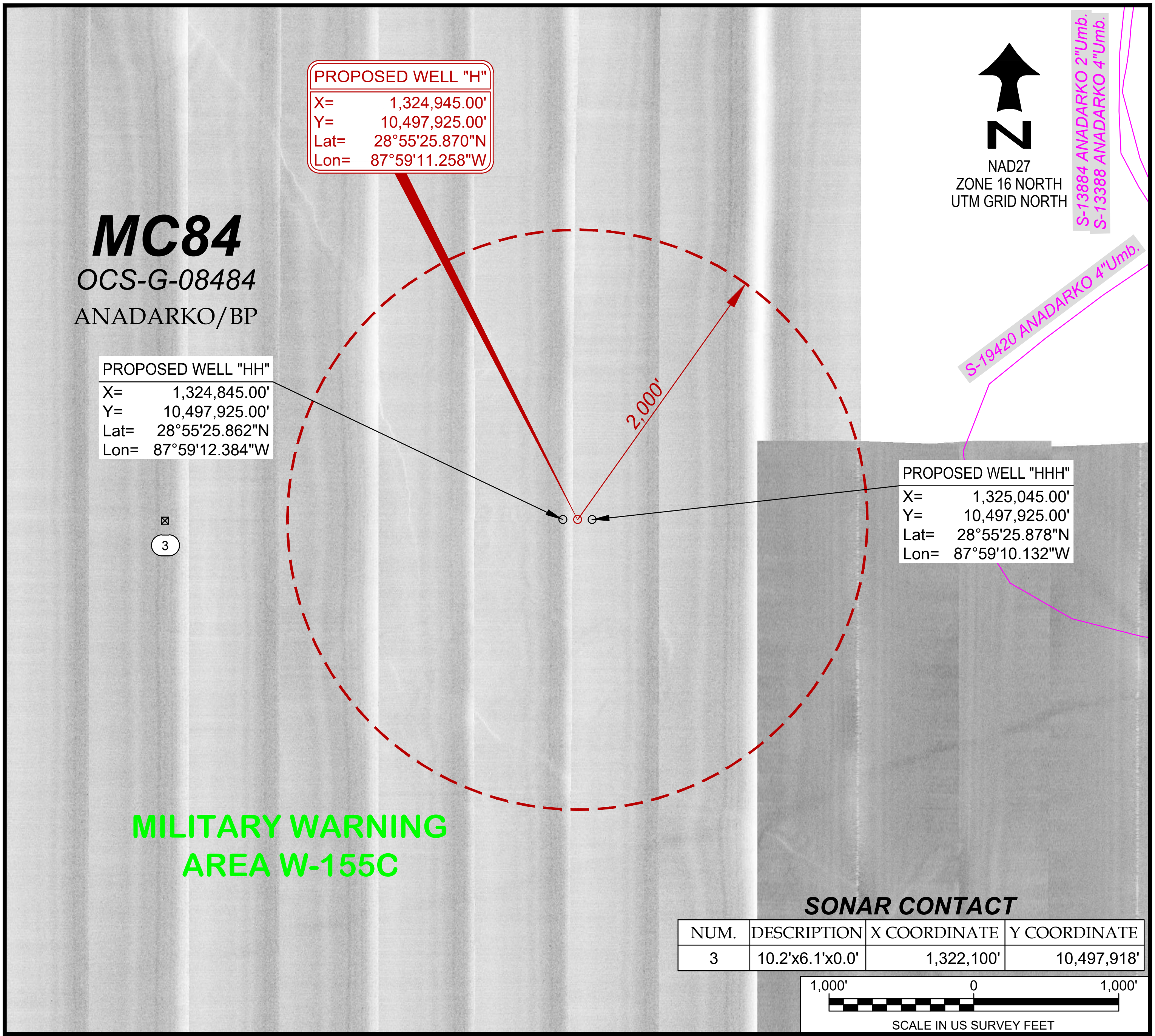

SONAR CONTACT

NUM.	DESCRIPTION	X COORDINATE	Y COORDINATE
3	10.2'x6.1'x0.0'	1,322,100'	10,497,918'

― Existing pipeline, umbilical, or groundbed	⊠ ③ Sonar contact & reference number (Job # 130270)

SONAR MOSAIC

Dark returns represent higher seafloor reflectivity.

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PROPOSED WELL "H"

SIDE SCAN SONAR MOSAIC MAP

Block 84, Mississippi Canyon Area

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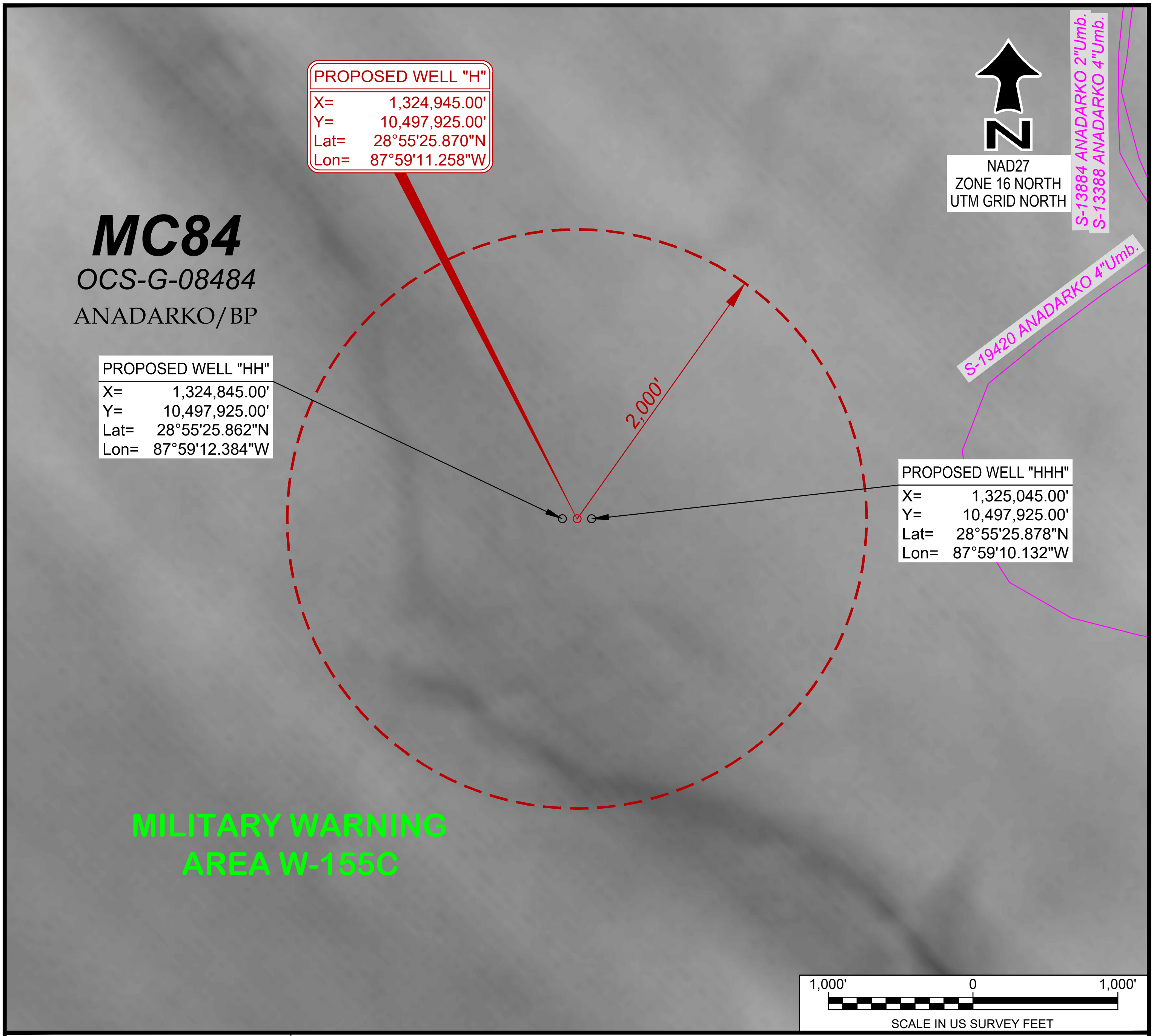
JOB: 198110	DRW: J. Guidry	DATE: MARCH 12, 2019
CKD: D. Pierrottie	APP: C. Baker	SHEET 3 of 5
DOC: 198110-OII-DRW-CLR-002-03		REV. 0

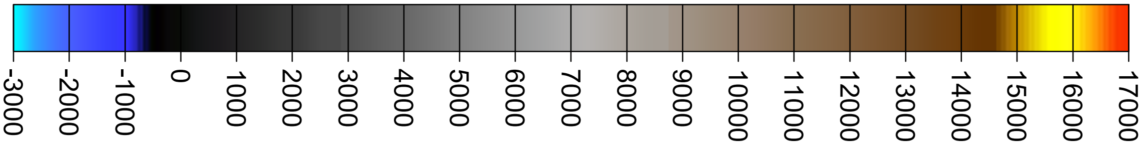


PROPOSED WELL "H"	
X=	1,324,945.00'
Y=	10,497,925.00'
Lat=	28°55'25.870"N
Lon=	87°59'11.258"W

PROPOSED WELL "HH"	
X=	1,324,845.00'
Y=	10,497,925.00'
Lat=	28°55'25.862"N
Lon=	87°59'12.384"W

PROPOSED WELL "HHH"	
X=	1,325,045.00'
Y=	10,497,925.00'
Lat=	28°55'25.878"N
Lon=	87°59'10.132"W

―	Existing pipeline, umbilical, or groundbed



SEAFLOOR AMPLITUDE
3D SEISMIC

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Petroleum Corporation

PROPOSED WELL "H"

SEAFLOOR AMPLITUDE MAP

Block 84, Mississippi Canyon Area

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JOB: 198110	DRW: J. Guidry	DATE: MARCH 12, 2019	
CKD: D. Pierrottie	APP: C. Baker	SHEET 4 of 5	REV. 0
DOC: 198110-OII-DRW-CLR-002-04			

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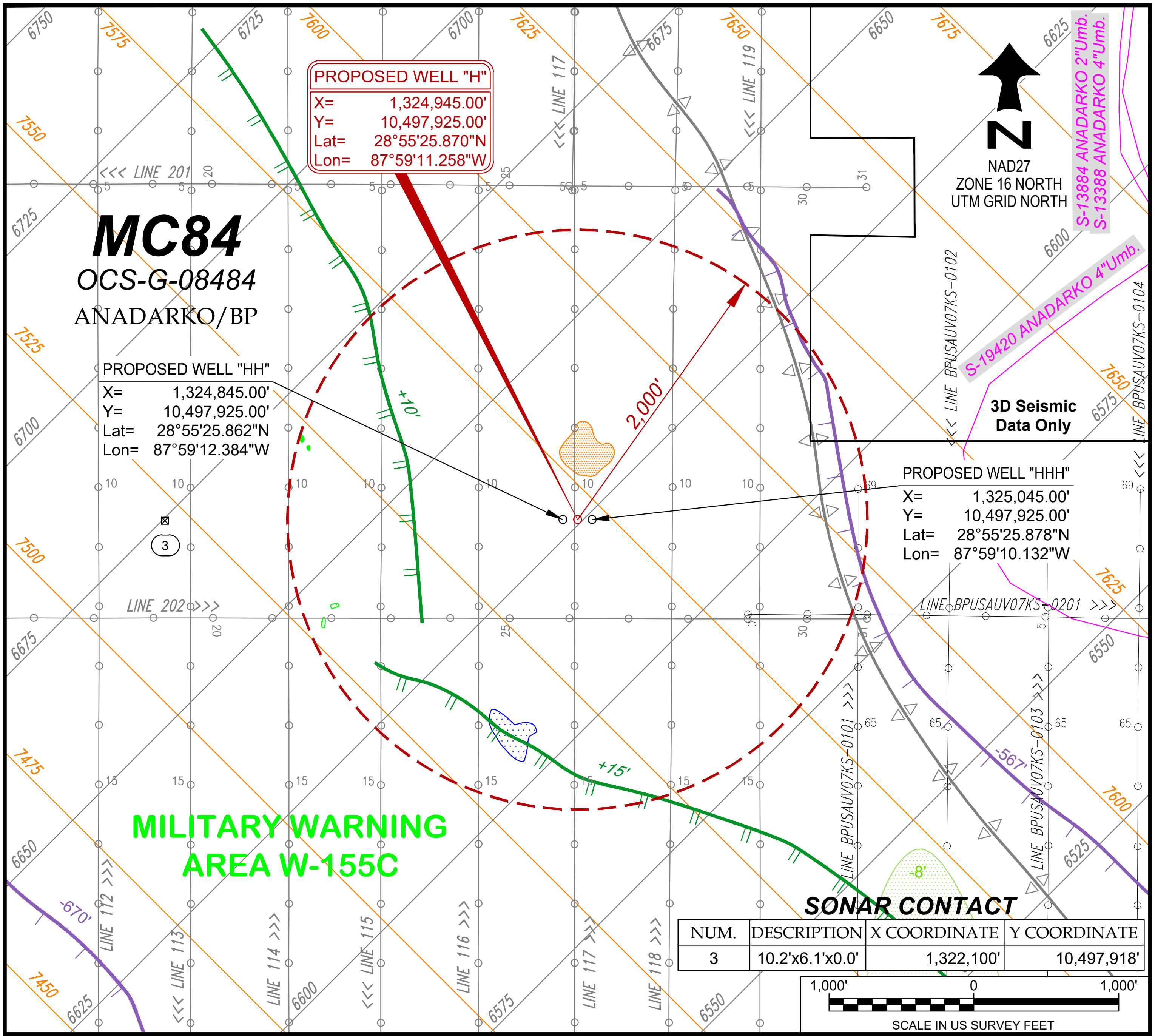

PROPOSED WELL "H"
X= 1,324,945.00'
Y= 10,497,925.00'
Lat= 28°55'25.870"N
Lon= 87°59'11.258"W

PROPOSED WELL "HH"
X= 1,324,845.00'
Y= 10,497,925.00'
Lat= 28°55'25.862"N
Lon= 87°59'12.384"W

PROPOSED WELL "HHH"
X= 1,325,045.00'
Y= 10,497,925.00'
Lat= 28°55'25.878"N
Lon= 87°59'10.132"W

SONAR CONTACT

NUM.	DESCRIPTION	X COORDINATE	Y COORDINATE
3	10.2'x6.1'x0.0'	1,322,100'	10,497,918'

—	Existing pipeline, umbilical, or groundbed	10 << LINE 101	AUV navigation trackline with name, direction run, fix, and fix number (Job # 130270)	10 LINE BPUSAUV07KS-0101 >>>	AUV navigation trackline with name, direction run, fix, and fix number (Job # 072372)	7600	Inline and inline number for 3D seismic data - Spacing = 312.5 meters (1025.25 feet)
6600	Crossline and crossline number for 3D seismic data - Spacing = 312.5 meters (1025.25 feet)	⊠ 3	Sonar contact & reference number (Job # 130270)	-8'	Mass transport deposits with depth below seafloor	+10'	Normal scarp from 3D data wth seafloor displacement (Hachures on downthrown side)
	Normal ridge from 3D data	-400'	Normal fault from 3D data with depth of burial (Hachures on downthrown side)		Unit C seismic amplitude anomaly 2,258 to 2,766 milliseconds (287 to 1,408 feet) below sea level		Unit D seismic amplitude anomaly 2,329 to 3,152 milliseconds (539 to 2,934 feet) below sea level
	Unit E seismic amplitude anomaly 2,742 to 3,687 milliseconds (1,643 to 4,620 feet) below sea level						

Anadarko
Petroleum Corporation

PROPOSED WELL "H"
SEAFLOOR & SUBSURFACE FEATURES MAP
Block 84, Mississippi Canyon Area

PREPARED BY: OCEANEERING®

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LAFAYETTE, LA 70508
(337) 210-0000

JOB: 198110	DRW: J. Guidry	DATE: MARCH 12, 2019
CKD: D. Pierrottie	APP: C. Baker	SHEET 5 of 5
DOC: 198110-OII-DRW-CLR-002-05		REV. 0

SIZE: 8.5" X 11" DATE: 03/12/2019 TIME: 11:09 FILENAME: Z:\198110\ACAD\198110-OII-DRW-CLR-002.DWG

D
HYDROGEN SULFIDE INFORMATION

Mississippi Canyon Blocks 84 and 85:

In accordance with Title 30 CFR 250.490(c), Anadarko requests that the area of proposed operations be classified by the BOEM as H2S absent. Anadarko anticipates encountering 0 ppm H2S during the proposed operations.

The basis for this determination is the evaluation of the OCS-G 08484 SS001 (D3) well and OSC-G 08797 SS002 (D5) well which drilled in Mississippi Canyon (MC) Block 084, and MC Block 085, respectively, through an equivalent target section.

- The OCS-G 08484 SS001 (D3) well is located less than 2.1 miles to the southwest of proposed Well Location G. It is the nearest well in MC Block 084 to the proposed locations producing from the primary objective sand.
- The OSC-G 08797 SS002 (D5) well is located less than 1.4 miles to the east of proposed Well Location G. It is the nearest well in MC Block 085 to the proposed locations producing from the econdary objective sand.

E
BIOLOGICAL, PHYSICAL, AND SOCIOECONOMIC INFORMATION

(a) Chemosynthetic Communities Report

The seafloor disturbing activities proposed in this plan are in approximately 5,093’-5,179’ of water. The wells will be drilled with a DP Drillship or DP Semisubmersible drilling unit.

Maps

Maps prepared using 3-D seismic data to depict bathymetry, seafloor and shallow geological features, and surface location of the proposed wells are included in Sections A and C.

Analysis

Features or areas that could support high-density chemosynthetic communities are not located within 2,000 feet of each proposed muds and cuttings discharge location.

Features or areas that could support high-density chemosynthetic communities are not located within 250 feet of any seafloor disturbances. Please refer to Site Clearance Letters included in Section C for summary statements for each well.

(b) Topographic Features Map

The proposed activities are not within 1,000 feet of a no-activity zone or within the 3-mile radius zone of an identified topographic feature. Therefore, no map is required per NTL No. 2008-G04.

(c) Topographic Features Statement (Shunting)

Anadarko does not plan to drill more than two wells from the same surface location within the Protective Zone of an identified topographic feature. Therefore, the topographic features statement required by NTL No. 2008-G04 is not applicable.

(d) Live Bottoms (Pinnacle Trend) Map

The activities proposed in this plan are not within 200 feet of any pinnacle trend feature with vertical relief equal to or greater than 8 feet. Therefore, no map is required per NTL No. 2008-G04.

(e) Live Bottoms (Low Relief) Map

The activities proposed in this plan are not within 100 feet of any live bottom low relief features. Therefore, no map is required per NTL No. 2008-G04.

(f) Potentially Sensitive Biological Features

The activities proposed in this plan are not within 200 feet of any potentially sensitive biological features. Therefore, no map is required per NTL No. 2008-G04.

(g) Threatened and Endangered Species Information

Under Section 7 of the Endangered Species Act (ESA) all federal agencies must ensure that any actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species, or destroy or adversely modify its designated critical habitat.

In accordance with the 30 CFR 250, Subpart B, effective May 14, 2007, and further outlined in Notice to Lessees (NTL) 2008-G04, lessees/operators are required to address site-specific information on the presence of federally listed threatened or endangered species and critical habitat designated under the ESA and marine mammals protected under the Marine Mammal Protection Act (MMPA) in the area of proposes activities under this plan.

Currently there are no designated critical habitats for the listed species in the Gulf of Mexico Outer Continental Shelf; however, it is possible that one or more of these species could be seen in the area of our operations. The following table reflects the Federally-listed endangered and threatened species in the lease area and along the northern Gulf coast:

The Environmental Impact Analysis in Section N of this plan further discusses potential impacts and mitigation measures related to threatened and endangered species.

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
West Indian manatee	*Trichechus manatus*[a]	E	--	X	Florida (Peninsular)
Sea Turtles					
Loggerhead turtle	*Caretta caretta*	T, E[b]	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[c]	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)

Species	Scientific Name	Status	Potential Presence		Critical Habitat Designated in Gulf of Mexico
			Lease Area	Coastal	
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.

[a] 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.

[b] The loggerhead turtle is composed of nine distinct population segments (DPSs) that are considered "species." The only DPS that may occur in the project area (Northwest Atlantic DPS) is listed as threatened (76 *Federal Register* [FR] 58868; 22 September 2011).

[c] Effective 6 May 2016, the entire North Atlantic DPS of green sea turtle is listed as threatened, including the Florida breeding population that was previously listed as endangered (81 FR 20057).

(h) Archaeological Report

Mississippi Canyon Blocks 84 and 85 have been determined to be located in an area where historic shipwrecks may exist. In accordance with NTL No. 2005-G07, "Archaeological Resource Surveys and Reports," and NTL No. 2011-JOINT-G01, "Revisions to the List of OCS Lease Blocks Requiring Archaeological Resource Surveys and Reports," an archaeological resource survey report was provided with previously approved Exploration Plan Control No. S-7638.

(i) Air and Water Quality Information

This EP does not propose activities for which the State of Florida is an affected State. Therefore, the discussion required per NTL 2008-G04 is not applicable to this EP.

(j) Socioeconomic Information

The activities proposed in this plan are not located offshore Florida. Therefore, socioeconomic information required per NTL 2008-G04 is not applicable to this EP.

F
WASTE AND DISCHARGE INFORMATION

The following estimates were prepared utilizing Anadarko's experience with similar drilling operations. Estimated maximum discharge rates are reflected below. Projected amounts may vary during the course of drilling and/or completion operations.

Total amount assumes drilling and completing six wells with 510 total number of days (eighty-five days to drill and complete each well).

(a) Projected Generated Wastes

Type of Waste	Composition	Projected Amount	Treatment/Storage/Disposal
Synthetic-based drilling fluids	Synthetic-based drilling muds	15,000 bbls/well	Re-use and/or transport to shore in DOT approved containers to an approved waste disposal facility, such as Fourchon, Louisiana and on to base/transfer station. If recycled, returned to vendor (Bariod or MI).
Cuttings wetted with synthetic-based fluids	Cuttings coated with synthetic drilling muds/fluids, including drilled out cement	1,500 bbls/well	Treated and discharge overboard **Note, an estimated 5-10% of cuttings may be transported to shore in tanks and/or cutting boxes and on to the base/transfer station if oil still remains.*
Water-based drilling fluids**	Water based drilling muds (NaCl saturated, seawater, freshwater, barite)	40,000 bbls/well	Discharge overboard or at seafloor
Cuttings wetted with water-based fluids	Cuttings coated with water-based drilling muds/fluids	2,500 bbls/well	Discharge overboard
Chemical product waste (well treatment fluids)	Ethylene glycol Methanol	1,700 bbls total 425 bbls total	Transport to shore in DOT approved containers to an approved waste disposal facility, such as Fourchon, Louisiana and on to Ecoserv Base.
Completion Fluids	Brine, spent acid, prop sand, debris, gelled fluids, dead oil	3,000 bbls/well	Transport to shore in DOT approved containers to an approved waste disposal facility, such as Fourchon, Louisiana and on to Ecoserv Base.
Non-pollutant completion fluids	Low density uninhibited completion brines	5,000 bbls/well	Discharge overboard
Workover fluids/ Stim fluids	Brine, spent acid, prop sand, debris, gelled fluids, dead oil	3,000 bbls/well	Transport to shore in DOT approved containers to an approved waste disposal facility, such as Fourchon, Louisiana and on to Ecoserv Base.
Trash and debris	Refuse generated during operations	850 bbls total	Transport to shore in disposal bags or DOT approved containers by vessel to shorebase for pickup by municipal operations.
Sanitary Wastes*	Treated human body waste	2,550 ,000 gals total	Chlorinate and discharge overboard
Domestic Waste*	Gray water	2,550 ,000 gals total	Chlorinate and discharge overboard
Deck drainage	Platform washings and rainwater	1,785,000 bbls total	Treat for oil and grease and discharge overboard
Produced water	N/A	N/A	N/A
Desalinization Unit	Seawater	178.500 bbls total	Discharge overboard
Wash water	Drill water (fresh)	25,500 bbls total	Discharge overboard

Blowout preventer fluid	Blend (3% Stack Magic & Filtered Fresh Water)	67,393 gals total	Discharge at seafloor
Ballast water	Seawater	47,650 m3/year	Discharge overboard
Bilge water	Seawater	161,670 bbls total	Discharge overboard through 15 ppm equipment
Excess cement at the seafloor	Nitrified cement slurry	1,000 bbls/well	Discharge at seafloor
Fire water	Seawater	137,142 bbls/day/well	Discharge overboard
Cooling water	Seawater	137,142 bbls/day/well	Discharge overboard
Produced Sand	N/A	N/A	N/A
Used oil	Excess oil from engines	1,828 bbls total	Transport in DOT approved containers to shore for recycling

*The rig is designed for maximum personnel capacity of 200 people. The discharge rates are based off of maximum personnel capacity but will generally not have this many personnel onboard during drilling and/or completion operations.
**The actual volume ordered out will be an estimated 35,000 bbls/well of mud. Once on location this volume will be cut back and mixed with seawater to different desired mud weights which will increase the volume that is discharged at the seafloor. The estimated volume that will be discharged at the seafloor will be approximately 65,000 bbls/well (NOTE: there will be six wells drilled for a total of 390,000 bbls).

(b) Projected Ocean Discharges

Type of Waste	**Total Amount to be Discharged**	**Discharge Rate**	**Discharge Method**
Sanitary Wastes*	2,550 ,000 gals total	25 gals per person daily	Chlorinate and discharge overboard
Domestic waste*	2,550 ,000 gals total	25 gals per person daily	Chlorinate and discharge overboard
Deck drainage	1,785,000 bbls total	3,500 bbls/day	Treat for oil and grease and discharge overboard
Desalinization Unit	178.500 bbls total	350 bbls/day	Discharge overboard
Wash water	25,500 bbls total	50 bbls/day	Discharge overboard
Blowout preventer fluid	67,393 gals total	925 gals/week/well; Vents on a weekly basis	Discharge at seafloor
Ballast water	47,650 m3/year	Not continuous	Discharge overboard
Bilge water	161,670 bbls total	317 bbls/day	Discharge overboard through 15 ppm equipment
Excess cement at the seafloor	1,000 bbls/well	20 bbls/min	Discharge at seafloor
Fire water	69,942,420 bbls total	137,142 bbls/day	Discharge overboard
Cooling water	69,942,420 bbls total	137,142 bbls/day	Discharge overboard
Cuttings wetted with Water-based fluids	15,000 bbls total	1,000 bbls/hr max	Discharge overboard
Water-based drilling fluids**	240,000 bbls total	1,000 bbls/hr max	Discharge at seafloor or overboard
Cuttings wetted with Synthetic-based fluids	9,000 bbls total	1,000 bbls/hr max	Treated and discharge overboard _*Note, an estimated 5-10% of cuttings may be transported to shore in tanks and/or cutting boxes and on to the base/transfer station if oil still remains._
Non-pollutant completion fluids	30,000 bbls total	100 bbl/hour	Discharge overboard

*The rig is designed for maximum personnel capacity of 200 people. The discharge rates are based off of maximum personnel capacity but will generally not have this many personnel onboard during drilling and/or completion operations.
**The actual volume ordered out will be an estimated 35,000 bbls/well of mud. Once on location this volume will be cut back and mixed with seawater to different desired mud weights which will increase the volume that is discharged at the seafloor. The estimated volume that will be discharged at the seafloor will be approximately 65,000 bbls/well (NOTE: there will be six wells drilled for a total of 390,000 bbls).

(c) Modeling Report

The proposed activities under this plan do not meet the U.S. Environmental Protection Agency requirements for an individual NPDES permit. Therefore, modeling report requirements per NTL No. 2008-G04 is not applicable to this EP.

G
AIR EMISSIONS INFORMATION

(a) Screening Questions

Screening Questions for EP's	Yes	No
Is any calculated Complex Total (CT) Emission amount (in 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)?		No
Do your emission calculations include any emission reduction measures or modified emission factors?	Yes	
Are your proposed exploration activities located east of 87.5 W longitude?		No
Do you expect to encounter H2S at concentrations greater than 20 parts per million (ppm)?		No
Do you propose to flare or vent natural gas for more than 48 continuous hours from any proposed well?		No
Do you propose to burn produced hydrocarbon liquids?		No

(b) Emissions Worksheets

Air emission worksheets have been prepared utilizing the maximum horsepower rating from an Anadarko contracted DP drillship. The DP drillship used for these air emission calculations has six main engines. The average number of engines on-line at once will be four engines. Rigs typically do not operate at maximum horsepower capacity or engine load; however, Anadarko has opted to calculate the plan emission amounts based on the total horsepower rating and 100% average engine load. A different rig may be utilized (DP drillship or DP semi-submersible); but the horsepower rating, average engine load, and air emissions will be equal to, or less than, the calculated plan emission amounts shown on the following pages. Air emission worksheets are enclosed as **Attachment G-1.**

(c) Summary Information

The following tables summarize information regarding the peak year emissions generated from the Plan Emissions and Complex Total Emissions:

***MC 84 Surface Locations*: If drilled with a DP Drillship or DP Semi (Horsepower equal to or less than 64,370 hp):**

Air Pollutant		Plan Emission Amounts[1] (tons)	Calculated Exemption Amounts[2] (tons)		Calculated Complex Total Emission Amounts[3] (tons)
Particulate matter (PM)		52.15	2231.10		n/a
Sulphur dioxide (SO_2)		0.90	2231.10		n/a
Nitrogen oxides (NO_x)		1793.21	2231.10		n/a
Volatile organic compounds (VOC)		54.38	2231.10		n/a
Carbon monoxide (CO)		394.98	56086.99		n/a

MC 85 Surface Locations: If drilled with a DP Drillship or DP Semi (Horsepower equal to or less than 64,370 hp):

Air Pollutant		Plan Emission Amounts[1] (tons)	Calculated Exemption Amounts[2] (tons)		Calculated Complex Total Emission Amounts[3] (tons)
Particulate matter (PM)		52.15	2231.10		n/a
Sulphur dioxide (SO_2)		0.90	2231.10		n/a
Nitrogen oxides (NO_x)		1793.21	2231.10		n/a
Volatile organic compounds (VOC)		54.38	2231.10		n/a
Carbon monoxide (CO)		394.98	56086.99		n/a

The air emission calculations were calculated by:

Jill Wiederhold
Regulatory Analyst
(832) 636-1554
Jill.wiederhold@anadarko.com

COMPANY	Anadarko Petroleum Corporation
AREA	Mississippi Canyon
BLOCK	MC 84 (Surface Locations Only)
LEASE	OCS-G 08484 (Surface Locations Only)
PLATFORM	N/A
WELL	MC 84 H, HH, HHH
COMPANY CONTACT	Jill Wiederhold
TELEPHONE NO.	832-636-1554
REMARKS	Drill and complete three wells with surface locations in MC 84: MC 84 H, HH, HHH

Drillships = 100% Engine Load
Vessels = 100% Engine Load for 24 hrs./day

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

Proposed Activity	Start Date	End Date	No. of Days
Drill, Complete, & Conduct Flowtest Well Location MC 84 G	11/1/2019	01/25/2020	85
Drill, Complete, & Conduct Flowtest Well Location MC 84 H	01/26/2020	04/20/2020	85
Drill, Complete, & Conduct Flowtest Well Location MC 84 GG	1/1/2021	03/27/2021	85
Drill, Complete, & Conduct Flowtest Well Location MC 84 HH	03/28/2021	06/21/2021	85
Drill, Complete, & Conduct Flowtest Well Location MC 84 GGG	01/01/2022	03/27/2022	85
Drill, Complete, & Conduct Flowtest Well Location MC 84 HHH	03/28/2022	06/21/2022	85

AIR EMISSIONS CUMPUTATION 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

Equipment/Emission Factors	units	PM	SOx	NOx	VOC	CO	REF.	DATE
NG Turbines	gms/hp-hr		0.00247	1.3	0.01	0.83	AP42 3.2-1& 3.1-1	10/96
NG 2-cycle lean	gms/hp-hr		0.00185	10.9	0.43	1.5	AP42 3.2-1	10/96
NG 4-cycle lean	gms/hp-hr		0.00185	11.8	0.72	1.6	AP42 3.2-1	10/96
NG 4-cycle rich	gms/hp-hr		0.00185	10	0.14	8.6	AP42 3.2-1	10/96
Diesel Recip. < 600 hp.	gms/hp-hr	1	0.005505	14	1.12	3.03	AP42 3.3-1	10/96
Diesel Recip. > 600 hp.	gms/hp-hr	0.32	0.005505	11	0.33	2.4	AP42 3.4-1	10/96
Diesel Boiler	lbs/bbl	0.084	0.009075	0.84	0.008	0.21	AP42 1.3-12,14	9/98
Diesel Marine Tier II	g/kw*hr			9.7				
NG Heaters/Boilers/Burners	lbs/mmscf	7.6	0.593	100	5.5	84	P42 1.4-1, 14-2, & 14	7/98
NG Flares	lbs/mmscf		0.593	71.4	60.3	388.5	AP42 11.5-1	9/91
Liquid Flaring	lbs/bbl	0.42	6.83	2	0.01	0.21	AP42 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
Glycol Dehydrator Vent	lbs/mmscf				6.6		La. DEQ	1991
Gas Venting	lbs/scf				0.0034			

Sulphur Content Source	**Value**	**Units**
Fuel Gas	3.33	ppm
Diesel Fuel[1]	0.0015	% weight
Produced Gas(Flares)	3.33	ppm
Produced Oil (Liquid Flaring)	1	% weight

AIR EMISSIONS CALCULATIONS - SECOND YEAR

COMPANY	**AREA**	**BLOCK**	**LEASE**		**PLATFORM**	**WELL**		**CONTACT**			**PHONE**	**REMARKS**					
Anadarko Petroleum Cor	Mississippi Canyon	MC 84 (Surface Locations Only)	OCS-G 08484 (Surface Location		N/A	MC 84 H, HH, HHH			Jill Wiederhold		832-636-1554	#REF!					
OPERATIONS	**EQUIPMENT**	**RATING**	**MAX. FUEL**	**Average Engine Load %**	**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	PRIME MOVER>600hp diesel [(1)]	64370	3109.071	100%	74617.70	24	85	45.37	0.78	1559.63	46.79	340.28	46.28	0.80	1590.82	47.72	347.09
3 days/week	VESSELS>600hp diesel(crew)	10800	521.64	100%	12519.36	24	36	7.61	0.13	261.67	7.85	57.09	3.29	0.06	113.04	3.39	24.66
2 days/week	VESSELS>600hp diesel(supply)	9266	447.5478	100%	10741.15	24	24	6.53	0.11	224.51	6.74	48.98	1.88	0.03	64.66	1.94	14.11
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	100%	31869.89	24	3	19.38	0.33	666.13	19.98	145.34	0.70	0.01	23.98	0.72	5.23
	VESSELS>600hp diesel(supply)	0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(tugs)	0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
							0.00										
	MISC.	**BPD**	**SCF/HR**		**COUNT**												
	TANK-						0				0.00					0.00	
	FLARE-						0		0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
	PROCESS VENT-						0				0.00					0.00	
	FUGITIVES-						0				0.00					0.00	
	GLYCOL STILL VENT-						0				0.00					0.00	
DRILLING	OIL BURN	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WELL TEST	GAS FLARE		416667			24	2		0.25	29.75	25.13	161.88		0.01	0.71	0.60	3.89
2020	**YEAR TOTAL**							**78.89**	**1.60**	**2741.69**	**106.48**	**753.57**	**52.15**	**0.90**	**1793.21**	**54.38**	**394.98**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**												**2231.10**	**2231.10**	**2231.10**	**2231.10**	**56086.99**
	67.0																

AIR EMISSIONS CALCULATIONS - SECOND YEAR

COMPANY	AREA	BLOCK	LEASE		PLATFORM	WELL		CONTACT			PHONE	REMARKS					
Anadarko Petroleum Cor	Mississippi Canyon	MC 84 (Surface Locations Only)	OCS-G 08484 (Surface Location		N/A	MC 84 H, HH, HHH			Jill Wiederhold		832-636-1554	#REF!					
OPERATIONS	**EQUIPMENT**	**RATING**	**MAX. FUEL**	**Average Engine Load %**	**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	PRIME MOVER>600hp diesel (1)	64370	3109.071	100%	74617.70	24	85	45.37	0.78	1559.63	46.79	340.28	46.28	0.80	1590.82	47.72	347.09
3 days/week	VESSELS>600hp diesel(crew)	10800	521.64	100%	12519.36	24	36	7.61	0.13	261.67	7.85	57.09	3.29	0.06	113.04	3.39	24.66
2 days/week	VESSELS>600hp diesel(supply)	9266	447.5478	100%	10741.15	24	24	6.53	0.11	224.51	6.74	48.98	1.88	0.03	64.66	1.94	14.11
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	100%	31869.89	24	3	19.38	0.33	666.13	19.98	145.34	0.70	0.01	23.98	0.72	5.23
	VESSELS>600hp diesel(supply)	0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(tugs)	0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
							0.00										
	MISC.	**BPD**	**SCF/HR**		**COUNT**												
	TANK-						0				0.00					0.00	
	FLARE-						0		0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
	PROCESS VENT-						0				0.00					0.00	
	FUGITIVES-						0				0.00					0.00	
	GLYCOL STILL VENT-						0				0.00					0.00	
DRILLING	OIL BURN	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WELL TEST	GAS FLARE		416667			24	2		0.25	29.75	25.13	161.88		0.01	0.71	0.60	3.89
2021	**YEAR TOTAL**							**78.89**	**1.60**	**2741.69**	**106.48**	**753.57**	**52.15**	**0.90**	**1793.21**	**54.38**	**394.98**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**												**2231.10**	**2231.10**	**2231.10**	**2231.10**	**56086.99**
	67.0																

AIR EMISSIONS CALCULATIONS - SECOND YEAR

COMPANY	**AREA**	**BLOCK**	**LEASE**		**PLATFORM**	**WELL**		**CONTACT**			**PHONE**	**REMARKS**					
Anadarko Petroleum Cor	Mississippi Canyon	MC 84 (Surface Locations Only)	OCS-G 08484 (Surface Location		N/A	MC 84 H, HH, HHH			Jill Wiederhold		832-636-1554	#REF!					
OPERATIONS	**EQUIPMENT**	**RATING**	**MAX. FUEL**	**Average Engine Load %**	**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	PRIME MOVER>600hp diesel (1)	64370	3109.071	100%	74617.70	24	85	45.37	0.78	1559.63	46.79	340.28	46.28	0.80	1590.82	47.72	347.09
3 days/week	VESSELS>600hp diesel(crew)	10800	521.64	100%	12519.36	24	36	7.61	0.13	261.67	7.85	57.09	3.29	0.06	113.04	3.39	24.66
2 days/week	VESSELS>600hp diesel(supply)	9266	447.5478	100%	10741.15	24	24	6.53	0.11	224.51	6.74	48.98	1.88	0.03	64.66	1.94	14.11
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	100%	31869.89	24	3	19.38	0.33	666.13	19.98	145.34	0.70	0.01	23.98	0.72	5.23
	VESSELS>600hp diesel(supply)	0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(tugs)	0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
							0.00										
	MISC.	**BPD**	**SCF/HR**		**COUNT**												
	TANK-						0				0.00					0.00	
	FLARE-						0		0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
	PROCESS VENT-						0				0.00					0.00	
	FUGITIVES-						0				0.00					0.00	
	GLYCOL STILL VENT-						0				0.00					0.00	
DRILLING	OIL BURN	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WELL TEST	GAS FLARE		416667			24	2		0.25	29.75	25.13	161.88		0.01	0.71	0.60	3.89
2022	**YEAR TOTAL**							**78.89**	**1.60**	**2741.69**	**106.48**	**753.57**	**52.15**	**0.90**	**1793.21**	**54.38**	**394.98**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**												**2231.10**	**2231.10**	**2231.10**	**2231.10**	**56086.99**
	67.0																

AIR EMISSIONS CALCULATIONS

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL
Anadarko Petrol	Mississippi Canyon	MC 84 (Surface Locations Only)	OCS-G 08484 (Surface Locations Only)	N/A	MC 84 H, HH, HHH

Year	Emitted		Substance		
	PM	SOx	NOx	VOC	CO
2019	0.00	0.00	0.00	0.00	0.00
2020	52.15	0.90	1793.21	54.38	394.98
2021	52.15	0.90	1793.21	54.38	394.98
2022	52.15	0.90	1793.21	54.38	394.98
Allowable	2231.10	2231.10	2231.10	2231.10	56086.99

COMPANY	Anadarko Petroleum Corporation
AREA	Mississippi Canyon
BLOCK	MC 85 (Surface Locations Only)
LEASE	OCS-G 08797 (Surface Locations Only)
PLATFORM	N/A
WELL	MC 84 G, GG, GGG
COMPANY CONTACT	Jill Wiederhold
TELEPHONE NO.	832-636-1554
REMARKS	Drill and complete three wells with surface locations in MC 85: MC 84 G, GG, GGG

Drillships = 100% Engine Load
Vessels = 100% Engine Load for 24 hrs./day

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

Proposed Activity	Start Date	End Date	No. of Days
Drill, Complete, & Conduct Flowtest Well Location MC 84 G	11/1/2019	01/25/2020	85
Drill, Complete, & Conduct Flowtest Well Location MC 84 H	01/26/2020	04/20/2020	85
Drill, Complete, & Conduct Flowtest Well Location MC 84 GG	1/1/2021	03/27/2021	85
Drill, Complete, & Conduct Flowtest Well Location MC 84 HH	03/28/2021	06/21/2021	85
Drill, Complete, & Conduct Flowtest Well Location MC 84 GGG	01/01/2022	03/27/2022	85
Drill, Complete, & Conduct Flowtest Well Location MC 84 HHH	03/28/2022	06/21/2022	85

AIR EMISSIONS CUMPUTATION 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

Equipment/Emission Factors	units	PM	SOx	NOx	VOC	CO	REF.	DATE
NG Turbines	gms/hp-hr		0.00247	1.3	0.01	0.83	AP42 3.2-1& 3.1-1	10/96
NG 2-cycle lean	gms/hp-hr		0.00185	10.9	0.43	1.5	AP42 3.2-1	10/96
NG 4-cycle lean	gms/hp-hr		0.00185	11.8	0.72	1.6	AP42 3.2-1	10/96
NG 4-cycle rich	gms/hp-hr		0.00185	10	0.14	8.6	AP42 3.2-1	10/96
Diesel Recip. < 600 hp.	gms/hp-hr	1	0.005505	14	1.12	3.03	AP42 3.3-1	10/96
Diesel Recip. > 600 hp.	gms/hp-hr	0.32	0.005505	11	0.33	2.4	AP42 3.4-1	10/96
Diesel Boiler	lbs/bbl	0.084	0.009075	0.84	0.008	0.21	AP42 1.3-12,14	9/98
Diesel Marine Tier II	g/kw*hr			9.7				
NG Heaters/Boilers/Burners	lbs/mmscf	7.6	0.593	100	5.5	84	P42 1.4-1, 14-2, & 14	7/98
NG Flares	lbs/mmscf		0.593	71.4	60.3	388.5	AP42 11.5-1	9/91
Liquid Flaring	lbs/bbl	0.42	6.83	2	0.01	0.21	AP42 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
Glycol Dehydrator Vent	lbs/mmscf				6.6		La. DEQ	1991
Gas Venting	lbs/scf				0.0034			

Sulphur Content Source	**Value**	**Units**
Fuel Gas	3.33	ppm
Diesel Fuel[1]	0.0015	% weight
Produced Gas(Flares)	3.33	ppm
Produced Oil (Liquid Flaring)	1	% weight

AIR EMISSIONS CALCULATIONS - SECOND YEAR

COMPANY	AREA	BLOCK	LEASE		PLATFORM	WELL		CONTACT			PHONE	REMARKS					
Anadarko Petroleum Cor	Mississippi Canyon	MC 85 (Surface Locations Only)	OCS-G 08797 (Surface Location		N/A	MC 84 G, GG, GGG			Jill Wiederhold		832-636-1554	#REF!					
OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	Average Engine Load %	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	PRIME MOVER>600hp diesel (1)	64370	3109.071	100%	74617.70	24	60	45.37	0.78	1559.63	46.79	340.28	32.67	0.56	1122.93	33.69	245.00
3 days/week	VESSELS>600hp diesel(crew)	10800	521.64	100%	12519.36	24	26	7.61	0.13	261.67	7.85	57.09	2.38	0.04	81.64	2.45	17.81
2 days/week	VESSELS>600hp diesel(supply)	9266	447.5478	100%	10741.15	24	17	6.53	0.11	224.51	6.74	48.98	1.33	0.02	45.80	1.37	9.99
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	100%	31869.89	0	0	19.38	0.33	666.13	19.98	145.34	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(supply)	0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(tugs)	0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
							0.00										
	MISC.	BPD	SCF/HR		COUNT												
	TANK-						0				0.00					0.00	
	FLARE-						0		0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
	PROCESS VENT-						0				0.00					0.00	
	FUGITIVES-						0				0.00					0.00	
	GLYCOL STILL VENT-						0				0.00					0.00	
DRILLING	OIL BURN	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WELL TEST	GAS FLARE						0		0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
2019	**YEAR TOTAL**							**78.89**	**1.36**	**2711.94**	**81.36**	**591.70**	**36.37**	**0.63**	**1250.37**	**37.51**	**272.81**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**												**2231.10**	**2231.10**	**2231.10**	**2231.10**	**56086.99**
	67.0																

AIR EMISSIONS CALCULATIONS - SECOND YEAR

COMPANY	AREA	BLOCK	LEASE		PLATFORM	WELL		CONTACT			PHONE	REMARKS					
Anadarko Petroleum Cor	Mississippi Canyon	MC 85 (Surface Locations Only)	OCS-G 08797 (Surface Location		N/A	MC 84 G, GG, GGG			Jill Wiederhold		832-636-1554	#REF!					
OPERATIONS	**EQUIPMENT**	**RATING**	**MAX. FUEL**	**Average Engine Load %**	**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	PRIME MOVER>600hp diesel (1)	64370	3109.071	100%	74617.70	24	24	45.37	0.78	1559.63	46.79	340.28	13.07	0.22	449.17	13.48	98.00
3 days/week	VESSELS>600hp diesel(crew)	10800	521.64	100%	12519.36	24	10	7.61	0.13	261.67	7.85	57.09	0.91	0.02	31.40	0.94	6.85
2 days/week	VESSELS>600hp diesel(supply)	9266	447.5478	100%	10741.15	24	7	6.53	0.11	224.51	6.74	48.98	0.55	0.01	18.86	0.57	4.11
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	100%	31869.89	24	3	19.38	0.33	666.13	19.98	145.34	0.70	0.01	23.98	0.72	5.23
	VESSELS>600hp diesel(supply)	0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(tugs)	0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
							0.00										
	MISC.	**BPD**	**SCF/HR**		**COUNT**												
	TANK-						0				0.00					0.00	
	FLARE-						0		0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
	PROCESS VENT-						0				0.00					0.00	
	FUGITIVES-						0				0.00					0.00	
	GLYCOL STILL VENT-						0				0.00					0.00	
DRILLING	OIL BURN	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WELL TEST	GAS FLARE		416667			24	2		0.25	29.75	25.13	161.88		0.01	0.71	0.60	3.89
2020	**YEAR TOTAL**							**78.89**	**1.60**	**2741.69**	**106.48**	**753.57**	**15.23**	**0.27**	**524.13**	**16.31**	**118.08**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**												**2231.10**	**2231.10**	**2231.10**	**2231.10**	**56086.99**
	67.0																

AIR EMISSIONS CALCULATIONS - SECOND YEAR

COMPANY	**AREA**	**BLOCK**	**LEASE**		**PLATFORM**	**WELL**		**CONTACT**			**PHONE**	**REMARKS**					
Anadarko Petroleum Cor	Mississippi Canyon	MC 85 (Surface Locations Only)	OCS-G 08797 (Surface Location		N/A	MC 84 G, GG, GGG			Jill Wiederhold		832-636-1554	#REF!					
OPERATIONS	**EQUIPMENT**	**RATING**	**MAX. FUEL**	**Average Engine Load %**	**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	PRIME MOVER>600hp diesel (1)	64370	3109.071	100%	74617.70	24	85	45.37	0.78	1559.63	46.79	340.28	46.28	0.80	1590.82	47.72	347.09
3 days/week	VESSELS>600hp diesel(crew)	10800	521.64	100%	12519.36	24	36	7.61	0.13	261.67	7.85	57.09	3.29	0.06	113.04	3.39	24.66
2 days/week	VESSELS>600hp diesel(supply)	9266	447.5478	100%	10741.15	24	24	6.53	0.11	224.51	6.74	48.98	1.88	0.03	64.66	1.94	14.11
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	100%	31869.89	24	3	19.38	0.33	666.13	19.98	145.34	0.70	0.01	23.98	0.72	5.23
	VESSELS>600hp diesel(supply)	0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(tugs)	0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
							0.00										
	MISC.	**BPD**	**SCF/HR**		**COUNT**												
	TANK-						0				0.00					0.00	
	FLARE-						0		0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
	PROCESS VENT-						0				0.00					0.00	
	FUGITIVES-						0				0.00					0.00	
	GLYCOL STILL VENT-						0				0.00					0.00	
DRILLING	OIL BURN	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WELL TEST	GAS FLARE		416667			24	2		0.25	29.75	25.13	161.88		0.01	0.71	0.60	3.89
2021	**YEAR TOTAL**							**78.89**	**1.60**	**2741.69**	**106.48**	**753.57**	**52.15**	**0.90**	**1793.21**	**54.38**	**394.98**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**												**2231.10**	**2231.10**	**2231.10**	**2231.10**	**56086.99**
	67.0																

AIR EMISSIONS CALCULATIONS - SECOND YEAR

COMPANY	AREA	BLOCK	LEASE		PLATFORM	WELL		CONTACT			PHONE	REMARKS					
Anadarko Petroleum Cor	Mississippi Canyon	MC 85 (Surface Locations Only)	OCS-G 08797 (Surface Location		N/A	MC 84 G, GG, GGG			Jill Wiederhold		832-636-1554	#REF!					
OPERATIONS	**EQUIPMENT**	**RATING**	**MAX. FUEL**	**Average Engine Load %**	**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	PRIME MOVER>600hp diesel (1)	64370	3109.071	100%	74617.70	24	85	45.37	0.78	1559.63	46.79	340.28	46.28	0.80	1590.82	47.72	347.09
3 days/week	VESSELS>600hp diesel(crew)	10800	521.64	100%	12519.36	24	36	7.61	0.13	261.67	7.85	57.09	3.29	0.06	113.04	3.39	24.66
2 days/week	VESSELS>600hp diesel(supply)	9266	447.5478	100%	10741.15	24	24	6.53	0.11	224.51	6.74	48.98	1.88	0.03	64.66	1.94	14.11
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	100%	31869.89	24	3	19.38	0.33	666.13	19.98	145.34	0.70	0.01	23.98	0.72	5.23
	VESSELS>600hp diesel(supply)	0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(tugs)	0	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
							0.00										
	MISC.	**BPD**	**SCF/HR**		**COUNT**												
	TANK-						0				0.00					0.00	
	FLARE-						0		0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
	PROCESS VENT-						0				0.00					0.00	
	FUGITIVES-						0				0.00					0.00	
	GLYCOL STILL VENT-						0				0.00					0.00	
DRILLING	OIL BURN	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WELL TEST	GAS FLARE		416667			24	2		0.25	29.75	25.13	161.88		0.01	0.71	0.60	3.89
2022 YEAR TOTAL								**78.89**	**1.60**	**2741.69**	**106.48**	**753.57**	**52.15**	**0.90**	**1793.21**	**54.38**	**394.98**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**												**2231.10**	**2231.10**	**2231.10**	**2231.10**	**56086.99**
	67.0																

AIR EMISSIONS CALCULATIONS

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL
Anadarko Petrol	Mississippi Canyon	MC 85 (Surface Locations Only)	OCS-G 08797 (Surface Locations Only)	N/A	MC 84 G, GG, GGG

Year	Emitted Substance				
	PM	SOx	NOx	VOC	CO
2019	36.37	0.63	1250.37	37.51	272.81
2020	15.23	0.27	524.13	16.31	118.08
2021	52.15	0.90	1793.21	54.38	394.98
2022	52.15	0.90	1793.21	54.38	394.98
Allowable	2231.10	2231.10	2231.10	2231.10	56086.99

H
OIL SPILL INFORMATION

(a) Oil Spill Response Planning

(i) OSRP Information

All the proposed activities and facilities in this EP are covered by the Regional Oil Spill Response Plan (OSRP) approved on August 14, 2015 for Anadarko Petroleum Corporation and its subsidiary Anadarko US Offshore LLC. (Company Numbers 00981 and 02219 respectively) in accordance with 30 CFR Part 254. The June 2017 updates for the OSRP were acknowledged by BSEE July 12, 2017 and in compliance with 30 CFR 254.30(a). Non-regulatory required OSRP updates were submitted to BSEE on June 19, 2018 and acknowledged as in compliance July 18, 2018.

(ii) Spill Response Sites

Primary Response Equipment Location(s)	Preplanned Staging Location(s)
Houma, Louisiana	Fourchon, Louisiana
Harvey, Louisiana	Harvey, Louisiana
Venice, Louisiana	Venice, Louisiana
Lake Charles, Louisiana	Cameron, Louisiana
Galveston, Texas	Galveston, Texas

(iii) OSRO Information

Anadarko maintains a contract with Clean Gulf Associates (CGA) for spill response equipment. Various equipment locations are staged throughout the Gulf of Mexico. CGA equipment can be referenced on their website: http://www.cleangulfassoc.com/. Personnel would be obtained from the Marine Spill Response Corporation's (MSRC) STARS network, including a supervisor to operate the equipment.

In addition Anadarko has a contract with the Marine Spill Response Corporation (MSRC) for spill response equipment. MSRC stages equipment throughout the Gulf of Mexico and has recently completed a large expansion of its resources, with particular focus on deepwater. The expansion is known as "Deep Blue". MSRC capabilities and a complete equipment listing are available on-line at: http://www.msrc.org/.

Anadarko is also a member of the Marine Well Containment Company (MWCC), which provides access to containment response capabilities and includes subsea dispersant injection equipment.

(iv) Worst-Case Scenario Determination

Category	Regional OSRP	EP
Type of Activity	Exploratory	Exploratory
Facility Location (area/block)	GC 683	MC 84
Facility Designation	GC 683 “G”	MC 84 “H”
Distance to Nearest Shoreline	120 miles	67 miles
Storage Tanks (total)	N/A	N/A
Flowlines (on facility)	N/A	N/A
Pipelines	N/A	N/A
Uncontrolled Blowout	403,608 BOPD	394,798 BOPD
Type of Oil(s)	Oil	Oil
API Gravity	28.9°	33.0°

Anadarko has determined that the worst-case scenario from the activities proposed in this Supplemental EP do not supersede the worst-case scenario for Green Canyon Block 683.

Since Anadarko has the capability to respond to the worst-case spill scenario included in our Regional OSRP, and since the worst-case scenarios determined for our EP do not replace the worst-case scenario in our Regional OSRP last approved on August 14, 2015 (and updates accepted by BSEE on July 18, 2018), I hereby certify that Anadarko 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 our EP.

(b) Worst-Case Discharge Volume Assumptions

Worst-case discharge (WCD) calculations and assumptions within this section utilized guidelines and requirements pursuant with NTL No. 2015-N01. Within this EP, the highest WCD volume for Mississippi Canyon Blocks 84 and 85 was determined to be 394,798 BOPD.

Worst Case Discharge

Discussions regarding geologic information are considered proprietary and have been omitted from this public copy of the EP, along with the attachments.

(c) Oil Spill Response Discussion

For the purpose of NEPA analysis, the largest spill volume originating from the proposed activity would be an uncontrolled blowout of the well during drilling operations at 394,798 BOPD with an API gravity of 33.0°. A discussion of the blowout scenario from this proposed activity is included within this Supplemental EP in accordance with NTL No. 2015-N01.

Land Segment and Resource Identification Modeling

Trajectory of a spill and the probability of its impacting a land segment have been projected utilizing information in the Oil Spill Risk Analysis Model (OSRAM) for the Central Gulf of Mexico. Additional information may be referenced in the "Oil-Spill Risk Analysis: Contingency Planning Statistics for Gulf of Mexico OCS Activities" (OCS Report MMS 2004-026), using the average conditional probability for 3, 10, and 30 day impacts.

Mississippi Canyon Blocks 84 and 85 are located within Launch Area C57. According to the BOEM OSRAM, the trajectory indicates a 21% probability of potential impact to the shoreline in Plaquemines Parish, Louisiana. The results are shown in Table H-2

Plaquemines Parish is identified as the most probable potential impacted parish or county within the Gulf of Mexico for this operation. Plaquemines Parish includes Barataria Bay, the Mississippi River Delta, Breton Sound and the affiliated islands and bays. This region is an extremely sensitive habitat and serves as a migratory, breeding, feeding and nursery habitat for numerous species of wildlife. Beaches in this area vary in grain particle size and can be classified as fine sand, shell or perched shell beaches. Sandy and muddy tidal flats are also abundant.

Response

Anadarko will make every effort to respond to the worst-case discharge as effectively as possible. Response equipment available to respond to the worst-case discharge and the estimated time of a spill response from oil spill detection to equipment deployment on-site is included in **Table H-3.** The table estimates individual times needed for procurement, load out, travel time to the site and deployment. In the event of an actual incident equipment and times can vary.

For the purpose of response scenario discussion, an uncontrolled blowout of the well would be considered the largest potential spill volume at 394,798 BOPD. An ADIOS weathering model was run based on a similar type of oil expected to be produced from this well. Based on this information, approximately 11% (43,428 bbls) of the initial volume would be evaporated/dispersed within 24 hours.

If approved and appropriate, 4 sorties (8,000 gallons) from the Basler aircraft and 8 sorties (9,600 gallons) from two DC-3 aircrafts could disperse approximately 7,540 barrels of oil.

If the conditions are appropriate, and the necessary approvals and permits have been obtained, in-situ burning may be utilized. Based on in-situ burn operations during Deepwater Horizon, approximately 5% (19,740 bbls) of the total initial worst case discharge could be burned.
Although unlikely in a spill lasting thirty (30) days, potential shoreline impact in Plaquemines Parish, Louisiana could occur depending on environmental conditions (wind, currents and temperature) at the time of an incident. Nearshore response may include the use of shoreline boom on beach areas, or protection/sorbent boom on vegetated areas. Surveillance and real time trajectories would aide in determining the most appropriate strategies to respond to a spill.

Table H.3 provides an example of offshore and nearshore equipment, response times, and personnel to respond to a spill of 351,370 bbls, which is the estimated amount that would remain considering natural evaporation/dispersion at 24 hours. This amount could be further reduced through the application of aerial and subsea dispersants, and in-situ burning provided such applications/actions were approved.

Anadarko's contingency plan for dealing with this worst-case discharge would be to activate its Spill Management Team and equipment resources as described in its Gulf of Mexico Regional Oil Spill Response Plan (OSRP) and provide continuous support for the duration of the event. Response resources are activated and supplemented according to need. These resources would remain engaged in the response until the incident is deemed complete or until released by Unified Command.

Anadarko is also a member of the Marine Well Containment Company (MWCC), which provides access to containment response capabilities and includes subsea dispersant injection equipment.

In the event of a blowout, Anadarko may:

1. Evacuate personnel, if necessary. Deploy emergency responders in an effort to preserve human life, if necessary.

2. Assess the damage and attempt to stop the flow at the source, if safe to do so, to reduce the amount of oil discharged.

3. Notify agencies.

4. Assess the amount of oil that has been spilled and calculate additional potential of oil flow. A continuous aerial surveillance program would be used to assess the growth of the slick and the volume of oil on the water. Observations of the size of the slick on the water, combined with observations at the source, would be used to provide a constant update. Additional potential to release fuel from the remaining tanks onboard the dynamically positioned (DP) semi-submersible drilling rig would be determined by marine surveyors. Operations and Unified Command would continue to assess the adequacy of response equipment capacities based on this continually updated mass balance.

5. Convene the Spill Management Team (SMT). Organize Unified Command and establish objectives and priorities.

6. Monitor the oil spill with aerial surveillance and obtain trajectories. If oil is seaward bound, going away from land, discuss additional strategies with Unified Command.

7. If oil is moving in the direction of a shoreline and weather conditions are favorable, request approval to utilize dispersants.

a. Prior to commencing application operations, conduct an on-site survey in consultation with natural resource specialists to determine if any threatened or endangered species are present in the projected application area or otherwise at risk from dispersant application.

b. Upon approval, mobilize one Basler aircraft and two DC-3 aircrafts from Houma, with surveillance aircraft and spotter. Mobilize MSRC contracted aircraft(s) if needed. Rotate aircraft, spraying the leading edge of the spill and working back to the source. Monitor/sample for effectiveness (USCG SMART Team). Truck additional dispersants from CGA/MSRC stockpile to Houma, if necessary.

c. Dispersants are most effective when applied as soon after discharge as possible, since weathering of the oil decreases dispersant effectiveness. The estimated window of opportunity for most effective use of dispersants is within 48-72 hours post-release. The oil may still be dispersible after 72 hours on the water surface, but the effectiveness of dispersant use would likely be diminished after the oil has been on the water for more than three days. Ultimately, the USCG SMART monitoring protocol will be used to determine whether or not dispersant operations are effective.

d. Once the CGA HOSS barge is on location and in the skimming mode, dispersants would only be used if required and approved.

8. Deploy offshore mechanical oil containment and recovery equipment. Attempt to recover as much oil at sea as possible, utilizing:

   a. The CGA HOSS barge, will be positioned in a stationary mode, will be situated down-wind and down-current from location for long-duration, high-volume skimming. Based on average travel times, the HOSS barge could be on location within approximately 31 hours of the release. The de-rated skimming capacity of the HOSS barge is 43,000 bbls per day. However, only the oil encountered by a skimmer can be recovered. In order to maximize oil encounter rate, boom will be deployed in a V-configuration in front of the HOSS barge to funnel oil to the skimmers. If necessary, temporary barges can be activated to support continuous skimming operations. (These barges arrive on-site at approximately the same time as the HOSS barge.) For an on-going release, multiple barges are deployed to provide for continuous off-loading of skimmer storage vessels and shuttling of recovered oil to an onshore waste handling facility. Sufficient barges are available to provide enough temporary storage for continuous recovery operations.

   b. CGA's Fast Response Units (FRU) would arrive on-scene between approximately 17-25 hours of the initial release. These skimmers operate downstream of the HOSS barge and are used to recover pockets and streamers of oil that may move past the large stationary skimmer. Each FRU has 200 barrels of on-board storage. Approval will be requested to decant water after gravity separation, through a hose forward of the skimmer, to optimize temporary storage capacity. A 42" Boom will be utilized to concentrate oil so that it is thick enough to be skimmed.

9. Dispersants, Fast Response Units (FRU), Oil Spill Response Vessels (OSRV or R/V) would typically work daylight hours only. The HOSS barge can operate continuously, including night operations. Available technology will be considered such as remote sensing devices that will enable 24 hour surveillance, trajectories, and planning. All response vessels are designed to be able to remain offshore continuously throughout the response. Even if sea conditions prohibit effective skimming, these resources would remain offshore until skimming operations could be commenced again. Safety would remain the first priority.

10. Prepare Site-Specific Waste Management Plan, Site Safety Plan, Decontamination Plans, Communications and Medical Plans.

11. If oil becomes a threat to any shoreline, data from the aerial surveillance, weather reports, and trajectories would be used to direct onshore teams to deploy protection/containment boom with reference to Area Contingency Plans and in coordination with State and Federal On-Scene Coordinators.

    a. Implement pre-designated strategies.

    b. Identify resources at risk in spill vicinity.

    c. Develop/implement appropriate protection tactics.

12. Establish Site-Specific Wildlife Rescue and Rehabilitation Plan.

The following types of additional support may be required for a blowout lasting 120 days.

- Additional Oil Spill Removal Organization (OSRO) personnel to relieve equipment operators
- Vessels for supporting offshore operations
- Field safety personnel
- Continued surveillance and monitoring of oil movement
- Helicopter, video cameras
- Infra red (night time spill tracking) capabilities, X-band radar
- Barge to transport recovered oil from offshore skimming system, and temporary storage barges to onshore disposal sites that are identified in Area Contingency Plans (ACP)
- Logistics needed to support equipment:
    - Staging areas
    - Parts, trailers, and mechanics to maintain skimmers and boom
    - Fueling facilities
    - Decontamination stations
    - Dispersant stockpile transported from Houston to Houma or other potential command post locations
    - Communications equipment and technicians

- Logistics needed to support responder personnel
  - Medical aid stations
  - Safety personnel
  - Food
  - Berthing
  - Additional clothing/safety supplies
  - Decontamination stations

Louisiana CZM Containment Response Information

Anadarko has the capability to respond and contain, to the maximum extent practicable as defined in 30 CFR 254.6 and 30 CFR 250.26(d)(1), to the estimated worst case discharge (WCD) associated with the proposed activity within 30 days. Deployment time for surface containment equipment is subject to availability and location, weather conditions, potential security zones around the spill site, and site/well specific assessment data. Personnel safety is always first and foremost. Refer to further details on equipment and timing provided in **Section H–Oil Spill Information** and **Table H-3** of the EP.

The potential WCD will be further evaluated during the Application for Permit to Drill (APD) process, including the Well Containment Screening Tool (WCST) and associated subsea containment plan for enhanced planning purposes.

There will be no new or unusual technology deployed that has not been previously deployed for Gulf of Mexico oil spill prevention, control, and/or cleanup.

Table H-1

Worst Case Discharge Calculation
(Based on Blowout during Drilling Operations)

Calculations for Uncontrolled Blowout> 10 miles from shore:		**Blocks 84 & 85**
i.	Type of Oil (crude, condensate, diesel)	Crude
ii.	API Gravity	33.0°
iii.	EP Location Used for NTL No. 2015-N01 WCD for MC 84 & 85	SEP MC 84 “H”
iv.	Largest Anticipated WCD Rate during blowout	394,798 BOPD
v.	**WCD Total for Drilling Operations for MC 84 & 85 (> 10 miles from shore):**	394,798 BOPD

Table H-2

Trajectory by Land Segment

Following are the average conditional probabilities (expressed as percent chance) that an oil spill starting at a particular launch area will contact a land segment as included in the BOEM Oil Spill Risk Analysis Model (OSRAM) for the Central and Western Gulf of Mexico. This information can be found on the BOEM website using 3/10/30 day potential impact, as applicable. The results are listed below.

Area/Block	OCS-G	Launch Area	Land Segment and/or Resource	Conditional Probability (%)		
				3 days	10 days	30 days
Mississippi Canyon Blocks 84 & 85 Drill, complete, test, and install subsea trees (67 miles from shore)	G08484 & G08797	C57 Central Planning Area	Cameron, LA	--	--	1
			Vermilion, LA	--	--	1
			Terrebonne, LA	--	--	2
			Lafourche, LA	--	--	2
			Plaquemines, LA	--	--	21
			St. Bernard, LA	--	--	**3**
			Hancock & Harrison, MS	--	--	1
			Jackson, MS	--	--	1
			Mobile, AL	--	--	1
			Baldwin, AL	--	--	1
			Escambia, AL	--	--	1
			Okaloosa, FL	-	-	1
			Walton, FL	-	-	1
			Bay, FL	-	-	1

Table H-3

WCD Scenario Drilling Activities – Based on a single well uncontrolled blowout (67 miles from shore)
Mississippi Canyon Blocks 84 & 85
394,798 BOPD (initial volume)
351.370 BOPD (after evaporation/dispersion)
API Gravity 33.0°

Offshore Equipment from Spill Detection to Equipment Deployment Response Time: Mississippi Canyon Blocks 84 and 85

Offshore Equipment				Owner/Location	Initial Staging	Hours to Staging Area	Time to Procure (1)	Time to Load Out (2)	Travel Time (Staging/ Spill) (3)	Time to Deploy (4)	Total Estimated Response Time
Type	Derated Capacity (bbls)	Storage (bbls)	No. of Units/ Persons								
Basler Spray Aircraft	--	--	1	ASI/Houma	Houma	0					
DC 3 Spray Aircraft	--	--	2			0					
Aero Commander			2			1	1	1	2	0	4
HOSS Barge	43,000	4,000	1	CGA/Harvey	Harvey	1					
Operators			8	STARS		2					
Tugs			3	VOO		4	4	0	36	1	41
Deep Blue Responder	18,086	4,000	1	MSRC/Fourchon	Fourchon	0					
LFF 100 Brush + OSRV			1			2					
6,600' 44" Sea Sentry Boom			14 crew			2					
660' 67" LAMOR							2	0	34	1	37
FRU	4,251	200	1	CGA/Ingleside	Ingleside	0					
Operators			6	STARS		2					
Utility Boat			1	VOO		2	1	2	23	1	27
FRU	4,251	200	1	CGA/Galveston	Galveston	0					
Operators			6	STARS		2					
Utility Boat			1	VOO		2	1	2	17	1	21
FRU	4,251	200	1	CGA/Lake Charles	Cameron	.5					
Operators			6	STARS		2					
Utility Boat			1	VOO		2	1	2	16.5	1	20.5
FRU	4,251	200	1	CGA/Harvey	Harvey	.5					
Operators			6	STARS		2					
Utility Boat			1	VOO		2	1	2	15	1	19
FRU	8,502	400	2	CGA/Venice	Venice	0					
Operators			12	STARS		2					
Utility Boat			2	VOO		2	1	2	14	1	18
FRU	8,502	400	2	CGA/Leeville	Leeville	.5					
Operators			12	STARS		2					
Utility Boat			2	VOO		2	1	2	12	1	16
Koseq Skimming Arms	17,830		1 set	CGA/Fourchon	Fourchon	0					
Operators			6	STARS		2					
Vessel w/ storage/hull		2,000	1	VOO		2	1	12	12	1	26

Spill Team Area Responders (STARS) called out by Marine Spill Response Corporation (MSRC)
Vessel of Opportunity=VOO
EMS=Enterprise Marine Services (available through contract with CGA)
T&T=T&T Marine (available through contract with CGA)

Offshore Equipment, cont.				Owner/Location	Initial Staging	Hours to Staging Area	Time to Procure (1)	Time to Load Out (2)	Travel Time (Staging/ Spill) (3)	Time to Deploy (4)	Total Estimated Response Time
Type	Derated Capacity (bbls)	Storage (bbls)	No. of Units/ Persons								
MSRC 452 Offshore Barge Tugs 1 Crucial Disk 88/30 1,980' 44" Sea Sentry II Boom 660' 67" LAMOR	11,122	45,000	1 3 1 6 crew	MSRC/Fort Jackson VOO	Fort Jackson	1	2	0	37	1	40
CTCo 5001 Operators Tug	--	47,000	1 12 2	EMS/Amelia STARS VOO	Amelia	0 2 4	4	0	32	1	37
CTCo 2607 Operators Tug	--	23,000	1 6 1	EMS/Amelia STARS VOO	Amelia	0 2 4	4	0	32	1	37
CTCo 2608 Operators Tug	--	23,000	1 6 1	EMS/Amelia STARS VOO	Amelia	0 2 4	4	0	32	1	37
10,000' 42" Auto Boom VOO	--	--	40 20 crew	CGA/Harvey STARS	Harvey	.5 2	1	2	15	1	19
5,000' 42" Auto Boom VOO	--	--	20 10 crew	CGA/Lake Charles STARS	Cameron	.5 2	1	2	16.5	1	20.5
5,000' 42" Auto Boom VOO	--	--	20 10 crew	CGA/Galveston STARS	Galveston	0 2	1	2	17	1	21
2,500' 42" Auto Boom VOO	--	--	12 6 crew	CGA/Ingleside STARS	Ingleside	0 2	1	2	23	1	27
2,500' 42" Auto Boom VOO	--	--	12 6 crew	CGA/Pascagoula STARS	Pascagoula	0 2	1	2	20	1	24
6,679' 44" Sea Sentry II Boom VOO	--	--	20 10 crew	MSRC/Lake Charles STARS	Lake Charles	0 2	1	2	23	1	27
1,980' 44" Sea Sentry II Boom VOO	--	--	12 6 crew	MSRC/Fort Jackson STARS	Fort Jackson	0 2	1	2	23.5	1	27.5
22,400' 42" Boom VOO	--	--	80 25 crew	AMPOL/New Iberia	New Iberia	0 2	1	2	14	1	18
4,800' 42" Boom VOO	--	--	18 9 crew	AMPOL/Harvey	Harvey	0 2	1	2	15	1	19
Spotter Helo	--	--	1	PHI/Fourchon	Spill Site	1	1	--	1.5	--	2.5
Surveillance Helo	--	--	1	PHI/Fourchon	Spill Site	1	1	--	1.5	--	2.5
Hand Held Radios	--	--	30	STARS	Fourchon	1.5	1.5	--	2	--	3.5
Total	124,046	149,600									

Nearshore Equipment from Spill Detection to Equipment Deployment Response Time: Mississippi Canyon Blocks 84 and 85

Nearshore Equipment*				Owner/Location	Initial Staging	Hours to Staging Area	Time to Procure (1)	Time to Load Out (2)	Travel Time (Staging/ Spill) (3)	Time to Deploy (4)	Total Estimated Response Time
Type	Derated Capacity (bbls)	Storage (bbls)	No. of Units/ Persons								
Basler Spray Aircraft DC 3 Spray Aircraft Aero Commander	--	--	1 2 2	ASI/Houma	Houma	0 0 1	1	1	1	0	3
Trinity SWS Operators	21,500	249	1 4	CGA/Leeville STARS	Fourchon	0 2	1	2	25	1	29
Trinity SWS Operators	21,500	249	1 4	CGA/Morgan City STARS	Morgan City	0 2	1	2	26	1	30
SWS Egmopol Operators	3,000	100	1 3	CGA/Galveston STARS	Galveston	0 2	1	2	35	0	38
SWS Egmopol Operators	3,000	100	1 3	CGA/Morgan City STARS	Morgan City	.5 2	1	2	32	0	35
SWS Marco Operators	3,588	34	1 3	CGA/Leeville STARS	Leeville	.5 2	1	2	20	0	23
SWS Marco Operators	3,588	20	1 3	CGA/Lake Charles STARS	Cameron	.5 2	1	2	30	0	33
R/V Grand Bay Operators	5,000	65	1 3	CGA/Venice STARS	Venice	.5 2	2	.5	9	0	11.5
R/V RW Armstrong Operators	5,000	65	1 3	CGA/Leeville STARS	Leeville	.5 2	2	.5	8	0	10.5
R/V Bastian Bay Operators	5,000	65	1 3	CGA/Lake Charles STARS	Cameron	.5 2	2	.5	10.5	0	13
R/V Timbalier Bay Operators	5,000	65	1 3	CGA/Galveston STARS	Galveston	0 2	2	.5	11	0	20
CTCo 2604 Operators Tugs	--	20,000	1 6 1	EMS/Amelia	Amelia	0 2 4	4	0	16	1	21
CTCo 2605 Operators Tugs	--	20,000	1 6 1	EMS/Amelia	Amelia	0 2 4	4	0	16	1	21
CTCo 2606 Operators Tugs	--	20,000	1 6 1	EMS/Amelia	Amelia	0 2 4	4	0	16	1	21
CTCo 2609 Operators Tugs	--	23,000	1 6 1	EMS/Amelia	Amelia	0 2 4	4	0	16	1	21
2,000' Beach Boom	--	--	6	CGA/Galveston	Galveston	0	1	2	17	2	22
1,000' Beach Boom	--	--	4	CGA/Ingleside	Ingleside	0	1	2	23	2	28
2,000' Beach Boom	--	--	6	CGA/Pascagoula	Pascagoula	0	1	2	20	2	25
10,000' 18" Boom VOO	--	--	10 4 crew	Oil Mop/New Iberia	New Iberia	0 2	1	1	15	3	20
10,000' 18" Boom VOO	--	--	10 4 crew	Oil Mop/Houston	Houston	1 2	1	1	10	3	15

Nearshore Equipment, cont.				Owner/Location	Initial Staging	Hours to Staging Area	Time to Procure (1)	Time to Load Out (2)	Travel Time (Staging/ Spill) (3)	Time to Deploy (4)	Total Estimated Response Time
Type	Derated Capacity (bbls)	Storage (bbls)	No. of Units/ Persons								
10,000' 18" Boom VOO	--	--	10 4 crew	Oil Mop/Port Arthur	Port Arthur	0 2	1	1	9.5	3	14.5
10,000' 18" Boom VOO	--	--	10 4 crew	Oil Mop/Houma	Fourchon	.5 2	1	1	12.5	3	17.5
10,000' 18" Boom VOO	--	--	10 4 crew	Oil Mop/Port Allen	Port Allen	0 2	1	1	16	3	21
20,000' 18" Boom VOO	--	--	20 8 crew	Oil Mop/Belle Chasse	Venice	.5 2	1	1	14	6	22
15,000' 18" Boom VOO	--	--	14 6 crew	Oil Mop/Gretna	Gretna	0 2	1	1	15	4	21
31,500' 18" Boom VOO	--	--	10 30 crew	AMPOL/New Iberia	New Iberia	0 2	0	.5	15	2	17.5
22,700' 18" Boom VOO	--	--	8 24 crew	AMPOL/Harvey	Harvey	0 2	0	1	15	2	18
Wildlife Support Trailer	--	--	1/ 2 crew	CGA/Harvey	Harvey	.5	1	2	6	3	12
Bird Scare Cannons	--	--	2	CGA/Venice	Venice	.5	1	2	4	2	9
Bird Scare Cannons	--	--	1	CGA/Galveston	Galveston	0	1	2	5	2	10
Bird Scare Cannons	--	--	1	CGA/Ingleside	Ingleside	0	1	2	6	2	11
Bird Scare Cannons	--	--	2	CGA/Harvey	Harvey	.5	1	2	4	2	9
Bird Scare Cannons	--	--	2	CGA/Lake Charles	Cameron	.5	1	2	4.5	2	9.5
Bird Scare Cannons	--	--	2	CGA/Pascagoula	Pascagoula	0	1	2	5.25	2	10.25
Spotter Helo	--	--	1	PHI/Fourchon	Spill Site	1	1	--	.5	--	1.5
Surveillance Helo	--	--	1	PHI/Fourchon	Spill Site	1	1	--	.5	--	1.5
Hand Held Radios	--	--	30	STARS	Fourchon	1.5	1.5	--	2	--	3.5
Total	76,176	84,012									

**Some equipment may be used offshore up to approximately 25 miles from shore*

H-3 *(continued)*

Operational Limitations of Response Equipment

- HOSS Barge–8 foot seas
- Fast Response Unit (FRU)–8 foot seas
- Oil Spill Response Vessel (OSRV and R/V)–4 foot seas
- Boom–3 foot seas, 20 knot winds
- Dispersants–winds more than 25 knots, visibility less than 3 nautical miles or ceiling less than 1,000 feet

I
Environmental Monitoring and Environmental Mitigation Measures

(a) Monitoring

If required, Anadarko will monitor loop currents per NTL 2005-G05.

Anadarko subscribes to Wilkins Weather Service which provides real-time weather conditions such as tropical depressions, storms and/or hurricanes entering the Gulf.

(b) Incidental Takes

Although marine mammals may be seen in the area, Anadarko does not believe that its operations proposed under this EP will result in the harassment, capture, collection or killing of any mammals covered by the Marine Mammal Protection Act.

Anadarko will operate in accordance with applicable regulations, including:

NTL No. 2016-G02 – "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program"
BSEE NTL No. 2015-G03 "Marine Trash and Debris Awareness and Elimination", and
JOINT NTL No. 2016-G01 "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting"

J
LEASE STIPULATIONS INFORMATION

Mississippi Canyon Block 84 (Lease Sale # 104), and Mississippi Canyon Block 85 (Lease Sale # 110) :

Protected Species Stipulation: This stipulation requires operators to collect and remove flotsam resulting from their activities; to post signs detailing why release of debris must be eliminated; watch for protected marine mammals and see turtles (includes speed and distance parameters if mammals or turtles are sited); reports sightings and locations of dead or injured marine mammals or turtles and if the operators activities are responsible remain available to assist in the recovery and comply with applicable mitigation measures when conducting seismic operations. It also requires operators to comply with applicable Notices to Lessees which contain further restrictions regarding protection of marine mammals and turtles.

All activities will be conducted in accordance to NTL 2015-G03 “Marine Trash and Debris Awareness Training and Elimination” and NTL 2016-G01 “Vessel Strike Avoidance and Injured/Dead Protected Species Reporting”.

Military Warning Area Stipulation: Mississippi Canyon Blocks 84 and 85 are located within designated Military Warning Area W-155C. Anadarko will contact the Fleet Area Control and Surveillance in Pensacola, Florida in order to coordinate and control the electromagnetic emissions during these proposed operations.

Protection of Archaeological Resources: Mississippi Canyon Blocks 84 and 85 have been determined to be located in an area where archaeological resources may exist. In accordance with NTL 2005-G07, “Archaeological Surveys and Reports,” and NTL 2001-JOINT-G01, “Revisions to the List of OCS Lease Blocks Requiring Archaeological Resource Surveys and Reports,” an archaeological survey report was submitted for Mississippi Canyon Blocks 84 and 85 with EP (Control No. S-7638) approved June 11, 2014.

K
Support Vessels and Aircraft Information

(a) General

Type	Max. Total Fuel Tank Storage Capacity	Max. No. in Area at any Time	Trip Frequency or Duration
Supply Vessel	336,227 gallons	1	2 trips/week
Helicopter	735.3 gallons	1	10 trips/week
Crew Vessel	70,000 gallons	1	3 trips/week
Support Vessel	450,698 gallons	1	3 days total/well
Tug Boats	N/A	N/A	N/A

(b) Diesel Oil Supply Vessels

Fuel for the rig will be transported via a supply vessel as follows:

a. Size of fuel supply vessel:	230 feet
b. Carrying capacity of fuel supply vessel:	336,227 gallons
c. Frequency that fuel supply vessel will visit the facilities:	Twice per week
d. Routes the fuel supply vessel will use to travel between the onshore support base and proposed facility:	Shortest route from shore-base to block

(c) Vicinity Map

A vicinity map is included in this section as **Attachment K-1.**

(d) Produced Liquid Hydrocarbons Transportation Vessels

Produced liquid hydrocarbons from future flow tests on wells in Mississippi Canyon Blocks 84 and 85 will be transported by a flowback vessel and/or flowback barge. Anadarko will flare a max volume during the 48-hour flow test period.

Transport Method	Vessel Capacity (estimated)	Average Volume to be Loaded (per vessel)	No. of Transfers (Yearly Average)
Flowback/ Crew Vessel	Proprietary	Proprietary	1-2/well
Flowback Barge	Proprietary	Proprietary	1/well

(e) Summary of Method to Transfer Liquid Hydrocarbons to the Transporting Vessel

Production from the well will be routed through portable surface well test equipment and safety controls aboard the rig. Gas will be flared and liquids (oil & water) will be collected in US Coast Guard approved tanks and a boat/barge. Each well will be produced / cleaned up and measured using various meters through portable surface well test equipment including a separator. A three phase separator will be used to analyze water cut if present. All liquids (hydrocarbons and water) will then be transferred to a coast guard approved flowback vessel or barge via tested & approved petroleum transfer hose. We will have a Safe Breakaway Coupling (KLAW) installed between the hoses connecting the barge-end and the rig-end. If this device parts the KLAW is designed to contain all fluids from both hoses.

(e) Solid and Liquid Wastes Transportation

Type of Waste	Composition	Total Projected Amount	Rate	Transport Method	Name/Location of Facility	Disposal Method
Synthetic-based drilling fluid or mud	Synthetic-based drilling muds	90,000 bbls	15,000 bbls/well	Re-use and/or transport to shore in DOT approved containers.	An approved waste disposal facility will be utilized, such as Port Fourchon, LA and on to Newpark Fourchon Transfer Station #1 & #2. Newpark Transfer Station Morgan City. Newpark Transfer Station Port Arthur. USLL Galveston and Fourchon Transfer Station. If recycled, returned to vendor (Bariod or MI).	Re-used and/or recycled; if can't be reused and/or recycled the waste is disposed of at an approved waste disposal facility, such as Newpark (injection disposal facility) or USLL (landfarm).
Cuttings wetted with synthetic-based muds	Cuttings coated with synthetic drilling muds, including drilled out cement	450-900 bbls	75-150 bbls/well* **An estimated 5-10% of cuttings may be transported to shore*	Re-use and/or transport to shore in DOT approved containers.	An approved waste disposal facility will be utilized, such as Port Fourchon, LA and on to Newpark Fourchon Transfer Station #1 & #2. Newpark Transfer Station Morgan City. Newpark Transfer Station Port Arthur. USLL Galveston and Fourchon Transfer Station. If recycled, returned to vendor (Bariod or MI).	Re-used and/or recycled; if can't be reused and/or recycled the waste is disposed of at an approved waste disposal facility, such as Newpark (injection disposal facility) or USLL (landfarm).
Chemical product waste (well treatment fluids)	Ethylene glycol Methanol	1,700 bbls 425 bbls	100 bbls/month 25 bbls/month	Transport to shore in DOT approved containers for pick up	An approved waste disposal facility will be utilized, such as Chemwaste in Sulphur, LA and Veolia Port Arthur, TX or to Ecoserv, Port Arthur as non-hazardous waste.	Can be returned to vendor and/or used at another facility; MEG is solidified and disposed of in a landfill. Methanol is incinerated or used for fuels blending.
Completion fluids	Brine, spent acid, prop sand, debris, gelled fluids, dead oil	18,000 bbls	3,000 bbls/well	Transport to shore in DOT approved containers and/or vessel tanks for pick up	An approved waste disposal facility will be utilized, such as Port Fourchon, LA and on to Ecoserv Fourchon Transfer Station #1 & #2. Ecoserv Transfer Station Morgan City. Ecoserv Transfer Station Port Arthur. USLL Galveston and Fourchon Transfer Station	Unused brine can be returned to vendor and/or stored for use on another job. Used brine and spent acid is transferred to an approved waste disposal facility, such as Ecoserv's Processing & Transfer facility for injection.

Workover fluids/ Stim fluids	Brine, spent acid, prop sand, debris, gelled fluids, dead oil	18,000 bbls	3,000 bbls/well	Transport to shore in DOT approved containers and/or vessel tanks for pick up	An approved waste disposal facility will be utilized, such as Port Fourchon, LA and on to Ecoserv Fourchon Transfer Station #1 & #2. Ecoserv Transfer Station Morgan City. Ecoserv Transfer Station Port Arthur. USLL Galveston and Fourchon Transfer Station	Unused brine can be returned to vendor and/or stored for use on another job. Used brine and spent acid is transferred to an approved waste disposal facility, such as Ecoserv's Processing & Transfer facility for injection.
Trash and debris	Refuse generated during operations	850 bbls	50 bbls/month/well	Transport to shore in disposal bags or DOT approved containers by vessel to shorebase for pickup by municipal operations	An approved waste disposal facility will be utilized, such as Recycled Material in ARC, New Iberia, LA, or trash disposal at SWDI landfill.	Recycled and/or disposed in landfill.
Used oil	Excess oil from engines	1,828 bbls	430 bbls/120 days/well	Transport in DOT approved containers to shore for pick up	An approved waste disposal facility will be utilized, such as American Recovery Fourchon, LA	Recycled

**** Total amount assumes drilling and completing six wells with 510 total number of days (eighty-five days to drill and complete each well).***

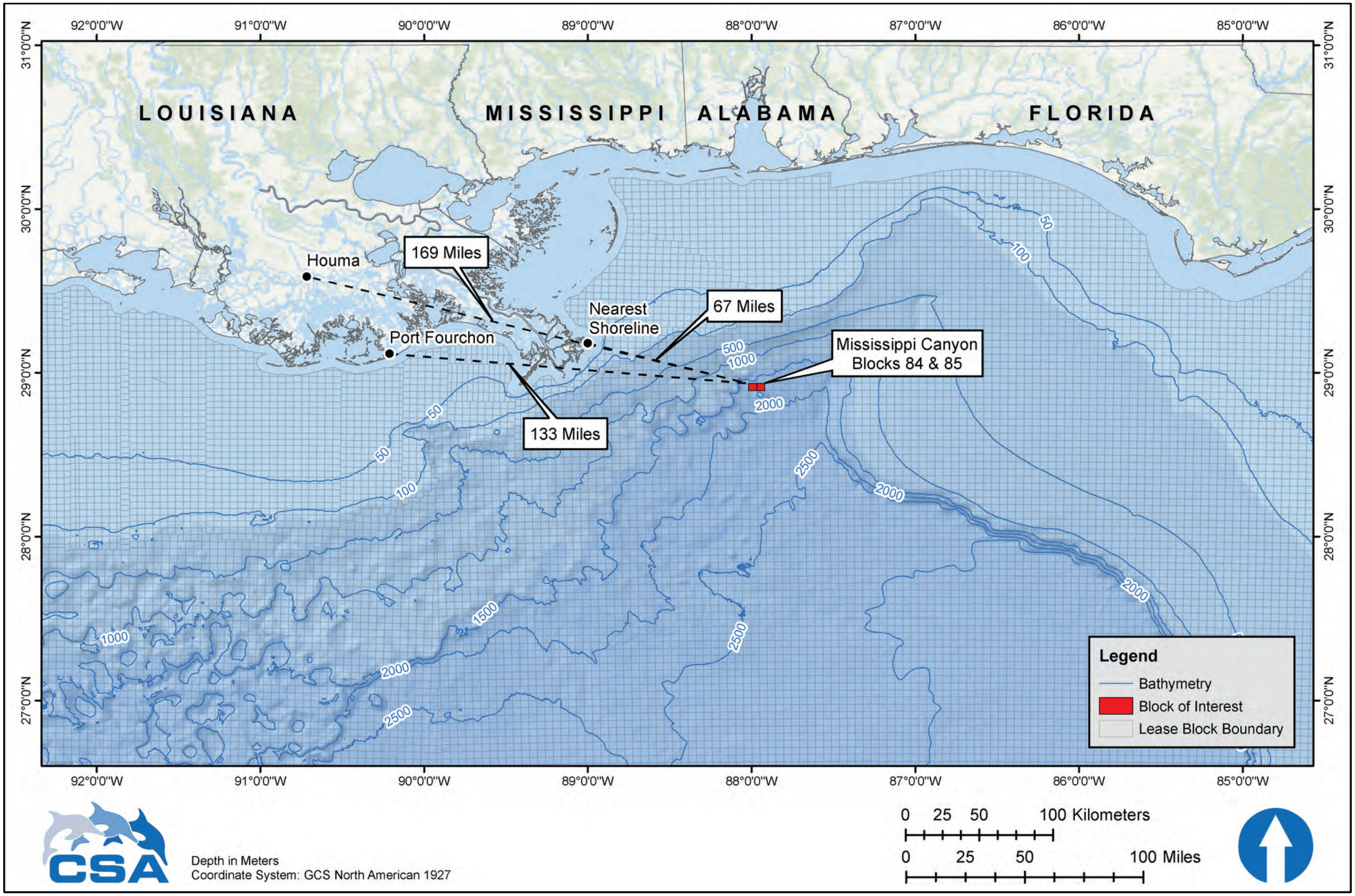

Figure 1. Location of Mississippi Canyon Blocks 84 and 85.

L
ONSHORE SUPPORT FACILITIES INFORMATION

(a) General

Per NTL No. 2008-G04, the following tables reflect the onshore facilities Anadarko may utilize to provide supplies and service support for the activities proposed in this EP.

Name	Primary Location(s)	Existing/New/Modified
Anadarko Service Base	Fourchon, Louisiana	Existing
Anadarko Service Base (Helicopter base)	Houma, LA	Existing

Name	*Alternate Locations	Existing/New/Modified
Anadarko Service Base	Galveston, TX	Existing
Anadarko Service Base	Cameron, LA	Existing
Anadarko Service Base	Lake Charles, LA**	Existing
Anadarko Service Base	Houma, LA	Existing
Anadarko Service Base	Pascagoula, MS**	Existing

***In the unlikely event Anadarko's primary service base cannot be utilized Anadarko will exercise the use of an alternate service base during drilling and/or completion operations.**

****Helicopter base**

(b) Support Base

No support base construction or expansion is planned for these activities.

(c) Waste Disposal

Disposed wastes describe those wastes generated by the proposed activity that are disposed of by means other than by release into the water of the GOM at the site where they are generated. These wastes can be disposed of by offsite release, injection, encapsulation, or placement at either onshore or offshore permitted locations for the purposes of returning them back to the environment.

Type of Waste	Composition	Total Projected Amount	Rate	Transport Method	Name/Location of Facility	Disposal Method
Synthetic-based drilling fluid or mud	Synthetic-based drilling muds	90,000 bbls	15,000 bbls/well	Re-use and/or transport to shore in DOT approved containers.	An approved waste disposal facility will be utilized, such as Port Fourchon, LA and on to Newpark Fourchon Transfer Station #1 & #2. Newpark Transfer Station Morgan City. Newpark Transfer Station Port Arthur. USLL Galveston and Fourchon Transfer Station. If recycled, returned to vendor (Bariod or MI).	Re-used and/or recycled; if can't be reused and/or recycled the waste is disposed of at an approved waste disposal facility, such as Newpark (injection disposal facility) or USLL (landfarm).

Cuttings wetted with synthetic-based muds	Cuttings coated with synthetic drilling muds, including drilled out cement	450-900 bbls	75-150 bbls/well* _*An estimated 5-10% of cuttings may be transported to shore_	Re-use and/or transport to shore in DOT approved containers.	An approved waste disposal facility will be utilized, such as Port Fourchon, LA and on to Newpark Fourchon Transfer Station #1 & #2. Newpark Transfer Station Morgan City. Newpark Transfer Station Port Arthur. USLL Galveston and Fourchon Transfer Station. If recycled, returned to vendor (Bariod or MI).	Re-used and/or recycled; if can’t be reused and/or recycled the waste is disposed of at an approved waste disposal facility, such as Newpark (injection disposal facility) or USLL (landfarm).
Chemical product waste (well treatment fluids)	Ethylene glycol Methanol	1,700 bbls 425 bbls	100 bbls/month 25 bbls/month	Transport to shore in DOT approved containers for pick up	An approved waste disposal facility will be utilized, such as Chemwaste in Sulphur, LA and Veolia Port Arthur, TX or to Ecoserv, Port Arthur as non-hazardous waste.	Can be returned to vendor and/or used at another facility; MEG is solidified and disposed of in a landfill. Methanol is incinerated or used for fuels blending.
Completion fluids	Brine, spent acid, prop sand, debris, gelled fluids, dead oil	18,000 bbls	3,000 bbls/well	Transport to shore in DOT approved containers and/or vessel tanks for pick up	An approved waste disposal facility will be utilized, such as Port Fourchon, LA and on to Ecoserv Fourchon Transfer Station #1 & #2. Ecoserv Transfer Station Morgan City. Ecoserv Transfer Station Port Arthur. USLL Galveston and Fourchon Transfer Station	Unused brine can be returned to vendor and/or stored for use on another job. Used brine and spent acid is transferred to an approved waste disposal facility, such as Ecoserv's Processing & Transfer facility for injection.
Workover fluids/ Stim fluids	Brine, spent acid, prop sand, debris, gelled fluids, dead oil	18,000 bbls	3,000 bbls/well	Transport to shore in DOT approved containers and/or vessel tanks for pick up	An approved waste disposal facility will be utilized, such as Port Fourchon, LA and on to Ecoserv Fourchon Transfer Station #1 & #2. Ecoserv Transfer Station Morgan City. Ecoserv Transfer Station Port Arthur. USLL Galveston and Fourchon Transfer Station	Unused brine can be returned to vendor and/or stored for use on another job. Used brine and spent acid is transferred to an approved waste disposal facility, such as Ecoserv's Processing & Transfer facility for injection.
Trash and debris	Refuse generated during operations	850 bbls	50 bbls/month/well	Transport to shore in disposal bags or DOT approved containers by vessel to shorebase for pickup by municipal operations	An approved waste disposal facility will be utilized, such as Recycled Material in ARC, New Iberia, LA, or trash disposal at SWDI landfill.	Recycled and/or disposed in landfill.

Used oil	Excess oil from engines	1,828 bbls	430 bbls/120 days/well	Transport in DOT approved containers to shore for pick up	An approved waste disposal facility will be utilized, such as American Recovery Fourchon, LA	Recycled

**** Total amount assumes drilling and completing six wells with 510 total number of days (eighty-five days to drill and complete each well).***

M

COASTAL ZONE MANAGEMENT ACT INFORMATION

STATE OF LOUISIANA

CONSISTENCY CERTIFICATION FOR

SUPPLEMENTAL EXPLORATION PLAN

MISSISSIPPI CANYON BLOCKS 84 & 85

OCS-G 08484 & 08797

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

Anadarko Petroleum Corporation

Jill Wiederhold

Jill Wiederhold, Certifying Official
May, 2019

ALABAMA COASTAL ZONE MANAGEMENT
CONSISTENCY CERTIFICATION
EP – MISSISSIPPI CANYON BLOCKS 84 & 85

The OCS related oil and gas development activities having potential impact on the Alabama Coastal Zone are based on the location of the proposed facilities, access to those sites, best practical techniques for operations and production equipment, guidelines for the prevention of adverse environmental effects, effective environmental protection, emergency plans and contingency plans. Alabama policies have been addressed below or are cross referenced to the appropriate sections of the plan:

Topic	Cross Reference	Comments
Coastal Resource Use Policies		
Coastal Development		Dock and port facilities in LA will be used. There will be no new construction, dredging, or filling in Alabama state waters. There will be no new commercial development or capital improvements in Alabama's coastal zone, nor will there be any employment effects.
Mineral Resource Exploration and Extraction		Proposed exploration operations will take place 94 miles from Alabama's shore.
Commercial Fishing	Section N	
Hazard Management	Section C	A Shallow Hazards Report has been prepared and previously submitted to BOEM in order to identify and assess the seafloor and shallow geologic conditions in this block(s).
Shoreline Erosion	Section N	Proposed exploration operations will take place 94 miles from Alabama's shore.
Recreation	Section N	
Transportation	Section K, L, N	
Natural Resource Protection Policies		
Biological Productivity	Section N	
Water Quality	Section N	
Water Resources	Section N	
Air Quality	Section N	
Wetlands and Submerged Grassbeds	Section N	
Beach and Dune Protection	Section N	
Wildlife Habitat Protection	Section N	
Endangered Species	Section N	
Cultural Resources Protection	Section N	Mississippi Canyon Block 84 and 85 is located in an area where historic shipwrecks may exist. The archaeological report covering Mississippi Canyon Blocks 84 and 85 is included with this Exploration Plan submittal. No areas in Mississippi Canyon Blocks 84 and 85 are recommended for investigation or avoidance on the basis of archaeological potential.

STATE OF ALABAMA

CONSISTENCY CERTIFICATION FOR

SUPPLEMENTAL EXPLORATION PLAN

MISSISSIPPI CANYON BLOCKS 84 & 85

OCS-G 08484 & 08797

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

Anadarko Petroleum Corporation

Jill Wiederhold

Jill Wiederhold, Certifying Official
May, 2019

TEXAS COASTAL MANAGEMENT PROGRAM

The following is an evaluation that includes findings relating the coastal effects of the proposed activities and associated facilities to the relevant enforceable policies of the Texas' Coastal Management Program (TCMP), Title 31, Part 16, Chapter 501, Subchapter B*:*

(Category 2)

Construction, Operation & Maintenance of Oil & Gas Exploration & Production Facilities

No operations are proposed in or near any critical areas. The proposed activities are explorative in nature, so no facility construction is proposed. The proposed activities are located approximately 320 miles from the Texas shoreline; therefore we expect no adverse impacts to CNRAs or beach access and use rights of the public. All activities shall be conducted in a manner that minimizes significant impacts to coastal resources. No adverse effects to Texas' coastal area are expected in association with the proposed activities.

(Category 3)

Discharges of Wastewater and Disposal of Waste from Oil and Gas Exploration and Production Activities

No discharge of wastewater or disposal of waste from the proposed activities will occur in the Texas' coastal zone; therefore no impact to Texas' coastal waters is expected.

(Category 4)

Construction and Operation of Solid Waste Treatment, Storage, and Disposal Facilities

No construction of solid waste facilities or expansion of existing facilities in the coastal zone are proposed in the attached plan, therefore, no adverse effects on any features of Texas' coastal cone are expected.

(Category 5)

Prevention, Response, and Remediation of Oil Spills

The proposed activities will be covered under an approved Regional Oil Spill Response Plan. The plan is in place, practiced, and updated as necessary. The best practical techniques shall be utilized to prevent the release of pollutants or toxic substances into the environment. All involved vessels and facilities are designed to be capable of prompt response and adequate removal of accidental discharges of oil. In addition, the proposed activities are 320 miles from shore; therefore no damages to natural resources are expected as the result of an unauthorized discharge of oil into coastal waters.

(Category 6)

Discharge of Municipal and Industrial Waste Water to Coastal Waters

No discharges from the proposed activities will occur in coastal waters. The proposed activities are 320 miles from shore; therefore there will be no effect on coastal waters.

(Category 8)
Development in Critical Areas

None of the proposed activities will occur in a critical area; therefore no effects to Texas' coastal zone are expected. The activity will not jeopardize the continued existence of species listed as endangered or threatened, and will not result in likelihood of the destruction or adverse modification of a habitat determined to be a critical habitat under the Endangered Species Act. The activity will not cause or contribute to violation of any applicable surface water quality standards. The activity will not violate any requirement imposed to protect a marine sanctuary.

(Category 9)
Construction of Waterfront Facilities and Other Structures on Submerged lands

No waterfront facilities or other structures are proposed on submerged lands in the Texas coastal zone, therefore the proposed activities are not expected to have any adverse impacts on submerged lands.

(Category 10)
Dredging and Dredged Material Disposal and Placement

No dredging or disposal/placement of dredged material is proposed; therefore no adverse effects to coastal waters, submerged lands, critical areas, coastal shore areas, or Gulf beaches are expected.

(Category 11)
Construction in the Beach / Dune System

The proposed activities do not include any construction projects in critical dune areas or areas adjacent to or on Gulf beaches, therefore, no impact to Texas' beach or dune systems are expected.

(Category 15)
Alteration of Coastal Historic Areas

The proposed activities do not include any alteration or disturbance of a coastal historic area; therefore, no impacts are expected to adversely affect any historical, architectural, or archaeological site in Texas' coastal zone.

(Category 16)
Transportation

The proposed activities do not include any transportation construction projects within the coastal zone; therefore, no impacts to Texas' coastal zone are expected.

(Category 17)
Emission of Air Pollutants

The proposed activities shall be carried out in conformance with applicable air quality laws, standards, and regulations. Emissions from the proposed activities are not expected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline. The proposed activities will occur approximately 320 miles from shore and will be within the exemption limits set by BOEM, therefore, no impacts to Texas' coastal zone is expected.

(Category 18)
Appropriations of Water

The proposed activities do not include the impoundment or diversion of state water, therefore, no impacts to Texas' coastal zone is expected.

(Category 20)
Marine Fishery Management

The proposed activities are located approximately 320 miles from shore and are not expected to have any effect on marine fishery management or fishery migratory patterns within waters in the coastal zone of Texas.

(Category 22)
Administrative Policies

The necessary information for applicable agencies to make an informed decision on the proposed activities has been provided In conclusion, all activities shall be consistent with Texas' coastal management program and shall comply with all relevant rules and regulations. No activities are planned within any critical areas. Activities will be carried out avoiding unnecessary conflicts with other uses of the vicinity.

STATE OF TEXAS

CONSISTENCY CERTIFICATION FOR

SUPPLEMENTAL EXPLORATION PLAN

MISSISSIPPI CANYON BLOCKS 84 & 85
OCS-G 08484 & 08797

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

Anadarko Petroleum Corporation

Jill Wiederhold

Jill Wiederhold, Certifying Official
May, 2019

MISSISSIPPI COASTAL ZONE MANAGEMENT ACT INFORMATION

As authorized by the Federal Coastal Zone Management Act (CZMA), The State of Mississippi developed a Coastal Management Program (CMP) to allow for the review of proposed Federal license and permit activities affecting any coastal use or resources, in or outside of the Mississippi Coastal Zone.

The OCS related oil and gas exploratory and development activities having potential impact on the Mississippi Coastal Zone are based on the location of the proposed facilities, access to those sites, best practical techniques for drilling locations, drilling equipment guidelines for the prevention of adverse environmental effects, effective environmental protection, emergency plans and contingency plans.

Below are goals identified by the State of Mississippi and our comments and/or corresponding cross references:

Goal 1: To provide for reasonable industrial expansion in the coastal area and to ensure the efficient utilization of waterfront industrial sites so that suitable sites are conserved for water dependent industry.

The activities proposed in this plan are based out of Fourchon, Louisiana. The activities will not provide any industrial expansion on the coastal area of Mississippi. Therefore Mississippi coastal areas will be conserved for water dependent industry.

Goal 2: To favor the preservation of the coastal wetlands and ecosystems, except where a specific alteration of specific coastal wetlands would serve a higher public interest in compliance with the public purposes of the public trust in which the coastal wetlands are held.

Goal 2 is addressed in Section N, Environmental Impact Analysis. The nearest proposed activities will be 85 miles from the Mississippi coast.

Goal 3: To protect, propagate and conserve the state's seafood and aquatic life in connection with the revitalization of the seafood industry of the State of Mississippi.

Goal 3 is addressed in Section N, Environmental Impact Analysis. Little impact to the seafood industry can be expected due to the activities occurring 85 miles from the Mississippi coast.

Goal 4: To conserve the air and waters of the state, and to protect, maintain and improve the quality thereof for public use, for the propagation of wildlife, fish and aquatic life, and for domestic, agricultural, industrial, recreational and other legitimate beneficial uses.

Goal 4 is addressed in Section B, General Information, Section G, Air Emissions Information, and Section N, Environmental Impact Analysis.

Goal 5: To put to beneficial use to the fullest extent of which they are capable the water resources of the state, and to prevent the waste, unreasonable use, or unreasonable method of use of water.

The activities proposed in this plan are based in Fourchon, Louisiana. As such, Mississippi's water resources should not be impacted by the proposed activities. Activities occurring at the sites in the OCS will be conducted in accordance with our Regional Oil Spill Response Plan referenced in Section H of this plan.

Goal 6: To preserve the state's historical and archaeological resources, to prevent their destruction, and to enhance these resources wherever possible.

Goal 6 is addressed in Section E, Biological, Physical and Socioeconomic Information, and Section N, Environmental Impact Analysis.

Goal 7: To encourage the preservation of natural scenic qualities in the coastal area.

Goal 7 is addressed in Section F, Waste Discharges Information, Section H, Oil Spill Information, Section G, Air Emissions Information, and Section N, Environmental Impact Analysis.

Goal 8: To assist local governments in the provision of public facilities services in a manner consistent with the coastal program.

As the proposed activities are located 85 miles from the Mississippi coast and are based out of a shorebase in Fourchon, Louisiana, local governments should not be affected.

STATE OF MISSISSIPPI

CONSISTENCY CERTIFICATION FOR

SUPPLEMENTAL EXPLORATION PLAN

MISSISSIPPI CANYON BLOCKS 84 & 85

OCS-G 08484 & 08797

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

Anadarko Petroleum Corporation

Jill Wiederhold

Jill Wiederhold, Certifying Official
May, 2019

N

ENVIRONMENTAL IMPACT ANALYSIS

Environmental Impact Analysis

For a

SUPPLEMENTAL EXPLORATION PLAN

Mississippi Canyon Blocks 84 and 85
(OCS-G 08484 and OCS-G 08797)
Offshore Louisiana

April 2019

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Environmental Impact Analysis
For a
SUPPLEMENTAL EXPLORATION PLAN
Mississippi Canyon Blocks 84 and 85
(OCS-G 08484 and OCS-G 08797)
Offshore Louisiana

DOCUMENT NO. CSA-ANADARKO-FL-19-3408-01-REP-01-FIN

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Acronyms and Abbreviations

ac	acre
ADIOS2	Automated Data Inquiry for Oil Spills 2
Anadarko	Anadarko Petroleum Corporation
bbl	barrels
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BSEE	Bureau of Safety and Environmental Enforcement
CFR	Code of Federal Regulations
CGA	Clean Gulf Associates
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
dB re 1 µPa^2	decibels relative to 1 micropascal squared
dB re 1 µPa^2 m^2	decibels relative to 1 micropascal squared at 1 meter squared
dB re 1 µPa^2 s	decibels relative to 1 micropascal squared seconds
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
FAD	fish-aggregating device
GPS	global positioning system
GMFMC	Gulf of Mexico Fishery Management Council
H_2S	hydrogen sulfide
ha	hectare
HAPC	Habitat Area of Particular Concern
HOSS	high-volume open sea skimmer
IPF	impact-producing factor
LARS	launch and recovery system
MARPOL	International Convention for the Prevention of Pollution from Ships
MC	Mississippi Canyon
MMC	Marine Mammal Commission
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MODU	mobile offshore drilling unit
MSRC	Marine Spill Response Corporation
MWCC	Marine Well Containment
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
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 muds
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 muds
WCD	worst-case discharge

Introduction

Anadarko Petroleum Corporation (Anadarko) is submitting a Supplemental Exploration Plan (EP) for Mississippi Canyon (MC) Blocks 84 (MC 84) and 85 (MC 85). Under this EP, Anadarko proposes to drill and complete 6 wells: MC 84 G, GG, GGG, H, HH, and HHH. The Environmental Impact Analysis (EIA) provides information on potential environmental impacts of Anadarko's proposed drilling activities for these exploration wells.

The project area is approximately 67 miles (108 km) from the nearest shoreline (Louisiana), 133 miles (214 km) from the onshore support base at Port Fourchon, Louisiana, and 169 miles (272 km) from the helicopter base at Houma, Louisiana (**Figure 1**). The water depth at the proposed wellsites ranges from approximately 5,093 to 5,179 ft (1,552 to 1,579 m). The mobile offshore drilling unit (MODU) has not yet been determined, but will be a dynamically positioned (DP) drillship or DP semisubmersible rig. Drilling operations are expected to require approximately 85 days per well, inclusive of drilling and completion activities.

The EIA for this EP was prepared for submittal to 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 Anadarko's planned activities under this EP. The EIA complies with guidance provided in existing Notices to Lessees and Operators (NTLs) issued by BOEM and its predecessors, Minerals Management Service (MMS) and Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), including NTLs 2008-G04 (extended by 2015-N02) and 2015-N01. Potential impacts from oil and gas operations were 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 lease sale EISs for the Western and Central Gulf of Mexico Planning Areas (BOEM, 2012a; b; 2013b; 2014b; 2015a; 2016c; 2017a; b). The most recent lease sale EISs contain updated environmental baseline information in light of the Macondo (*Deepwater Horizon*) incident and addressed potential impacts of a catastrophic spill (BOEM, 2012a; b; 2013b; 2014b; 2015a; 2016c; 2017a; b). The analyses from those documents are incorporated here by reference.

All the proposed activities and facilities discussed in this EP are covered by Anadarko's Gulf of Mexico Regional Oil Spill Response Plan (OSRP) last approved on 14 August 2015 for Anadarko and its subsidiary, Anadarko US Offshore LLC (Company Numbers 00981 and 02219, respectively), in accordance with 30 CFR Part 254. The June 2017 biennial updates were acknowledged by the Bureau of Safety and Environmental Enforcement (BSEE) on 12 July 2017; 5 October 2017 updates were acknowledged by BSEE on 2 November 2017. Non-regulatory required OSRP updates were submitted to BSEE on 19 June 2018 and acknowledged as in compliance in 18 July 2018. The OSRP details Anadarko's plan to rapidly and effectively manage oil spills that may result from drilling and production operations. Anadarko 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. Anadarko'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 Anadarko'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 to be taken and notifications necessary in the event of a spill.

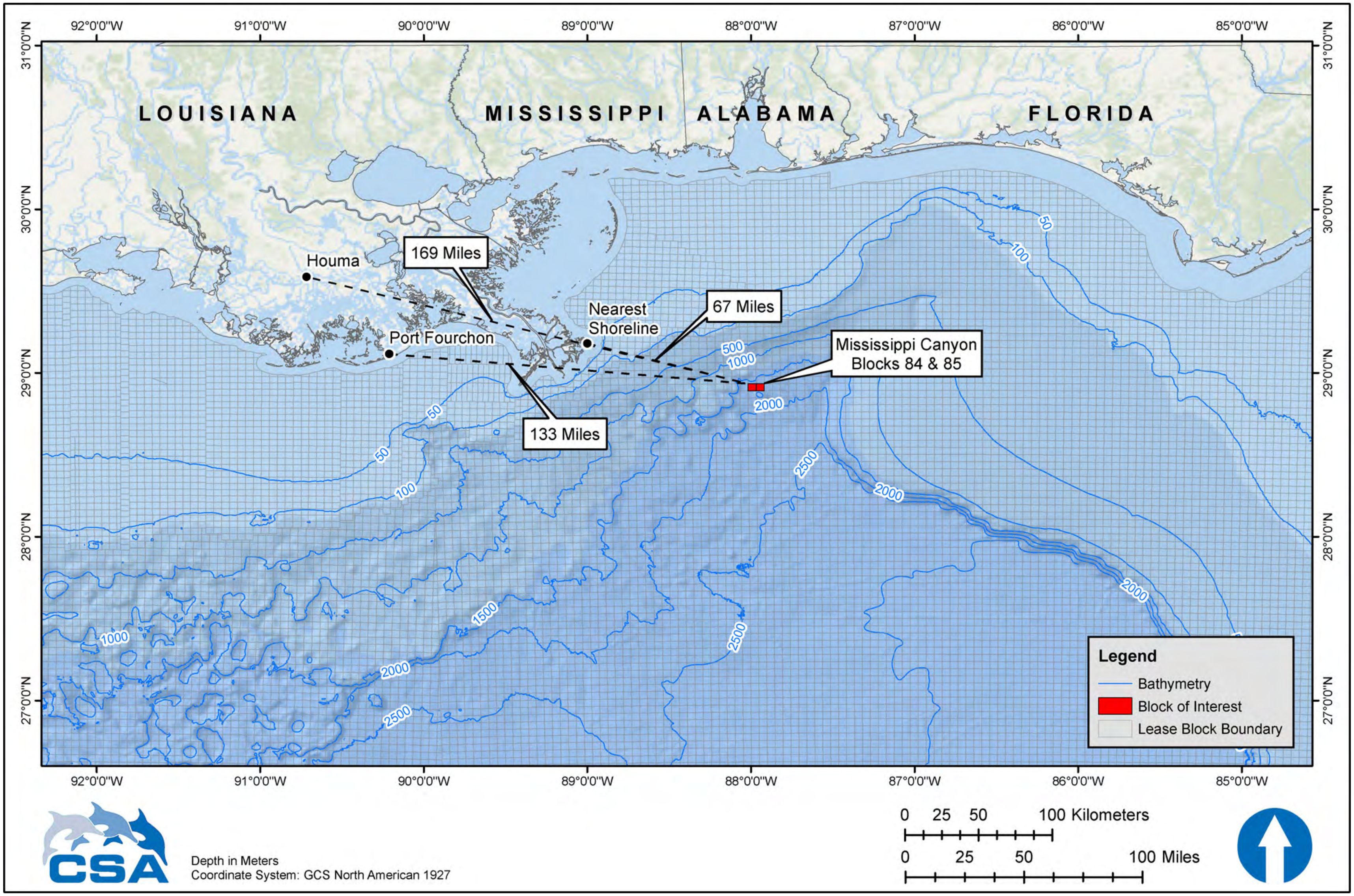

Figure 1. Location of Mississippi Canyon Blocks 84 and 85.

Sections A through **I** of the EIA provide information required by NTL 2008-G04 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 that are applicable to the EIA.

Table 1. Notices to Lessees and Operators (NTLs) that are applicable to the 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.
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.
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 Bureau of Ocean Energy Management (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 (WCD) and Blowout Scenarios	Provides guidance regarding information required in WCD descriptions and blowout scenarios.
BOEM 2014-G04	Military Warning and Water Test Areas	Provides contact links to individual command headquarters for military warning and water test areas in the Gulf of Mexico.
BSEE 2014-N01	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 BSEE website.
BSEE 2012-N06	Guidance to Owners and Operators of Offshore Facilities Seaward of the Coast Line Concerning Oil Spill Response Plans (OSRPs)	Provides clarification, guidance, and information concerning the preparation of an OSRP; and recommends the description of a response strategy for WCD scenarios to ensure that the 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 on which OCS blocks require archaeological surveys and reports; and 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 or surface blowout preventers 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); and informs operators that BOEM will evaluate 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); and 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 the 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 Anadarko'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 (IPFs) 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 resource and a dash (--) indicates no impact or negligible impact. Where there may be an impact, an analysis is provided in **Section C**. The potential IPFs for the proposed activity are discussed in the following subsections:

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

Table 2. Matrix of impact-producing factors and potentially affected environmental resources.

Environmental Resources	Impact-Producing Factors									
	MODU Presence (including noise and lights)	Physical Disturbance to Seafloor	Air Pollutant Emissions	Effluent Discharges	Water Intake	Onshore Waste Disposal	Marine Debris	Support Vessel/Helicopter Traffic	Accidents	
									Small 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)
Oceanic whitetip shark (threatened)	**X**	--	--	--	--	--	--	--	--	**X**(6)
Giant manta ray (threatened)	**X**	--	--	--	--	--	--	--	--	**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)
Coastal 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										
Coastal Habitats and Protected Areas	--	--	--	--	--	--	--	**X**	--	**X**(6)
Socioeconomic and Other Resources										
Recreational and commercial fishing	**X**	--	--	--	--	--	--	--	**X**(6)	**X**(6)
Public health and safety	--	--	--	--	--	--	--	--	--	**X**(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:

(1) *Activities that may affect a marine sanctuary or topographic feature. Specifically, if the well, platform 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, or no-activity zone. There are no known submarine banks in the project area.

(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 project 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 project area.

(4) *Activities on blocks designated by the BOEM as being in water depths 300 m or greater.*
   - No impacts on high-density deepwater benthic communities are anticipated. There are no features that could support significant high-density deepwater benthic communities within 2,000 ft (610 m) of the proposed project location (Geoscience Earth & Marine Services Inc., 2016; Oceaneering International Inc, 2019b; a). Because a dynamic positioning (DP) drilling vessel will be used, there will be no seafloor disturbances from the use of anchors.

(5) *Exploration or production activities where hydrogen sulfide (H_2S) concentrations greater than 500 ppm might be encountered.*
   - Mississippi Canyon Blocks 84 and 85 were classified as H_2S absent under a previously approval Initial Exploration Plan.

(6) *All activities that could result in an accidental spill of produced liquid hydrocarbons or diesel fuel that you determine would 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 "Accidents" portion of 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, although the blocks in the project area are on BOEM's list of archaeology survey blocks (BOEM, 2011). A dynamically positioned mobile offshore drilling unit (MODU) will be used; therefore, seafloor disturbances due to anchoring will not occur. No unidentified side-scan sonar targets were noted within 2,000 ft (610 m) of the location of the proposed wellsites (Oceaneering International Inc, 2019b; a).

(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 drilling vessel presence and emissions, vessel 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.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 85 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 associated with propulsion machinery that transmits directly to the water during station-keeping, wellhead installation, and maintenance operations. Additional sound and vibration are transmitted through the hull to the water from auxiliary machinery, such as generators, pumps, and compressors (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; therefore, they vary based on local ocean currents, sea and weather conditions, and operational requirements. Representative source levels for DP vessels range from 184 to 190 decibels (dB) relative to one micropascal squared (dB re 1 μPa^2) with a primary amplitude frequency below 600 Hz (Blackwell and Greene Jr., 2003; McKenna et al., 2012; Kyhn et al., 2014).

When drilling, the drill string represents a long vertical sound source (McCauley, 1998). Based on available data, marine sound generated during drilling, in the absence of thrusters, can be expected to range between 154 and 176 dB relative to one micropascal squared at 1 meter squared (dB re 1 μPa^2 m^2) (Nedwell et al., 2001). Sound pressure levels associated with drilling activities have a maximum broadband (10 Hz to 10 kHz) energy of about 190 dB re 1 μPa^2 m^2 (Hildebrand, 2005). The use of thrusters, whether drilling or not, can elevate sound source levels to approximately 188 dB re 1 μPa^2 m^2 (Nedwell and Howell, 2004). Nedwell and Howell (2004) reported that the majority of noise from a semi-submersible drilling rig occurred below 600 Hz and sound pressure levels increased by 10 to 20 dB when drilling was active. Within the low bandwidths (<600 Hz), measured sound pressure levels were shown to be greatly influenced by the drilling rig for up to 1.2 miles (2 km) but at distances beyond 3.1 miles (5 km), the drill rig did not contribute significantly to the overall sound pressure levels in that bandwidth.

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 are located. Depending on the specific well configuration, the total disturbed area is estimated to be 0.25 hectare (ha) (0.62 acre [ac]) per well (BOEM, 2012a). For the 6 wells proposed in this EP, the total potential area of seafloor disturbance could be 1.5 ha (3.7 ac). However, the overall area of seafloor disturbance could be lower due to the geographic proximity of the proposed wells.

A.3 Air 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

The discharges will include treated sanitary and domestic wastes, deck drainage, desalination unit brine, wash water, blowout preventer fluid, non-pollutant completion fluids, uncontaminated ballast and bilge water, noncontact cooling water, fire water, water-based drilling muds (WBM) and cuttings, cuttings wetted with synthetic-based drilling muds (SBM), and excess cement. All offshore discharges will be in accordance with requirements of the National Pollutant Discharge Elimination System (NPDES) General Permit No. GMG290006 issued by the U.S. Environmental Protection Agency (USEPA), including permit compliance terms, discharge volumes, discharge rates, and associated monitoring requirements.

WBM 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, SBM will be used and collected on the MODU through the riser. 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 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 850 barrels (bbl) 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 include 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

Anadarko will comply with all regulations relating to solid waste handling, transportation 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 materials. 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 Vessel Traffic

The project will be supported by one supply vessel, one crew vessel, and one support vessel. All vessels will be based out of Port Fourchon, Louisiana. The supply vessel will make an estimated two round trips per week between the port and the project area while the crew vessel and the support vessel will make an estimated three round trips per week between the port and the project area. The vessels typically will transit to and from the project area via the most direct route from the shorebase. Anadarko 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 includes 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 make an estimated 10 round trips per week between the project area and the heliport in Houma, Louisiana. The helicopter 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 project area when air traffic and weather conditions permit. 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). Anadarko 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 accidents addressed in the EIA focus on the following two potential types:

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

The following subsections summarize assumptions about the size and fate of these spills as well as Anadarko's spill response plans. Potential impacts are analyzed in **Section C**.

Recent EISs (BOEM, 2014a; 2015a; 2016c; 2017a; b) analyze other types of accidents relevant to offshore oil and gas operations that could lead to potential impacts to the marine environment: loss of well control, vessel collisions, 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, and/or water. 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; b). 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). Not all loss of well control events result in a blowout (BOEM, 2017d).

Anadarko 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 (75 *FR* 63365) and NTL 2010-N10, which specify additional safety measures for OCS activities.

<u>Vessel Collisions</u>. BSEE data show that there were 168 OCS-related collisions between 2007 and 2017 (BSEE, 2017). Most collisions involved service 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 (BOEM, 2017a). Diesel fuel is the product most frequently spilled, but oil, natural gas, corrosion inhibitor, hydraulic fluid, and lube oil have also been released as a result of vessel collisions. As summarized by BOEM (2017d), vessel collisions occasionally occur during routine drilling and completion activities. Some of these collisions have caused spills of diesel fuel or chemicals. Anadarko will comply with all USCG- and BOEM-mandated safety requirements to minimize the potential for vessel collisions.

<u>Chemical Spills</u>. Chemicals are stored and used for pipeline hydrostatic testing, during drilling, and in-well completion operations. The relative quantities of their use are reflected in the largest volumes spilled (BOEM, 2017a). Completion fluids contribute the largest quantity of chemical used and comprise the largest releases. Between 5 and 15 chemical spills are anticipated each year in the Gulf of Mexico as a result of offshore drilling programs, with the majority being <50 bbl in size. The most common chemicals spilled are methanol, ethylene glycol, and zinc bromide.

<u>H_2S Release</u>. MC 84 and 85 are classified as “H_2S absent”.

A.9.1 Small Fuel Spill

<u>Spill Size</u>. According to the analysis by BOEM (2017a), the most likely type of small spill (<1,000 bbl) resulting from OCS activities is a containment 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 volume 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 fuel spill in the project 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 project area and the duration of a small spill, the opportunity for impacts to occur would be very brief.

The water-soluble fractions of diesel fuel are dominated by two- and three-ringed polycyclic aromatic hydrocarbons (PAHs), which are moderately volatile (National Research Council, 2003a). 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 is so light that it will not sink to the seafloor unless it is dispersed in the water column and adheres to suspended sediments, but this generally occurs only in coastal areas with high suspended solids loads (National Research Council, 2003a) 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).

A sheen from a small fuel spill 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 (ADIOS2) model (NOAA, 2016a). This model uses the physical properties of oils in its database to estimate the rate of evaporation and dispersion over time as well as changes in the density, viscosity, and water content of the product spilled. Based on the model results, it is estimated that more than 90% of a small diesel spill would evaporate or disperse within 24 hours. Based on results of the ADIOS2 model, the estimated sea surface area that could have diesel fuel on it 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 model results, coupled with spill trajectory information discussed in the following subsection for a large spill, indicate that a small fuel spill would not likely impact coastal or shoreline resources because of the distance to the nearest shoreline; the project area is 67 miles (108 km) from the nearest shoreline. The lack of persistence of small oil spills in the environment and the project's distance from shore make it 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 spill prevention procedures fail to avoid a fuel spill, response equipment and trained personnel will be activated so that spill effects will be localized and result in only short-term environmental consequences. EP Section H provides a detailed discussion of Anadarko'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 installation operations. The scenario assumes that the wellhead fails mechanically and a blowout occurs at the seafloor, allowing the entire wellbore fluid to flow up the existing production string. The maximum total volume during a blowout could potentially be 24,082,678 bbl.

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 this EP. An estimated 32 to 61 days will be required to mobilize equipment and drill a relief well under the blowout scenario. The maximum total volume of liquid hydrocarbons released during a blowout is potentially 24,082,678 bbl, assuming 61 days for the duration of a blowout, multiplied by the worst-case daily uncontrolled volume (394,798 bbl per day).

The detailed analysis of the WCD calculations can be found in EP Section H, as required by NTL 2015-N01 and 30 CFR 550.219(a)(2)(iv). Descriptions of the measures to be undertaken by Anadarko 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. Anadarko will also comply with NTL 2010-N10 and the Well Control Rule (75 *FR* 63365) 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 and estimated a blowout frequency of 0.0017 per exploratory well for non-North Sea locations. BOEM updated OCS spill frequencies (bbl spilled per bbl produced) to include the Macondo incident. According to ABS Consulting Inc. (2016), the spill rate for spills >1,000 bbl dropped to 0.22 spills per billion barrels produced. According to the BSEE analysis conducted for the Final Drilling Safety Rule issued in 2010, 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 project area would depend on meteorological and oceanographic conditions at the time. The Oil Spill Risk Analysis (OSRA) model (herein referred to as the 30-day 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.

The results for the 30-day OSRA model for Launch Area 57 (where MC 84 and 85 are located) are presented in **Table 3**. The model predicts a 4% conditional probability of shoreline contact in Plaquemines Parish, Louisiana, within 3 days of a spill. Within 10 days, the model predicts a 1% conditional probability of shoreline contact in Terrebonne, Lafourche, and St. Bernard Parishes, Louisiana, and a 14% conditional probability of shoreline contact in Plaquemines Parish, Louisiana. Within 30 days, the model predicts 1% to 21% chance of shoreline contact from Cameron Parish, Louisiana and to Bay County, Florida. Plaquemines Parish, Louisiana, is projected to have the highest probability of shoreline contact within 30 days (21% conditional probability) (**Table 3**). Counties with a conditional probability for shoreline contact of <0.5% for 3, 10, and 30 days are not shown in **Table 3**.

Table 3. Conditional probabilities of a spill in the project area contacting shoreline segments (Ji et al., 2004). Values are conditional probabilities that a hypothetical spill in the project area (represented by Oil Spill Risk Analysis Launch Area 57) could contact shoreline segments within 3, 10, or 30 days.

Shoreline Segment	County or Parish, State	Conditional Probability of Contact[1] (%)		
		3 Days	10 Days	30 Days
C13	Cameron Parish, Louisiana	--	--	1
C14	Vermilion Parish, Louisiana	--	--	1
C17	Terrebonne Parish, Louisiana	--	1	2
C18	Lafourche Parish, Louisiana	--	1	2
C20	Plaquemines Parish, Louisiana	4	14	21
C21	St. Bernard Parish, Louisiana	--	1	3
C22	Hancock and Harrison Counties, Mississippi	--	--	1
C23	Jackson County, Mississippi	--	--	1
C24	Mobile County, Alabama	--	--	1
C25	Baldwin County, Alabama	--	--	1
C26	Escambia County, Florida	--	--	1
C28	Okaloosa County, Florida	--	--	1
C29	Walton County, Florida	--	--	1
C30	Bay County, Florida	--	--	1

[1] Conditional probability refers to the probability of contact within the stated time period, assuming that a spill has occurred (-- indicates < 0.5%).

The OSRA modeling runs reported by Ji et al. (2004) did not evaluate the fate of a spill over periods longer than 30 days, nor did they estimate the fate of a release that continues for weeks or months. Also, as noted by Ji et al. (2004), the OSRA model does not take into account the chemical composition or biological weathering of oil spills, the spreading and splitting of oil spills, or spill response activities. The model does not assume a particular spill size but has been used by BOEM to evaluate contact probabilities for spills greater than 1,000 bbl.

BOEM (2017d) presented 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 (herein referred to as the 60-day 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, 2017d). The spatial resolution was limited, with seven launch points to represent the entire northern Gulf of Mexico. These launch points were deliberately located in areas identified as having a high possibility of containing large oil reserves. The 60-day OSRA model launch point most appropriate for modeling a spill in the project area is Launch Point 2. The 60-day OSRA results for Launch Point 2 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 2 based on the 60-day Oil Spill Risk Analysis. Values are conditional probabilities that a hypothetical spill in the project area could contact shoreline segments within 60 days.

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] (%)															
Matagorda, Texas	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
Vermilion, Louisiana	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1
Terrebonne, Louisiana	--	--	--	--	--	--	--	1	--	--	--	--	--	--	2	2
Lafourche, Louisiana	--	--	--	--	--	--	--	--	--	--	1	1	--	--	--	1
Jefferson, Louisiana	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	1
Plaquemines, Louisiana	--	2	3	3	2	9	17	19	2	17	24	24	1	12	18	20
St. Bernard, Louisiana	--	5	6	6	1	8	13	14	1	8	10	10	1	5	8	8
Hancock, Mississippi	--	2	3	3	11	2	2	2	1	2	3	3	--	1	2	3
Harrison, Mississippi	2	5	5	5	1	4	5	5	1	2	3	3	2	3	4	4
Jackson, Mississippi	7	13	14	14	3	6	8	8	6	11	12	13	6	10	12	13
Mobile, Alabama	13	18	19	19	4	9	10	10	8	12	12	13	9	12	12	13
Baldwin, Alabama	8	15	18	18	2	8	9	9	1	2	3	3	3	6	7	7
Escambia, Florida	1	6	9	10	1	4	6	6	--	1	1	1	--	2	2	3
Okaloosa, Florida	--	1	2	2	--	1	2	2	--	--	--	--	--	--	--	--
Walton, Florida	--	--	1	1	--	1	1	1	--	--	--	1	--	--	--	--
Bay, Florida	--	2	3	3	--	1	2	3	--	--	--	--	--	--	--	1
Gulf, Florida	--	1	3	4	--	--	2	2	--	--	--	--	--	--	--	--
Franklin, Florida	--	--	1	2	--	--	1	1	--	--	--	--	--	--	--	--
Dixie, Florida	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
Levy, Florida	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--
State Coastline	Conditional Probability of Contact[1] (%)															
Texas	--	--	--	--	--	--	--	1	--	--	1	2	--	--	--	2
Louisiana	--	6	8	9	3	17	30	35	3	25	36	36	2	18	29	33
Mississippi	9	20	22	22	5	12	15	15	8	15	18	19	8	15	18	20
Alabama	21	33	37	37	6	17	20	20	9	14	15	15	12	18	20	20
Florida	1	11	19	26	1	7	14	16	--	1	3	3	--	2	4	5

[1] Conditional probability refers to the probability of contact within the stated time period assuming that a spill has occurred (-- indicates <0.5%). Modified from BOEM (2017d).

From Launch Point 2, potential shoreline contacts within 60 days range from Matagorda County, Texas, to Levy County, Florida. Based on statewide contact probabilities within 60 days, Louisiana has the highest likelihood of contact during summer, fall and winter (ranging from 33% to 36% within 60 days), while Alabama has the highest probability of contact in spring (37% within 60 days). The model predicts potential contact with Mississippi shorelines in any season ranging from a 15% probability in summer to a 22% probability in spring (within 60 days of a spill). Texas shorelines are predicted to be potentially contacted only during summer, fall, or winter, with probabilities of contact 2% or less within 60 days. Florida shorelines are predicted to be potentially contacted during any season, with a probability up to 26% in spring. Based on the 60-day trajectories, counties or parishes with greater than 10% contact probability during any season include Plaquemines and St. Bernard Parishes in Louisiana, Hancock and Jackson counties in Mississippi, Mobile and Baldwin counties in Alabama, and Escambia County, Florida (**Table 4**).

<u>Weathering</u>. Following an oil spill, several physical, chemical, and biological processes, collectively called weathering, interact to change the physical and chemical properties of the oil,

thereby influencing its potential effects on 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, 2003a; International Tanker Owners Pollution Federation Limited, 2018).

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% of its weight to evaporation during the first 3 to 5 days while floating on the sea surface (Daling et al., 2014). Several studies in the aftermath of the Macondo spill concluded that approximately 25% of mass below n-C_8 was lost during the oil's ascent to the surface, before an increased rate of weathering occurred once on the surface due to photo-oxidation (Lewan et al., 2014; Faksness et al., 2015; Stout and Payne, 2016; Stout et al., 2016).

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. Anadarko's Regional OSRP was last approved on 14 August 2015 for Anadarko and its subsidiary, Anadarko US Offshore LLC (Company Numbers 00981 and 02219, respectively), in accordance with 30 CFR Part 254. The June 2017 biennial updates were acknowledged by BSEE on 12 July 2017; 5 October 2017 updates were acknowledged by BSEE on 2 November 2017. Non-regulatory required OSRP updates were submitted to BSEE on 19 June 2018 and acknowledged as in compliance on 18 July 2018. The OSRP provides a detailed plan that enables Anadarko to respond rapidly and effectively manage response efforts for oil spills that may result from drilling and production operations. The OSRP contains detailed information on "Quick Response" procedures, including:

- responsibilities of all Anadarko and contract personnel to report any observed discharge from known or unknown sources;
- procedures to locate and determine the size of a discharge; and
- contact information for alerting the spill management team, complete with names, phone numbers, and locations.

In the event of a large oil spill up to and including a WCD, Anadarko has access to surface and subsea response/containment capabilities that could be implemented through various organizations under contract. Anadarko's primary spill response equipment provider is Clean Gulf Associates (CGA).

CGA has 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 Fast Response Systems staged throughout the Gulf of Mexico available for offshore use.

The CGA high-volume open sea skimmer (HOSS) barge consists of a skimming system built into an oil recovery barge. There are 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. The estimated daily recovery capacity for the HOSS barge is approximately 43,000 bbl of surface oil. CGA has recently acquired Koseq skimming arms and Aqua Guard skimmers to enhance its readiness. In addition, an x-band radar/infrared tracking system has been installed on the HOSS barge. Additional CGA equipment can be referenced online at http://www.cleangulfassoc.com/equipment.

Anadarko also has a contract with the Marine Spill Response Corporation (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 oil spill response vessels, fast response vessels, oil spill response barges, platform supply vessels, and shallow water barges. Various equipment is outfitted with x-band radar and infrared technology for detecting surface oil. Additional MSRC capabilities and a complete equipment listing are available online at http://www.msrc.org/.

Anadarko is a member of the Marine Well Containment Company (MWCC). In the event of an incident, MWCC can provide a 15,000 psi single ram capping stack and dispersant injection capability. MWCC can install and operate the interim containment system, including subsea flowlines, manifolds, and risers. The interim system is engineered to be used in depths up to 10,000 ft (3,048 m) and has the capacity to contain 60,000 bbl of liquid per day (and 120 million standard cubic feet per day of gas) with potential for expansion.

Additionally, MWCC offers its members access to equipment, instruments, and supplies for marine environmental sampling and monitoring in the event of an oil spill in the Gulf of Mexico. Members have access to a mobile Laboratory Container, Operations Container, and Launch and Recovery System (LARS) that enable water sampling and monitoring to water depths of 9,843 ft (3,000 m). The two 8 ft × 20 ft (2.4 m × 6.1 m) containers have been certified for offshore use by Det Norske Veritas and the American Bureau of Shipping. The LARS is a combined winch, A-frame, and 9,843 ft (3,000 m) long cable, customized for the instruments in the containers.

The containers are designed to enable rapid mobilization of necessary equipment to an incident site, including redundant systems to avoid downtime and supplies for sample handling and storage. Once deployed on a suitable vessel, the mobile containers then act as work spaces for scientists and operations personnel.

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

B. Affected Environment

The project area is approximately 67 miles (108 km) from the nearest shoreline (Louisiana), 133 miles (214 km) from the onshore support base at Port Fourchon, Louisiana, and 169 miles (272 km) from the helicopter base at Houma, Louisiana (**Figure 1**). The water depth at the location of the proposed activities is approximately 5,093 to 5,179 ft (1,552, to 1,579 m) (**Figure 2**).

The site clearance letters for the proposed wellsites noted two existing wells, nine existing pipelines, and numerous jumpers and leads within 2,000 ft (610 m) of proposed wellsite MC 84-G (Oceaneering International Inc, 2019b).

The seafloor location of all proposed wellsites is relatively smooth with gradients of 2.5° or less. No high-density deepwater benthic or chemosynthetic communities or archaeological avoidance zones were noted within 2,000 ft (610 m) of the proposed wellsite locations (Oceaneering International Inc, 2019b; a).

A detailed description of the regional potentially 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 in recent EISs (2012a; 2013b; 2014b; 2015a; 2016c; 2017a; b). These regional descriptions remain valid and are incorporated by reference. General background information is presented in the following sections, and brief descriptions of each potentially affected resource, including site-specific and new information if available, are presented in **Section C**.

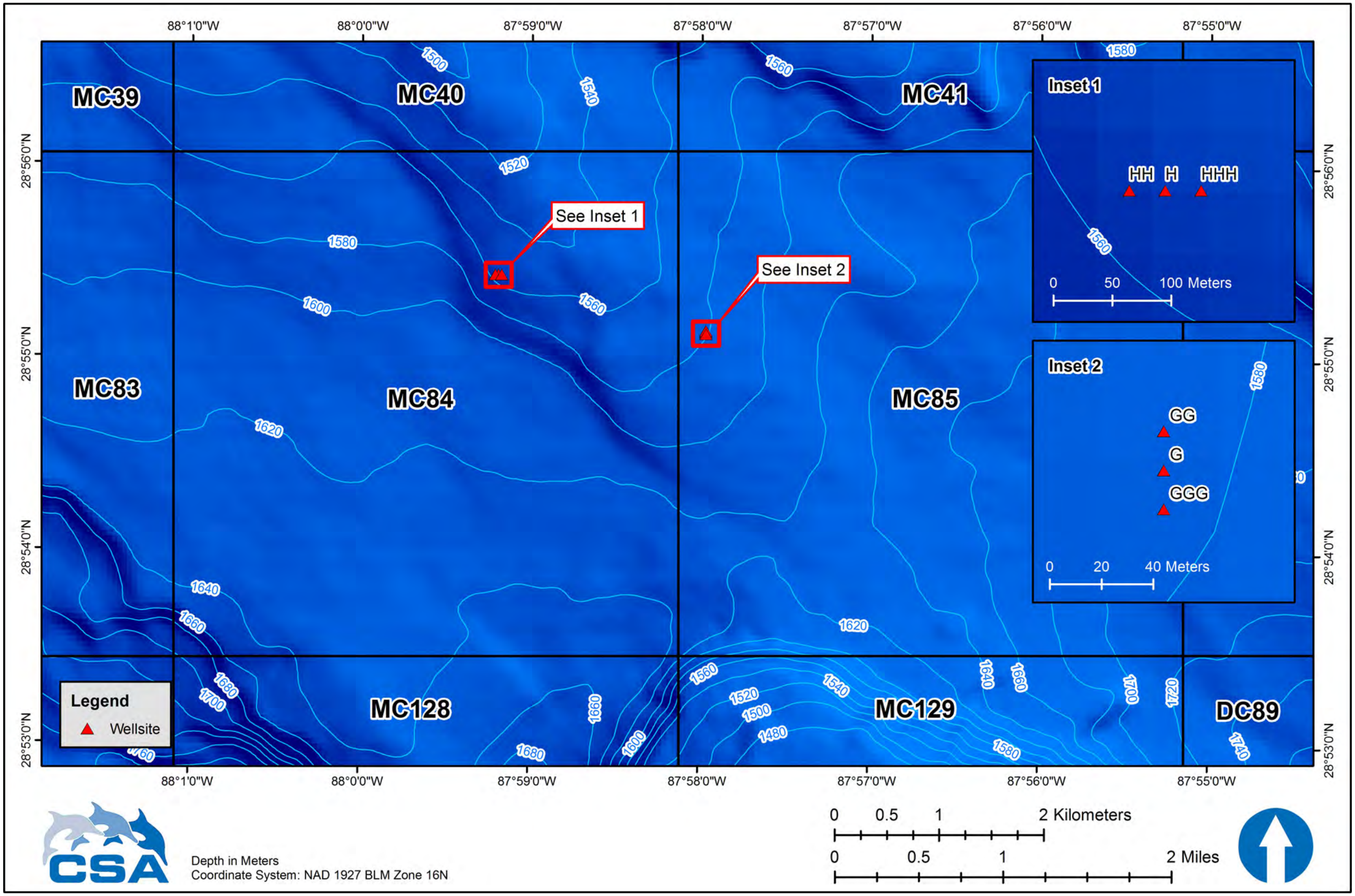

Figure 2. Surface hole locations of the proposed wellsites in Mississippi Canyon (MC) Blocks 84 and 85. Naming convention of the wellsites are based on the bottom hole locations.

C. Impact Analysis

This section analyzes the potential direct and indirect impacts of routine activities and accidents. Impacts have been analyzed extensively in the multiscale EISs for the Western and Central Gulf of Mexico Planning Areas (BOEM, 2012a; 2013a; 2014b; 2015a; 2017a; b). 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.

C.1 Physical/Chemical Environment

C.1.1 Air Quality

There are no site-specific air quality data for the project area. However, because of the distance from shore-based pollution sources and the relatively small number of sources of pollutants offshore, air quality at the proposed 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 April 2019, Mississippi, Alabama, and Florida Panhandle coastal counties are in attainment of the National Ambient Air Quality Standards (NAAQS) for all criteria pollutants (USEPA, 2019). St. Bernard Parish in Louisiana and Hillsborough County in Florida are nonattainment areas for sulfur dioxide based on the 2010 standard. One coastal metropolitan area in Texas (Houston-Galveston-Brazoria) is a nonattainment area for 8-hour ozone (2015 Standard). One coastal metropolitan area in Florida (Tampa) is was recently reclassified from a nonattainment area to maintenance status for lead based on the 2008 Standard (USEPA, 2019).

As noted earlier, based on calculations made pursuant to applicable regulations, emissions from drilling 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 drilling activities and accidental spills (a small diesel fuel spill or a large oil spill). Potential impacts from air emissions to resources listed in **Table 2** are discussed below.

Impacts of Air Pollutant Emissions

Air pollutant emissions are the only routine IPF likely to affect air quality in addition to two types of accidents (a small diesel fuel spill and a large oil spill) (**Table 2**). 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 PM, SO_x, NO_x, VOCs, and CO. As noted by BOEM (2017c), 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 this EP are not likely to contribute to violations of any NAAQS on shore. Therefore, according to 30 CFR 550.303, the emissions would 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). 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, in coastal Louisiana, 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 within 186 miles (300 km) of the Breton Class I area that exceed emission limits agreed upon by the administering agencies (National Park Service, 2010). The project area is approximately 75 miles (121 km) from the Breton Wilderness Area. Based on Anadarko's Air Quality Emissions report (EP Section G), no significant impacts on coastal air quality are expected, including in the Breton Wilderness Area. Anadarko 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; 2015b; 2016c; 2017a; c). **Section A.9.1** discusses the size and fate of a potential small diesel fuel spill as a result of Anadarko's proposed activities. EP Section H includes a detailed discussion of the spill response measures that would be employed. Given the open ocean location of the project area, the extent and duration of air quality impacts from a small spill are not likely to 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 (**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 12.4 ac), depending on sea state and weather conditions. A small diesel fuel spill would not likely affect coastal air quality because the spill would not be expected to make landfall or reach coastal waters prior to natural dispersion (**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; 2015a; 2016a; 2017a; b).

A large oil spill could affect air quality by introducing VOCs into the atmosphere through evaporation from the slick. The extent and persistence of any 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 could generate a plume of black smoke and result in emissions of NO_x, SO_x, CO, and PM as well as greenhouse gases. However, *in situ* burning would occur as a response measure only if authorized by the USEPA.

Depending on the spill trajectory, meteorological and oceanographic conditions, and the effectiveness of spill response measures, coastal air quality could also be affected. Based on the 30-day OSRA modeling (**Table 3**), coastal areas of Plaquemines Parish could be affected within 3 days of a spill (4% conditional probability). Within 10 days of a spill, the model predicts potential contact to four Louisiana Parishes (1 to 14% conditional probability). Coastal areas between Cameron Parish, Louisiana, and Bay County, Florida, may be affected within 30 days of a spill (1 to 21% conditional probability). Based on the 60-day OSRA modeling estimates (**Table 4**), the potential shoreline contacts range from Matagorda County, Texas, to Levy County, Florida (up to 24% conditional probability). However, due to the project area's distance from the nearest shoreline, most adverse impacts to air quality 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 project area. Because the project location is 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. Based on the site clearance letters for proposed wellsites, no natural seeps were noted in the vicinity of the proposed wellsites (Oceaneering International Inc, 2019b; a).

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

Impacts of Effluent Discharges

Discharges of treated SBM cuttings will produce temporary, localized increases in suspended solids in the water column around the drilling rig. After discharge, SBM retained on cuttings would be expected to adhere tightly to the cuttings particles and, consequently, would not produce much additional 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, with suspended solids concentrations decreasing with distance (National Research Council, 1983; Neff, 1987). All NPDES permit limitations and requirements will be implemented during proposed activities; therefore, there should not be persistent impacts to water quality from the overboard releases of treated sanitary and domestic wastes and deck drainage in the project area.

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 gutters, drains, and 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 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 non-pollutant completion fluids, uncontaminated wash, ballast and bilge water, and non-contact cooling 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 fuel spill on water quality are expected to be consistent with those analyzed and discussed by BOEM (2012a; 2015a; 2016a; 2017a; b). **Section A.9.1** discusses the size and fate of a potential small diesel fuel spill as a result of Anadarko's proposed activities. 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 PAHs, which are moderately volatile (National Research Council, 2003a). The constituents of these oils are light to intermediate in molecular weight 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 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, 2003a) and would not be expected to occur to any appreciable degree in offshore waters of the Gulf of Mexico.

It is estimated that more than 90% of a small diesel spill would evaporate or disperse within 24 hours (**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, constituents of diesel oil are readily and completely degraded by naturally occurring microbes (NOAA, 2006). Given the open ocean location of the project area, the extent and duration of water quality impacts from a small spill would not be significant.

A small fuel spill would not affect coastal water quality because the spill would not be expected to make landfall or reach coastal waters prior to breaking up (**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; 2015a; 2016a; 2017a; b).

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; Valentine et al., 2014). 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; Spier et al., 2013). Subsea dispersants would be applied only after approval from the USEPA.

A report by Kujawinski et al. (2011) indicated 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 after the 2010 *Deepwater Horizon* incident. 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 that 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 the 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 the project area location is 67 miles (108 km) from the nearest shoreline, any water quality impacts would likely occur in offshore waters. Depending on the spill trajectory and the effectiveness of spill response measures, coastal water quality could be affected. The 30-day OSRA modeling (**Table 4**) indicates nearshore waters and embayments of Plaquemines Parish, Louisiana, are the coastal areas with the most potential for water quality to be affected (4% probability within 3 days; 14% probability within 10 days; and 21% probability within 30 days). Other Louisiana shorelines may be affected within 10 days, and shorelines in

Mississippi, Alabama, and Florida could be affected within 30 days. Based on the 60-day OSRA modeling estimates (**Table 4**), the potential for shoreline contact range from Matagorda County, Texas, to Levy County, Florida (up to 24% conditional probability).

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 5,093 to 5,179 ft (1,552 to 1,579 m). Based on the geohazards evaluation summarized in the site clearance letters (see **EP Section C**), there are no interpreted features or areas capable of supporting densely populated benthic communities within 2,000 ft (610 m) of the location of the proposed wellsites (Oceaneering International Inc, 2019b; a).

C.2.1 Soft Bottom Benthic Communities

There are no site-specific benthic community data from the project 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 in the area. **Table 5** summarizes data from nearby stations that are also in comparable water depths.

Table 5. Baseline benthic community data from stations near the project area and/or in similar water depths sampled during the Northern Gulf of Mexico Continental Slope Habitats and Benthic Ecology Study.

Station	Faunal Zone	Water Depth (m)	Density		
			Meiofauna (individuals m^{-2})	Macroinfauna (individuals m^{-2})	Megafauna (individuals ha^{-1})
HiPro	1	1,565	343,118	5,076	--
S36	2E	1,826	799,963	4,481	359

Meiofaunal and megafaunal data from Rowe and Kennicutt (2009); macroinfaunal data from Wei (2006).
-- = unavailable.

Meiofaunal (animals passing through a 0.3-millimeter sieve but retained on a 0.062-millimeter sieve) densities in water depths representative of the project area typically range from approximately 343,000 to 800,000 individuals m^{-2} (Rowe and Kennicutt, 2009). Nematodes, nauplii, and harpacticoid copepods were the three dominant meiofaunal groups, accounting for 90% of total abundance.

The benthic macroinfauna (animals retained on a 0.3-millimeter sieve) is characterized by small mean individual sizes and low densities, both of which reflected intrinsically low primary production in surface water of the Gulf of Mexico continental slope (Wei, 2006). Densities decrease exponentially with water depth (Carvalho et al., 2013). Densities at nearby stations ranged from approximately 4,134 to 4,516 individuals m^{-2} (**Table 5**). Based on an equation presented by Wei (2006) in which densities decrease exponentially with water depth, the macroinfaunal density at a water depth of the proposed wellsites is expected to be range from approximately 2,110 to 2,152 individuals m^{-2}; however, actual densities at the proposed project location are unknown.

Polychaetes are typically 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 of the northern Gulf of Mexico when compared to the eastern and western regions. Wei (2006) recognized four depth-dependent faunal zones (1 through 4), two of which are divided into eastern and western subzones. The project area is located in Zone 1, which includes stations on the upper Texas-Louisiana Slope, the west flank of the upper Mississippi Fan, the head of Mississippi Canyon, and the upper West Florida Terrace. The most abundant species in this zone were the polychaetes *Litocorsa antennata*, *Prionospio cirrifera*, and *Aricidea suecica*; the amphipod *Ampelisca mississippina*; and the bivalve *Heterodonta* spp.

The megafaunal density at a nearby station was 359 individuals ha^{-1} (**Table 5**). Common megafauna in the northern Gulf of Mexico include motile groups such as decapods, ophiuroids, holothurians, and demersal fishes as well as sessile groups such as sponges and anemones.

Bacteria are the foundation of deep sea chemosynthetic communities (Ross et al., 2012) and are an important component in terms of biomass and cycling of organic carbon (Cruz-Kaegi, 1998). 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 project area is typically 1 to 2 g C m^{-2} in the top 15 cm (6 in) of sediment (Rowe and Kennicutt, 2009).

IPFs that may affect benthic communities are physical disturbance to the seafloor in the immediate vicinity of the wellsites, subsea effluent discharges, and potential effects from a large oil spill 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 to soft bottom benthic communities listed in **Table 2** are discussed below.

Impacts of Physical Disturbance to the Seafloor

In water depths such as those in the project area, the areal extent of physical disturbance to the seafloor from the DP MODU will be small compared to the project area itself. DP MODUs disturb the seafloor only around the wellbore (surface hole location) where the bottom template and blowout preventer are located (**Section A.2**).

Soft bottom communities are ubiquitous along the northern Gulf of Mexico continental slope (Gallaway, 1988; Gallaway et al., 2003; Rowe and Kennicutt, 2009). Impacts from the physical disturbance of the seafloor during this project will be localized and are not expected to have significant impacts on soft bottom benthic communities in the region.

Impacts of Effluent Discharges

Drilling muds and cuttings are the only effluents from the MODU with the potential to affect benthic communities. During initial well interval(s) before the marine riser is set, cuttings and seawater-based “spud mud” will be released at the seafloor. Excess cement slurry will also 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 potential impacts could be burial and smothering of benthic organisms within several meters to tens of 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.

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 (2002; 2004). In general, treated cuttings with adhering SBM tend to clump together and form thick cuttings piles close to the drillsite. Areas of SBM cuttings deposition 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 in bottom sediments, benthic infaunal communities may be adversely affected because of both the toxicity of the base fluid and organic enrichment (with resulting anoxia) (Neff et al., 2000). Infaunal 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 discharges will be relatively small. Based on the monitoring studies discussed above, benthic community impacts are expected to be concentrated within approximately 1,640 ft (500 m) of each wellsite. Soft bottom communities are ubiquitous along the northern Gulf of Mexico continental slope (Gallaway, 1988; Gallaway et al., 2003; Rowe and Kennicutt, 2009); however, drilling discharges during this project are not expected to have a significant impact on soft bottom benthic communities on a regional basis.

Impacts of a Large Oil Spill

The most likely effects of a subsea blowout on benthic communities 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) from 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). Affected areas would be recolonized by benthic organisms over a period of months to years (National Research Council, 2003a).

While impacts on benthic communities from large oil spills are anticipated to be confined to the immediate vicinity of the blowout location, additional benthic community impacts could extend beyond the immediate vicinity of the wellhead, depending on the circumstances of the incident (BOEM, 2016c). During the Macondo spill, the use of subsea dispersants at the wellhead caused the formation of subsurface oil plumes (NOAA, 2011c; Spier et al., 2013). 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). 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 0.62 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 10.5 miles (17 km) to the southwest and 5.3 miles (8.5 km) to the northeast of the wellhead, covering an area of 57.1 miles^2 (148 km^2). NOAA (2016b) documented a footprint of over 772 miles^2 (2,000 km^2) of injury 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 plume-related benthic impacts likely extend beyond the immediate vicinity of the wellsite, depending on the extent, trajectory, and persistence of the plume. Baguley et al. (2015) noted that while nematode abundance increased with proximity to the Macondo wellhead, copepod abundance, relative species abundance, and diversity decreased in response to the Macondo spill. Washburn et al. (2017) noted that richness, diversity, and evenness were affected within a radius of 0.62 miles (1 km) of the wellhead. Reuscher et al. (2017) found that meiofauna and macrofauna community diversity was significantly lower in areas that were impacted by Macondo oil. Demopoulos et al. (2016) reported an abnormally high variability in meiofaunal and macrofaunal density in areas near the Macondo wellhead, which supports the Valentine et al. (2014) supposition that hydrocarbon deposition and impacts in the vicinity of the Macondo wellhead were patchy. While there were some indications of a partial recovery of benthic fauna, a full recovery had not occurred as of 2015 (Montagna et al., 2016; Reuscher et al., 2017; Washburn et al., 2017).

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 (e.g., Volkes, 1963; Boland, 1986; Callender et al., 1990; 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.

In water depths such as those encountered in the project area, the DP MODU will disturb the seafloor only in the immediate vicinity of the drill sites (**Section A.2**). Based on the site clearance letters (Oceaneering International Inc, 2019b; a), there is no evidence of the presence of high-density deepwater benthic or chemosynthetic communities within 2,000 ft (610 m) of the project area. The nearest known high-density deepwater benthic community is located in Viosca Knoll Block 826, approximately 17 miles (27 km) from the project area (MacDonald et al., 1995; U.S. Geological Survey, 2011; BOEM, nd).

A large oil spill from a well blowout at the seafloor is the only IPF that could affect high-density deepwater benthic communities (**Table 2**) A small fuel spill would not affect benthic communities because the diesel fuel would float and dissipate on the sea surface. Because a DP vessel will be used, there will be no physical disturbance to the seafloor from anchoring during the drilling activities analyzed in the EIA. 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 in the immediate vicinity of the proposed wellsites.

Impacts of a Large Oil Spill

A large oil spill caused by a seafloor blowout could cause direct impacts on benthic communities within approximately 984 ft (300 m) of the blowout location (i.e., caused by the physical impacts of a blowout) (BOEM, 2012a). Because there is no evidence of the presence of high-density deepwater benthic or chemosynthetic communities within 2,000 ft (610 m) of the proposed wellsites (Oceaneering International Inc, 2019b; a), a caldera, if formed would not be expected to impact any high-density deepwater benthic or chemosynthetic communities.

Additional benthic community impacts could extend beyond the immediate vicinity of the wellheads, depending on the specific circumstances (BOEM, 2016c). 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). While the behavior and impacts of subsurface plumes are not well known, a subsurface plume could 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 by BOEM (2012a; 2015a; 2016a; 2017a; b). Although chemosynthetic communities live among hydrocarbon seeps, natural seepage typically is constant and occurs at low rates as 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. 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 (BOEM, 2012a; 2017a; b). 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; 2015a; 2016c; 2017a; b). Based on information learned from the Macondo spill, a few patches of live bottom 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, 2016c).

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). 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 material containing oil from the Macondo spill and with signs of widespread stress, including varying degrees of tissue loss and excess mucous production (White et al., 2012). 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 floc 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. Prouty et al. (2016) found evidence that corals located northeast of the Macondo spill were also affected. 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). Based on data from Girard et al. (2018), recovery at these locations could take up to three decades and biomass is expected to decrease by 3% to 14%.

C.2.3 Designated Topographic Features

The project 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 approximately 91 miles (146 km) from the project area in West Delta Block 147. There are no IPFs associated with routine operations that could affect designated topographic features (**Table 2**).

Due to the distance from the project area, it is unlikely that topographic features would be affected by accidental spills. A small 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 was to occur, impacts on these features would be unlikely because of the distance of the spill from these features, the depth of the features, and the currents that surround the features. Near-bottom currents in the region generally flow along the isobaths (Nowlin et al., 2001) and typically would not 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 there are mechanisms that could 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 oil does contact topographic features, lethal effects to benthic organisms would be unlikely because the distance between the spill source and topographic features would likely prevent concentrated oil from contacting any designated feature.

C.2.4 Pinnacle Trend Area Live Bottoms

The project area is not covered by the Live Bottom (Pinnacle Trend) Stipulation. The nearest pinnacle trend blocks, as defined by NTL 2009-G39, are approximately 20 miles (32 km) from the project area in Viosca Knoll Block 778. There are no IPFs associated with routine operations that could affect pinnacle trend live bottom areas (**Table 2**).

Due to their distance from the project 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, thereby reducing potential impacts to these features.

C.2.5 Eastern Gulf Live Bottoms

The project area is not covered by the Live Bottom (Low-Relief) Stipulation, which applies mainly to Eastern Gulf of Mexico Planning Area leases in water depths of 328 ft (100 m) or less. The nearest block covered by the live bottom stipulation, as defined by NTL 2009-G39, is approximately 21 miles (34 km) from the project area in Destin Dome Block 573. There are no IPFs associated with routine drilling activities that could affect Eastern Gulf live bottom areas (**Table 2**).

Because of their distance from the project 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 to 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/or 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 that contain physical or biological features essential to conservation and 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 mammals (cetaceans), sea turtles in the marine environment, and fishes. The USFWS has jurisdiction for ESA-listed birds, the West Indian manatee (*Trichechus manatus*), and sea turtles on their nesting beaches.

Coastal endangered or threatened species include the West Indian manatee, Piping Plover (*Charadrius melodus*), Whooping Crane (*Grus americana*), Gulf sturgeon (*Acipenser oxyrinchus desotoi*), and four subspecies of beach mouse. Critical habitat has been designated for all of these species as indicated in **Table 6** and discussed in individual subsections. Two other coastal species (Bald Eagle [*Haliaeetus leucocephalus*] and Brown Pelican [*Pelecanus occidentalis*]) are no longer federally listed as endangered or threatened; these are discussed in **Section C.4.2**.

Table 6. Federally listed endangered, threatened, and candidate species potentially present in the project area and along the northern Gulf Coast.

Species	Scientific Name	Status	Potential Presence		Critical Habitat Designated in Gulf of Mexico
			Project Area	Coastal	
Marine Mammals					
Sperm whale	*Physeter macrocephalus*	E	X	--	None
Bryde's whale	*Balaenoptera edeni*	P/E[a]	X	--	None
West Indian manatee	*Trichechus manatus*[b]	E	--	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; *Sargassum* spp. habitat (includes most of central and western Gulf)
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
Whooping Crane	*Grus americana*	E	--	X	Coastal Texas (Aransas National Wildlife Refuge)
Sharks and Fishes					
Oceanic whitetip shark	*Carcharhinus longimanus*	T	X	--	None
Giant manta ray	*Manta birostris*	T	X	X	None
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	T	--	X	Coastal Louisiana, Mississippi, Alabama, and Florida
Nassau grouper	*Epinephelus striatus*	T	--	X	None
Invertebrates					
Elkhorn coral	*Acropora palmata*	T	--	X	Florida Keys and Dry Tortugas
Staghorn coral	*Acropora cervicornis*	T	--	X	Florida Keys and the Dry Tortugas
Pillar coral	*Dendrogyra cylindrus*	T	--	X	None
Rough cactus coral	*Mycetophyllia ferox*	T	--	X	None
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 mouse (subspecies: Alabama, Choctawhatchee, Perdido Key, St. Andrew)	*Peromyscus polionotus*	E	--	X	Alabama and Florida (Panhandle) beaches

Abbreviations: E = endangered; P = proposed; T = threatened; X = potentially present; -- = not present.

[a] Gulf of Mexico Bryde's whales are protected by the Marine Mammal Protection Act (MMPA). Per 84 FR 15446, NMFS determined the Gulf of Mexico Bryde's whale warranted listing as Endangered under the Endangered Species Act (ESA). The listing will be effective on 15 May 2019.

[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 Northwest Atlantic Ocean distinct population segment (DPS) of loggerhead turtles is designated as threatened (76 *Federal Register* [FR] 58868). NMFS and the USFWS designated critical habitat for this DPS, including beaches and nearshore reproductive habitat in Mississippi, Alabama, and the Florida Panhandle as well as *Sargassum* spp. habitat throughout most of the central and western Gulf of Mexico (79 FR 39756 and 79 FR 39856).

The sperm whale (*Physeter macrocephalus*), five species of sea turtles, and the oceanic whitetip shark (*Carcharhinus longimanus*) are the only endangered or threatened species likely to occur in or near the project area. The listed sea turtles are the leatherback turtle (*Dermochelys coriacea*), Kemp's ridley turtle (*Lepidochelys kempii*), hawksbill turtle (*Eretmochelys imbricate*), loggerhead turtle (*Caretta caretta*), and green turtle (*Chelonia mydas*). Effective August 11, 2014, NMFS has designated certain marine areas as critical habitat for the northwest Atlantic distinct population segment (DPS) of the loggerhead sea turtle (**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, sperm whale, or oceanic whitetip shark. Five endangered mysticetes (blue whale [*Balaenoptera musculus*], fin whale [*Balaenoptera physalus*], humpback whale [*Megaptera novaeangliae*], North Atlantic right whale [*Eubalaena glacilis*], and sei whale [*Balaenoptera borealis*]) 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 report (Hayes et al., 2017) or in the most recent BOEM multisale EIS (BOEM, 2017a). Therefore, they are not considered further in the EIA. The threatened giant manta ray (*Manta birostris*) is known from the Gulf of Mexico and could occur in the project area but is most commonly observed in the Gulf of Mexico at the Flower Garden Banks. The Nassau grouper (*Epinephelus striatus*) has been observed in the Gulf of Mexico at the Flower Garden Banks but is most commonly observed in shallow tropical reefs of the Caribbean and is not expected to occur in the project area.

Seven threatened coral species are known from the northern Gulf of Mexico: elkhorn coral (*Acropora palmata*), staghorn coral (*Acropora cervicronis*), lobed star coral (*Orbicella annularis*), mountainous star coral (*Orbicella faveolata*), boulder star coral (*Orbicella franksi*), pillar coral (*Dendrogyra cylindrus*), and rough cactus coral (*Mycetophyllia ferox*). None of these species are expected to be present in the project area (**Section C.3.11**). There are no other endangered animals or plants in the Gulf of Mexico that are reasonably likely to be adversely 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 project area and highly unlikely to be affected.

C.3.1 Sperm Whale (Endangered)

The only endangered marine mammal likely to be present at or near the project area is the sperm whale. Resident populations of sperm whales occur within the Gulf of Mexico. A species description is presented in the recovery plan for this species (NMFS, 2010a). Gulf of Mexico sperm whales are classified as an endangered species and a strategic stock (defined as a stock that may have unsustainable human-caused impacts) by NOAA Fisheries (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, 2010a). 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).

The distribution of sperm whales in the Gulf of Mexico is correlated with mesoscale physical features such as eddies associated with the Gulf of Mexico Loop Current (Jochens et al., 2008). Sperm whale populations in the north-central Gulf of Mexico are present there throughout the year (Davis et al., 2000). Results of a multiyear tracking study show female sperm whales typically concentrated along the upper continental slope between the 656- and 3,280-ft (200- and 1,000-m) 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 and juveniles as well as groups of bachelor males. The 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. In these mitigation surveys, sperm whales were the most common large cetacean encountered (Barkaszi et al., 2012). Study results also showed that sperm whales transit through the vicinity of the project area. Movements of satellite-tracked individuals suggest that this area of the Gulf continental slope is within the home range of the Gulf of Mexico population (within the 95% utilization distribution) (Jochens et al., 2008).

IPFs that could affect 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 (**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 drilling activities has the potential to disturb individuals or groups of sperm whales or mask the sounds sperm whales would normally produce and hear. It is unlikely that any auditory injury would result from drilling activites. Behavioral responses to noise by marine mammals vary widely; overall they are short-term and include temporary displacement or cessation of feeding, resting, or social interactions (NMFS, 2009a; Gomez et al., 2016). Additionally, behavioral changes resulting in auditory masking sounds may induce an animal to produce more calls, make longer calls, or shift the frequency of the calls. For example, masking caused by vessel noise was found to reduce the number of whale calls in the Gulf of Mexico (Azzara et al., 2013).

NMFS (2018b) 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). Sperm whale sounds generally consist of clicks that have a bandwidth of

100 Hz to 30 kHz (Erbe et al., 2017). For sperm whales, acoustic energy peaks at around 15 kHz and is generally concentrated below 10 kHz, although diffuse energy up to and past 20 kHz is common (Weilgart and Whitehead, 1993; Goold and Jones, 1995; Møhl et al., 2003; Erbe et al., 2017). Source levels of clicks are generally 186 ± 0.9 dB re 1 µPa^2 m^2 with extremes up to 236 dB re 1 µPa^2 m^2 (Møhl et al., 2003; Mathias et al., 2013).

Noise produced by the drilling rigs, DP thrusters, and drilling operations are all classified as nonimpulsive sound source and are within the hearing frequency sensitivity of sperm whales. As discussed in **Section A.1**, drilling noise can produce broadband (10 Hz to 10 kHz) sound pressure levels of approximately 190 dB re 1 µPa^2 m^2 (Hildebrand, 2005). Therefore, vessel-related noise is likely to be heard by sperm whales. As sound pressure levels produced during active drilling operations may have greater amplitudes than vessel noise alone, they may have a greater likelihood of eliciting a behavioral response.

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 drilling 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). 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).

The most recent acoustic criteria (NMFS, 2018b) are based on received sound level accumulations that equate to the onset of marine mammal auditory threshold shifts. For mid frequency cetaceans exposed to a non-impulsive source (such as drilling operations), permanent threshold shifts are estimated to occur when the mammal has received a cumulative exposure level of 198 decibels relative to 1 micropascal squared seconds (dB re 1 µPa^2 s) over a 24-hour period. Similarly, temporary threshold shifts are estimated to occur when the mammal has received a sound exposure level of 178 dB re 1 µPa^2 s over a 24-hour period. Based on transmission loss calculations (Urick, 1983b), open water propagation of noise produced by typical sources with DP thrusters in use during drilling, are not expected to produce mean-square sound pressure levels greater than 160 dB re 1 µPa^2 beyond 105 ft (32 m) from the source. Due to the short propagation distance of high sound pressure levels, the transient nature of sperm whales, and the stationary nature of drilling activities, it is not expected that any sperm whales will receive exposure levels necessary for the onset of auditory threshold shifts.

There are other OCS facilities and activities near the project 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 (NMFS, 2007; BOEM, 2012a; 2016c; 2017a; b).

Impacts of Support Vessel and Helicopter Traffic

Support vessel traffic has the potential to disturb sperm whales and there is also a risk of vessel strikes, which are identified as a threat in the recovery plan for this species (NMFS, 2010a). 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. 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 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. 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 level of the population. With implementation of the vessel strike avoidance measures, 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, and the guidelines and regulations issued by NMFS under the authority of the MMPA 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 helicopter flight altitude would minimize the potential for disturbing sperm whales.

Impacts of a Small Fuel Spill

Potential spill impacts on marine mammals, including sperm whales, are discussed by NMFS (2007) and BOEM (2017a; b). 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 Anadarko's preventative measures that will be implemented during routine operations, including fuel transfer. In the unlikely event of a spill, implementation of Anadarko's OSRP could mitigate and lessen the potential for impacts on sperm whales. Given the open ocean location of the project 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, the volume released, 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 (**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 whales 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 exposure to 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; b). 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 caused by response activities and materials (e.g., vessel traffic, noise, dispersants) (MMC, 2011). Natural or chemical dispersion of oil could cause a subsurface plume which would have the possibility of contacting sperm whales. Potential 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 oiled 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 related to 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, including displacement from preferred habitat, disruption of social structure, change in prey availability and foraging distribution and/or patterns, change in reproductive behavior/productivity, and change in 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 level of vessel and aircraft activity associated with spill response could disturb sperm whales and potentially include vessel strikes, entanglement, or other injury or stress. Response vessels would operate in accordance with NTL BOEM-2016-G01 (**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 West Indian manatee population is located in peninsular Florida (U.S. Fish and Wildlife Service, 2001). Critical habitat has been designated in southwest Florida in Manatee, Sarasota, Charlotte, Lee, Collier, and Monroe Counties, although increased sightings in warmer months indicate the north and northwest regions of the Gulf of Mexico are also important regions for manatees (Hieb et al., 2017). There have been three verified reports of Florida manatee sightings on the OCS during seismic mitigation surveys in mean water depths of over 1,969 ft (600 m) (Barkaszi and Kelly, 2018). One of these sightings resulted in a shutdown of airgun operations. A species description is presented in the recovery plan for this species (U.S. Fish and Wildlife Service, 2001).

IPFs that could affect manatees include support vessel and helicopter traffic and a large oil spill. A small fuel spill in the project area would be unlikely to affect manatees because the project area is approximately 67 miles (102 km) from the nearest shoreline. As explained in **Section A.9.1**, a small fuel spill would not be expected to make landfall or reach coastal waters prior to breaking up. Compliance with NTL BSEE-2015-G03 (**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 also a risk of vessel strikes, which are identified as a threat in the recovery plan for this species (U.S. Fish and Wildlife Service, 2001). Manatees are expected to be limited to inner shelf and coastal waters, and impacts are expected to be limited to transits of these vessels through these waters. To reduce the potential for vessel strikes, BOEM and BSEE have issued NTL BOEM-2016-G01, which recommends protected species identification training for vessel operators and crews; recommends that vessel 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. Implementation of these NTL's mitigation measures will reduce the potential for 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 and guidelines and regulations issued by NMFS under the authority of the MMPA 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

Based on the 30-day OSRA modeling (**Table 3**), coastal areas of Plaquemines Parish could be affected within 3 days of a spill (4% conditional probability). Within 10 days of a spill, the model predicts potential contact to four Louisiana Parishes (1 to 14% conditional probability). Coastal areas between Cameron Parish, Louisiana, and Bay County, Florida, may be affected within 30 days of a spill (1 to 21% conditional probability). However, no manatee critical habitat exists in these areas and manatees are unlikely to be present. Based on the 60-day OSRA modeling estimates (**Table 4**), the potential for shoreline contact ranges from Matagorda County, Texas, to Levy County, Florida. This range does not include any areas of designated manatee critical habitat.

In the event that manatees are exposed to oil, potential effects could include direct impacts from oil exposure as well as indirect impacts caused by response activities and materials (e.g., vessel traffic, noise, dispersants) (MMC, 2011). Potential 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 related to the above could lead to dysfunction of immune and reproductive systems, physiological stress, declining physical condition, and death. Behavioral responses could include displacement of animals from prime habitat, disruption of social structure, change in prey availability and foraging distribution and/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 level of vessel and aircraft activity associated with spill response could disturb manatees and potentially include vessel strikes, entanglement, or other injury or stress. Response vessels would operate in accordance with NTL BOEM-2016-G01 (**Table 1**) to reduce the potential for striking or disturbing these animals.

C.3.3 Non-Endangered Marine Mammals (Protected)

All marine mammal species are protected under the MMPA. Excluding the endangered species that have been discussed in **Sections C.3.1** and **C.3.2**, there are 21 additional marine mammal species that may be found in the Gulf of Mexico. This includes one species of mysticete whale, the dwarf sperm whale (*Kogia sima*) and pygmy sperm whale (*Kogia breviceps*), four species of beaked whales, and 14 species of delphinid whales and dolphins. The most common non-endangered cetaceans in the deepwater environment are the odontocetes, such as the pantropical spotted dolphin (*Stenella attenuata*), spinner dolphin (*Stenella longirostris*), and Clymene dolphin (*Stenella clymene*). A brief summary is presented in this subsection, and additional information on protected marine mammals is discussed 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 (Natural Resources Defense Council, 2014). This petition received a 90-day positive finding by NMFS in 2015 and a proposed rule to list was published in 2016 (Hayes et al., 2018). On 15 April 2019, NMFS issued a final rule to list the Gulf of Mexico DPS of Bryde's whale as Endangered under the ESA. The listing is effective on 15 May 2019. The Bryde's whale distribution is most frequently sighted in the waters over the Desoto Canyon between the 328 ft (100 m) and 3,280 ft (400 m) isobaths (Rosel et al., 2016; Hayes et al., 2018). Based on the available data, it is possible that Bryde's whales could occur in the project area.

Dwarf and pygmy sperm whales. At sea, it is difficult to differentiate dwarf sperm whales from pygmy sperm whales, and sightings are often grouped together as "*Kogia* spp." Both species have a global 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 project 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*), 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 species in the region. Sowerby's beaked whale is considered extralimital, with only one documented 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).

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

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

The bottlenose dolphin is a common inhabitant of the northern Gulf of Mexico, particularly within continental shelf waters. There are two bottlenose dolphin ecotypes, 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 project area. Inshore populations in the northern Gulf of Mexico are separated into 31 geographically distinct population units, or stocks, for management purposes by NMFS (Hayes et al., 2018).

The strategic stock designation, in this case, was based primarily on the occurrence of an "unusual mortality event" (UME) of unprecedented size and duration (from April 2010 through July 2014) (NOAA, 2016c) that affected these stock areas. Carmichael et al. (2012) hypothesized that the unusual number of bottlenose dolphin strandings in the northern Gulf of Mexico during this time 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. Carmichael et al. (2012) and 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.

IPFs that could affect non-endangered marine mammals include MODU presence, noise, and lights; vessel traffic; and two types of accidents (a small fuel spill and a large oil spill). Any impact on marine mammals is expected to be negligible because of rapid dispersion, the small area of ocean affected, the intermittent nature of the discharges, and the mobility of marine mammals. Implementation of NTL BSEE-2015-G03 (**Table 1**) mitigation measures will reduce the potential for marine debris-related impacts on marine mammals. The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of MODU Presence, Noise, and Lights

The presence of the MODU presents an attraction to pelagic food sources that may attract cetaceans. Some odontocetes have shown increased feeding activity around lighted platforms at night (Todd et al., 2009). Therefore, prey congregation could pose an attraction to protected species that exposes them to higher levels or longer durations of noise that might otherwise be avoided. Vessel lighting is not considered as IPFs for marine mammals.

Noise from routine drilling operations has the potential to disturb marine mammals. A discussed in **Section A.1**, noise impacts would be expected at greater distances when thrusters are in use than with vessel and drilling 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, 2018b). Eighteen of the 20 odonotocete species are considered to be in the mid-frequency functional hearing group, two species (*Kogia* spp.) are in the high frequency functional hearing group, and one species (Bryde's whale) is in the low frequency functional hearing group (NMFS, 2018b). Thruster and drilling noise will affect each group differently depending on the frequency bandwiths produced by operations. Generally, noise produced by drilling is dominated by frequencies below 10 kHz. Thus, out of range for the high frequency group whereas the low frequency group is more likely to be disturbed by the low frequency output of drilling sound sources.

For mid frequency cetaceans exposed to a non-impulsive source (like drilling operations), permanent threshold shifts are estimated to occur when the mammal has received a sound exposure level of 198 dB relative to 1 micropascal squared seconds (dB re 1 µPa^2 s) over a 24-hour period (NMFS, 2018b). Similarly, temporary threshold shifts are estimated to occur when a mammal has received a cummulative noise exposure level of 178 dB re 1 µPa^2 s over a 24-hour period. For low frequency cetaceans, specifically the Bryde's whale, permanent and temporary threshold shift onset is estimated to occur at 199 dB re 1 µPa^2 s and 179 re 1 µPa^2 s, repectively. Based on transmission loss calculations (see Urick, 1983a), open water propagation of noise produced by typical sources with DP thrusters in use during drilling, are not expected to produce mean-squared sound pressure levels greater than 160 dB re 1 µPa^2 beyond 105 ft (32 m) from the source. Due to the short propagation distance of high mean-squared sound pressure levels, the transient nature of marine mammals and the stationary nature of drilling activites, it is not expected that any marine mammals will receive exposure levels necessary for the onset of auditory threshold shifts.

NOAA Fisheries West Coast Region (2005) presents criteria that are used in the interim to determine behavioral disturbance thresholds for marine mammals and are applied equally across all functional hearing groups. Received mean-squared sound pressure levels of 120 dB re 1 µPa^2 from a non-impulsive source are considered high enough to elicit a behavioral reaction in some marine mammal species. The 120-dB isopleth may extend tens to hundreds of kilometers from the source depending on the propagation environment.

There are other OCS facilities and activities near the project 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, 2003b). Due to the limited scope, timing, and geographic extent of drilling activities, this project would represent a small, temporary contribution to the overall noise regime, and any short-term behavioral impacts are not expected to be biologically significant to marine mammal populations.

Impacts of Support Vessel and Helicopter Traffic

Vessel traffic has the potential to disturb marine mammals, and there is also a risk of vessel strikes. Data concerning the frequency of vessel strikes are presented in a previous multisale EIS (BOEM, 2012a). To reduce the potential for vessel strikes, BOEM and BSEE have issued NTL BOEM-2016-G01, which recommends protected species identification training for vessel operators and crews; recommends that vessel 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 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. 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 (**Table 1**) mitigation measures will minimize the potential 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 expected to be 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 MMPA specify that helicopters maintain an altitude of 1,000 ft (305 m) within 300 ft (91 m) of marine mammals. Maintaining this flight altitude will minimize the potential for disturbing marine mammals, and no significant impacts are expected (BOEM, 2017a).

Impacts of a Small Fuel Spill

Potential spill impacts on marine mammals are discussed by BOEM (2017a; b), and 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.

Section A.9.1 discusses the size and fate of a potential small diesel fuel spill as a result of Anadarko's proposed activities. Given the open ocean location of the project area, the duration of a small spill and opportunity for impacts to occur would be very brief. The extent and persistence of any impacts would depend on the meteorological and oceanographic conditions at the time, volume released, and effectiveness of spill response measures. More than 90% would evaporate or disperse naturally within 24 hours; and the estimated 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 (**Section A.9.1**).

Potential 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 oiled prey; and stress from the activities and noise of response vessels and aircraft (MMC, 2011). However, because of the limited areal extent and short duration of water quality impacts from a small 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; b). For this EP, there are no unique site-specific issues.

Potential impacts of oil spills on marine mammals could include direct impacts from oil exposure as well as indirect impacts caused by response activities and materials (e.g., vessel traffic, noise, and dispersants) (MMC, 2011). Direct physical and physiological effects could 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 oiled prey; and stress from the activities and noise of response vessels and aircraft. Complications related to the above could lead to dysfunction of immune and reproductive systems (De Guise et al., 2017), physiological stress, declining physical condition, and death. Kellar et al. (2017) estimated that the reproductive success rates for two northern Gulf of Mexico stocks affected by oil were less than a third (19.4%) of those previously reported in other areas (64.7%) not impacted. Behavioral responses could include displacement of animals from preferred habitat (McDonald et al., 2017b), disruption of social structure, change in prey availability and foraging distribution and/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 the slick, where they likely inhaled, aspirated, ingested, physically contacted, and absorbed oil components (NOAA, 2016b; Takeshita et al., 2017). 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. Because of the known low detection rates of carcasses (Williams et al., 2011), it is possible that the number of marine mammal deaths was underestimated. Also, necropsies to confirm the cause of death could not be conducted for many of these marine mammals; therefore, some cause of deaths reported as unknown are likely attributable to oil interaction. Many dolphins in Barataria Bay, Louisiana, had evidence of disease conditions associated with petroleum exposure and toxicity (Schwacke et al., 2014). Lane et al. (2015) noted a decline in pregnancy success rate among dolphins in the same region. BOEM (2012a) concluded that potential effects from a low probability large spill could potentially contribute to more significant and longer-lasting impacts including mortality and longer-lasting chronic or sublethal effects than a small, but severe accidental spill. It is expected that impacts to non-listed marine mammals from a large oil spill resulting in the death of individuals would be adverse but not significant at a population level.

In the aftermath of the Macondo spill, an unusual mortality event (UME) of unprecedented size affected marine 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. 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 were proposed as a cause. Therefore, if a large spill occurred, similar impacts to marine mammals could be expected.

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, booms) (BOEM, 2017a; c). 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 chance 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; c) of marine mammals. It is expected that impacts to non-listed marine mammals from oil spill response activities resulting in the death of individuals would be adverse but not likely 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 project area. Endangered species are the leatherback, Kemp's ridley, and hawksbill turtles. As of May 6, 2016, the entire North Atlantic DPS of the green turtle is listed as threatened (81 FR 20057). The DPS of loggerhead turtles that occur 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 seaward from these beaches; and a large area of *Sargassum* spp. 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-mile (1.6 km) seaward of the mean high-water line at these same nesting beaches. NMFS also designated large areas of shelf and oceanic waters, termed *Sargassum* spp. habitat in the Gulf of Mexico (and Atlantic Ocean) as critical habitats. *Sargassum* is a genus of brown algae (Class Phaeophyceae) that has a pelagic existence. Rafts of *Sargassum* spp. serve as important foraging and developmental habitat for numerous fishes, and young sea turtles, including loggerhead turtles. NMFS also designated three other categories of critical habitat; 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 project area is located approximately 43 miles (69 km) from the designated *Sargassum* critical habitat for loggerhead sea turtles (**Figure 3**).

Leatherbacks and loggerheads are the most likely species to be present near the project area as adults. Green, hawksbill, and Kemp's ridley turtles are typically inner-shelf and nearshore species and are unlikely to occur near the project area as adults. Hatchlings or juveniles of any of the sea turtles may be present in deepwater areas, including the project area, where they may be associated with *Sargassum* spp. and other flotsam.

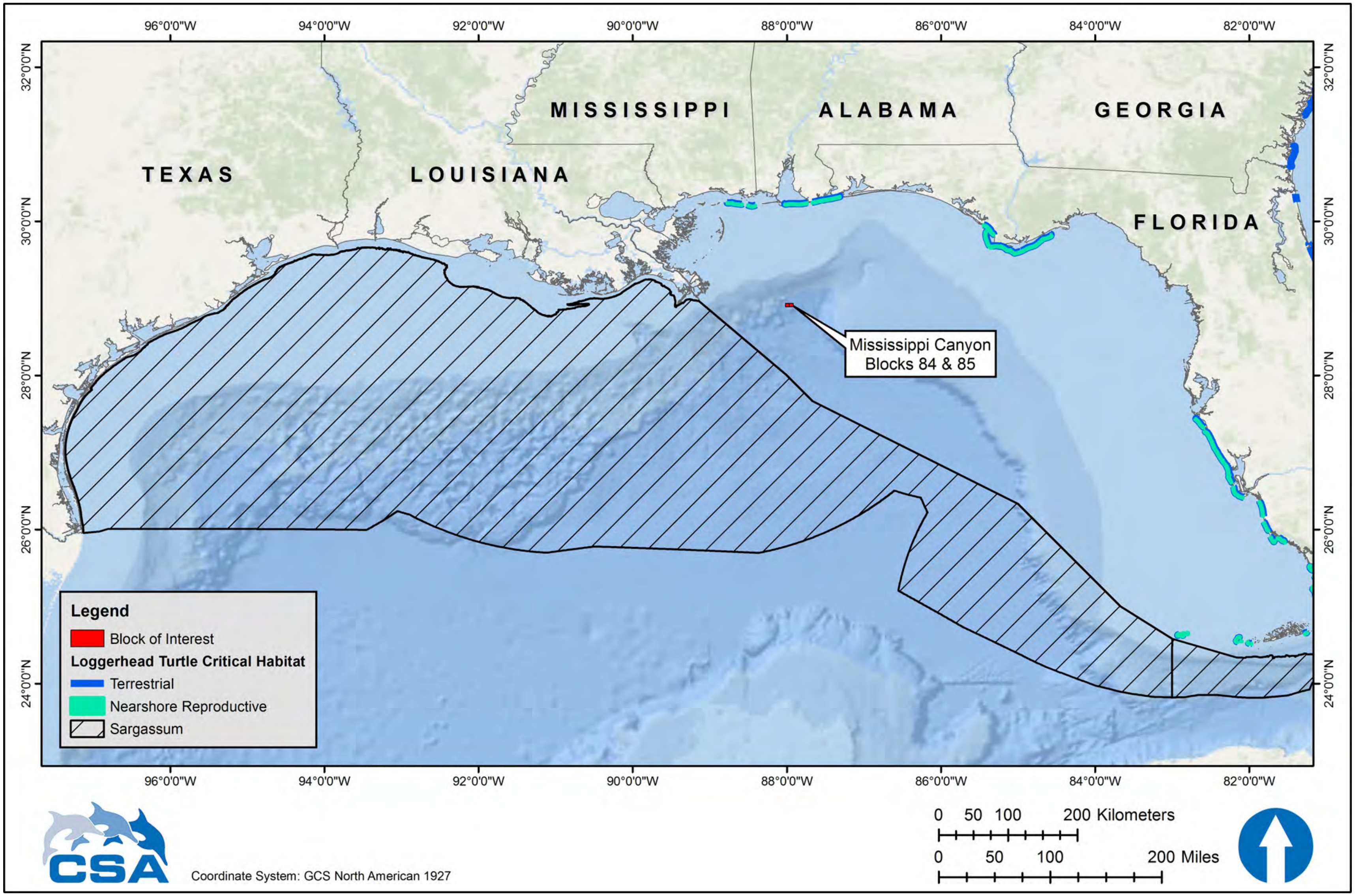

Figure 3. Location of loggerhead turtle critical habitat in the northern Gulf of Mexico. The critical habitat includes terrestrial habitat (nesting beaches) and nearshore reproductive habitat in Mississippi, Alabama, and the Florida Panhandle as well as *Sargassum* spp. habitat.

Sea turtle nesting in the northern Gulf of Mexico 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, n.d.-a), 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, n.d.-b; c);
- 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 Yucatan Peninsula (U.S. Fish and Wildlife Service, 2016a); and
- Kemp's ridley turtles – The main Kemp's ridley nesting site is Rancho Nuevo beach, Tamaulipas, Mexico (NMFS, 2011). A much smaller but growing population nests in Padre Island National Seashore, Texas, mostly as a result of reintroduction efforts (NMFS, 2011). As of April 2019, a total of 62 Kemp's ridley turtle nests were counted on Texas beaches during the 2019 nesting season and a total of 250 Kemp's ridley turtle nests were counted during the 2018 nesting season. In 2017, 353 Kemp's ridley turtle nests were counted, an increase from the 185 counted in 2016; 159 counted in 2015; and 118 counted in 2014 (Turtle Island Restoration Network, 2019). Padre Island National Seashore in southern Texas, is the most important nesting location for this species in the U.S. Kemp's ridley turtles typically do not nest anywhere near the project area, although there have been occasional reports of nesting in Alabama (Share the Beach, 2016).

IPFs that could affect sea turtles include MODU presence, noise, and lights; support vessel and helicopter traffic; and two types of accidents (a small fuel spill and a large oil spill). Any impacts on sea turtles from effluent discharges are expected to be negligible because of rapid dispersion, the small area of ocean affected, and the intermittent nature of the discharges. Implementation of NTL BSEE-2015-G03 (**Table 1**) mitigation measures will reduce 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

Offshore drilling 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 could include behavioral disruption and displacement from the area near the sound source. There is scarce information regarding hearing and acoustic thresholds for marine turtles. Sea turtles can hear low to mid-frequency sounds and they appear to hear best between 200 and 750 Hz and do not respond well to sounds above 1,000 Hz (Ketten and Bartol, 2005). 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) lists the sea turtle underwater acoustic root mean square sound pressure level injury threshold as 207 dB re 1 μPa^2; Blackstock et al. (2018) identified the sea turtle underwater acoustic root mean square sound pressure level behavioral threshold as 175 dB re 1 μPa^2. No distinction is made between impulsive and continuous sources for these thresholds. Based on transmission loss calculations (see Urick, 1983a), open water propagation of noise produced by typical sources with DP thrusters in use during drilling, are not expected to produce mean-squared sound pressure levels greater than 160 dB re 1 μPa^2 beyond 105 ft (32 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 drilling activities. Any impacts would likely be short-term behavioral changes such as diving and evasive swimming, disruption of activities, or departure from the area. Because of the limited scope and short duration of drilling 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 (Tuxbury and Salmon, 2005; Berry et al., 2013; Simões et al., 2017). 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 vessel traffic has the potential to disturb sea turtles, and there is also a risk of vessel strikes. Data show that a vessel strike is one cause of sea turtle mortality in the Gulf of Mexico (NMFS, 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 and BSEE have issued NTL BOEM-2016-G01, which recommends protected species identification training for vessel operators and crews; recommends that vessel 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 (**Table 1**) will reduce the potential for vessel strikes during periods of daylight and during sea and weather 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 Fuel Spill

Potential spill impacts on sea turtles are discussed by NMFS (2007) and BOEM (2017a; c). For this EP, there are no unique site-specific issues with respect to spill impacts on sea turtles. **Section A.9.1** discusses the size and fate of a potential small diesel fuel spill as a result of Anadarko's proposed activities. EP Section H provides detail on spill response measures. Given the open ocean location of the project area, the duration of a small spill and opportunity for impacts on sea turtles to occur would be brief.

The extent and persistence of any impacts would depend on the meteorological and oceanographic conditions at the time of the spill, the volume released, and the effectiveness of spill response measures. More than 90% would evaporate or disperse naturally within 24 hours; and the estimated 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 (**Section A.9.1**).

Potential 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 oiled prey; and stress from the activities and noise of response vessels and aircraft (NMFS, 2014a). However, because of the limited areal extent and short duration of water quality impacts from a small fuel spill, no significant impacts are expected.

Loggerhead Turtle Critical Habitat – Nesting Beaches. A small diesel fuel spill in the project area would be unlikely to affect sea turtle nesting beaches because the project area is 67 miles (108 km) 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 88 miles (142 km) from the project 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 breaking up.

Loggerhead Turtle Critical Habitat – *Sargassum* habitat. The project area is located 43 miles (69 km) from the *Sargassum* portion of the loggerhead turtle critical habitat (**Figure 2**). A small fuel spill would be unlikely affect *Sargassum* habitat due to the distance from the project area. If fuel did contact the *Sargassum* habitat, juvenile sea turtles could come into contact with or ingest oil, resulting in death, injury, or other sublethal effects. However, the small area of the sea surface estimated to be affected by a small spill (0.5 to 5 ha [1.2 to 12 ac]) would represent a negligible percentage of the available *Sargassum* habitat in the region (the total area of the designated *Sargassum* portion of the loggerhead critical habitat is 40,662,810 ha [100,480,000 ac]).

Impacts of a Large Oil Spill

Impacts of oil spills on sea turtles could include direct impacts from oil exposure as well as indirect impacts caused by response activities and materials (e.g., vessel traffic, noise, dispersants). Potential direct physical and physiological effects could 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 affected food; and stress from the activities and noise of response vessels and aircraft. Complications related to the above could lead to dysfunction of immune and reproductive systems, physiological stress, declining physical condition, and death. Behavioral responses could include displacement of animals from prime habitat, disruption of social structure, change in food availability and foraging distribution and/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 Anadarko'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 loggerheads 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) estimated that between 4,900 and up to 7,600 large juvenile and adult sea turtles (Kemp's ridleys, loggerheads, and hard-shelled 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 hard-shelled sea turtles not identified to species) were killed by the Macondo spill. Nearly 35,000 hatchling sea turtles (loggerheads, Kemp's ridleys, and green turtles) were also injured by response activities (NOAA, 2016b). Evidence from McDonald et al. (2017a) suggests that 402,000 turtles were exposed to oil in the aftermath of the Macondo spill, including 54,800 which were likely to have been heavily oiled.

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. 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 (or a reduction of 43.7%) in 2010 (NOAA, 2016b; Lauritsen et al., 2017). Impacts from a large oil spill resulting in the death of individual listed sea turtles could be significant to local populations.

Loggerhead Turtle Critical Habitat – Nesting Beaches. Spilled oil reaching sea turtle nesting beaches could have effects on nesting sea turtles and egg development (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 would be subject to the same types of oil spill exposure hazards as adults. Hatchlings that contact oil residues while crossing a beach could exhibit a range of effects, from acute toxicity to impaired movement and bodily functions (NMFS, 2007).

Based on the 30-day OSRA modeling (**Table 3**), coastal areas of Plaquemines Parish could be affected within 3 days of a spill (4% conditional probability). Within 10 days of a spill, the model predicts potential contact to four Louisiana Parishes (1 to 14% conditional probability). Coastal areas between Cameron Parish, Louisiana, and Bay County, Florida, may be affected within 30 days of a spill (1 to 21% conditional probability). Based on the 60-day OSRA modeling estimates (**Table 4**), the potential shoreline contacts range from Matagorda County, Texas, to Levy County, Florida (up to 24% conditional probability), shorelines that support significant loggerhead sea turtle nesting. The nearest nearshore reproductive critical habitat for the loggerhead turtle is located in Baldwin County, Alabama, approximately 88 miles (142 km) from the project area (**Figure 3**) and is predicted by the 60-day OSRA model to have an 18% or less conditional probability of contact within 60 days of a spill.

Loggerhead Turtle Critical Habitat – *Sargassum* habitat. The project area is located approximately 43 miles (69 km) from the *Sargassum* habitat portion of the loggerhead turtle critical habitat (**Figure 2**). Because of the large area designated as *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. For example, the 2010 Macondo spill affected approximately one-third of the *Sargassum* habitat in the northern Gulf of Mexico (BOEM, 2014b; a). It is extremely unlikely that the entire *Sargassum* portion of loggerhead critical habitat would be affected by a large spill. Because *Sargassum* spp. is a floating, pelagic species, it would only be affected by oil that is present near the surface.

The effects of oiling on *Sargassum* spp. vary with spill severity, but moderate to heavy oiling that could occur during a large spill could cause complete mortality to *Sargassum* spp. and its associated communities (BOEM, 2016a; 2016c). *Sargassum* spp. also have the potential to sink during a large spill, thus temporarily removing the habitat and possibly being an additional pathway of oil exposure to the benthic environment (Powers et al., 2013). Lower levels of oiling may cause sub-lethal effects, including a reduction in growth, productivity, and recruitment of organisms associated with *Sargassum* spp*.* The *Sargassum* spp. 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, 2016c). *Sargassum* spp. have an annual seasonal growth cycle and annual dispersal cycle from the Gulf of Mexico to the western Atlantic. A large spill could affect a large portion of the annual algal crop; however, because of its ubiquitous distribution and seasonal cycle, recovery of the *Sargassum* spp. community would be expected to occur within 1 to 2 years (BOEM, 2016a).

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 (**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 could result in substantial impacts to local populations.

C.3.5 Piping Plover (Threatened)

The Piping Plover 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 (U.S. Fish and Wildlife Service, 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 (U.S. Fish and Wildlife Service, 2003).

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 assumed 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 project area would be unlikely to affect Piping Plovers because a diesel fuel would not be expected to make landfall or reach coastal waters prior to natural dispersion (**Section A.9.1**).

Impacts of a Large Oil Spill

The project area is 67 miles (108 km) from the nearest Piping Plover critical habitat in Terrebone Parish, Louisiana. The 30-day OSRA modeling (**Table 3**) predicts that Piping Plover critical habitat in Plaquemines Parish, Louisiana, could be contacted within 3 days of a spill (4% conditional probability). Within 30 days, the conditional probability for shoreline contact in Plaquemines Parish is estimated to be 21%. The 60-day OSRA modeling (**Table 4**) predicts a 24% or less probability of shoreline contact within 60 days of a spill between Matagorda County, Texas, and Levy County, Florida, a stretch of shoreline that includes numerous areas of Piping Plover Critical habitat.

Plovers could physically oil themselves while foraging on oiled shores or secondarily contaminate themselves through ingestion of oiled intertidal sediments and prey (BOEM, 2017a). Plovers congregate and feed along tidally exposed banks and shorelines, following the tide out and 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 these birds are most common along the coastal Gulf or if spills contacted their critical habitat. Impacts could also occur from vehicular traffic on beaches and other activities associated with spill cleanup.

Anadarko 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 could be significant to the local population, depending on the number of individuals lost.

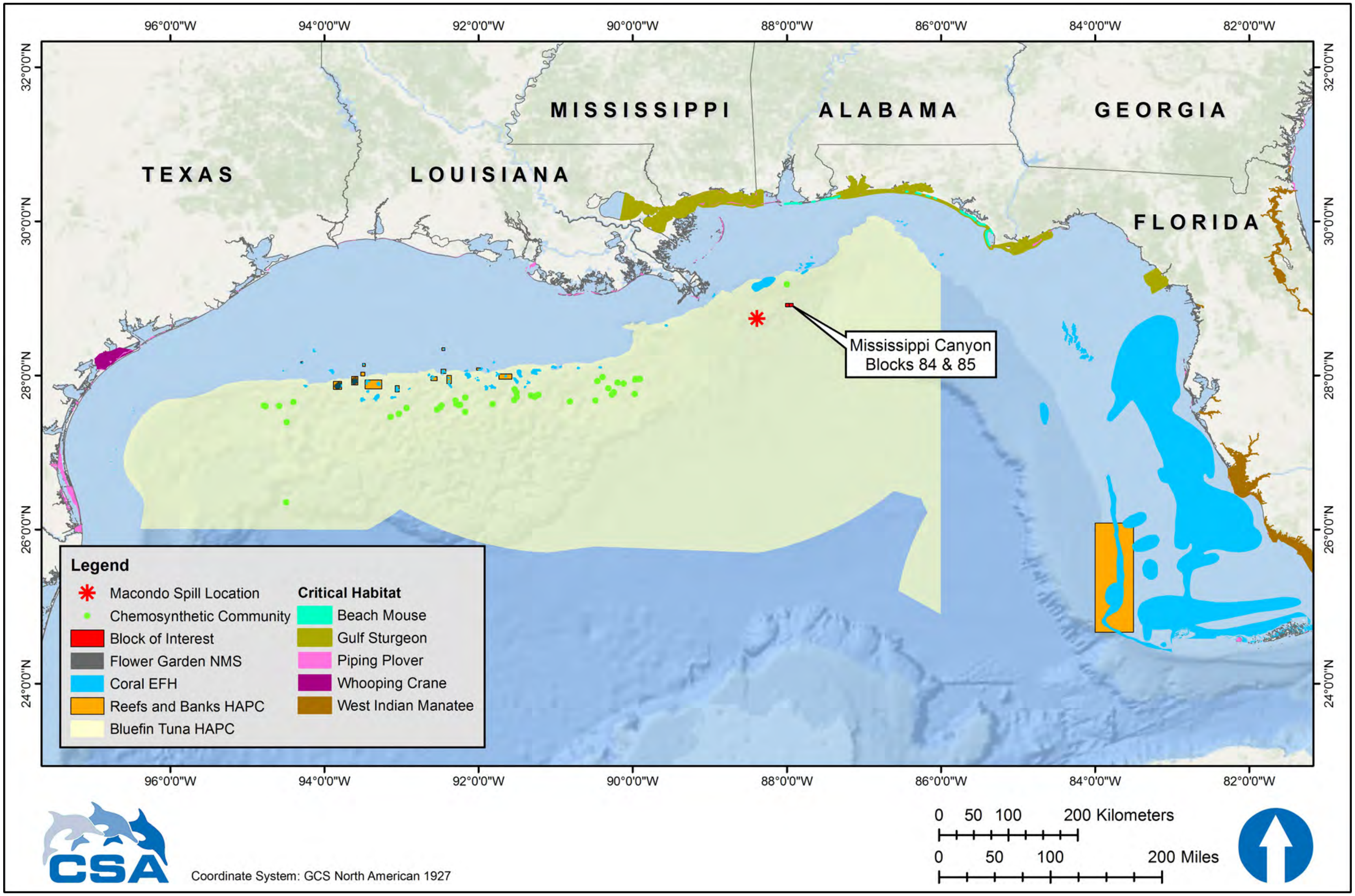

Figure 4. Location of selected environmental features in relation to the project area. EFH=Essential Fish Habitat; HAPC= Habitat Area of Particular Concern; NMS=National Marine Sanctuary.

C.3.6 Whooping Crane (Endangered)

The Whooping Crane is an 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 an estimated population of 505 at Aransas NWR during the 2017 to 2018 winter (U.S. Fish and Wildlife Service, 2018). 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 (U.S. Fish and Wildlife Service, 2007). Approximately 9,000 ha (22,240 ac) of salt flats in Aransas NWR and adjacent islands make up the principal wintering grounds of the Whooping Crane. Aransas NWR (located in Aransas and Calhoun counties, Texas) is designated as critical habitat for the species.

The only IPF potentially affecting Whooping Cranes is a large oil spill. A small diesel fuel spill in the project area would be unlikely to affect Whooping Cranes because of the distance from Aransas NWR. As explained in **Section A.9.1**, a small fuel spill would not be expected to make landfall or reach coastal waters prior to breaking up.

Impacts of a Large Oil Spill

A large oil spill is unlikely to affect Whooping Cranes as the project area is approximately 514 miles (827 km) from the nearest shoreline that is designed as critical habitat for Whooping Cranes (Aransas NWR). The 30-day OSRA model (**Table 3**) predicts that there is <0.5% probability that an oil spill in the project area would reach a shoreline designated as critical habitat for the Whooping Crane in Calhoun or Aransas counties, Texas. The 60-day OSRA model (**Table 4**) predicts that a <0.5% conditional probability of contact in Aransas County, Texas 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. Anadarko 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 Oceanic Whitetip Shark (Threatened)

The oceanic whitetip shark was listed as threatened under the ESA on January 30, 2018 (effective March 30, 2018) by NMFS (83 FR 4153). Oceanic whitetip sharks are found worldwide in offshore waters between approximately 30° N and 35° S latitude, and historically were one of the most widespread and abundant species of shark (Baum et al., 2015). However, based on reported oceanic whitetip shark catches in several major long-line fisheries, the global population appears to have suffered substantial declines (Camhi et al., 2008) and the species is now only occasionally reported in the Gulf of Mexico (Baum et al., 2015).

A comparison of historical shark catch rates in the Gulf of Mexico by Baum and Myers (2004) noted that most recent papers dismissed the oceanic whitetip shark as rare or absent in the

Gulf of Mexico. NMFS (2018a) noted that there has been an 88% decline in abundance of the species in the Gulf of Mexico since the mid-1990s due to commercial fishing pressure.

IPFs that could affect the oceanic whitetip shark include MODU presence, noise, and lights, and a large oil spill. A small diesel fuel spill in the project area would be unlikely to affect oceanic whitetip sharks due to rapid natural dispersion of diesel fuel and the low density of oceanic whitetip sharks potentially present in the project area. Any impacts on oceanic whitetip sharks from effluent discharges are expected to be negligible because of rapid dispersion, the small area of ocean affected, and the intermittent nature of the discharges. The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of MODU Presence, Noise, and Lights

Offshore drilling activities produce a broad array of sounds at frequencies and intensities that may be detected by elasmobranchs including the threatened oceanic whitetip shark. The general frequency range for elasmobranch hearing is approximately between 20 Hz and 1 kHz (Ladich and Fay, 2013), which includes frequencies exhibited by individual species such as the nurse shark (*Ginglymostoma cirratum*; 300 and 600 Hz) and the lemon shark (*Negaprion brevirostris*; 20 Hz to 1 kHz) (Casper and Mann, 2006). These frequencies overlap with sound pressure levels associated with drilling activities (typically 10 Hz to 10 kHz) (Hildebrand, 2005). Impacts from offshore drilling activities (i.e., continuous sound) could include masking or behavioral change (Popper et al., 2014). However, because of the limited propagation distances of high sound pressure levels from the drilling activities, impacts would be limited in geographic scope and no population level impacts on oceanic whitetip sharks are expected.

Impacts of a Large Oil Spill

Information regarding the direct effects of oil on elasmobranchs, including the oceanic whitetip shark are largely unknown. However, in the event of a large oil spill, oceanic whitetip sharks could be affected by direct ingestion, ingestion of oiled prey, or the absorption of dissolved petroleum products through the gills. Because oceanic whitetip sharks are typically found in surface waters (Andrzejaczek et al., 2018), they could be more likely to be impacted by floating oil than other species which only reside at depth.

It is possible that a large oil spill could affect individual oceanic whitetip sharks and result in injuries or deaths of individuals. However, due to the low density of oceanic whitetip sharks thought to exist in the Gulf of Mexico, it is unlikely that a large spill would result in population level effects.

C.3.8 Giant Manta Ray (Threatened)

The giant manta ray was listed as threatened under the ESA on January 22, 2018 (effective February 21, 2018) by NMFS (83 FR 2916). The species is a slow-growing, migratory, and planktivorous elasmobranch, inhabiting tropical, subtropical, and temperate bodies of water worldwide (NOAA, 2018).

Commercial fishing is the primary threat to giant manta rays (NOAA, 2018). The species is targeted and caught as bycatch in several global fisheries throughout its range. Although protected in U.S. waters, protection of populations is difficult as they are highly migratory with sparsely distributed and fragmented populations throughout the world. Some estimated regional population sizes are small (between 100 to 1,500 individuals) (Marshall et al., 2018;

NOAA, 2018). Stewart et al. (2018) recently reported evidence that the Flower Garden Banks serves as nursery habitat for aggregations of juvenile manta rays; at least 74 unique individuals have been positively identified based on unique underbelly coloration (Flower Garden Banks National Marine Sanctuary, 2018). Genetic and photographic evidence in the Flower Garden Banks over 25 years of monitoring showed that 95% of identified giant manta ray male individuals were smaller than mature size (Stewart et al., 2018).

IPFs that may affect giant manta rays include MODU presence, noise, and lights, and a large oil spill. A small diesel fuel spill in the project area would be unlikely to affect giant manta rays due to rapid natural dispersion of diesel fuel and the low density of giant manta rays potentially present in the project area. Any impacts on giant manta rays from effluent discharges are expected to be negligible because of rapid dispersion, the small area of ocean affected, and the intermittent nature of the discharges. The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of MODU Presence, Noise, and Lights

Offshore drilling activities produce a broad array of sounds at frequencies and intensities that may be detected by elasmobranchs including the giant manta ray. The general frequency range for elasmobranch hearing is approximately between 20 Hz and 1 kHz (Ladich and Fay, 2013). Studies indicate that the most sensitive hearing ranges for individual species were 300 and 600 Hz (yellow stingray [*Urobatis jamaicensis*]) and 100 to 300 Hz (little skate [*Erinacea raja*]) (Casper et al., 2003; Casper and Mann, 2006). These frequencies overlap with sound pressure levels associated with drilling activities (typically 10 Hz to 10 kHz) (Hildebrand, 2005). Impacts from offshore drilling activities (i.e., non-impulsive sound) could include masking or behavioral change (Popper et al., 2014). However, because of the limited propagation distances of high sound pressure levels from the drilling activities, impacts would be limited in geographic scope and no population level impacts on giant manta rays are expected.

Impacts of a Large Oil Spill

A large oil spill in the project area could reach coral reefs at the Flower Garden Banks which is the only known location of giant manta ray aggregations in the Gulf of Mexico. Individuals may occur anywhere in the Gulf. In the unlikely event of a large oil spill impacting areas with giant manta rays, individual rays could be affected by direct ingestion of oil which could cover their gill filaments or gill rakers, or by ingestion of oiled plankton. Giant manta rays typically feed in shallow waters of less than 10 m depth (NOAA, 2018). Because of this shallow water feeding behavior, giant manta rays would be more likely to be impacted by floating oil than other species which only reside at depth.

In the event of a large oil spill, due to the distance between the project area and the Flower Garden Banks (approximately 346 miles [557 km]), it is unlikely that oil would impact the threatened giant manta ray nursery habitat. It is possible that a large oil spill could contact individual giant manta rays, but due to the low density of individuals thought to occur in the Gulf of Mexico, there would not likely be any population-level effects.

C.3.9 Gulf Sturgeon (Threatened)

The Gulf sturgeon 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). Populations have been depleted or even extirpated throughout the species' historical 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**). Species descriptions are 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 fuel spill in the project area would be unlikely to affect Gulf sturgeon because a small fuel spill would not be expected to make landfall or reach coastal waters prior to breaking up (**Section A.9.1**). The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of a Large Oil Spill

Potential spill impacts on Gulf sturgeon are discussed by NOAA (2007) 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 and by BOEM (2012a). For this EP, there are no unique site-specific issues with respect to this species.

The project area is approximately 89 miles (143 km) from the nearest Gulf sturgeon critical habitat.

The 30-day OSRA modeling (**Table 3**) predicts that a spill in the project area has a 1% 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 project area has up to a 19% 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 habitats, 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 only during winter months (from September 1 through April 30) when this species is foraging in estuarine and 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 and 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.3.10 Nassau Grouper (Threatened)

The Nassau grouper (*Epinephelus striatus*) is a threatened, long-lived reef fish typically associated with hard bottom structures such as natural and artificial reefs, rocks, and underwater ledges (NOAA, nd). Once one of the most common reef fish species in the coastal waters of the United States and Caribbean (Sadovy, 1997), the Nassau grouper has been subject to overfishing and is considered extinct in much of its historical range. Observations of current spawning aggregations compared with historical landings data suggest that the Nassau grouper population is substantially smaller than its historical size (NOAA, nd). The Nassau grouper was listed as Threatened under the ESA in 2016 (81 FR 42268).

Nassau groupers are found mainly in the shallow tropical and subtropical waters of eastern Florida (rare), the Florida Keys, Bermuda, the Yucatan Peninsula, and the Caribbean, including the U.S. Virgin Island and Puerto Rico (NOAA, nd). There has been one confirmed sighting of Nassau grouper from the Flower Garden Banks in the Gulf of Mexico at a water depth of 118 ft (36 m) (Foley et al., 2007). Three additional unconfirmed reports (i.e. lacking photographic evidence) of Nassau grouper have also been documented from mooring buoys and the coral cap region of the West Flower Garden flats (Foley et al., 2007).

There are no IPFs associated with routine project activities that could affect Nassau grouper. A small fuel spill would not affect Nassau grouper because the fuel would float and dissipate on the sea surface and would not be expected to reach the Flower Garden Banks or the Florida Keys. A large oil spill is the only relevant IPF.

Impacts of a Large Oil Spill

Based on the 60-day OSRA modeling results (**Table 4**), a large oil spill would be unlikely (<0.5% probability) to reach Nassau grouper habitat in the Florida Keys (Monroe County, Florida). A spill would be unlikely to contact the Flower Garden Banks based on the distance between the project area and the Flower Garden Banks (approximately 346 miles [557 km]), and the difference in water depth between the project area (5,093 to 5,179 ft [1,552 to 1,579 m]) and the Banks (approximately 56 to 476 ft [17 to 145 m]). While on the surface, oil would not be expected to contact subsurface fish. Natural or chemical dispersion of oil could cause a subsurface plume which would have the possibility of contacting Nassau groupers.

If a subsurface plume were to occur, impacts to Nassau groupers on the Flower Garden Banks would be unlikely due to the low density of Nassau grouper present on the Banks, the distance between the project area and the Flower Garden Banks (approximately 171 statute miles [275 km]), and the shallow location of the coral cap of the Banks. 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 *Deepwater Horizon* 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 should reach Nassau grouper habitat, oil droplets or oiled sediment particles could come into contact with Nassau grouper present on the reefs. Potential impacts include the direct ingestion of oil which could cover their gill filaments or gill rakers, ingestion of oiled prey, or the absorption of dissolved petroleum products through the gills.

In the event of a large oil spill, due to the distance between the project area and the Flower Garden Banks and the Florida Keys, it is unlikely that oil would impact Nassau grouper habitats. It is possible that a large oil spill could contact individual Nassau grouper fish, but due to the low density of individuals estimated to exist in the Gulf of Mexico, population-level effects are unlikely.

C.3.11 Beach Mouse (Endangered)

Four subspecies of endangered beach mouse occur on the barrier islands of Alabama and the Florida Panhandle: the Alabama, Choctawhatchee, Perdido Key, and St. Andrew beach mouse. Critical habitat has been designated for all four subspecies and is shown combined for all four subspecies in **Figure 4**. Species descriptions are presented by BOEM (2012a).

A large oil spill is the only IPF that could affect the beach mouse. There are no IPFs associated with routine project activities that could affect these animals because of the distance from shore and the lack of any onshore support activities near their habitat. A small fuel spill in the project area would not affect the beach mouse because a small fuel spill would not be expected to make landfall or reach coastal waters prior to breaking up (**Section A.9.1**). The large oil spill IPF with potential impacts listed in **Table 2** is discussed below.

Impacts of a Large Oil Spill

Potential spill impacts on the endangered beach mouse subspecies are discussed by BOEM (2017a). For this EP, there are no unique site-specific issues with respect to these animals.

The project area is approximately 89 miles (143 km) from the nearest beach mouse critical habitat. The 30-day OSRA results (**Table 3**) predicts a 1% 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 project area has a 18% 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 potential 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 oiled food. Potential 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; b). 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 could be significant at a species level.

C.3.12 Threatened Coral Species

Seven threatened coral species are known from the northern Gulf of Mexico and Florida Keys: elkhorn coral, staghorn coral, lobed star coral, mountainous star coral, boulder star coral, pillar coral, and rough cactus coral. Elkhorn coral, lobed star coral, mountainous star coral, and boulder star coral have been reported from the coral cap region of the Flower Garden Banks (NOAA, 2014), but are unlikely to be present as regular residents in the northern Gulf of Mexico because they typically inhabit coral reefs in shallow, clear, tropical, or subtropical waters. Staghorn coral, pillar coral, and rough cactus coral are only known to inhabit reefs in the Florida

Keys and Dry Tortugas within this range (Florida Fish and Wildlife Conservation Commission, n.d.-d). 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, Florida Keys, or Dry Tortugas. Critical habitat has been designated for elkhorn coral and staghorn coral in the Florida Keys (Monroe County, Florida) and Dry Tortugas, but none has been designated for the other threatened coral species included here.

There are no IPFs associated with routine project activities that could affect threatened corals in the northern Gulf of Mexico. A small 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 (potential impacts listed in **Table 2**) and is discussed below.

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**) predicts the conditional probability of oil contacting the Florida Keys is 0.5% or less. A surface slick would not contact corals growing on the seafloor, but could feasibly impact planktonic larvae. If a subsurface plume were to occur, impacts on the Flower Garden Banks would be unlikely due to the distance from the project area and the difference in water depths.

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 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 including 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 between the project 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; Davis and Fargion, 1996; Davis et al., 2000). Seabirds spend much of their lives offshore over the open ocean, except during breeding season when they nest on islands and 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., 2000). Davis et al. (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 [*Onychoprion fuscatus*], Least Tern [*Sternula antillarum*], Sandwich Tern [*Thalasseus sandvicensis*], Magnificent Frigatebird [*Fregata magnificens*]); winter residents (gannets, gulls, jaegers); and permanent resident species (Laughing Gull [*Leucophaeus atricilla*], Royal Tern [*Thalasseus maximus*], Bridled Tern [*Onychoprion anaethetus*]) (Davis et al., 2000). The GulfCet II study did not estimate bird densities; however, Haney et al. (2014) indicated that seabird densities over the open ocean were estimated to be 1.6 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., 2000), 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.

Trans-Gulf migrant birds including shorebirds, wading birds, and terrestrial birds may also be present in the project 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 birds include MODU presence, noise, and lights; support vessel and helicopter traffic; and two types of accidents (a small fuel spill and a large oil spill). Any impacts on the birds from effluent discharges is expected to be negligible because of rapid dispersion, the small area of ocean affected, the intermittent nature of the discharges, and the mobility of these animals. Implementation of BSEE NTL 2015-G03 (**Table 1**) mitigation measures will reduce 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 (Russell, 2005; Ronconi et al., 2015). Mortality of migrant birds at tall towers and other land-based structures has been reviewed extensively, and the mechanisms involved in platform collisions appear to be similar. In some cases, migrants simply do not see a part of the platform 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 most trans-Gulf migrant species, particularly in the spring (Russell, 2005).

Because of the limited scope and duration of drilling activities as described in this EP, any impacts on populations of either seabirds or trans-Gulf migrant birds are not expected to be significant.

Impacts of Support Vessel and Helicopter Traffic

Support vessels and helicopters are unlikely to substantially disturb marine birds in open, offshore waters. Schwemmer et al. (2011) showed that several sea birds exhibited behavioral responses and altered distribution patterns in response to ship traffic, which could potentially cause loss of foraging time and resting habitat. However, it is likely that individual birds would experience, at most, only short-term behavioral disruption resulting from vessel traffic, and the impact would not be significant.

Impacts of a Small Fuel Spill

Potential spill impacts on marine birds are discussed by BOEM (2017a; b). For this EP, there are no unique site-specific issues with respect to spill impacts on these animals.

Section A.9.1 discusses the size and fate of a potential small diesel fuel spill as a result of Anadarko's proposed activities. EP Section H provides detail on spill response measures. Given the open ocean location of the project area, the duration of a small spill and opportunity for impacts to occur would be very brief.

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. Because of the limited areal extent and short duration of water quality impacts from a small fuel spill, secondary impacts caused by ingestion of oil via oiled prey or reductions in prey abundance are unlikely. Because of 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 birds are discussed by BOEM (2017a; b). For this EP, there are no unique site-specific issues with respect to spill impacts on marine birds.

Marine seabirds could be exposed to oil from a spill at the project area. Davis et al. (2000) reported that terns, storm-petrels, shearwaters, and jaegers were the most frequently sighted seabirds in the deepwater (>200 m) Gulf of Mexico. Haney et al. (2014) indicated that seabird densities over the open ocean were estimated to be 1.6 birds km^{-2}. The number of marine 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 marine 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 (*Morus bassanus*), Magnificent Frigatebird, and Masked Booby (*Sula dactylatra*) (U.S. Fish and Wildlife Service, 2011). The Northern Gannet was among the species with the largest numbers of birds affected by the spill. NOAA reports 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). Additionally, oiled birds could return to their nests and contaminate juveniles or eggs. 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) have been discussed previously in **Sections C.3.5** and **C.3.6**. The Brown Pelican was delisted from federal endangered status in 2009 (U.S. Fish and Wildlife Service, 2016b) and was delisted from state species of special concern status by the State of Florida in 2017 (Florida Fish and Wildlife Conservation Commission, 2018). 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, 2018). 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, indicate that Brown Pelicans do not occur in deep offshore waters (Fritts and Reynolds, 1981; Davis and Fargion, 1996; Davis et al., 2000). Nearly half the southeastern population of Brown Pelicans lives in the northern Gulf Coast, generally nesting on protected islands (U.S. Fish and Wildlife Service, 2010b).

The Bald Eagle was delisted from its federal threatened status in the lower 48 states on June 28, 2007 but still receives protection under the Migratory Bird Treaty Act of 1918 and the Bald and Golden Eagle Protection Act of 1940 (U.S. Fish and Wildlife Service, 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 (*Charadrius wilsonia*), Black Skimmer (*Rynchops niger*), Forster's Tern (*Sterna forsteri*), Gull-Billed Tern (*Gelochelidon nilotica*), Laughing Gull, Least Tern, and Royal Tern (U.S. Fish and Wildlife Service, 2010b). 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 fuel spill in the project area would be unlikely to affect shorebirds or coastal nesting birds due to the project area's distance from the nearest shoreline. As explained in **Section A.9.1**, a small fuel spill would not be expected to make landfall or reach coastal waters prior to natural dispersion. Compliance with NTL BSEE-2015-G03 (**Table 1**) will reduce the potential for marine debris-related impacts on shorebirds. The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of Support Vessel and Helicopter Traffic

Vessels may transit coastal areas near Port Fourchon, Louisiana. 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 some foraging and resting birds. The disturbances will be limited to flushing birds away from vessel pathways. Flushing distances vary among species and individuals (Rodgers and Schwikert, 2002; Schwemmer et al., 2011). 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 an outboard-powered boat (Rodgers and Schwikert, 2002). The MODU will not approach nesting or breeding areas on the shoreline, so disturbance to nesting birds, eggs, and chicks is not expected. Vessel operators will use designated navigation channels and comply with posted speed and wake restrictions while transiting sensitive inland waterways. Because of the limited scope and short duration of drilling 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 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 adherence to the Federal Aviation Administration guidelines, it is likely that individual birds would experience, at most, only short-term behavioral disruption from aircraft traffic.

Impacts of Large Oil Spill

Based on the 30-day OSRA modeling (**Table 3**), coastal areas of Plaquemines Parish could be affected within 3 days of a spill (4% conditional probability). Within 10 days of a spill, the model predicts potential contact to four Louisiana Parishes (1 to 14% conditional probability). Coastal areas between Cameron Parish, Louisiana, and Bay County, Florida, may be affected within 30 days of a spill (1 to 21% conditional probability). Based on the 60-day OSRA modeling estimates (**Table 4**), the potential for shoreline contact ranges from Matagorda County, Texas, to Levy County, Florida, within 60 days of a spill (up to 24% conditional probability).

Coastal birds can be exposed to oil as they float on the water's 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 (U.S. Fish and Wildlife Service, 2010a). 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 oiled 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 harmed 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 (*Pelecanus erythrorhynchos*), Black Skimmer, Black Tern (*Chlidonias niger*), 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, whose surface waters 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 mid-water fauna to characterize vertical distribution of mesopelagic fishes in deepwater areas of the Gulf of Mexico revealed high species richness, but the community was dominated by relatively few families and species.

IPFs that could affect pelagic communities and ichthyoplankton include MODU presence, noise, and lights; effluent discharges; seawater intake; and two types of accidents (a small fuel spill and a large oil spill). The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of MODU Presence, Noise, and Lights

The MODU, as a floating structure in the deepwater environment, will act as fish-aggregating devices (FADs). In oceanic waters, the FAD effect would be most pronounced for epipelagic fishes such as tunas, dolphinfish (*Coryphaena hippurus*), billfishes, and jacks, which are commonly attracted to fixed and drifting 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; Wilson et al., 2006). The FAD effect could possibly enhance the feeding of epipelagic predators by attracting and concentrating smaller fishes. 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 they 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^2 accumulated over a 48-hour period for onset of recoverable injury and 158 dB re 1 µPa^2 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; Nedelec et al., 2017). 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 µPa^2 s but resulted in no increased mortality between the exposure and control groups. Non-impulsive noise sources (such as drilling operations) are expected to be far less injurious than impulsive noise. Based on transmission loss calculations (see Urick, 1983a), open water propagation of noise produced by typical sources with DP thrusters in use during drilling, are not expected to produce mean-squared sound pressure levels greater than 160 dB re 1 µPa^2 beyond 32 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 drilling rig. 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). All NPDES permit limits and requirements will be met for these types of discharges.

WBM and cuttings will also be released at the seafloor during the initial well intervals, before the marine riser is set that allows their return to the surface vessel. Excess cement slurry and blowout preventer 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, domestic wastes, water-based bentonite gel, and guar gel will have little or no impact 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 will have little or no impact on the pelagic environment in the immediate vicinity of these discharges. Deck drainage from oily 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 hydrocarbon levels, 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 effluent discharges in accordance with the NPDES permit, such as desalination unit brine, uncontaminated ballast water, uncontaminated water from testing of the firewater system, and non-contact cooling water, are expected to dilute rapidly and have little or no potential for impact on water column biota.

Impacts of Seawater Intake

Seawater will be drawn from the ocean for once-through, non-contact cooling of machinery on the MODU. The MODU used 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 except for a few fast-swimming larvae of certain taxonomic groups. Those organisms entrained may be stressed or killed, primarily through changes in water temperature during the route from the cooling intake structure to the discharge structure and mechanical damage (turbulence in pumps and condensers). Because of the limited scope and short duration of drilling activities, any short-term impacts of entrainment are not expected to be biologically significant to plankton or ichthyoplankton populations (BOEM, 2017a).

Impacts of a Small Diesel Fuel Spill

Potential spill impacts on fisheries resources are discussed by BOEM (2017a; b). For this EP, there are no unique site-specific issues with respect to spill impacts.

Section A.9.1 discusses the size and fate of a potential small diesel fuel spill as a result of Anadarko's proposed activities. Given the open ocean location of the project area, the duration of a small spill and opportunity for impacts to occur would be very brief.

A small fuel spill could have localized impacts (i.e., hydrocarbon contamination) on phytoplankton, zooplankton, ichthyoplankton, and nekton. Because of the limited areal extent, short duration of water quality impacts, and patchy presence of these groups, 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 BOEM (2017a; b). 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. Eggs and larvae of fishes 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 would be potentially 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, 2016c). Adult and juvenile fishes could also be impacted through the ingestion of oiled prey. It is expected that impacts to pelagic communities 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 those 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 20 miles (32 km) from the project area.

Highly migratory pelagic fishes, which occur as transients in the project 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 at or near the project area include the following (NMFS, 2009b):

- Atlantic bluefin tuna (*Thunnus thynnus*) (spawning, eggs, larvae, adults)
- Bigeye thresher shark (*Alopias superciliosus*) (all)
- Blue marlin (*Makaira nigricans*) (juveniles, adults)
- Longfin mako shark (*Isurus paucus*) (all)
- Oceanic whitetip shark (all)
- Scalloped hammerhead shark (*Sphryna lewini*) (juveniles, adults)
- Skipjack tuna (*Katsuwonus pelamis*) (spawning, adults)
- Smooth dogfish (*Mustelus canis*) (all)
- Swordfish
- (*Xiphias gladius*) (larvae, juveniles, adults)
- Tiger shark (*Galeocerdo cuvier*) (adults)
- Whale shark (*Rhincodon typus*) (all)
- White marlin (*Kajikia albidus*) (juveniles, adults)
- Yellowfin tuna (*Thunnus albacares*) (spawning, juveniles, adults)

Research indicates that the central and western Gulf of Mexico may be important spawning habitat for Atlantic bluefin tuna, 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 project 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 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 to 2022 WPA/CPA Multisale EIS (BOEM, 2017a). The necessary components of the EFH consultation were completed and there is ongoing coordination among NMFS, BOEM, and BSEE, including discussions of mitigation (BOEM, 2016b).

Other HAPCs have been identified in the Gulf of Mexico 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 other reefs and banks of the northwestern Gulf of Mexico (listed as reefs and banks on **Figure 3**). The nearest HAPC is Madison Swanson Marine Reserve, which is located approximately 129 miles (208 km) from the project area.

IPFs that could affect EFH include MODU presence, noise, and lights; effluent discharges; seawater intake; and two types of accidents (a small fuel spill and a large oil spill). The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts MODU Presence, Noise, and Lights

The MODU, as floating structure in the deepwater environment, will act as a FAD. In oceanic waters, the FAD effect would be most pronounced for epipelagic fishes such as tunas, dolphinfish, 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.

Vessel 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; Nedelec et al., 2017). Further discussion on impact to fish from sound and injury criteria are discussed in **Section C.5.1**. Because the project activities are temporary and high sound pressure levels from the drilling activities have short propagation distances, any impacts to EFH for highly migratory pelagic fishes are biologically insignificant.

Impacts of Effluent Discharges

Effluent discharges affecting EFH by diminishing ambient water quality include drilling muds and cuttings, excess cement, treated sanitary and domestic wastes, deck drainage, non-pollutant completion fluid, and miscellaneous discharges such as desalination unit brine, uncontaminated cooling water, fire water, and bilge and ballast water. Impacts on water quality have been discussed previously. No significant impacts on EFH for highly migratory pelagic fishes are expected from these discharges.

Impacts of Seawater Intake

As noted previously, cooling water intake will entrain and impinge plankton, including fish eggs and larvae (ichthyoplankton). Because of the limited scope and 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. No significant impacts on EFH for highly migratory pelagic fishes are expected from these discharges if discharged according to NPDES permit conditions.

Impacts of a Small Diesel Fuel Spill

Potential spill impacts on EFH are discussed by BOEM (2016b; 2017a). For this EP, there are no unique site-specific issues with respect to spill impacts.

Section A.9.1 discusses the size and fate of a potential small diesel fuel spill as a result of Anadarko's proposed activities. EP Section H provides detail on spill response measures. Given the open ocean location of the project area, the duration of a small spill and opportunity for impacts to occur would be very brief.

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 project area. A spill would also produce a short-term impact on surface and near-surface water quality in the HAPC for spawning Atlantic 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 not affect EFH for corals and coral reefs, the nearest of which is located approximately 20 miles (32 km) from the project area. A small diesel fuel spill would float and dissipate on the sea surface and would not contact these seafloor features.

Impacts of a Large Oil Spill

Potential spill impacts on EFH are discussed by BOEM (2016b; 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; National Marine Fisheries Service, 2009b), some impact on EFH would be unavoidable.

A large spill could affect the EFH for many managed species including shrimps, 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 oiled and result in persistent degradation of the seafloor habitat for managed demersal fish and shellfish species.

The project area is within the HAPC for spawning Atlantic bluefin tuna (NMFS, 2009b). A large spill could temporarily degrade the HAPC by increasing 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 this species migrates to the Gulf of Mexico to spawn in April, May, and June (NMFS, 2009b).

The nearest area designated as EFH for corals is approximately 20 miles (32 km) from the project 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, MC 84 and 85 are on BOEM's list of archaeology survey blocks (BOEM, 2011), but water depth at the proposed wellsites 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. The site clearance letters for the proposed wellsites noted no sonar contacts recommended for avoidance based on archaeological potential (Oceaneering International Inc, 2019b; a).

A large oil spill is the only IPF considered. A small fuel spill would not affect shipwrecks because the oil would float and dissipate on the sea surface. The IPFs with potential impacts listed in **Table 2** are discussed below.

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 known historic shipwrecks in the project area, this impact would not be relevant.

Beyond the seafloor blowout 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). Additionally, the shipwreck-associated sediment microbiomes may also be impacted (i.e., reduced biodiversity) (Hamdan et al., 2018). 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 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, Anadarko will immediately halt operations, take steps to ensure that the site is not disturbed, and contact the Regional Supervisor, Leasing and Environment, within 48 hours of its discovery. Anadarko 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. Based on the 30-day OSRA modeling (**Table 3**), coastal areas of Plaquemines Parish could be affected within 3 days of a spill (4% conditional probability). Within 10 days of a spill, the model predicts potential contact to four Louisiana Parishes (1 to 14% conditional probability). Coastal areas between Cameron Parish, Louisiana, and Bay County, Florida, may be affected within 30 days of a spill (1 to 21% conditional probability). Based on the 60-day OSRA modeling estimates (**Table 4**), the potential for shoreline contact ranges from Matagorda County, Texas, to Levy County, Florida, within 60 days of a spill (up to 24% conditional probability). 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

Prehistoric archaeological sites are not expected in the project area. With water depths at the proposed wellsites ranging from approximately 5,093 to 5,179 ft (1,552 to 1,579 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. Based on this, the only IPF associated with activities in the project area that could affect prehistoric archaeological sites 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. The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of a Large Oil Spill

Because of the water depth and the lack of prehistoric archaeological sites found in the project area, it is highly unlikely that any such resources would be affected by the physical effects of a subsea blowout, which are limited to an estimated radius of 984 ft (300 m) (BOEM, 2012a).

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). Based on the 30-day OSRA modeling (**Table 3**), coastal areas of Plaquemines Parish could be affected within 3 days of a spill (4% conditional probability). Within 10 days of a spill, the model predicts potential contact to four Louisiana Parishes (1 to 14% conditional probability). Coastal areas between Cameron Parish, Louisiana, and Bay County, Florida, may be affected within 30 days of a spill (1 to 21% conditional probability). Based on the 60-day OSRA modeling estimates (**Table 4**), the potential for shoreline contact ranges from Matagorda County, Texas, to Levy County, Florida, within 60 days of a spill (up to 24% conditional probability).

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 (2017d) 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; b) and are tabulated in the OSRP. Coastal habitats inshore of the project area include coastal and barrier island beaches and dunes, wetlands, oyster reefs, and submerged seagrass beds. Most of the northeastern Gulf of Mexico is fringed by coastal and barrier island beaches, with wetlands, oyster reefs, and submerged seagrass beds occurring in sheltered areas behind the barrier islands and in estuaries.

Because of the distance from shore, the only IPF associated with routine activities in the project area that could affect beaches and dunes, wetlands, oyster reefs, seagrass beds, coastal wildlife refuges, wilderness areas, or any other managed or protected coastal area is support vessel traffic. The support base at Port Fourchon, Louisiana, is not located within a wildlife refuge or wilderness area. Potential impacts of 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 project area would be unlikely to affect coastal habitats because the project area is 67 miles (108 km) 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. The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of Support Vessel Traffic

Support operations are detailed in EP Section G. For OCS activities in general, vessel operations may have a minor incremental impact on coastal and barrier island beaches, wetlands, oyster reefs, and protected areas. Vessel wakes produced by heavy vessel traffic can, over time, erode shorelines along inlets, channels, and harbors, resulting in localized land loss. Impacts to beaches, wetlands, oyster reefs, and protected areas will be minimized by following the speed and wake restrictions in harbors and channels.

Operations of the MODU is 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; b)

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 beaches, wetlands, and submerged seagrass beds. For this EP, there are no unique site-specific issues with respect to coastal habitats.

Based on the 30-day OSRA modeling (**Table 3**), coastal areas of Plaquemines Parish could be affected within 3 days of a spill (4% conditional probability). Within 10 days of a spill, the model predicts potential contact to four Louisiana Parishes (1 to 14% conditional probability). Coastal areas between Cameron Parish, Louisiana, and Bay County, Florida, may be affected within 30 days of a spill (1 to 21% conditional probability). Based on the 60-day OSRA modeling estimates (**Table 4**), the potential for shoreline contact ranges from Matagorda County, Texas, to Levy County, Florida, within 60 days of a spill (up to 24% 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 Anadarko'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 of a hypothetical spill from Launch Point C057 based on the 30-day Oil Spill Risk Analysis (OSRA) model.

County or Parish, State	Wildlife Refuge, Wilderness Area, or State/National Park
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)
Plaquemines, Louisiana	Breton National Wildlife Refuge
	Delta National Wildlife Refuge
	Pass a Loutre Wildlife Management Area
St. Bernard, Louisiana	Biloxi Wildlife Management Area
	Breton National Wildlife Refuge
	Saint Bernard State Park
Hancock and Harrison, Mississippi	Buccaneer State Park
	Grand Bayou Preserve
	Jourdan River Preserve
	Hancock County Marshes Preserve
	Bayou Portage Preserve
	Biloxi River Marshes Preserve
	Cat Island Preserve
	Deer Island Preserve
	Gulf Islands National Seashore
	Hiller Park Recreation Area
	Sandhill Crane Refuge Preserve
	Ship Island Preserve
	Wolf River Preserve
Jackson, Mississippi	Bellefontaine Marsh Preserve
	Davis Bayou Preserve
	Escatawpa River Marsh Preserve
	Grand Bay National Estuarine Research Reserve
	Grand Bay Savanna Preserve
	Graveline Bay Preserve
	Gulf Islands National Seashore
	Gulf Islands Wilderness
	Horn Island Preserve
	Old Fort Bayou Preserve
	Pascagoula River Marsh Preserve
	Petit Bois Island Preserve

Table 7. (Continued).

County or Parish, State	Wildlife Refuge, Wilderness Area, or State/National Park
Jackson, Mississippi (Cont'd)	Round Island Preserve
	Shepard State Park
Mobile, Alabama	Grand Bay National Wildlife Refuge
	Grand Bay Savanna State Nature Preserve
	Mobile-Tensaw Delta WMA
	Penalver Park
	The Grand Bay Savanna Tract (and Addition Tract)
	W.L. Holland WMA
Baldwin, Alabama	Betty and Crawford Rainwater Perdido River Nature Preserve
	Bon Secour NWR
	Gulf State Park
	Meaher State Park
	Mobile-Tensaw Delta CIAP Parcel State Habitat Area
	Mobile-Tensaw Delta WMA
	Perdido River Water Management Area
	W.L. Holland WMA
	Weeks Bay Harris and Worcester Tracts
	Weeks Bay National Estuarine Research Reserve
	Weeks Bay Reserve Addition - Beck Tract
	Betty and Crawford Rainwater Perdido River Nature Preserve
Escambia, Florida	Bayou Marcus Wetlands
	Big Lagoon State Park
	Blue Angel Recreation Park
	Bay Bluffs Park
	Ft. Pickens Aquatic Preserve
	Gulf Islands National Seashore
	Mallory Heights Park #3
	Perdido Bay/Crown Pointe Preserve
	Perdido Key State Park
	Tarkiln Bayou Preserve State Park
	USS Massachusetts (BB-2) Underwater Archaeological Preserve
	Wayside Park
Okaloosa, Florida	Eglin Beach Park
	Fred Gannon Rocky Bayou State Park
	Gulf Islands National Seashore
	Henderson Beach State Park
	Rocky Bayou Aquatic Preserve
	Yellow River Wildlife Management Area
Walton, Florida	Choctawhatchee River Delta Preserve
	Choctawhatchee River Water Management Area
	Deer Lake State Park
	Grayton Beach State Park
	Point Washington State Forest
	Topsail Hill Preserve State Park

Table 7. (Continued).

County or Parish, State	Wildlife Refuge, Wilderness Area, or State/National Park
Bay, Florida	Camp Helen State Park
	SS Tarpon Underwater Archaeological Preserve
	St. Andrews Aquatic Preserve
	St. Andrews State Park
	Vamar Underwater Archaeological Preserve

The level of potential impacts from oil spills on coastal habitats depends on many factors, including 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 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 could 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; Lin et al., 2016). 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. At 103 salt marsh locations that spanned 267 miles (430 km) of shoreline in Louisiana, Mississippi, and Alabama, Silliman et al. (2016) determined a threshold for oil impacts on marsh edge erosion with higher erosion rates occurring for approximately 1 to 2 years after the *Deepwater Horizon* spill at sites with the highest amounts of plant stem oiling (90% to 100%). Thus, displaying a large-scale ecosystem loss. In addition to the direct impacts of oil, cleanup activities in marshes may accelerate erosion rates and retard recovery rates (BOEM, 2017a). Impacts associated with an extensive oiling of coastal wetland habitat from a large oil spill are expected to be significant.

A review of studies by BOEM (2012a) determined that effects of oil on marsh vegetation depend on the type of oil, the type of vegetation, and environmental factors of the area. Impacts to slightly oiled vegetation are considered short term and reversible, as recent studies suggest that they will experience plant die-back followed by recovery without replanting (BOEM, 2012a). Vegetation coated with oil experiences the highest mortality rates due to decreased photosynthesis (BOEM, 2012a). A review of the literature 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).

C.8 Socioeconomic and Other Resources

C.8.1 Recreational and Commercial Fishing

Potential impacts to recreational and commercial fishing were analyzed by BOEM (2017a). The major species sought by commercial fishermen in federal waters of the Gulf of Mexico include shrimp (*Penaeus* spp.), menhaden (*Brevoortia tyrannus*), red snapper (*Lutjanus campechanus*), tunas, and groupers (BOEM, 2017a). However, most of the fishing effort for these species is on the continental shelf in shallow waters. 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; Beerkircher et al., 2009). Pelagic longlining has occurred historically in the project area, primarily during spring and summer.

It is unlikely that any commercial fishing activity other than longlining will occur at or near the project area due to the water depth. 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) (Stiles et al., 2007). Tilefishes (primarily *Lopholatilus 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; Keithly and Roberts, 2017). 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 area.

The only routine IPF that could affect fisheries and, therefore, commercial and recreational fishing, is MODU presence, noise, and lights. Two potential accident IPFs that could affect fisheries are a small diesel fuel spill and a large oil spill. Other factors such as effluent discharges are likely to have negligible impacts on commercial or recreational fisheries because of rapid dispersion, the small area of ocean affected, and the intermittent nature of the discharges. The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of MODU Presence, Noise, and Lights

There is a slight possibility of pelagic longlines becoming entangled with an offshore vessel. 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.

Impacts of a Small Fuel Spill

Pelagic longlining activities in the project area, if any, could be interrupted in the event of a small diesel fuel spill. Fishing activities could be interrupted due to the activities of response vessels operating in the project area. Given the open ocean location of the project area, the duration of a small spill, the window of opportunity for impacts to occur is expected to be very small. **EP Section H** provides detail on spill response measures.

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 project 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 from 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, 2010b). 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; b), 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. However, most commercially valuable fish species in the Gulf of Mexico have planktonic eggs or larvae which may be affected by a large oil spill in deep water (BOEM, 2017a). 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; b). An analysis of the effects of the Macondo spill on the seafood industry in the Gulf of Mexico estimated that the spill reduced total seafood sales by $51.7 to $952.9 million, with an estimated loss of 740 to 9,315 seafood related jobs (Carroll et al., 2016).

C.8.2 Public Health and Safety

A large oil spill is the only accidental IPF that could affect public health and safety. A small diesel fuel spill in the project area would not have any impacts on public health and safety because it would affect only a small area of the open ocean, 67 miles (108 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**). The IPFs with potential impacts listed in **Table 2** are discussed 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 Anadarko's OSRP and the MODU's emergency response plans.

Depending on the spill rate and duration, the physical/chemical characteristics of the oil, the 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; 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 also 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 drilling activities that are expected to affect employment and infrastructure. The project involves support from contractors and associated third-party services, and existing shorebase facilities in Port Fourchon, 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 negligible impacts on socioeconomic conditions such as local employment and existing offshore and coastal infrastructure. A large oil spill is the only accidental IPF that could affect employment and infrastructure. A small 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. The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of a Large Oil Spill

Potential socioeconomic impacts of an oil spill are discussed by BOEM (2017a; b). 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 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. The total spending by drilling operators is estimated to have declined by US$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 potential 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, 2017a).

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 project 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 (**Table 1**) will minimize the chance of trash or debris being lost overboard from the MODU and subsequently washing up on beaches.

A large oil spill is the only accidental IPF that could affect recreation and tourism. A small diesel fuel spill in the project 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. The IPFs with potential impacts listed in **Table 2** are discussed below.

Impacts of a Large Oil Spill

Potential impacts of an oil spill on recreation and tourism are discussed by BOEM (2017a; b). 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.

Based on the 30-day OSRA modeling (**Table 3**), coastal areas of Plaquemines Parish could be affected within 3 days of a spill (4% conditional probability). Within 10 days of a spill, the model predicts potential contact to four Louisiana Parishes (1 to 14% conditional probability). Coastal areas between Cameron Parish, Louisiana, and Bay County, Florida, may be affected within 30 days of a spill (1 to 21% conditional probability). Based on the 60-day OSRA modeling estimates (**Table 4**), the potential for shoreline contact ranges from Matagorda County, Texas, to Levy County, Florida, within 60 days of a spill (up to 24% conditional probability).

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 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 Port Fourchon, 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 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. 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. The IPFs with potential impacts listed in **Table 2** are discussed below.

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 project 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 (2016c) 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 project area is not located within any USCG-designated fairway, shipping lane, but is located within Military Warning Area W-155C. Anadarko 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 project 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 project area and the duration would be brief. The IPFs with potential impacts listed in **Table 2** are discussed below.

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. Other OCS activities located nearby the location of a large spill may be temporarily interrupted, which could include evacuation of non-essential personnel. Anadarko will comply with BOEM requirements and lease stipulations to avoid impacts on uses of the area by military vessels and aircraft.

D. Environmental Hazards

D.1 Geologic Hazards

The proposed wellsites are in a favorable location for the proposed activities, are situated along a relatively benign seafloor, and no seafloor or subsurface faults will be penetrated by the proposed wellsites (Oceaneering International Inc, 2019b; a). 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 that will be used for this project. High winds and limited visibility during a severe storm could disrupt support activities and make it necessary to suspend some activities and potentially evacuate the vessel for safety reasons until the storm or weather event passes. Evacuation in the event of a hurricane or other severe weather would increase the number and frequency of vessel 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 an 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 that will be used this project. High waves during a severe storm could disrupt support activities (i.e., vessel traffic) and make it necessary to suspend some activities on 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 were considered by Anadarko 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 Anadarko's OSRP and Safety and Environmental Management System. Additional information can be found in EP Section H.

G. Consultation

The EIA was prepared by CSA Ocean Sciences Inc. for Anadarko. No additional 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

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ADMINISTRATIVE INFORMATION

(a) Proprietary Information

Proprietary copies of this plan contain information not available to the public and include structure maps, seismic information, cross sections, depths of wells, etc.

(b) Bibliography

- Shallow Hazards Report
- C&C Technologies Survey Services Archaelogical Assessments No. 130270 and 072372-073019
- Final Sale Package for Gulf of Mexico Sale Numbers 104 and 110