UNITED STATES GOVERNMENT
MEMORANDUM

September 8, 2016

To: Public Information (MS 5030)

From: Plan Coordinator, FO, Plans Section (MS 5231)

Subject: Public Information copy of plan

Control #	-	S-07813
Type	-	Supplemental Exploration Plan
Lease(s)	-	OCS-G16783 Block - 727 Green Canyon Area
Operator	-	Anadarko Petroleum Corporation
Description	-	Subsea Wells H, HH, I, J, K, and KK
Rig Type	-	Not Found

Attached is a copy of the subject plan.

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

Madonna Montz
Plan Coordinator

Site Type/Name	Botm Lse/Area/Blk	Surface Location	Surf Lse/Area/Blk
WELL/H	G16783/GC/727	3395 FSL, 1772 FEL	G16783/GC/727
WELL/HH	G16783/GC/727	3459 FSL, 1849 FEL	G16783/GC/727
WELL/I	G16783/GC/727	6526 FSL, 2151 FEL	G16783/GC/727
WELL/J	G16783/GC/727	8111 FSL, 1362 FEL	G16783/GC/727
WELL/K	G16783/GC/727	2078 FSL, 1742 FEL	G16783/GC/727
WELL/KK	G16783/GC/727	2001 FSL, 1806 FEL	G16783/GC/727

SUPPLEMENTAL EXPLORATION PLAN S-7813

ANADARKO PETROLEUM CORPORATION

GREEN CANYON BLOCK 727 OCS-G 16783

PUBLIC COPY

RECORD OF CHANGE LOG

Submission Type	Date Sent to BOEM	Summary of Submission	Page Numbers
Initial	07/27/2016	Supplemental EP	All
Amendment	08/10/2016	Site Clearance Letters-Sheets 1-6 for well locations: H, HH, I, J, K, KK	35-40 55-60 75-80 95-100 115-120 135-140
Amendment	08/15/2016	Revised Complex AQR Totals for years 2023-2025 only	167-170
Final Copy of Plan	08/25/2016	Complete EP Submittal	All
Change of Record Log	08/25/2016	Change of Record Log	1

PUBLIC

SUPPLEMENTAL EXPLORATION PLAN

GREEN CANYON BLOCK 727
OCS-G 16783

UNIT No. 754311007

OFFSHORE, LOUISIANA

Anadarko Petroleum Corporation
1201 Lake Robbins Drive
The Woodlands, Texas 77380
Contact: Teri Powell
teri.powell@anadarko.com
(832) 636-1261

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

July, 2016

SUPPLEMENTAL EXPLORATION PLAN
LEASES OCS-G 16783
GREEN CANYON BLOCK 727

A
PLAN CONTENTS

(a) Plan Information Form

Under this Supplemental Exploration Plan (EP), Anadarko Petroleum Corporation (Anadarko) proposes to drill and complete six wells total in Green Canyon (GC) Block 727.

The wells will be drilled 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 well.

(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 Green Canyon Block 727 wells will be drilled with a DP drillship/ DP semisubmersible unit.

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	Fuel Oil Storage Tank	5,514 bbls	2	11,028 bbls	No. 2 Diesel	**12 tanks total= 62,874 bbls**
	Fuel Oil Storage Tank	12,458 bbls	2	24,916 bbls	No. 2 Diesel	
	Fuel Oil Storage Tank	12,065 bbls	2	24,130 bbls	No. 2 Diesel	
	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	Fuel Oil Hull Tanks	4,541 bbls	2	9,082 bbls	No. 2 Diesel	**7 tanks total= 16,689 bbls**
	Fuel Oil Hull Tanks	3,392 bbls	2	6,784 bbls	No. 2 Diesel	

	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 Green Canyon Block 727.

Approval was granted to drill and complete the following well locations under the Initial Exploration Plan (filed by Chevron) for Green Canyon Block 727 (Plan Control No. N-7577) approved on December 24, 2002:

Well Location	Status of Well Location	Potential Future Operations
A	Approved well location for future utility	Drill location canceled.
B	Approved well location for future utility	Drill location canceled
C	Used location to drill GC 727 #001 well.	Well was P&A'd in 2003.
D	Approved well location for future utility	Drill location canceled.
E	Approved well location for future utility	Drill location canceled.

Approval was granted to drill and complete the following well location under the Supplemental Exploration Plan (filed by Anadarko) for Green Canyon Block 727 (Plan Control No. S-7509) approved on January 6, 2012:

Well Location	Status of Well Location	Potential Future Operations
002	Approved well location for future utility	Well is on production.

Approval was granted to drill and complete the following well location under the Supplemental Exploration Plan (filed by Anadarko) for Green Canyon Block 727 (Plan Control No. S-7585) approved on December 13, 2012:

Well Location	Status of Well Location	Potential Future Operations
F	Approved well location for future utility	Future drill location.

Approval was granted to drill and complete the following well locations under the Supplemental Exploration Plan (filed by Anadarko) for Green Canyon Block 727 (Plan Control No. S-7791) approved on March 31, 2016:

Well Location	Status of Well Location	Potential Future Operations
F	Approved well location for future utility	Future drill location.
FF	Approved well location for future utility	Future drill location.
G	Approved well location for future utility	Future drill location.
GG	Approved well location for future utility	Future drill location.

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

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

OCS PLAN INFORMATION FORM

General Information

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

Company Name: Anadarko Petroleum Corporation	BOEM Operator Number: 00981
Address:	Contact Person: Teri Powell
1201 Lake Robbins Drive	Phone Number: 832-636-1261
The Woodlands, TX 77380	E-Mail Address: teri.powell@anadarko.com

If a service fee is required under 30 CFR 550.125(a), provide the	Amount paid	$14,692.00	Receipt No.	25SNLUKH 75052586049

Project and Worst Case Discharge (WCD) Information

Lease(s): OCS-G 16783	Area: GC	Block(s): 727	Project Name (If Applicable): Calpurnia

Objective(s)	X	Oil	X	Gas		Sulphur		Salt

Onshore Support Base(s): Fourchon, LA

Platform/Well Name: GC 860 "A"	Total Volume of WCD: 340,281 BOPD	API Gravity: 28.9
Distance to Closest Land (Miles): 122	Volume from uncontrolled blowout: 41,174,001	

Have you previously provided information to verify the calculations and assumptions for your WCD?	X	Yes		No
If so, provide the Control Number of the EP or DOCD with which this information was provided	S-7509			
Do you propose to use new or unusual technology to conduct your activities?		Yes	X	No
Do you propose to use a vessel with anchors to install or modify a structure?		Yes	X	No
Do you propose any facility that will serve as a host facility for deepwater subsea development?		Yes	X	No

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

Proposed Activity	Start Date	End Date	No. of Days
Drill and Complete Well Location H	1/1/2017	5/21/2017	140
Drill and Complete Well Location HH	1/1/2018	5/21/2018	140
Drill and Complete Well Location I	1/1/2019	5/21/2019	140
Drill and Complete Well Location J	1/1/2020	5/20/2020	140
Drill and Complete Well Location K	1/1/2021	5/21/2021	140
Drill and Complete Well Location KK	1/1/2022	5/21/2022	140

Description of Drilling Rig

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

Drilling Rig Name (If Known):

Description of Structure

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

Description of Lease Term Pipelines

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

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

Proposed Well/Structure Location

Well or Structure Name/Number (If renaming well or structure, reference previous name): GC 727 H	Previously reviewed under an approved EP or DOCD?		Yes	X	No
Is this an existing well or structure?		Yes		No X	If this is an existing well or structure, list the Complex ID or API No. 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 16783	OCS	OCS OCS
Area Name	Green Canyon		
Block No.	727		
Blockline Departures (in feet)	N/S Departure: F____ L 3,395.00 FSL	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 1,772.00 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: 2,358,388.00	X:	X: X: X:
	Y: 9,887,555.00	Y:	Y: Y: Y:
Latitude/ Longitude	Latitude 27.230533	Latitude	Latitude Latitude Latitude
	Longitude -90.790145	Longitude	Longitude Longitude Longitude

Water Depth (Feet): 4,585	MD (Feet):	TVD (Feet):	MD (Feet): MD (Feet): MD (Feet):	TVD (Feet): TVD (Feet): TVD (Feet):
Anchor Radius (if applicable) in feet:				

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

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

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

Proposed Well/Structure Location

Well or Structure Name/Number (If renaming well or structure, reference previous name): GC 727 HH	Previously reviewed under an approved EP or DOCD?		Yes	X	No
Is this an existing well or structure?		Yes		No X	If this is an existing well or structure, list the Complex ID or API No. 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 16783	OCS	OCS OCS
Area Name	Green Canyon		
Block No.	727		
Blockline Departures (in feet)	N/S Departure: F____ L 3,459.00 FSL	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 1,849.00 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: 2,358,311.00	X:	X: X: X:
	Y: 9,887.619.00	Y:	Y: Y: Y:
Latitude/ Longitude	Latitude 27.230713	Latitude	Latitude Latitude Latitude
	Longitude -90.790378	Longitude	Longitude Longitude Longitude

Water Depth (Feet): 4,587	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

<table>
<tr><th colspan="8">Proposed Well/Structure Location</th></tr>
<tr><td colspan="3">Well or Structure Name/Number (If renaming well or structure, reference previous name): GC 727 I</td><td colspan="2">Previously reviewed under an approved EP or DOCD?</td><td>Yes</td><td>X</td><td>No</td></tr>
<tr><td>Is this an existing well or structure?</td><td>Yes</td><td>No X</td><td colspan="2">If this is an existing well or structure, list the Complex ID or API No.</td><td colspan="3">N/A</td></tr>
<tr><td colspan="5">Do you plan to use a subsea BOP or a surface BOP on a floating facility to conduct your proposed activities?</td><td>X Yes</td><td></td><td>No</td></tr>
<tr><td>WCD info</td><td colspan="2">For wells, volume of uncontrolled blowout (Bbls/day): N/A</td><td colspan="2">For structures, volume of all storage and pipelines (Bbls): N/A</td><td>API Gravity of fluid</td><td colspan="2">N/A</td></tr>
<tr><td></td><td colspan="2">Surface Location</td><td colspan="2">Bottom-Hole Location (For Wells)</td><td colspan="3">Completion (For multiple completions, enter separate lines)</td></tr>
<tr><td>Lease No.</td><td colspan="2">OCS
16783</td><td colspan="2">OCS</td><td colspan="3">OCS
OCS</td></tr>
<tr><td>Area Name</td><td colspan="2">Green Canyon</td><td colspan="2"></td><td colspan="3"></td></tr>
<tr><td>Block No.</td><td colspan="2">727</td><td colspan="2"></td><td colspan="3"></td></tr>
<tr><td rowspan="2">Blockline Departures (in feet)</td><td colspan="2">N/S Departure: F____ L
6,526.00 FSL</td><td colspan="2">N/S Departure: F____ L</td><td colspan="3">N/S Departure: F____ L
N/S Departure: F____ L
N/S Departure: F____ L</td></tr>
<tr><td colspan="2">E/W Departure: F____ L
2,151.00 FEL</td><td colspan="2">E/W Departure: F____ L</td><td colspan="3">E/W Departure: F____ L
E/W Departure: F____ L
E/W Departure: F____ L</td></tr>
<tr><td rowspan="2">Lambert X-Y coordinates</td><td colspan="2">X:
2,358,009.00</td><td colspan="2">X:</td><td colspan="3">X:
X:
X:</td></tr>
<tr><td colspan="2">Y:
9,890,686.00</td><td colspan="2">Y:</td><td colspan="3">Y:
Y:
Y:</td></tr>
<tr><td rowspan="2">Latitude/ Longitude</td><td colspan="2">Latitude
27.239161</td><td colspan="2">Latitude</td><td colspan="3">Latitude
Latitude
Latitude</td></tr>
<tr><td colspan="2">Longitude
-90.791141</td><td colspan="2">Longitude</td><td colspan="3">Longitude
Longitude
Longitude</td></tr>
<tr><td colspan="3">Water Depth (Feet):
4,578</td><td>MD (Feet):</td><td>TVD (Feet):</td><td colspan="2" rowspan="2">MD (Feet):
MD (Feet):
MD (Feet):</td><td rowspan="2">TVD (Feet):
TVD (Feet):
TVD (Feet):</td></tr>
<tr><td colspan="4">Anchor Radius (if applicable) in feet:</td><td></td></tr>
</table>

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

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

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

Proposed Well/Structure Location

Well or Structure Name/Number (If renaming well or structure, reference previous name): GC 727 J	Previously reviewed under an approved EP or DOCD?		Yes	X	No
Is this an existing well or structure?	Yes	No X	If this is an existing well or structure, list the Complex ID or API No.	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 16783	OCS	OCS OCS
Area Name	Green Canyon		
Block No.	727		
Blockline Departures (in feet)	N/S Departure: F____ L 8,111.00 FSL	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 1,362.00 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: 2,358,798.00	X:	X: X: X:
	Y: 9,892,271.00	Y:	Y: Y: Y:
Latitude/ Longitude	Latitude 27.243482	Latitude	Latitude Latitude Latitude
	Longitude -90.788628	Longitude	Longitude Longitude Longitude

Water Depth (Feet): 4,522	MD (Feet):	TVD (Feet):	MD (Feet): MD (Feet): MD (Feet):	TVD (Feet): TVD (Feet): TVD (Feet):
Anchor Radius (if applicable) in feet:				

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

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

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

Proposed Well/Structure Location					
Well or Structure Name/Number (If renaming well or structure, reference previous name): GC 727 K	Previously reviewed under an approved EP or DOCD?		Yes	X	No
Is this an existing well or structure?		Yes	No X	If this is an existing well or structure, list the Complex ID or API No.	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 16783	OCS	OCS OCS
Area Name	Green Canyon		
Block No.	727		
Blockline Departures (in feet)	N/S Departure: F____ L 2,078.00 FSL	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 1,742.00 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: 2,358,418.00	X:	X: X: X:
	Y: 9,886,238.00	Y:	Y: Y: Y:
Latitude/ Longitude	Latitude 27.226910	Latitude	Latitude Latitude Latitude
	Longitude -90.790124	Longitude	Longitude Longitude Longitude

Water Depth (Feet): 4,675	MD (Feet):	TVD (Feet):	MD (Feet): MD (Feet): MD (Feet):	TVD (Feet): TVD (Feet): TVD (Feet):
Anchor Radius (if applicable) in feet:				

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

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

OCS PLAN INFORMATION FORM (CONTINUED)

Include one copy of this page for each proposed well/structure

Proposed Well/Structure Location					
Well or Structure Name/Number (If renaming well or structure, reference previous name): GC 727 KK	Previously reviewed under an approved EP or DOCD?		Yes	X	No
Is this an existing well or structure?	Yes		No X	If this is an existing well or structure, list the Complex ID or API No.	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	

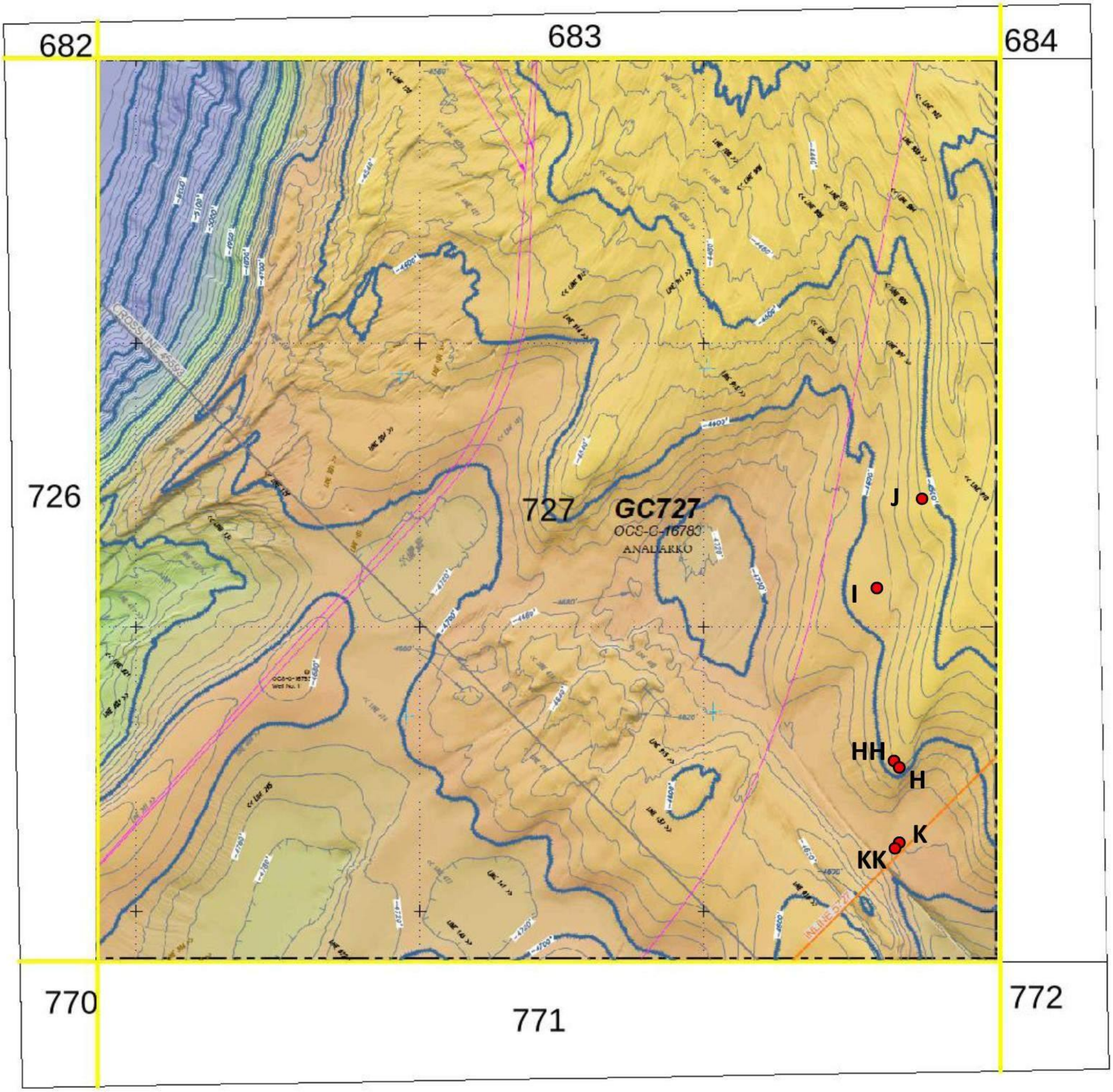
	Surface Location	**Bottom-Hole Location (For Wells)**	**Completion (For multiple completions, enter separate lines)**
Lease No.	OCS 16783	OCS	OCS OCS
Area Name	Green Canyon		
Block No.	727		
Blockline Departures (in feet)	N/S Departure: F____ L 2,001.00 FSL	N/S Departure: F____ L	N/S Departure: F____ L N/S Departure: F____ L N/S Departure: F____ L
	E/W Departure: F____ L 1,806.00 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: 2,358,354.00	X:	X: X: X:
	Y: 9,886,161.00	Y:	Y: Y: Y:
Latitude/ Longitude	Latitude 27.226701	Latitude	Latitude Latitude Latitude
	Longitude -90.790325	Longitude	Longitude Longitude Longitude

Water Depth (Feet): 4,675	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 =	

GOM REGIONAL - TM15N US FEET



Location	Easting (feet)	Northing (feet)	Latitude	Longitude	Calls From Block 727, Green Canyon Area		Water Depth
H	2,358,388.00’	9,887,555.00’	27°13’49.922”N	90°47’24.524”W	1,772.00’ FEL	3,395.00’ FSL	4585’
HH	2,358,311.00’	9,887,619.00’	27°13’50.569”N	90°47’25.364”W	1,849.00’ FEL	3,459.00’ FSL	4587’
I	2,358,009.00’	9,890,686.00’	27°14’20.983”N	90°47’28.109”W	2,151.00’ FEL	6,526.00’ FSL	4578’
J	2,358,798.00’	9,892,271.00’	27°14’36.536”N	90°47’19.061”W	1,362.00’ FEL	8,111.00’ FSL	4522’
K	2,358,418.00’	9,886,238.00’	27°13’36.879”N	90°47’24.449”W	1,742.00’ FEL	2,078.00’ FSL	4675’
KK	2,358,354.00’	9,886,161.00’	27°13’36.127”N	90°47’25.173”W	1,806.00’ FEL	2,001.00’ FSL	4675’

Anadarko Petroleum Corporation

1:30000
0 0.50
MILES

NAD27 / BLM 15N (ftUS) (EPSG 32065)
Transverse Mercator
Clarke 1866 spheroid
Natural origin: [93 00 00W, 0 00 00N]

GC 727 Location and Bathymetry Map

By: BTK	Date: 25MAY2016

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	28,000 bbls per well of 16.3 ppg will be ordered out and cut back on location as required**
Synthetic-based (internal olefin, ester)	20,000 bbls per well
Oil-based	NA

***The actual volume ordered out will be an estimated 28,000 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 80,000 bbls/well (NOTE: there will be six wells drilled for a total of 480,000 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. 2000-G16, "Guidelines for General Lease Surety Bonds," and National NTL No. 2008-N07, "Supplemental Bond Procedures".

(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 previously approved Green Canyon 727 #2 location (Plan Control No. S-7509), is addressed in this blowout scenario since it is the location with the highest potential worst-case discharge (WCD) rate for

Green Canyon Block 727, however additional WCD data has been included in Section H to address objective sands not previously included in Plan Control No. S-7509. After further evaluation of the well locations submitted under this plan, the WCD rate remains lower than the previously approved rate for Green Canyon Block 727. A similar approach would be taken in the event of a blowout for the wells covered under this plan. Based on NTL No. 2015-N01 guidance, the maximum hydrocarbon discharge for Green Canyon Block 727 is calculated to be 340,281 BOPD as approved in Plan Control No. S-7509.

Purpose

This information provides a generic blowout scenario, additional information regarding any potential oil spill, the measures Anadarko Petroleum 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 250.213(g), 250.219, 250.250 and NTL No. 2015-N01.

Background

This information has been developed to document the additional information requirements for Exploration Plans as requested by NTL No. 2015-N01. Within this scenario, the GC 726 #2 development well will be directionally drilled.

Information Requirements

Blowout Scenario

The GC 727 "2" well will be drilled to the Sand objectives, as outlined in the Geological and Geophysical Information section of this Plan, utilizing a MODU rig with a marine riser and sub-sea BOP. A typical sub-sea wellhead system, conductor, and surface and intermediate casing program will be used.

The Blowout Scenario assumes a hydrocarbon influx occurs from the objective sands, followed by a well control event. The sub-sea BOP and marine riser fails, and a blowout occurs at the seabed. The WCD scenario assumes a 13-5/8" x 14" casing string set, 11-7/8" liner set, and 10-5/8" x 12-1/4" open hole is drilled. The WCD scenario assumes simultaneous flow from the objective zones.

Estimated Flow Rate of the Potential Blowout

Category	Supplemental EP
Type of Activity	Drilling
Facility Location (area/block)	GC Block 727
Facility Designation	MODU
Distance to Nearest Shoreline (miles)	122
Uncontrolled Blowout (volume per day)	340,281 bbl
Type of Fluid(s)	Crude Oil

a) Potential for the well to bridge over:

Mechanical collapse of the reservoirs in the open-hole section of the wellbore was not considered.

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 and is based on the following equipment specific to the MODU that has been contracted to do this drilling program:

- ROV Secondary BOP Control System: The BOP is confirmed to have a ROV Intervention Panel and circuits that have the following attributes:
  - Hot stab is capable of closing one set of:
    - Blind-Shear Rams (one set)
    - Pipe Rams (one set)
    - Unlatch the Lower Marine Riser Package
  - ROV hot stab to be function tested in conjunction with the Stump test and tested at the same rate and pressure as the pump installed on the ROV used by the rig.
  - 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. As of July 11, 2016, there were 11 additional rigs capable of operating under these conditions in the Gulf of Mexico. A rig that could be used to drill a relief well is the Transocean *Asgard Drillship*, which is a drill ship capable of drilling in 10,000 ft of water without any constraints. The rig is currently under contract to Chevron and is on location in Green Canyon Block 640 working on the Tahiti North Project.

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:

A rig capable of drilling in 4,600 ft of water to a total depth of greater than 23,000 ft. TVD with a 15k Stack is required for any relief well operations. The Transocean *Asgard* 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 90-100 days, for a total estimated time of 107-121 days from time of blowout to finishing the relief well.

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

- The Merlin reservoir simulator and Avalon nodal analysis programs were used to estimate the WCD for this well. Supporting input data was previously submitted with Plan Control No. S-7509.
- At the seafloor, the estimated worst case discharge for the well is 340,281 BOPD based on simultaneous flow from the objective intervals.
- The maximum total volume during a blowout could potentially be 41,174,001 bbl. assuming 121 days for the maximum duration of a blowout, multiplied by the worst case daily uncontrolled blowout volume of 340,281 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 two 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. 250.416(f)

- **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 GC 727 #2 well, in that casing weights, grades, and setting points would be identical. A two block wide shallow hazard assessment has been completed (and submitted) for GC Blocks 683 and 727. Site clearance letters for surface locations in both blocks have been completed and deemed acceptable for drilling. A surface location approximately 3,204 ft southwest of the proposed well GC 727 #2 surface location has been identified as a suitable SHL for the relief well. The potential areas for high density chemo-synthetic communities in the study area have been identified and can be avoided. 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", and 16") and connectors required. Smaller OD casing (13 5/8", 11 7/8", and 9 7/8") 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 Schlumberger 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 Report was previously submitted with the Initial Exploration Plan.

(f) Shallow Hazards Assessment

Shallow Hazards Site Clearance Letters for the proposed well locations in Green Canyon Block 727 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.

April 27, 2016

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

Attn: Mr. Rick Kincaid

Site Clearance Letter
Proposed Well "H"
Block 727 (OCS-G-16783)
Green Canyon Area

Mr. Rick,

INTRODUCTION

Anadarko Petroleum Corporation (Anadarko) contracted Oceaneering International, Inc. (OII) to prepare a well site clearance letter for the proposed Well "H" location of the Calpurnia Prospect in Block 727 (OCS-G-16783), Green Canyon (GC) Area. The data used for the site clearance letter is based on the interpretation of an exploration-quality 3D seismic volume and a high-resolution geophysical dataset collected with OII's Autonomous Underwater Vehicle (AUV) *C-Surveyor III*™. OII completed a geohazard assessment titled "*Shallow Hazard Report, Block 727 (OCS-G-16783) and 771 (OCS-G-33259), Green Canyon Area*" in March, 2016. This site clearance letter is based on the findings provided within that report.

This letter provides a top-hole drilling prognosis and addresses seafloor conditions within a 2,000-foot radius of the proposed surface location. The depth limit of investigation is approximately 2.0 seconds of two-way traveltime (~5,000 feet) below the mud line (BML), or to the salt/sediment interface if it is encountered less than 2.0 seconds below the seafloor. The reporting and mapping presented in this letter comply with the BOEM/BSEE guidelines provided in NTL No. 2008-G05 (Shallow Hazards Program) and No. 2009-G40 (Deepwater Benthic Communities).

METHODS

AUV Survey Data

OII's *C-Surveyor III*™ AUV provided multibeam bathymetric mapping, high-resolution side scan sonar imagery, and subbottom profiles. The AUV remote-sensing instruments include a Simrad EM 2040 Multibeam Echosounder (200, 300, and 400 kHz), an EdgeTech 2200-M Full Spectrum Chirp Dual Frequency Side Scan Sonar (120/410 kHz), and an EdgeTech DW106 Chirp Subbottom Profiler (1.5–4.5 kHz). All the raw digital data were logged utilizing proprietary software developed by OII. The multibeam system delivered a 3-meter gridded dataset with relative vertical accuracies within 20 centimeters.

The AUV survey grid in the study area consisted of 62 main tracklines (Lines 101–114 and 120–167) running northeast to southwest at 200-meter line spacing, 13 ties lines (Lines 201–213) running northwest to southeast at 900-meter line spacing, and 29 in-fill lines (Lines 901–929) run to fill in bathymetry data gaps caused by steep seafloor terrain. Navigation fixes (event marks) were annotated at 125-meter (410-foot) intervals along all survey lines. The survey grid

was designed to provide a representative sampling with the subbottom profiler system and overlapping coverage with side scan sonar and multibeam echosounder systems.

3D Seismic Data

The 3D seismic data used for this assessment was provided in SEG-Y format, and were loaded into IHS' Kingdom Suite 2d/3dPAK for interpretation. The 3D data were acquired by WesternGeco in 1999–2000, and reprocessing was completed in 2006 with Post-Stack Time Migration (PSTM). Inlines and crosslines are depicted on the Surface and Subsurface Features Maps (Sheets 5 and 6). The 3D data were provided at a four-millisecond sample rate and extend to the full data range of 13 seconds. The inlines of the data run southwest to northeast and are spaced at 30-meter (98.43-foot) intervals. The crosslines run southwest to northeast and are spaced at 25-meter (82.02-foot) intervals. Spectral whitening was applied to the 3D seismic dataset to amplify the higher frequencies. After applying the spectral whitening, a power spectrum generated at a few selected locations indicated the seismic data volume contains sufficiently high frequency content for a shallow hazards assessment (Figure 1).

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 (faults, salt, high acoustic impedance, stratigraphic horizons, etc.).

WELL LOCATION

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

Table 1. Proposed Well "H"

Easting (feet)	Northing (feet)	Latitude	Longitude	Calls From Block 727, Green Canyon Area	
2,358,388.00'	9,887,555.00'	27°13'49.922"N	90°47'24.524"W	1,772.00' FEL	3,395.00' FSL

A 2,000-foot clearance radius is required for assessing deepwater benthic communities in proximity to the proposed Well "H".

The geodetic datum used for this project is the North American Datum 1927 (NAD27) with the Clarke 1866 Ellipsoid. The datum is projected using the Universal Transverse Mercator (UTM), Zone 15 North (15N) 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. Mapping and reporting units are in U.S. Survey Feet.

REGIONAL GEOLOGY

The Gulf of Mexico is a semi-enclosed basin that has been receiving sediment influx dominated by the Mississippi River since the Late Jurassic. Mesozoic and Cenozoic sediments have attained a thickness in excess of 9 miles (Coleman et al., 1991). The prograded shelf sequence consists of intercalated coastal plain, delta, estuarine, and marine sediments. Sediment deposition along the northern rim of the Gulf of Mexico resulted in particularly thick Tertiary

and Quaternary sections. These rapidly deposited sediments have prograded the Cretaceous shelf-edge up to 185 miles basinward. The exceptionally high rate of shelf-edge progradation is on the order of 3.0 to 3.7 miles per 1,000 years.

The near surface geology across the Gulf Coast region is the product of fluctuating sea levels associated with climatic variations over the past 20,000 years. During this time, low sea levels left the continental shelf exposed to subaerial weathering and other erosional processes. Streams and rivers meandered and cut into the exposed landmass, depositing bedloads along the modern-day shelf break. Fan systems were formed, and mass movement events were common as deltaic sediments were deposited on the steep upper continental slope. As the climate warmed, seas transgressed, and marine sediments were deposited on the shelf.

The proposed wellsite is located in the northern Gulf of Mexico in an area designated as the Green Canyon Area by the BOEM and BSEE. The study area is located on the middle Texas Louisiana Slope in GC727 and is characterized by extensive faulted/fractured sediments due to salt diapiric uplift.

BATHYMETRY AND SEAFLOOR GRADIENTS

The water depth at the proposed Well "H" location is 4,585 feet below mean sea level (MSL). Within the 2,000-foot radius centered at the proposed well location, the seafloor depth ranges from 4,495 feet in the northeast to 4,700 feet in the south (Sheet 1, Color Shaded Bathymetry Map).

The proposed well is situated on a slightly irregular seafloor atop a ridge located in the southeast corner of GC727. The seafloor in the area surrounding the proposed well location slopes south-southwest at a gradient of 4° (Sheet 2, Seafloor Gradient Map).

SEAFLOOR HAZARDS

Low to moderate sonar and multibeam backscatter reflectivity occurs around the proposed well site indicating mostly fine-grained sediments. Higher acoustic reflectivity in the side scan sonar and backscatter images occur along fault scarps and represent coarser sediments (Figure 2; Sheet 3, Side Scan Sonar Mosaic Map).

The 3D seafloor amplitude image displays low to moderate acoustic amplitudes within the 2,000-foot radius area (Sheet 4, Seafloor Amplitude Map). These low to moderate seafloor amplitudes indicate finely textured seafloor sediments that are likely comprised of hemipelagic clay. One large low amplitude anomaly is located 2,200 feet northwest of the proposed site.

One sonar contact is located within 2,000 feet of the proposed well location. Sonar Contact No. 20 is located 1,700 feet west of the well site and measures 17.2 feet long, 5.4 feet wide, and has a height of 2.7 feet.

Multiple surface faults were identified within the 2,000-foot radius (Sheet 5, Seafloor Features Map). These faults typically trend north-south and exhibit seafloor displacement between 1 and 10 feet. One fault, located 210 feet to the southeast, shows 42 feet of seafloor relief. Slump deposits were noted along the downthrown sides of the fault scarps, and are characterized by slightly irregular and undulating topography and may represent unstable seafloor for construction activities.

POTENTIAL DEEPWATER BENTHIC COMMUNITIES

High or low-amplitude seismic seafloor anomalies are potential indicators of carbonates, benthic community habitats, and gas/fluid seepages. The seafloor at the proposed Well "H" and surrounding 2,000-foot radius contains no high or low positive seafloor amplitude anomalies associated with fluid expulsion or mounded carbonates representing potential benthic communities. The side scan sonar and multibeam backscatter agree with the seafloor amplitude image, and show no evidence of outcrops or fluid expulsion.

SUBSURFACE GEOHAZARDS AND STRATIGRAPHY

The AUV subbottom profiler data exhibit continuous, sharp bottom echoes with parallel to divergent, continuous reflectors throughout the well site area. The uppermost shallow sediments consist of a 15 foot thick acoustically semi-transparent hemipelagic clay drape. Sediments below this drape are characterized by parallel, low to moderate amplitude reflectors that represent cyclic deposition of hemipelagic clay and silty clays (Figure 3).

Four sedimentary units (Units A to D), each consisting of one or more distinctive sequences, were interpreted within the study area from the 3D seismic data to approximately 0.6 seconds of two-way traveltime (~2,000 feet) below the seafloor, the lower limit of investigation. Five horizons mark the upper and/or lower contacts of each of the successive units (Figures 3 and 4).

Subsurface faulting/fracturing occurs throughout the 2,000-foot vicinity, with most faults trending north-south (Sheet 6, Subsurface Features Map). The stratigraphy throughout the well site area is extremely faulted and fractured due to the shallow salt.

One mass transport deposit (MTD) was identified within the 2,000-foot radius. The MTD is generally characterized by chaotic and mixed sequences or lack of visible internal structure, which suggest the integrity of the internal sedimentary structures was lost while moving downslope. The deposit is located 477 feet southeast of the proposed well site and is buried 40 feet.

OII used check shot data from the BOEM web site for a nearby well with a series of time-depth pairs for the sediment column. The following polynomial equation was derived from Total Vertical Depth (TVD) (feet) and the corresponding two-way traveltime (seconds) using the time-depth values to calculate depths below the seafloor:

$$D = 186.45T^2 + 2,637.05T$$

where D = depth below sea level in feet and T = time below sea level in seconds.

A detailed description of the sequence units, beginning at the seafloor, can be found in the 2016 Geohazard Report. The Top-Hole Prognosis Chart (Figure 6) summarizes the stratigraphy.

Unit A (Seafloor to Horizon 1)
Unit A consists of low to moderate amplitude, parallel, semi-continuous reflectors and measures 309 feet thick at the proposed well location. The reflection patterns suggest the unit is comprised mostly of hemipelagic clay with a few interbedded mass transport deposits. No high amplitude anomalies occur within Unit A near the proposed well location. Fractured/faulted sediments were identified in the AUV subbottom data within this unit (Figure 3).

Unit B (Horizon 1 to Horizon 2)
Unit B consists of mostly low amplitude, sub-parallel reflectors and measures 539 feet thick at the proposed well location. The unit is interpreted as interbedded channel fill and mass transport deposits. No high amplitude anomalies occur within Unit B near the proposed well location. Fractured/faulted sediments were identified in the 3D seismic data within this unit (Figures 4 and 5).

Unit C (Horizon 2 to Horizon 3)
Unit C consists of low to moderate amplitude, semi-continuous to sub-chaotic reflectors and measures 304 feet thick. This unit is interpreted as a interbedded coarse-grained channel fill and mass transport deposits. Several high amplitude anomalies occur within Unit C, most of which appear next to fault lines which may act as structural traps for the possible gas hazards. The closest of these anomalies is relatively small and is located 200 feet to the west. Fractures/faults were identified in the 3D data within this unit (Figures 4 and 5).

Unit D (Horizon 3 to Salt/Sediment Interface)
Unit D consists of low to moderate amplitude, semi-continuous to chaotic reflectors and measures 815 feet thick. This unit is interpreted as a coarser-grained channel fill and mass transport deposits. Several high amplitude anomalies occur within Unit D, most of which appear next to fault lines which may act as structural traps for the possible gas hazards. The closest of these anomalies is located 100 feet to the west. Fractures/faults were identified in the 3D data within this unit (Figures 4 and 5). The base of Unit D marks the salt/sediment interface at the proposed well site.

SHALLOW GAS
Anomalies of very high amplitude, commonly termed bright spots, are interpreted as potential regions of fluid saturation usually associated with porous sands. Seismic amplitude anomalies are mapped on a unit-by-unit basis to assess the potential risk of gas. Seismic amplitude anomalies are exhibited on the Subsurface Features Map when present.

The risk of gas refers to the risk of encountering shallow gas. The risk of gas is interpreted based on amplitude levels. Stratigraphic and structural settings may also be taken into account. The four risk levels of gas are:

- **Negligible**—No amplitude anomalies or other gas indicator present.
- **Low risk of gas**—Generally indicated by increased amplitude (2–3× 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× background level) and phase reversal.
- **High risk of gas**—Generally indicated by the highest amplitudes (in excess of 4× 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.

Amplitude anomalies were identified within Units C and D within 2,000 feet of the proposed Well "H" location. Units A and B are assessed as having a low risk of gas, while Units C and D are assessed as having a low to moderate risk of gas.

SHALLOW WATER FLOW

Several factors may contribute to shallow water flows. These include: high porosity and permeability, sand-prone aquifer, mechanism to pressurize, and seal. Additional details are described below:

- **Water depth and burial depth.** Significant water depths (> 500 feet below the seafloor) 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.

All of these factors occur within the study area. Since there is presently no method for quantifying the risk of shallow water flow, caution is recommended when drilling through units with shallow water flow potential. Sands with SWF potential often occur in unconsolidated, overpressured sands that lie below a seal. This seal prevents dewatering and compaction after deposition. The pressure rises with overburden causing a potentially disastrous hazard for drilling operations.

The nearest SWF event, according to information listed on the BOEM and BSEE website, is located approximately 15 miles northeast of the study area in GC644. This SWF event occurred at 644 feet below the seafloor and is listed as minor severity. Several other SWF events have been reported 25–40 miles east of the study area in GC783, GC823, GC825, and GC826. These SWF events are listed as occurring 1,274–5,527 feet below mudline and are all of low severity.

The assessment of seismic profiles suggests that Units A–D all exhibit a low risk of SWF. The numerous faults found in these units would serve to release pressures. 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 between the hydrate and free gas trapped at the base of the hydrate stability zone forms a Bottom Simulating Reflector (BSR) on seismic profiles. This BSR reflector cross cuts 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 deepwater benthic communities may all be found in close association. No indication of BSRs was found in the vicinity of the proposed well.

CONCLUSIONS

The proposed Well "H" location is situated on a slightly irregular seafloor atop a ridge at a water depth of 4,585 feet MSL. The seabed slopes to south-southwest at a gradient of 4°.

Numerous surface faults are located within 2,000 feet of the proposed well site, and typically exhibit between 1 and 10 feet of seafloor relief. One fault, located 210 feet southeast, measures 42 feet of relief. Slump deposits were noted along the downthrown sides of the fault scarps, and may represent unstable seafloor for construction activities.

One sonar contact (Sonar Contact No. 20) was identified 1,700 feet west of the proposed Well "H" location.

No high or low seafloor amplitudes anomalies that may indicate the occurrence of hardgrounds, carbonates, benthic communities or potential expulsions are found within 2,000 feet of the proposed Well "H" location.

Four (4) subsurface units interpreted from the 3D seismic data were assessed to approximately 2,500 feet BSF at the proposed Well "H" location (Units A to D). Unit A is comprised mostly of low to moderate amplitude, parallel, semi-continuous reflectors and consists of hemipelagic clays and interbedded mass transport deposits. Unit B is characterized by mostly low amplitude, sub-parallel reflectors and consists of interbedded channel fill and mass transport deposits. Unit C is comprised of low to moderate amplitude, semi-continuous to sub-chaotic reflectors and is interpreted as interbedded coarse-grained channel fill and mass transport deposits. Unit D is characterized by low to moderate amplitude, semi-continuous to chaotic reflectors and is interpreted as coarser-grained channel fill and mass transport deposits. Subsurface faults and fractures were identified within every unit due to the salt diapiric uplift in the area.

Subsurface amplitude anomalies were identified within Units C and D within 2,000 feet of the proposed Well "H" location. Units A and B are assessed as having a low risk of gas, while Units C and D have a low to moderate risk. No indication of gas hydrates was found within the study area.

Units A–D are all assessed as having a low risk of SWF, due to the numerous faults found in the units which would serve to release pressures.

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

Regards,

Christopher Baker
Senior Geologist

ENCLOSURES

Figure 1. Extracted wavelet and power spectrum at the proposed Well "H".
Figure 2. Backscatter image showing seafloor near the proposed Well "H".
Figure 3. Subbottom profiler Line 122 near the proposed Well "H".
Figure 4. 3D seismic Inline 5720 through the proposed Well "H".
Figure 5. 3D seismic Crossline 45777 through the proposed Well "H".
Figure 6. Top-Hole Prognosis Chart for the proposed Well "H".

Sheet 1.	Color Shaded Bathymetry Map, Proposed Well "H" Location	1"=1,000'
Sheet 2.	Seafloor Gradient Map, Proposed Well "H" Location	1"=1,000'
Sheet 3.	Side Scan Sonar Mosaic Map, Proposed Well "H" Location	1"=1,000'
Sheet 4.	Seafloor Amplitude Map, Proposed Well "H" Location	1"=1,000'
Sheet 5.	Seafloor Features Map, Proposed Well "H" Location	1"=1,000'
Sheet 6.	Subsurface Features Map, Proposed Well "H" Location	1"=1,000'

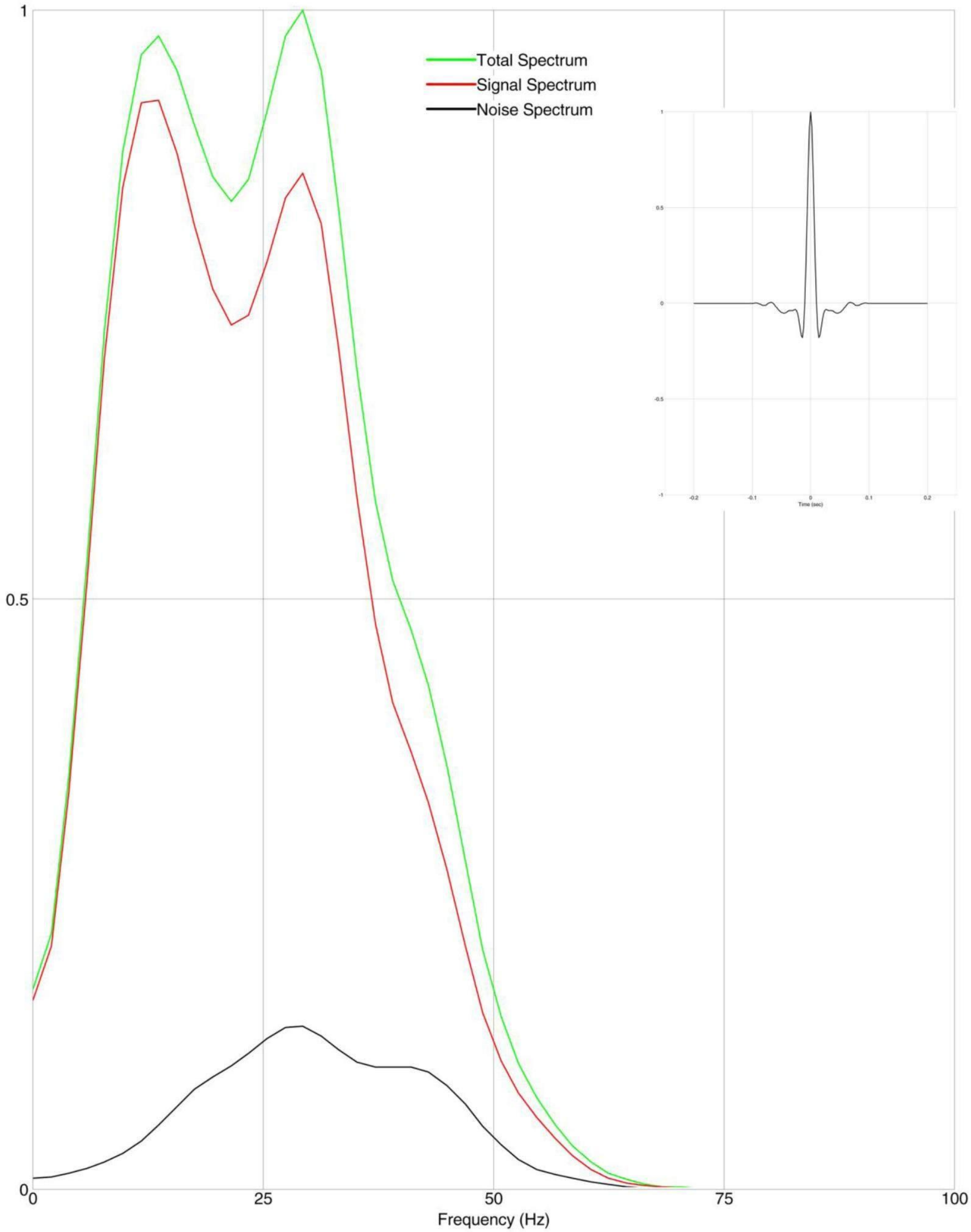


Figure 1. Extracted wavelet and power spectrum at the proposed Well "H" (1 second).

730 EAST KALISTE SALOOM ROAD, LAFAYETTE, LA 70508

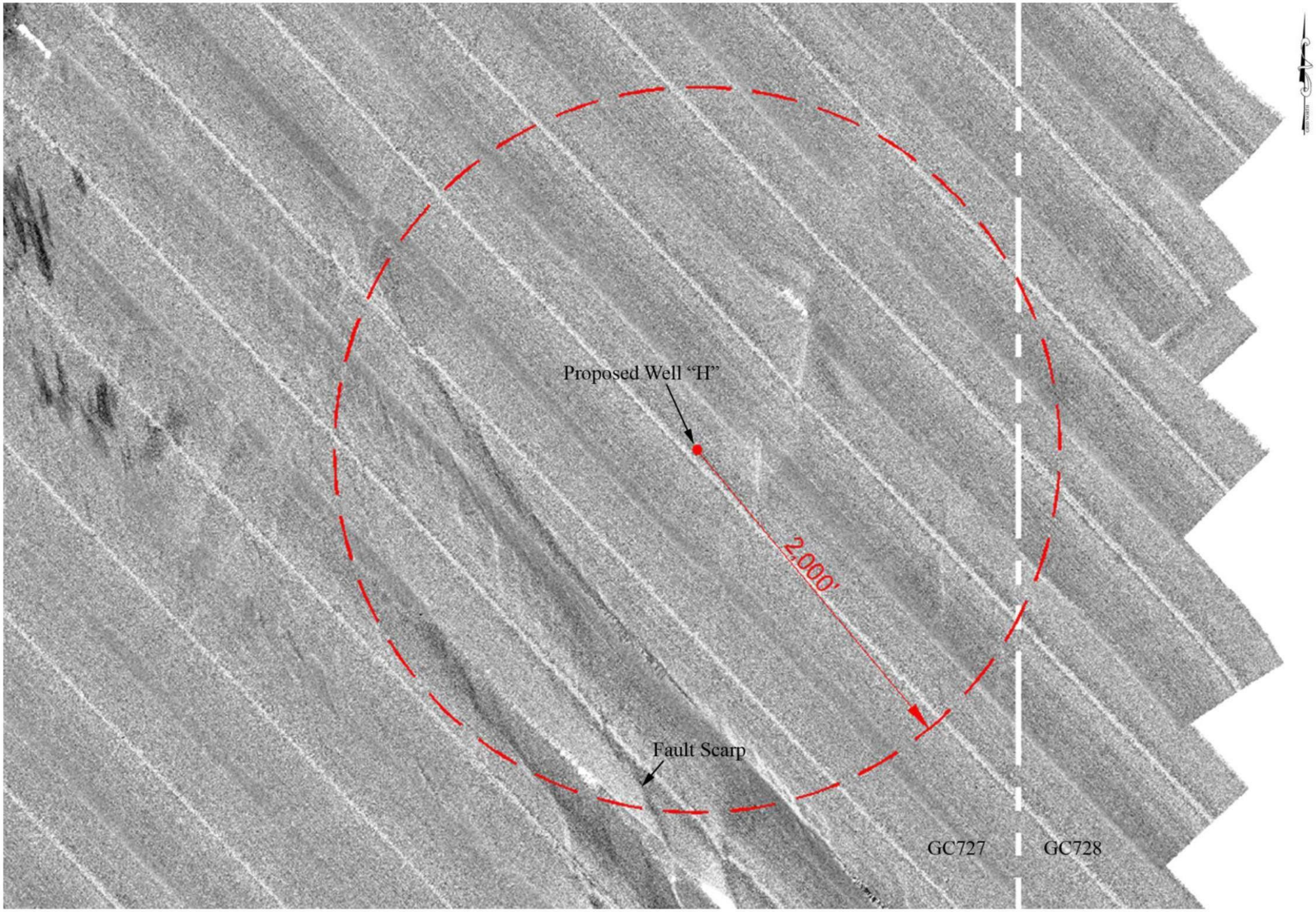


Figure 2. Backscatter image showing seafloor near the proposed Well "H".

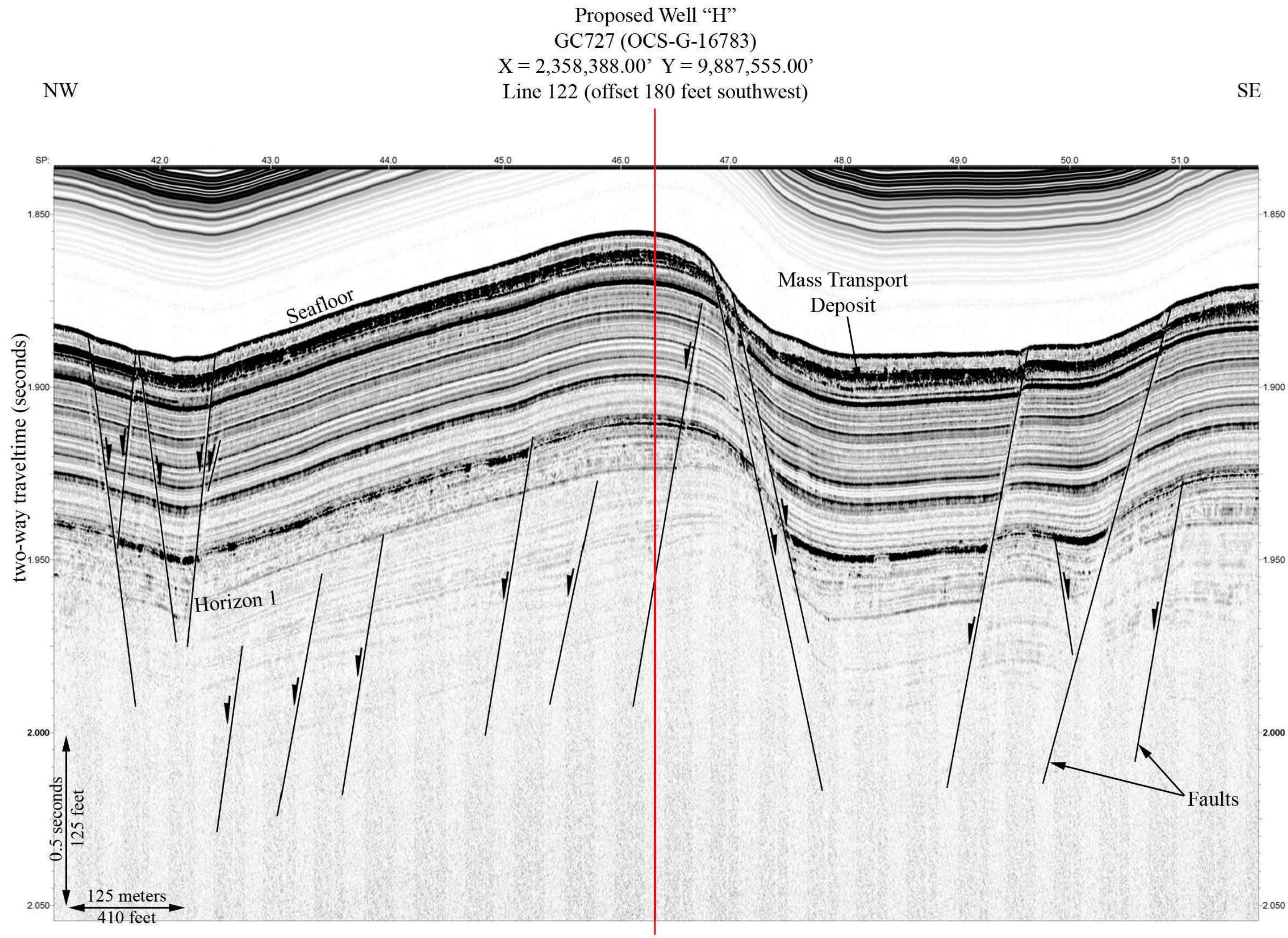


Figure 3. Subbottom profiler Line 122 near the proposed Well "H".

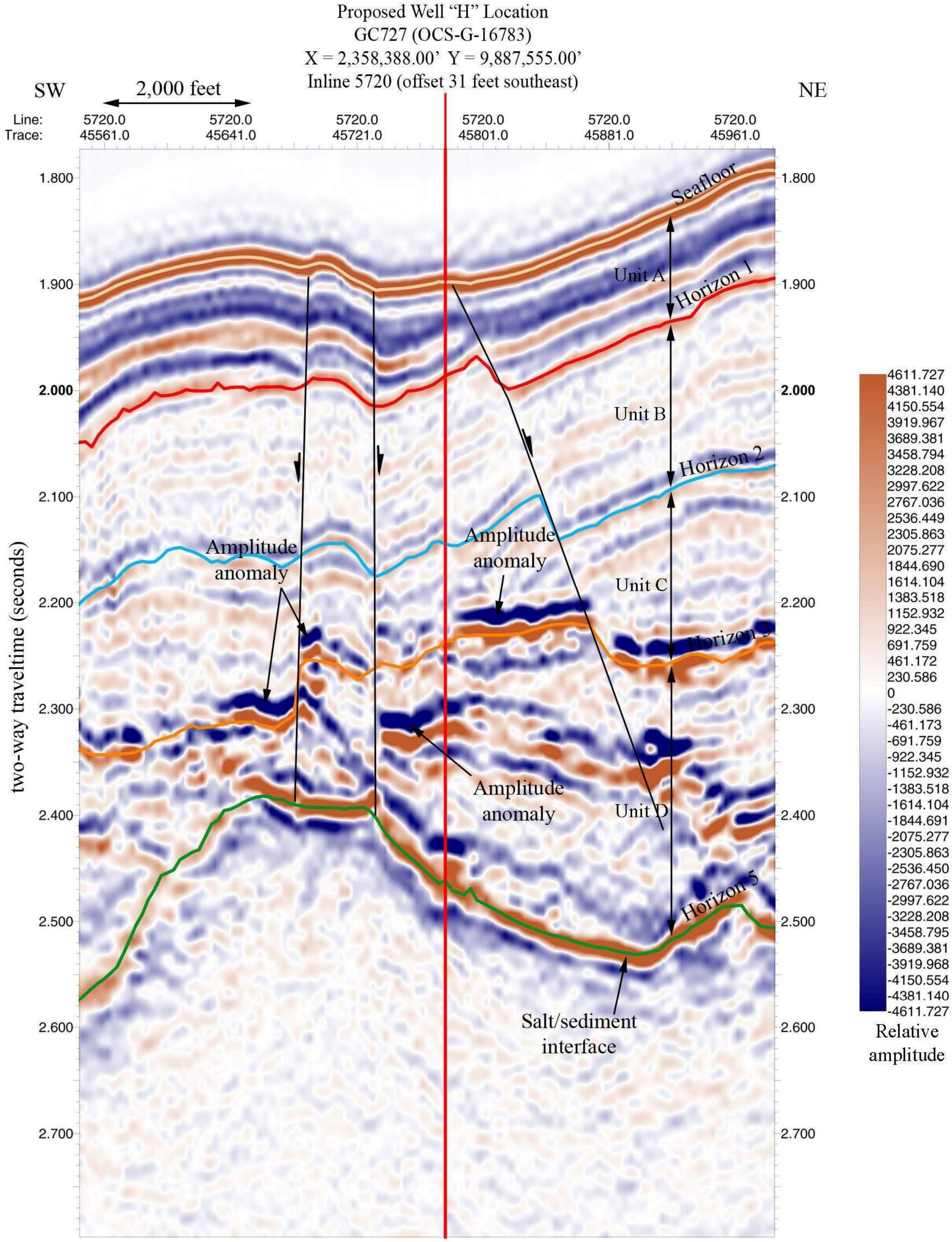


Figure 4. 3D seismic Inline 5720 through the proposed Well "H".

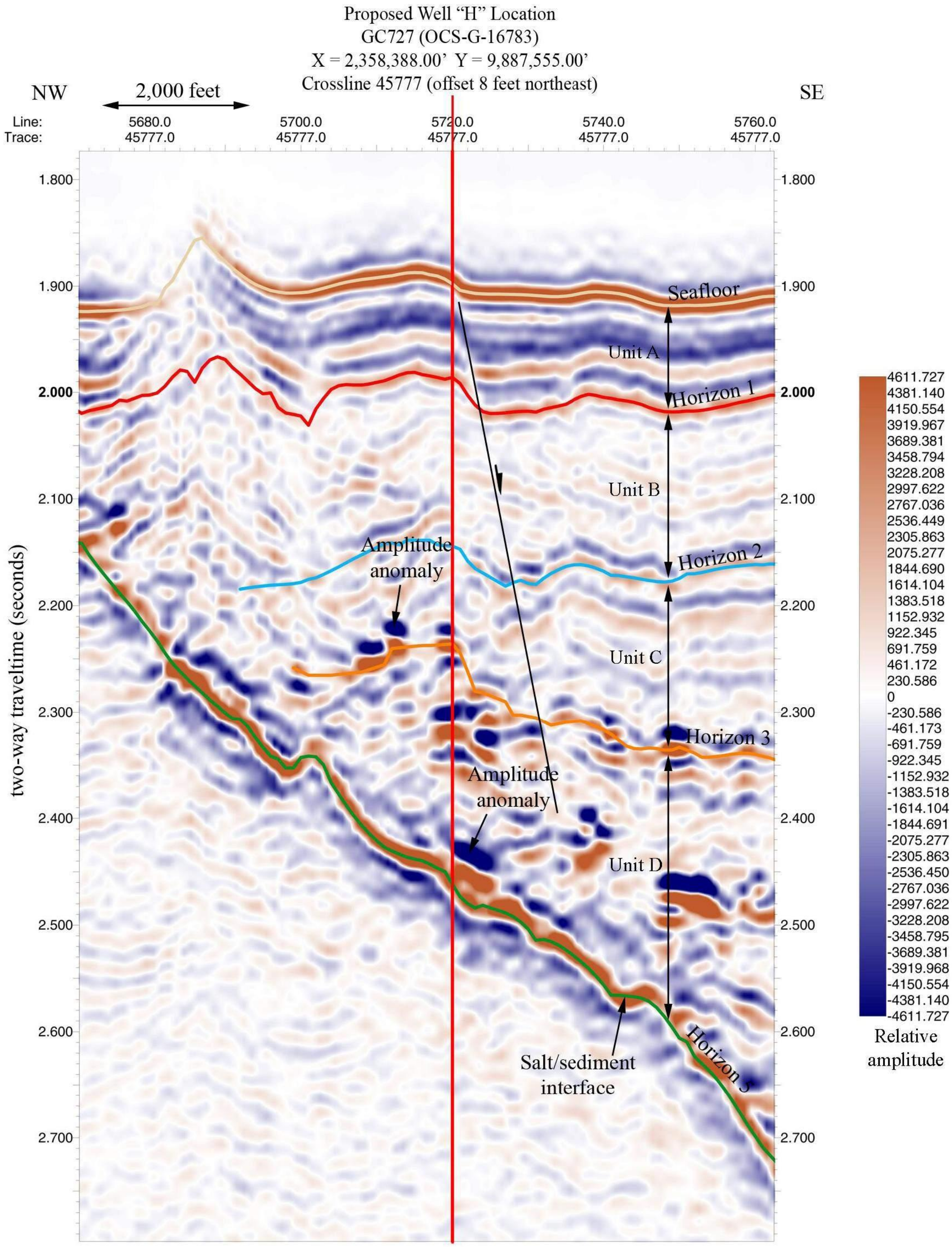
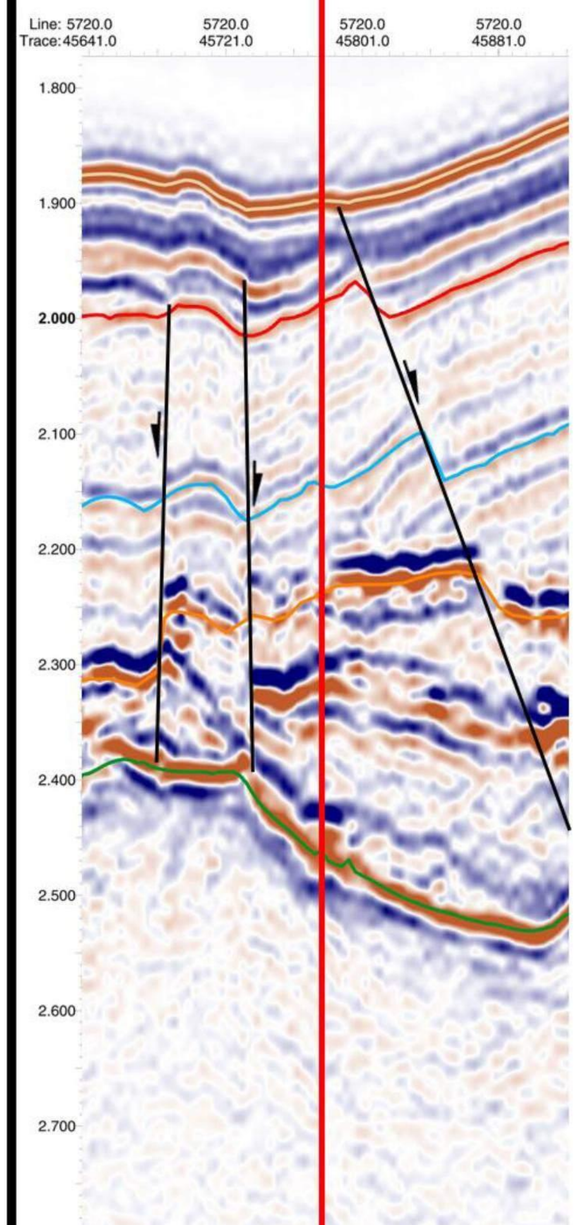


Figure 5. 3D seismic Crossline 45777 through the proposed Well "H".

Proposed Well "H" Location
GC727 (OCS-G-16783)
X = 2,358,388.00' Y = 9,887,555.00'
Inline 5720 (offset 31 feet southeast)

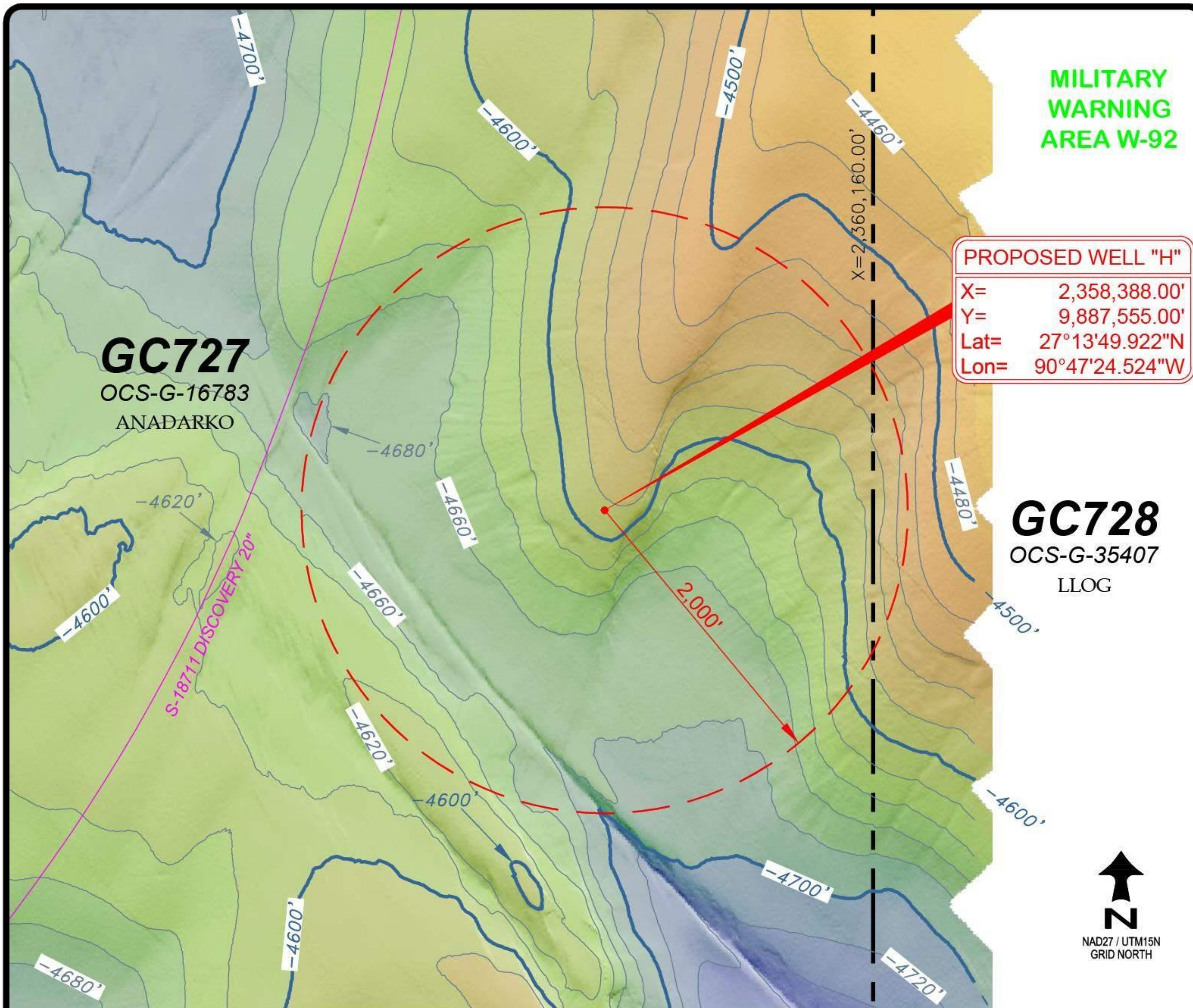


Note: Subsurface depths based on T-D equation
$D = 186.45T^2 + 2,637.05T$

Subsurface Sequence (Well Intersect) Unit	Horizon	Water Flow and Gas Potential: Gas	Water Flow	Depth BML (feet)	Depth MSL (feet)	TWT BSL (sec)	Interval Thickness (feet)	Lithology Description
	Seafloor				4,585	1.898		
A	Horizon 1			309	4,894	1.990	309	Drape deposit of hemipelagic clays with interbedded fine-grained mass transport deposits.
B	Horizon 2			848	5,433	2.148	539	Interbedded channel fill and mass transport deposits. The sediments within Unit B are highly fractured and faulted due to the salt diapiric uplift in the area.
C	Horizon 3			1,152	5,737	2.324	304	Interbedded coarse-grained channel fill and mass transport deposits. The sediments within Unit C are highly fractured and faulted due to the salt diapiric uplift in the area.
D	Salt/Sediment Interface			1,967	6,552	2.468	815	Coarser-grained channel fill and mass transport deposits. The sediments within Unit D are highly fractured and faulted due to the salt diapiric uplift in the area.
	Depth of study							

Hazard Potential: Negligible: (blue) Low: (green) Moderate: (yellow) High: (red)

Figure 6. Top-Hole Prognosis Chart for the proposed Well "H".



Multibeam processing sequence

1. Water column velocity corrections applied
2. Tide corrections applied using Goddard Ocean Tide Model GOT99.2
3. Bin size = 3 meters (9.84 feet)
4. Median filter applied
5. Produced gridded-binned dataset using weighted-neighbor algorithm; search radius = 9 meters (29.53 feet)

Contour interval = 20 feet
Zero datum = Mean Sea Level

Color shaded image
Sun azimuth = 0°
Sun elevation = 30°

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

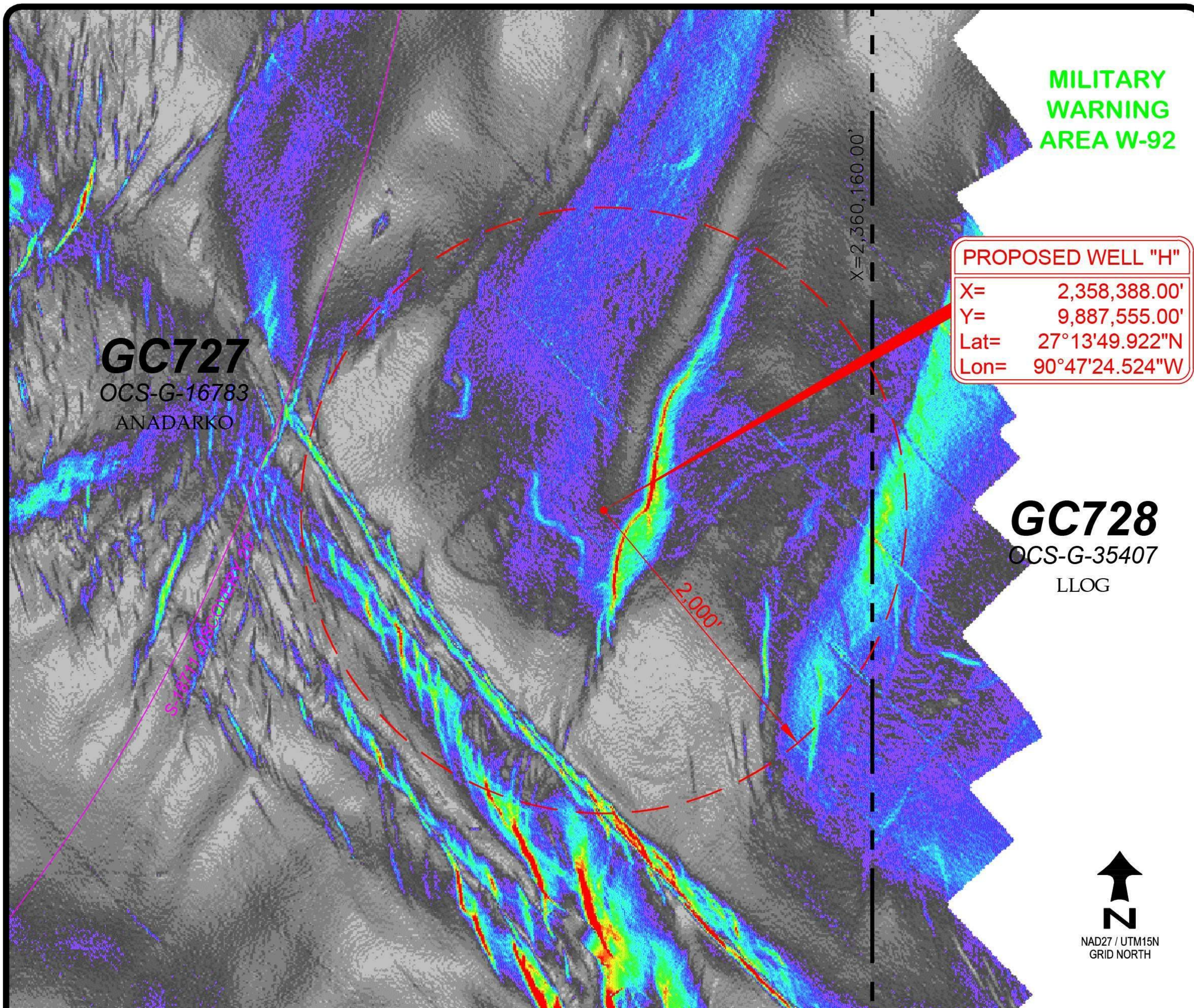
DATE: 04/27/2016 TIME: 11:32 FILENAME: Z:\151051\ACAD\151051_WELL-H.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "H"
COLOR SHADED BATHYMETRY MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

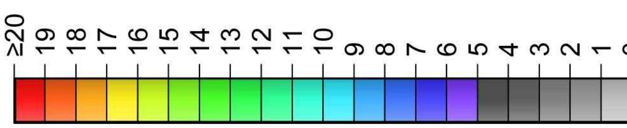
JOB No: 151051, 172082	DATE: Apr. 27, 2016
DRAWN: A. McBride	SHEET 1 of 6
FILE: 151051_WELL-H.DWG	REV. 0



GRADIENT

Gradient is the first order derivative of the multibeam data.

Bin size = 3 meters (9.84 feet)



SLOPE IN DEGREES

1,000' 0' 1,000'

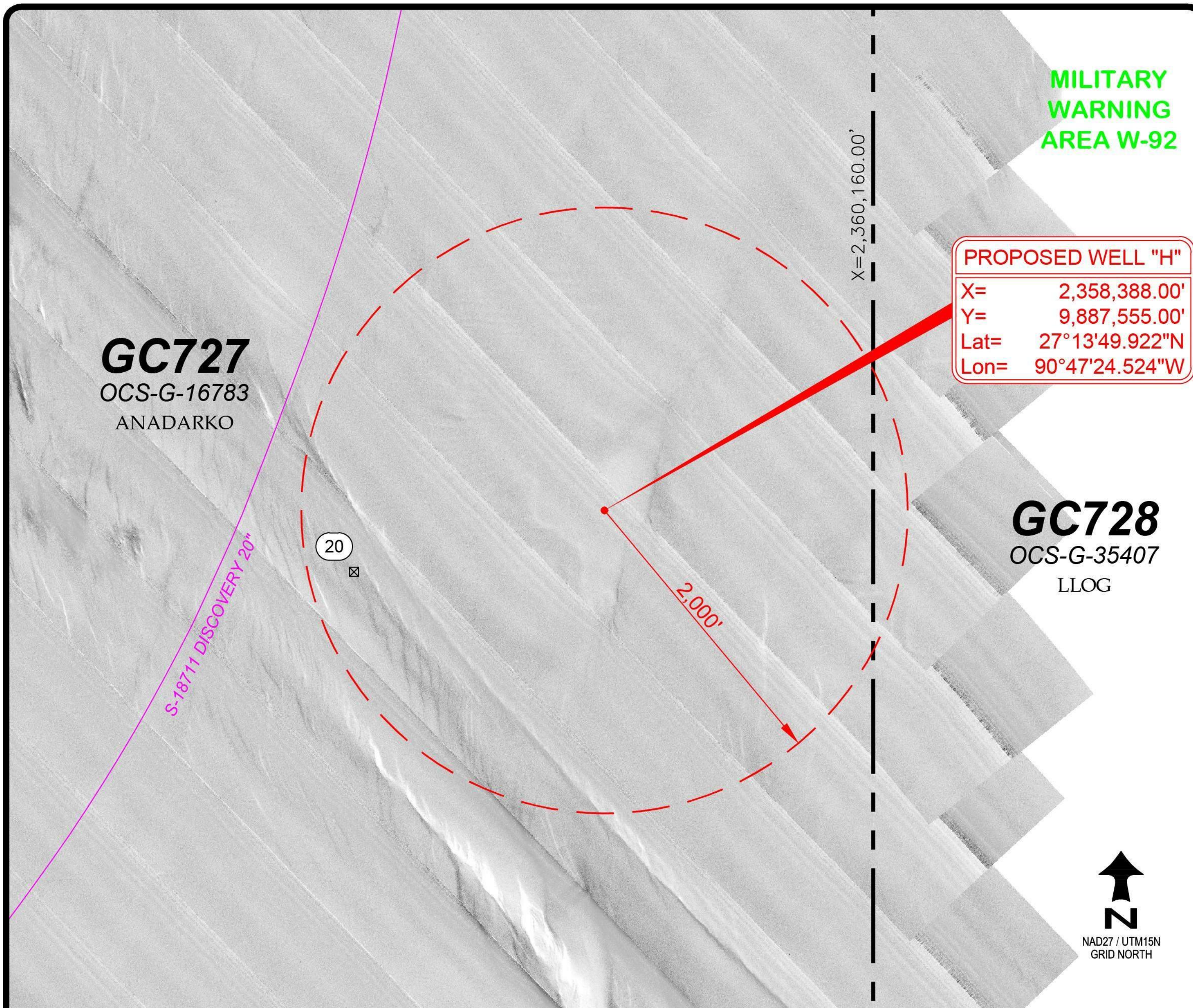
SCALE IN US SURVEY FEET

DATE: 04/27/2016 TIME: 11:33 FILENAME: Z:\151051\ACAD\151051_WELL-H.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "H"
SEAFLOOR GRADIENT MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING® 730 E. KALISTE SALOOM RD. LAFAYETTE, LA 70508 (337) 210-0000 LA Reg. No. 747	JOB No: 151051, 172082	DATE: Apr. 27, 2016	
	DRAWN: A. McBride	SHEET 2 of 6	REV. 0
	FILE: 151051_WELL-H.DWG		



SONAR MOSAIC

Dark returns represent higher seafloor reflectivity.

SONAR CONTACT

NUM.	DESCRIPTION	X COORDINATE	Y COORDINATE
20	17.2'x5.4'x2.7'	2,356,737'	9,887,150'

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

DATE: 04/27/2016 TIME: 11:33 FILENAME: Z:\151051\ACAD\151051_WELL-H.DWG

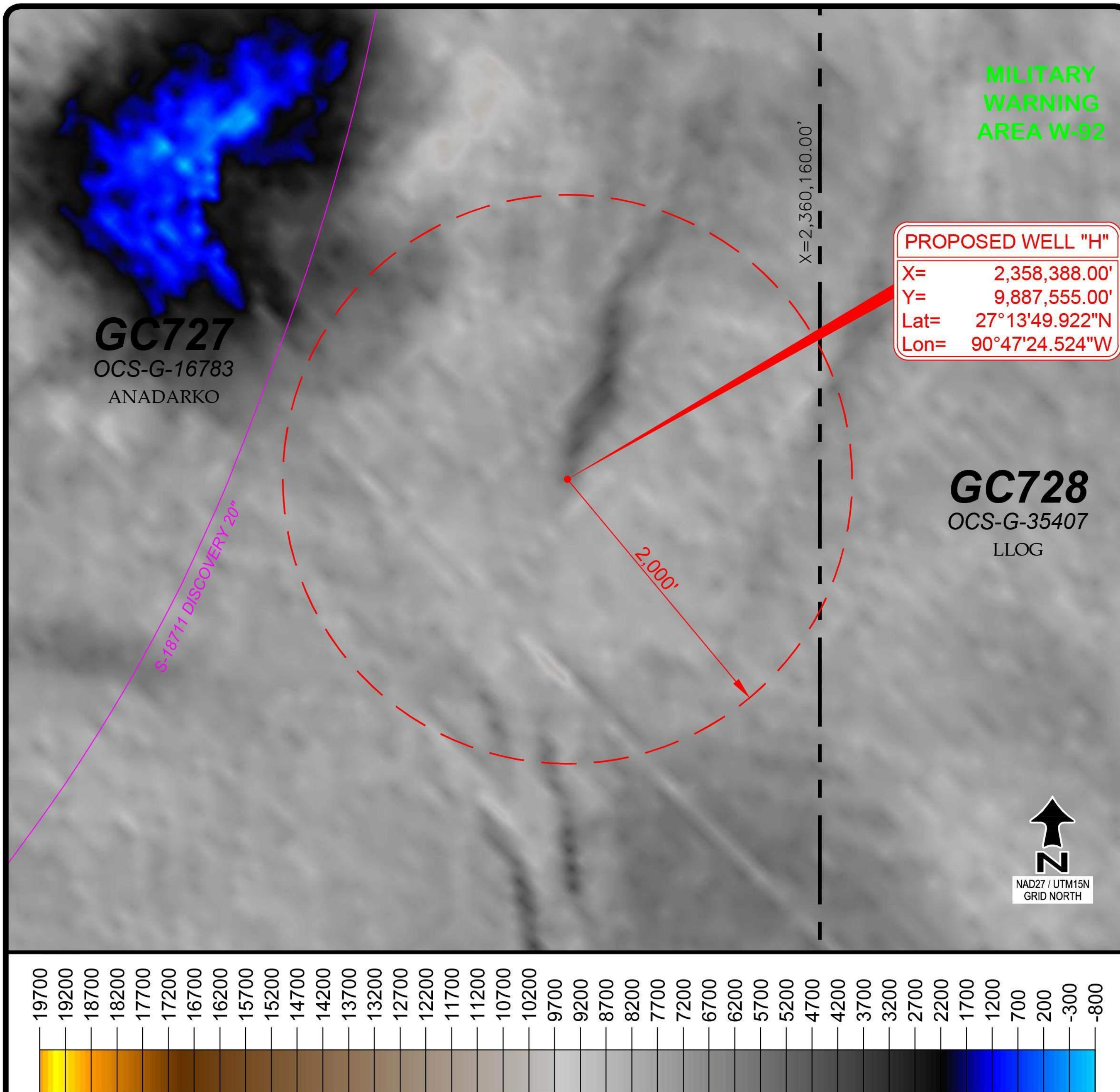
Anadarko Petroleum Corporation

PROPOSED WELL "H"
SIDE SCAN SONAR MOSAIC MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®

730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 3 of 6	REV. 0
FILE: 151051_WELL-H.DWG		



RELATIVE AMPLITUDE
3D SEISMIC

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

DATE: 04/27/2016 TIME: 11:33 FILENAME: Z:\151051\ACAD\151051_WELL-H.DWG

Anadarko Petroleum Corporation

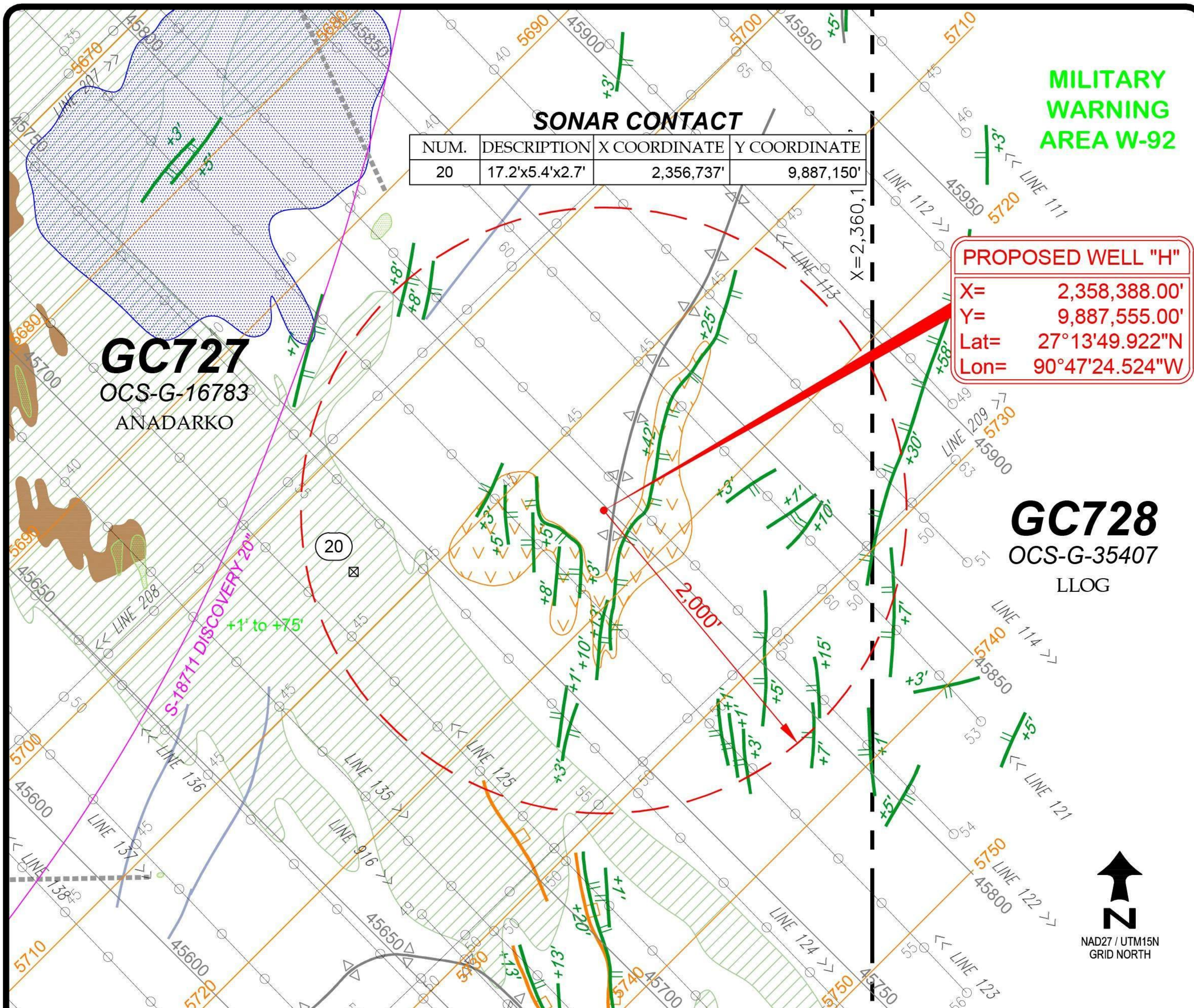
PROPOSED WELL "H"
SEAFLOOR AMPLITUDE MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 4 of 6	REV. 0
FILE: 151051_WELL-H.DWG		

SONAR CONTACT

NUM.	DESCRIPTION	X COORDINATE	Y COORDINATE
20	17.2'x5.4'x2.7'	2,356,737'	9,887,150'



<< LINE 201	AUV navigation trackline with name and direction run, fix and fix number	+10'	Fault scarp with seafloor displacement (Hachures on downthrown side)
5550	Inline and inline number for 3D seismic data Spacing = 30 meters (98.43 feet)	+1' to +75'	Scarp zone with seafloor displacement range
46300	Crossline and crossline number for 3D seismic data Spacing = 25 meters (82.02 feet); Trace increment = 4		Drag scar
			Gullies / Channels
20	Sonar contact and reference number		Pockmarks
			Slump
	Headwall scarp		Hardgrounds / Outcrops
	Ridge		3D seismic low amplitude anomaly

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

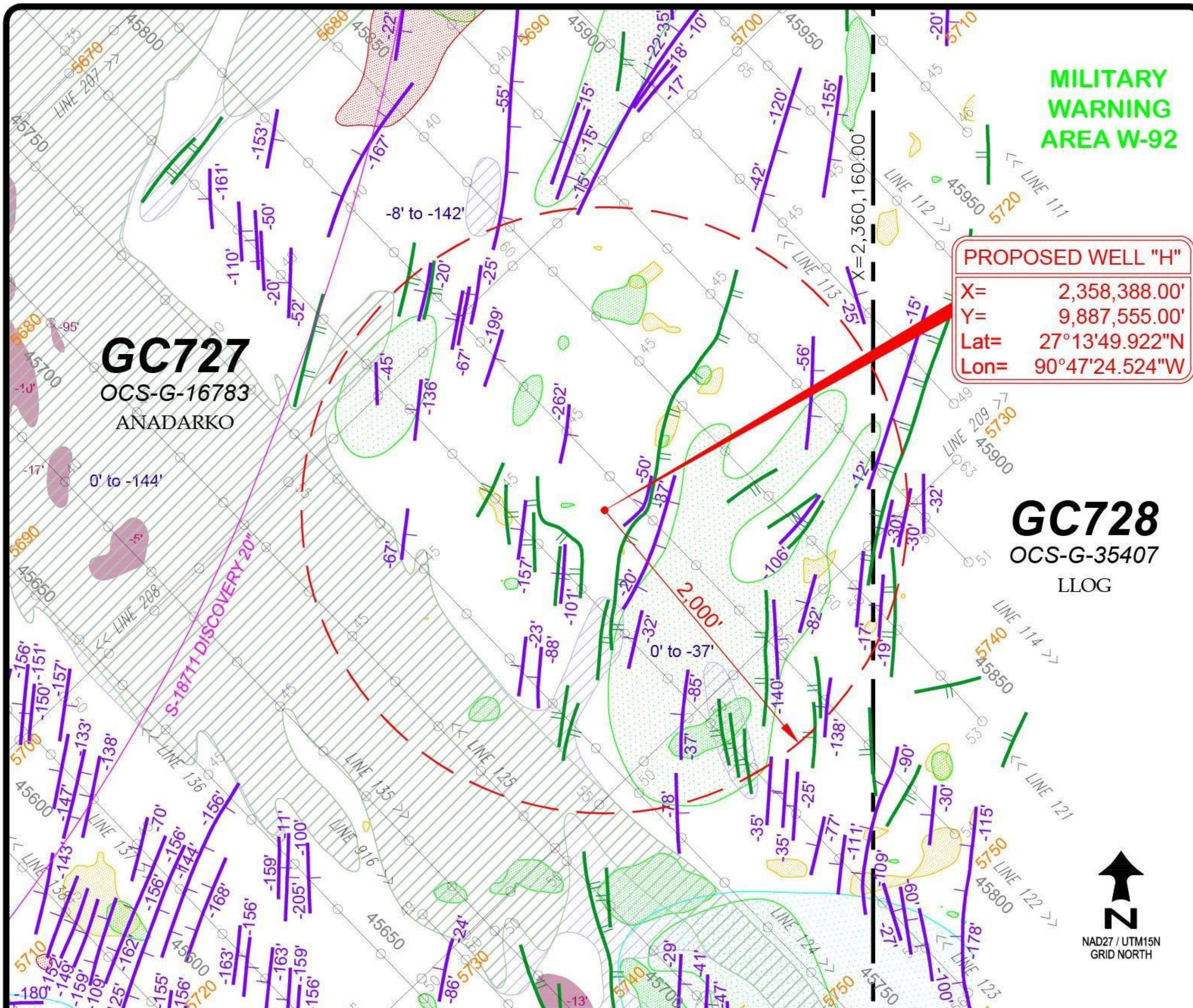
DATE: 04/27/2016 TIME: 11:34 FILENAME: Z:\151051\ACAD\151051_WELL-H.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "H"
SEAFLOOR FEATURES MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 5 of 6	REV. 0
FILE: 151051_WELL-H.DWG		



<< LINE 201 — AUV navigation trackline with name and direction run, fix and fix number	Mass transport deposit 1 (-4' to -10')
	Mass transport deposit 3 (-12' to -63')
5550 — Inline number for 3D seismic data Spacing = 30 meters (98.43 feet)	-13' — Acoustic void with depths below seafloor
46300 — Crossline number for 3D seismic data Spacing = 25 meters (82.02 feet); Trace increment = 4	Amplitude anomalies within Unit B (1.810 sec. - 2.778 sec. BSL) 104' - 2,379' BML
Fault scarp (Hachures on downthrown side)	Amplitude anomalies within Unit C (1.987 sec. - 2.757 sec. BSL) 434' - 3,543' BML
-10' — Normal fault with depth of burial (Hachures on downthrown side)	
0' to -144' — Fault zone with depth range of burial	Amplitude anomalies within Unit D (2.133 sec. - 3.231 sec. BSL) 805' - 5,922' BML
Scarp zone	

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

DATE: 04/27/2016 TIME: 11:34 FILENAME: Z:\151051\ACAD\151051_WELL-H.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "H"
SUBSURFACE FEATURES MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 6 of 6	REV. 0
FILE: 151051_WELL-H.DWG		

April 27, 2016

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

Attn: Mr. Rick Kincaid

Site Clearance Letter
Proposed Well "HH"
Block 727 (OCS-G-16783)
Green Canyon Area

Mr. Rick,

INTRODUCTION

Anadarko Petroleum Corporation (Anadarko) contracted Oceaneering International, Inc. (OII) to prepare a well site clearance letter for the proposed Well "HH" location of the Calpurnia Prospect in Block 727 (OCS-G-16783), Green Canyon (GC) Area. The data used for the site clearance letter is based on the interpretation of an exploration-quality 3D seismic volume and a high-resolution geophysical dataset collected with OII's Autonomous Underwater Vehicle (AUV) *C-Surveyor III*™. OII completed a geohazard assessment titled "*Shallow Hazard Report, Block 727 (OCS-G-16783) and 771 (OCS-G-33259), Green Canyon Area*" in March, 2016. This site clearance letter is based on the findings provided within that report.

This letter provides a top-hole drilling prognosis and addresses seafloor conditions within a 2,000-foot radius of the proposed surface location. The depth limit of investigation is approximately 2.0 seconds of two-way traveltime (~5,000 feet) below the mud line (BML), or to the salt/sediment interface if it is encountered less than 2.0 seconds below the seafloor. The reporting and mapping presented in this letter comply with the BOEM/BSEE guidelines provided in NTL No. 2008-G05 (Shallow Hazards Program) and No. 2009-G40 (Deepwater Benthic Communities).

METHODS

AUV Survey Data

OII's *C-Surveyor III*™ AUV provided multibeam bathymetric mapping, high-resolution side scan sonar imagery, and subbottom profiles. The AUV remote-sensing instruments include a Simrad EM 2040 Multibeam Echosounder (200, 300, and 400 kHz), an EdgeTech 2200-M Full Spectrum Chirp Dual Frequency Side Scan Sonar (120/410 kHz), and an EdgeTech DW106 Chirp Subbottom Profiler (1.5–4.5 kHz). All the raw digital data were logged utilizing proprietary software developed by OII. The multibeam system delivered a 3-meter gridded dataset with relative vertical accuracies within 20 centimeters.

The AUV survey grid in the study area consisted of 62 main tracklines (Lines 101–114 and 120–167) running northeast to southwest at 200-meter line spacing, 13 ties lines (Lines 201–213) running northwest to southeast at 900-meter line spacing, and 29 in-fill lines (Lines 901–929) run to fill in bathymetry data gaps caused by steep seafloor terrain. Navigation fixes (event marks) were annotated at 125-meter (410-foot) intervals along all survey lines. The survey grid

was designed to provide a representative sampling with the subbottom profiler system and overlapping coverage with side scan sonar and multibeam echosounder systems.

3D Seismic Data

The 3D seismic data used for this assessment was provided in SEG-Y format, and were loaded into IHS' Kingdom Suite 2d/3dPAK for interpretation. The 3D data were acquired by WesternGeco in 1999–2000, and reprocessing was completed in 2006 with Post-Stack Time Migration (PSTM). Inlines and crosslines are depicted on the Surface and Subsurface Features Maps (Sheets 5 and 6). The 3D data were provided at a four-millisecond sample rate and extend to the full data range of 13 seconds. The inlines of the data run southwest to northeast and are spaced at 30-meter (98.43-foot) intervals. The crosslines run southwest to northeast and are spaced at 25-meter (82.02-foot) intervals. Spectral whitening was applied to the 3D seismic dataset to amplify the higher frequencies. After applying the spectral whitening, a power spectrum generated at a few selected locations indicated the seismic data volume contains sufficiently high frequency content for a shallow hazards assessment (Figure 1).

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 (faults, salt, high acoustic impedance, stratigraphic horizons, etc.).

WELL LOCATION

The coordinates and calls for the proposed Well "HH" surface location are tabulated below:

Table 1. Proposed Well "HH"

Easting (feet)	Northing (feet)	Latitude	Longitude	Calls From Block 727, Green Canyon Area	
2,358,311.00'	9,887,619.00'	27°13'50.569"N	90°47'25.364"W	1,849.00' FEL	3,459.00' FSL

A 2,000-foot clearance radius is required for assessing deepwater benthic communities in proximity to the proposed Well "HH".

The geodetic datum used for this project is the North American Datum 1927 (NAD27) with the Clarke 1866 Ellipsoid. The datum is projected using the Universal Transverse Mercator (UTM), Zone 15 North (15N) 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. Mapping and reporting units are in U.S. Survey Feet.

REGIONAL GEOLOGY

The Gulf of Mexico is a semi-enclosed basin that has been receiving sediment influx dominated by the Mississippi River since the Late Jurassic. Mesozoic and Cenozoic sediments have attained a thickness in excess of 9 miles (Coleman et al., 1991). The prograded shelf sequence consists of intercalated coastal plain, delta, estuarine, and marine sediments. Sediment deposition along the northern rim of the Gulf of Mexico resulted in particularly thick Tertiary

and Quaternary sections. These rapidly deposited sediments have prograded the Cretaceous shelf-edge up to 185 miles basinward. The exceptionally high rate of shelf-edge progradation is on the order of 3.0 to 3.7 miles per 1,000 years.

The near surface geology across the Gulf Coast region is the product of fluctuating sea levels associated with climatic variations over the past 20,000 years. During this time, low sea levels left the continental shelf exposed to subaerial weathering and other erosional processes. Streams and rivers meandered and cut into the exposed landmass, depositing bedloads along the modern-day shelf break. Fan systems were formed, and mass movement events were common as deltaic sediments were deposited on the steep upper continental slope. As the climate warmed, seas transgressed, and marine sediments were deposited on the shelf.

The proposed wellsite is located in the northern Gulf of Mexico in an area designated as the Green Canyon Area by the BOEM and BSEE. The study area is located on the middle Texas Louisiana Slope in GC727 and is characterized by extensive faulted/fractured sediments due to salt diapiric uplift.

BATHYMETRY AND SEAFLOOR GRADIENTS

The water depth at the proposed Well "HH" location is 4,587 feet below mean sea level (MSL). Within the 2,000-foot radius centered at the proposed well location, the seafloor depth ranges from 4,496 feet in the northeast to 4,698 feet in the south (Sheet 1, Color Shaded Bathymetry Map).

The proposed well is situated on a slightly irregular seafloor atop a ridge located in the southeast corner of GC727. The seafloor in the area surrounding the proposed well location slopes south-southwest at a gradient of 4° (Sheet 2, Seafloor Gradient Map).

SEAFLOOR HAZARDS

Low to moderate sonar and multibeam backscatter reflectivity occurs around the proposed well site indicating mostly fine-grained sediments. Higher acoustic reflectivity in the side scan sonar and backscatter images occur along fault scarps and represent coarser sediments (Figure 2; Sheet 3, Side Scan Sonar Mosaic Map).

The 3D seafloor amplitude image displays low to moderate acoustic amplitudes within the 2,000-foot radius area (Sheet 4, Seafloor Amplitude Map). These low to moderate seafloor amplitudes indicate finely textured seafloor sediments that are likely comprised of hemipelagic clay. One large low amplitude anomaly is located 2,100 feet northwest of the proposed site.

One sonar contact is located within 2,000 feet of the proposed well location. Sonar Contact No. 20 is located 1,630 feet west of the well site and measures 17.2 feet long, 5.4 feet wide, and has a height of 2.7 feet.

Multiple surface faults were identified within the 2,000-foot radius (Sheet 5, Seafloor Features Map). These faults typically trend north-south and exhibit seafloor displacement between 1 and 10 feet. One fault, located 310 feet to the southeast, shows 42 feet of seafloor relief. Slump deposits were noted along the downthrown sides of the fault scarps, and are characterized by slightly irregular and undulating topography and may represent unstable seafloor for construction activities.

POTENTIAL DEEPWATER BENTHIC COMMUNITIES

High or low-amplitude seismic seafloor anomalies are potential indicators of carbonates, benthic community habitats, and gas/fluid seepages. The seafloor at the proposed Well "HH" and surrounding 2,000-foot radius contains no high or low positive seafloor amplitude anomalies associated with fluid expulsion or mounded carbonates representing potential benthic communities. The side scan sonar and multibeam backscatter agree with the seafloor amplitude image, and show no evidence of outcrops or fluid expulsion.

SUBSURFACE GEOHAZARDS AND STRATIGRAPHY

The AUV subbottom profiler data exhibit continuous, sharp bottom echoes with parallel to divergent, continuous reflectors throughout the well site area. The uppermost shallow sediments consist of a 15 foot thick acoustically semi-transparent hemipelagic clay drape. Sediments below this drape are characterized by parallel, low to moderate amplitude reflectors that represent cyclic deposition of hemipelagic clay and silty clays (Figure 3).

Four sedimentary units (Units A to D), each consisting of one or more distinctive sequences, were interpreted within the study area from the 3D seismic data to approximately 0.6 seconds of two-way traveltime (~2,000 feet) below the seafloor, the lower limit of investigation. Five horizons mark the upper and/or lower contacts of each of the successive units (Figures 3 and 4).

Subsurface faulting/fracturing occurs throughout the 2,000-foot vicinity, with most faults trending north-south (Sheet 6, Subsurface Features Map). The stratigraphy throughout the well site area is extremely faulted and fractured due to the shallow salt.

One mass transport deposit (MTD) was identified within the 2,000-foot radius. The MTD is generally characterized by chaotic and mixed sequences or lack of visible internal structure, which suggest the integrity of the internal sedimentary structures was lost while moving downslope. The deposit is located 590 feet southeast of the proposed well site and is buried 40 feet.

OII used check shot data from the BOEM web site for a nearby well with a series of time-depth pairs for the sediment column. The following polynomial equation was derived from Total Vertical Depth (TVD) (feet) and the corresponding two-way traveltime (seconds) using the time-depth values to calculate depths below the seafloor:

$$D = 186.45T^2 + 2,637.05T$$

where D = depth below sea level in feet and T = time below sea level in seconds.

A detailed description of the sequence units, beginning at the seafloor, can be found in the 2016 Geohazard Report. The Top-Hole Prognosis Chart (Figure 6) summarizes the stratigraphy.

Unit A (Seafloor to Horizon 1)
Unit A consists of low to moderate amplitude, parallel, semi-continuous reflectors and measures 316 feet thick at the proposed well location. The reflection patterns suggest the unit is comprised mostly of hemipelagic clay with a few interbedded mass transport deposits. No high amplitude anomalies occur within Unit A near the proposed well location. Fractured/faulted sediments were identified in the AUV subbottom data within this unit (Figure 3).

Unit B (Horizon 1 to Horizon 2)
Unit B consists of mostly low amplitude, sub-parallel reflectors and measures 545 feet thick at the proposed well location. The unit is interpreted as interbedded channel fill and mass transport deposits. No high amplitude anomalies occur within Unit B near the proposed well location. Fractured/faulted sediments were identified in the 3D seismic data within this unit (Figures 4 and 5).

Unit C (Horizon 2 to Horizon 3)
Unit C consists of low to moderate amplitude, semi-continuous to sub-chaotic reflectors and measures 314 feet thick. This unit is interpreted as a interbedded coarse-grained channel fill and mass transport deposits. Several high amplitude anomalies occur within Unit C, most of which appear next to fault lines which may act as structural traps for the possible gas hazards. The closest of these anomalies is relatively small and is located 200 feet to the west. Fractures/faults were identified in the 3D data within this unit (Figures 4 and 5).

Unit D (Horizon 3 to Salt/Sediment Interface)
Unit D consists of low to moderate amplitude, semi-continuous to chaotic reflectors and measures 773 feet thick. This unit is interpreted as a coarser-grained channel fill and mass transport deposits. Several high amplitude anomalies occur within Unit D, most of which appear next to fault lines which may act as structural traps for the possible gas hazards. The closest of these anomalies is located 100 feet to the west. Fractures/faults were identified in the 3D data within this unit (Figures 4 and 5). The base of Unit D marks the salt/sediment interface at the proposed well site.

SHALLOW GAS

Anomalies of very high amplitude, commonly termed bright spots, are interpreted as potential regions of fluid saturation usually associated with porous sands. Seismic amplitude anomalies are mapped on a unit-by-unit basis to assess the potential risk of gas. Seismic amplitude anomalies are exhibited on the Subsurface Features Map when present.

The risk of gas refers to the risk of encountering shallow gas. The risk of gas is interpreted based on amplitude levels. Stratigraphic and structural settings may also be taken into account. The four risk levels of gas are:

- **Negligible**—No amplitude anomalies or other gas indicator present.
- **Low risk of gas**—Generally indicated by increased amplitude (2–3× 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× background level) and phase reversal.
- **High risk of gas**—Generally indicated by the highest amplitudes (in excess of 4× 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.

Amplitude anomalies were identified within Units C and D within 2,000 feet of the proposed Well "HH" location. Units A and B are assessed as having a low risk of gas, while Units C and D are assessed as having a low to moderate risk of gas.

SHALLOW WATER FLOW

Several factors may contribute to shallow water flows. These include: high porosity and permeability, sand-prone aquifer, mechanism to pressurize, and seal. Additional details are described below:

- **Water depth and burial depth.** Significant water depths (> 500 feet below the seafloor) 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.

All of these factors occur within the study area. Since there is presently no method for quantifying the risk of shallow water flow, caution is recommended when drilling through units with shallow water flow potential. Sands with SWF potential often occur in unconsolidated, overpressured sands that lie below a seal. This seal prevents dewatering and compaction after deposition. The pressure rises with overburden causing a potentially disastrous hazard for drilling operations.

The nearest SWF event, according to information listed on the BOEM and BSEE website, is located approximately 15 miles northeast of the study area in GC644. This SWF event occurred at 644 feet below the seafloor and is listed as minor severity. Several other SWF events have been reported 25–40 miles east of the study area in GC783, GC823, GC825, and GC826. These SWF events are listed as occurring 1,274–5,527 feet below mudline and are all of low severity.

The assessment of seismic profiles suggests that Units A–D all exhibit a low risk of SWF. The numerous faults found in these units would serve to release pressures. 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 between the hydrate and free gas trapped at the base of the hydrate stability zone forms a Bottom Simulating Reflector (BSR) on seismic profiles. This BSR reflector cross cuts 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 deepwater benthic communities may all be found in close association. No indication of BSRs was found in the vicinity of the proposed well.

CONCLUSIONS

The proposed Well "HH" location is situated on a slightly irregular seafloor atop a ridge at a water depth of 4,587 feet MSL. The seabed slopes to south-southwest at a gradient of 4°.

Numerous surface faults are located within 2,000 feet of the proposed well site, and typically exhibit between 1 and 10 feet of seafloor relief. One fault, located 310 feet southeast, measures 42 feet of relief. Slump deposits were noted along the downthrown sides of the fault scarps, and may represent unstable seafloor for construction activities.

One sonar contact (Sonar Contact No. 20) was identified 1,630 feet west of the proposed Well "HH" location.

No high or low seafloor amplitudes anomalies that may indicate the occurrence of hardgrounds, carbonates, benthic communities or potential expulsions are found within 2,000 feet of the proposed Well "HH" location.

Four (4) subsurface units interpreted from the 3D seismic data were assessed to approximately 2,500 feet BSF at the proposed Well "HH" location (Units A to D). Unit A is comprised mostly of low to moderate amplitude, parallel, semi-continuous reflectors and consists of hemipelagic clays and interbedded mass transport deposits. Unit B is characterized by mostly low amplitude, sub-parallel reflectors and consists of interbedded channel fill and mass transport deposits. Unit C is comprised of low to moderate amplitude, semi-continuous to sub-chaotic reflectors and is interpreted as interbedded coarse-grained channel fill and mass transport deposits. Unit D is characterized by low to moderate amplitude, semi-continuous to chaotic reflectors and is interpreted as coarser-grained channel fill and mass transport deposits. Subsurface faults and fractures were identified within every unit due to the salt diapiric uplift in the area.

Subsurface amplitude anomalies were identified within Units C and D within 2,000 feet of the proposed Well "HH" location. Units A and B are assessed as having a low risk of gas, while Units C and D have a low to moderate risk. No indication of gas hydrates was found within the study area.

Units A–D are all assessed as having a low risk of SWF, due to the numerous faults found in the units which would serve to release pressures.

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

Regards,

Christopher Baker
Senior Geologist

ENCLOSURES

Figure 1. Extracted wavelet and power spectrum at the proposed Well "HH".
Figure 2. Backscatter image showing seafloor near the proposed Well "HH".
Figure 3. Subbottom profiler Line 122 near the proposed Well "HH".
Figure 4. 3D seismic Inline 5719 through the proposed Well "HH".
Figure 5. 3D seismic Crossline 45777 through the proposed Well "HH".
Figure 6. Top-Hole Prognosis Chart for the proposed Well "HH".

Sheet 1.	Color Shaded Bathymetry Map, Proposed Well "HH" Location	1"=1,000'
Sheet 2.	Seafloor Gradient Map, Proposed Well "HH" Location	1"=1,000'
Sheet 3.	Side Scan Sonar Mosaic Map, Proposed Well "HH" Location	1"=1,000'
Sheet 4.	Seafloor Amplitude Map, Proposed Well "HH" Location	1"=1,000'
Sheet 5.	Seafloor Features Map, Proposed Well "HH" Location	1"=1,000'
Sheet 6.	Subsurface Features Map, Proposed Well "HH" Location	1"=1,000'

730 EAST KALISTE SALOOM ROAD, LAFAYETTE, LA 70508

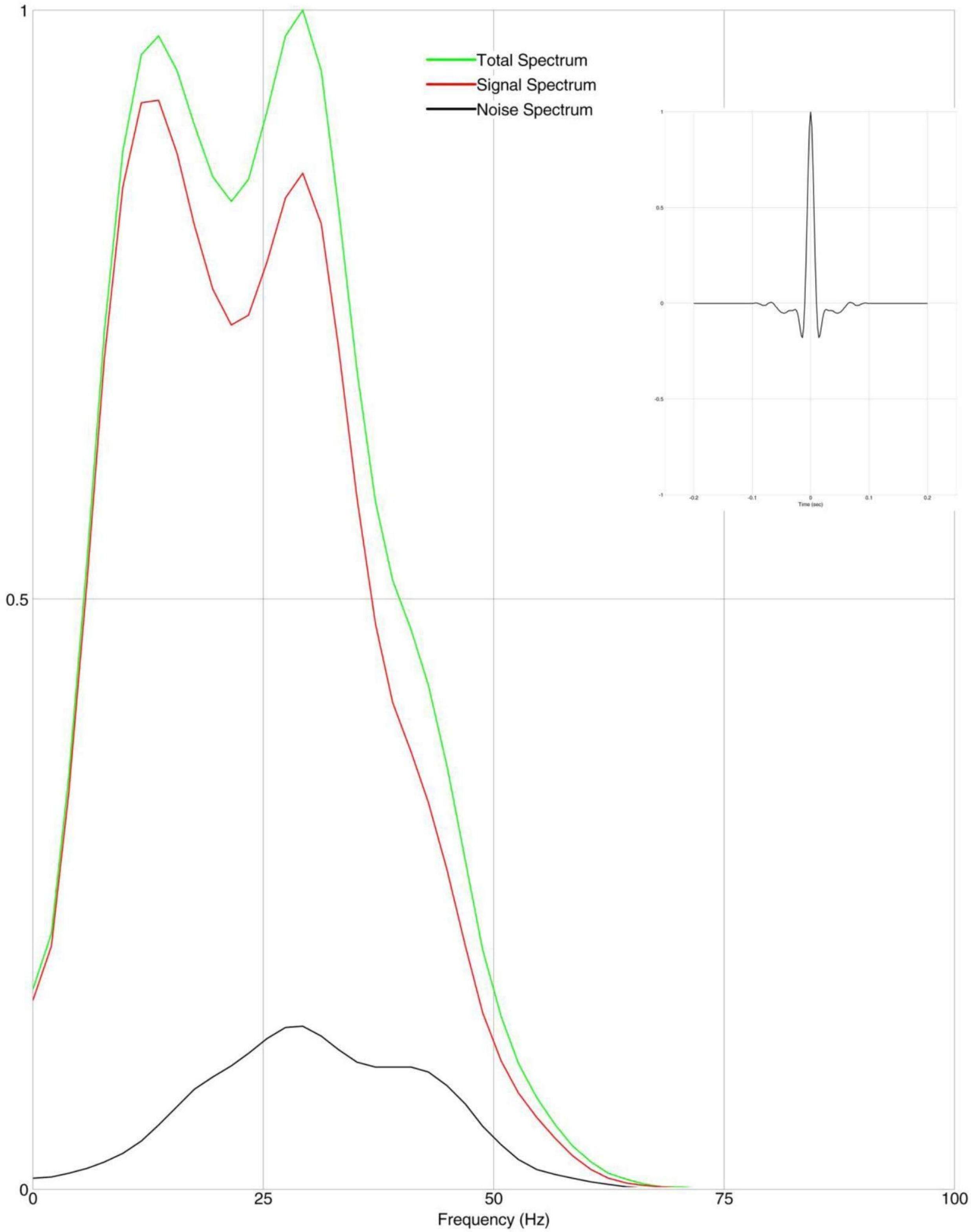


Figure 1. Extracted wavelet and power spectrum at the proposed Well "HH" (1 second).

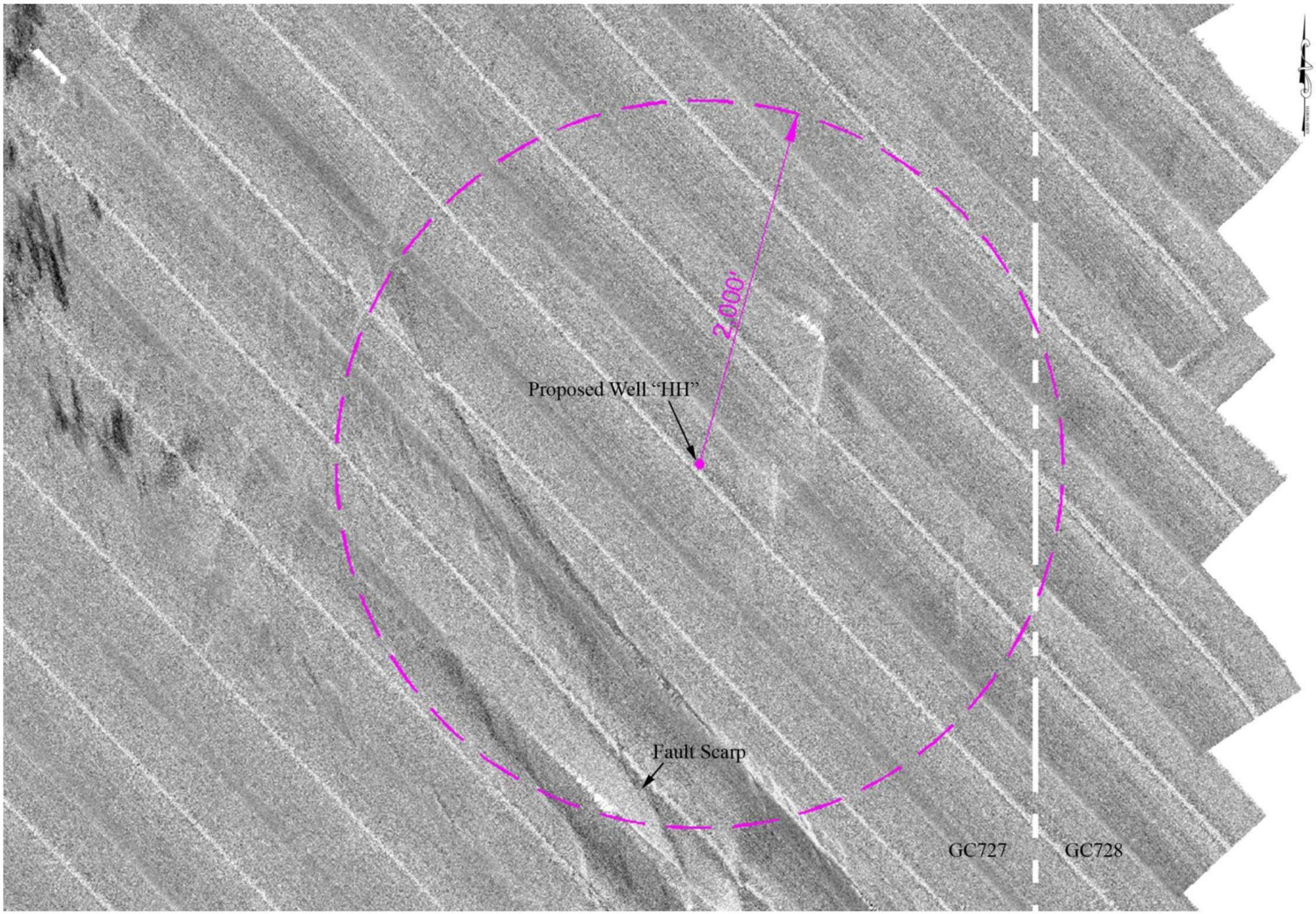


Figure 2. Backscatter image showing seafloor near the proposed Well "HH".

Proposed Well "HH"
GC727 (OCS-G-16783)
X = 2,358,311.00' Y = 9,887,619.00'
Line 122 (offset 190 feet southwest)

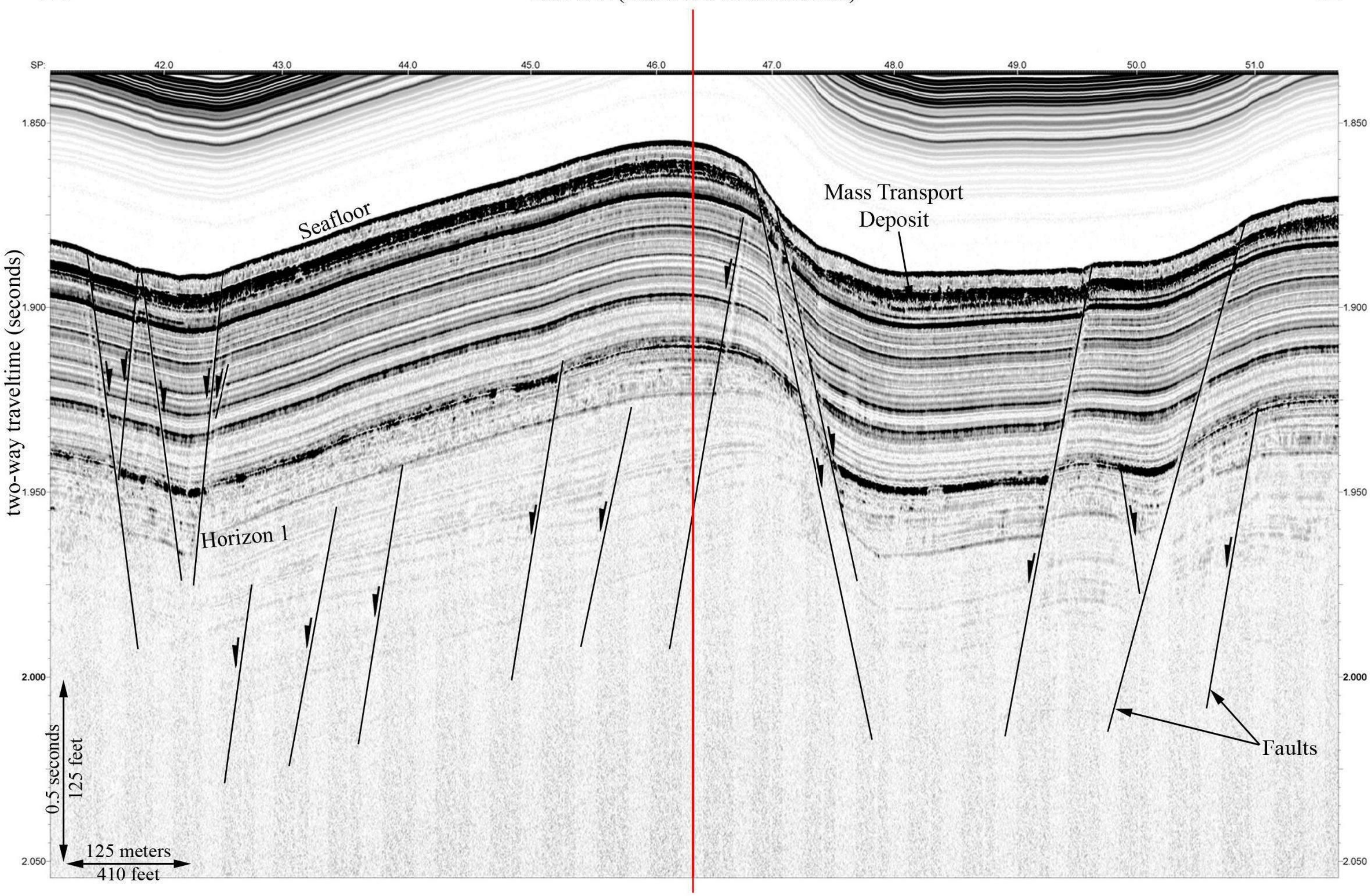


Figure 3. Subbottom profiler Line 122 near the proposed Well "HH".

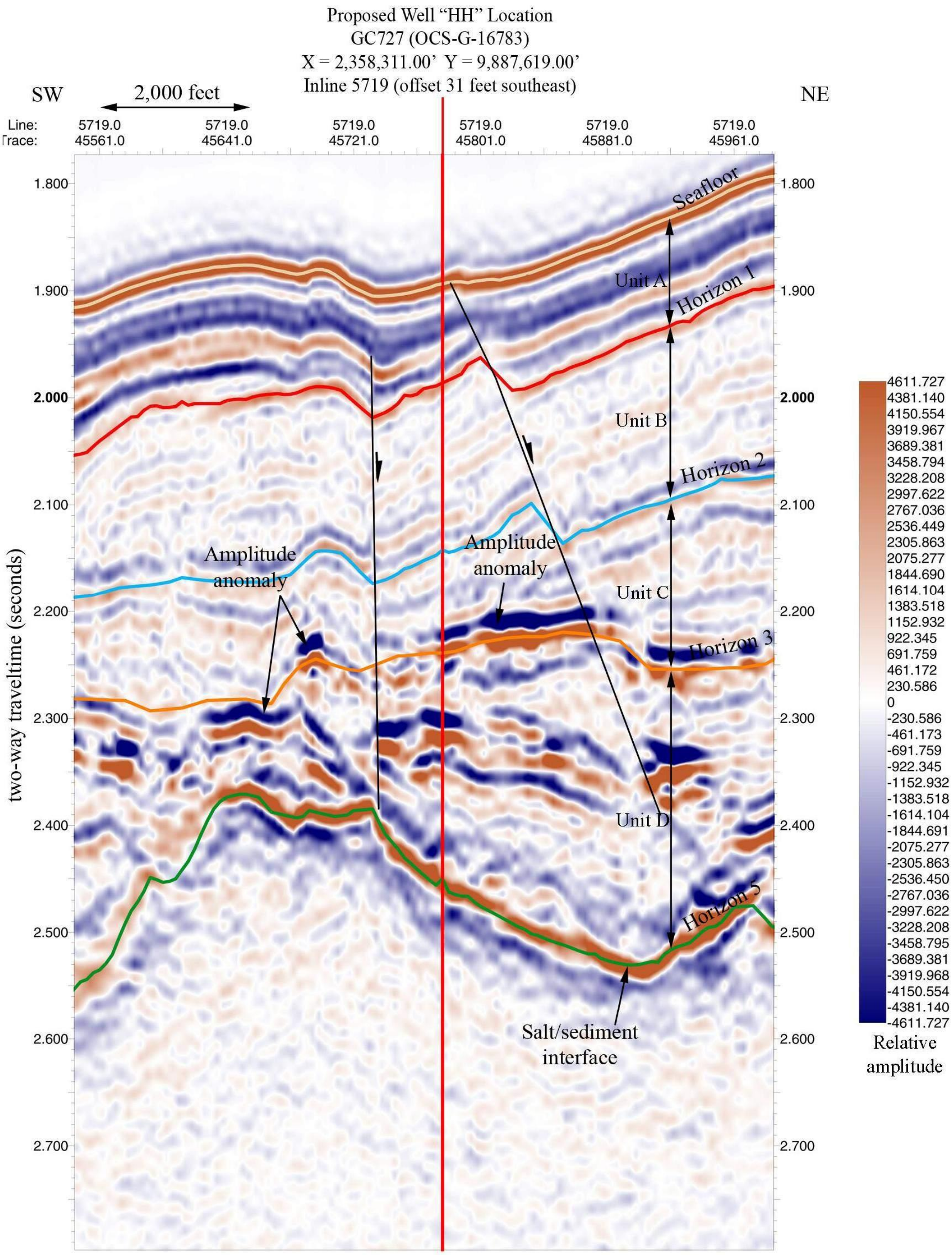


Figure 4. 3D seismic Inline 5719 through the proposed Well "HH".

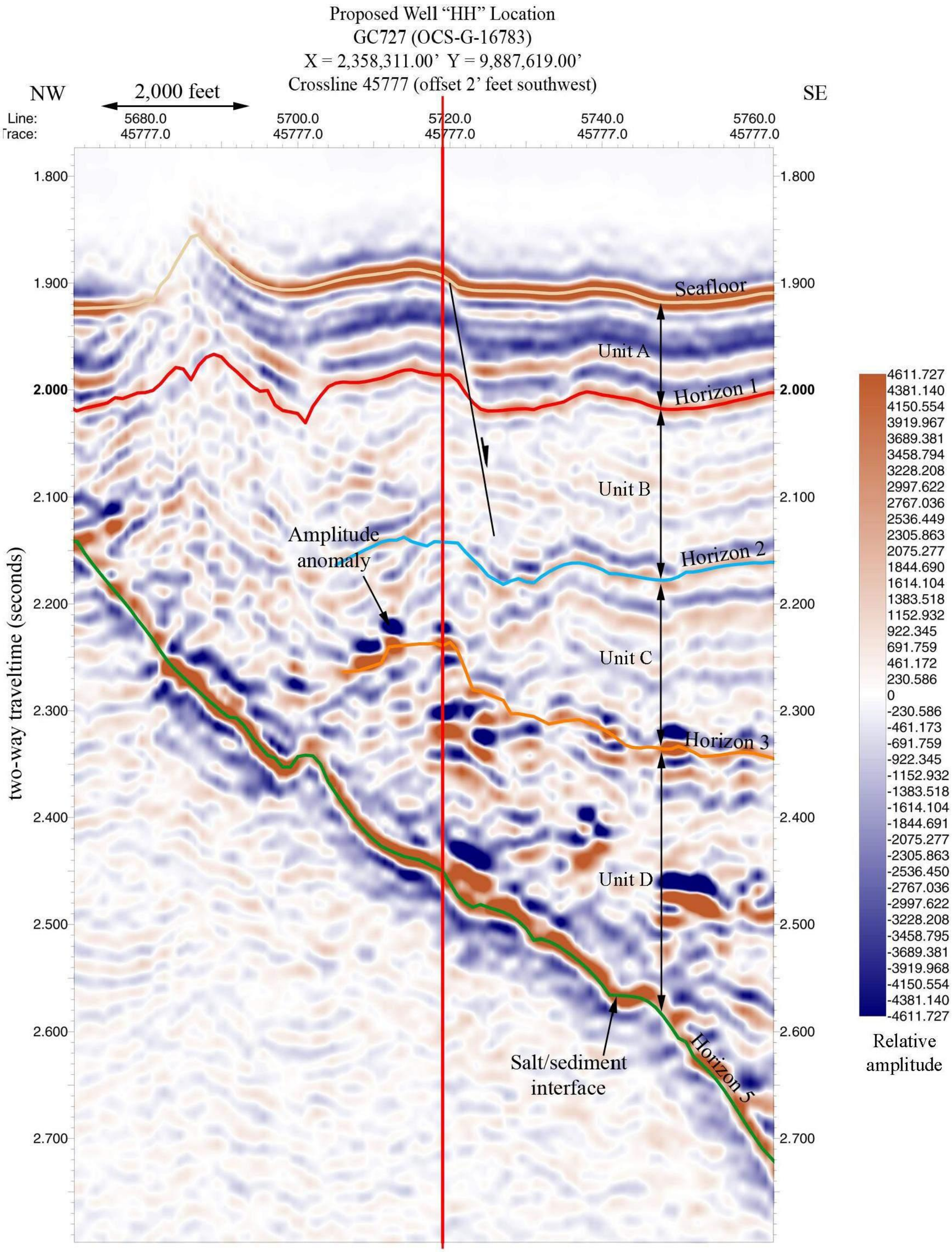
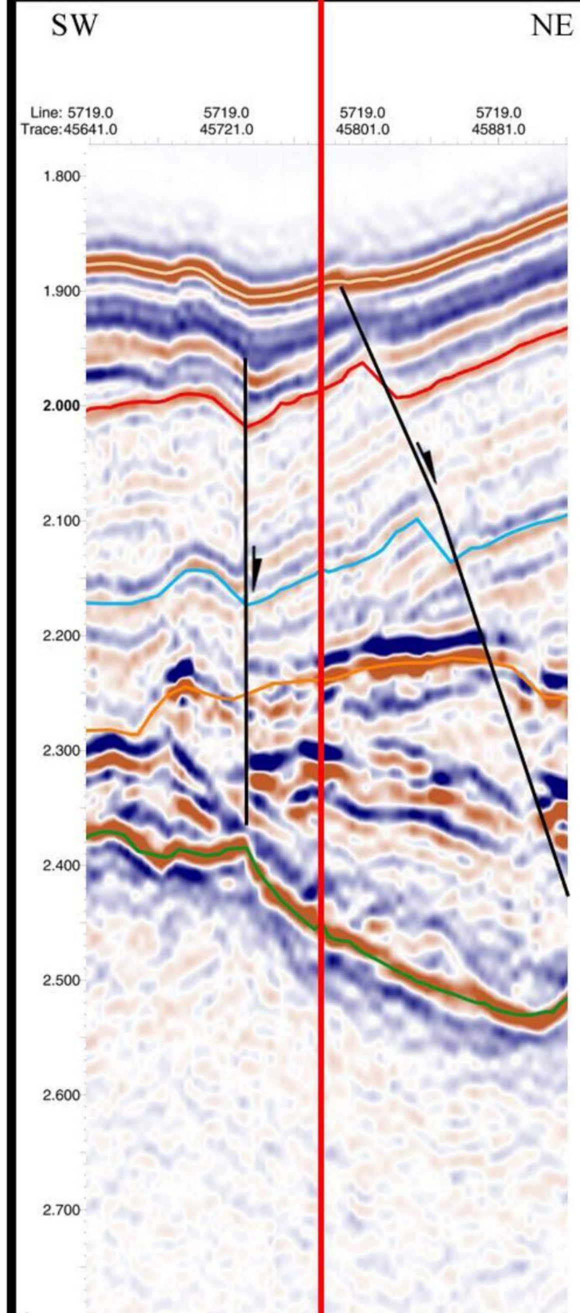


Figure 5. 3D seismic Crossline 45777 through the proposed Well "HH".

Proposed Well "HH" Location
GC727 (OCS-G-16783)
X = 2,358,311.00' Y = 9,887,619.00'
Inline 5719 (offset 31 feet southeast)

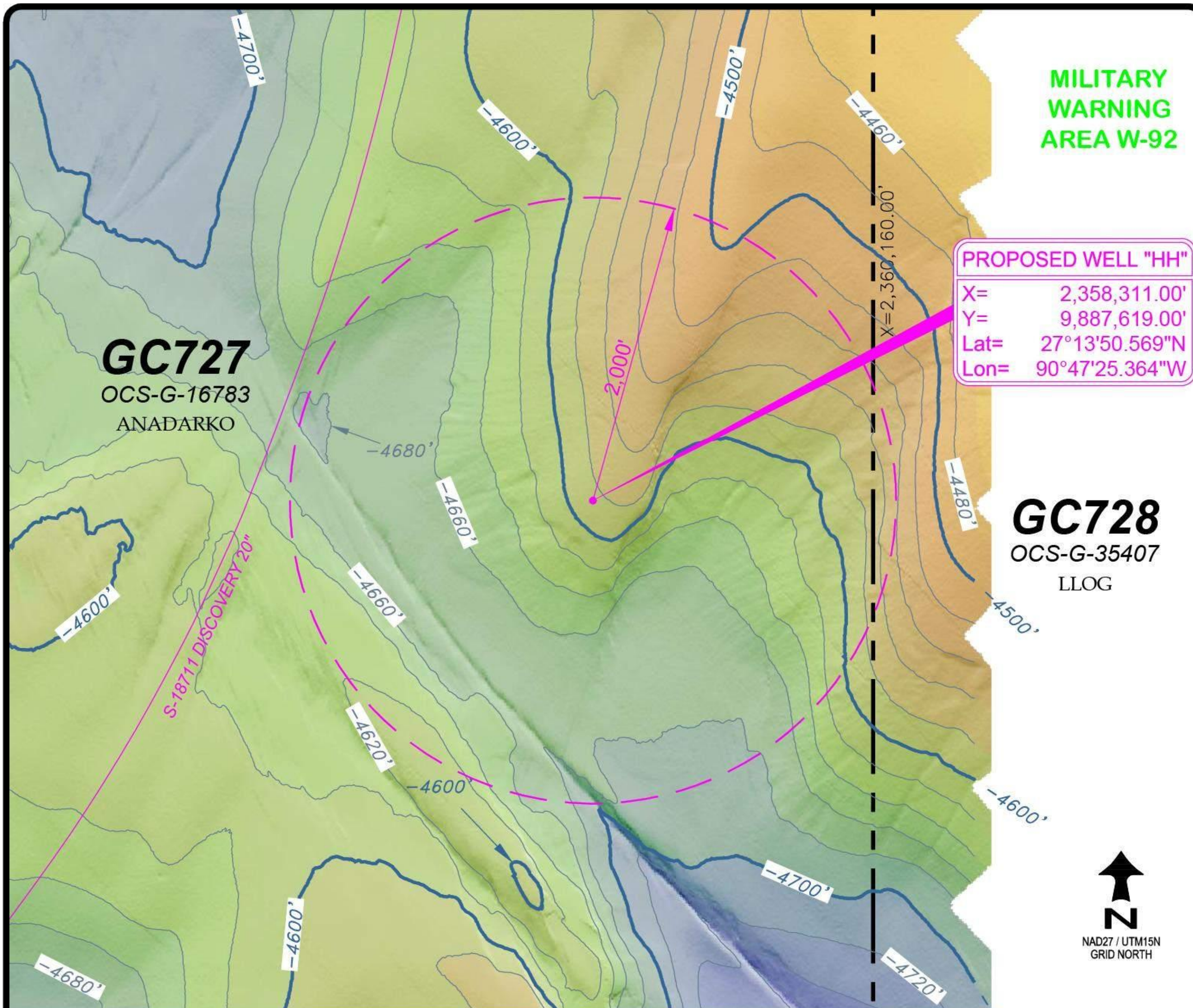


Note: Subsurface depths based on T-D equation
$D = 186.45T^2 + 2,637.05T$

Subsurface Sequence (Well Intersect) Unit	Subsurface Sequence (Well Intersect) Horizon	Water Flow and Gas Potential Gas	Water Flow and Gas Potential Water Flow	Depth BML (feet)	Depth MSL (feet)	TWT BSL (sec)	Interval Thickness (feet)	Lithology Description
	Seafloor				4,587	1.894		
A	Horizon 1			316	4,903	1.988	316	Drape deposit of hemipelagic clays with interbedded fine-grained mass transport deposits.
B	Horizon 2			861	5,448	2.148	545	Interbedded channel fill and mass transport deposits. The sediments within Unit B are highly fractured and faulted due to the salt diapiric uplift in the area.
C	Horizon 3			1,176	5,763	2.239	314	Interbedded channel fill and mass transport deposits. The sediments within Unit C are highly fractured and faulted due to the salt diapiric uplift in the area.
D	Salt/Sediment Interface			1,949	6,535	2.459	773	Coarser-grained channel fill and mass transport deposits. The sediments within Unit D are highly fractured and faulted due to the salt diapiric uplift in the area.
	Depth of study							

Hazard Potential Negligible: Low: Moderate: High:

Figure 6. Top-Hole Prognosis Chart for the proposed Well "HH".



Multibeam processing sequence

1. Water column velocity corrections applied
2. Tide corrections applied using Goddard Ocean Tide Model GOT99.2
3. Bin size = 3 meters (9.84 feet)
4. Median filter applied
5. Produced gridded-binned dataset using weighted-neighbor algorithm; search radius = 9 meters (29.53 feet)

Contour interval = 20 feet
Zero datum = Mean Sea Level

Color shaded image

Sun azimuth = 0°
Sun elevation = 30°

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

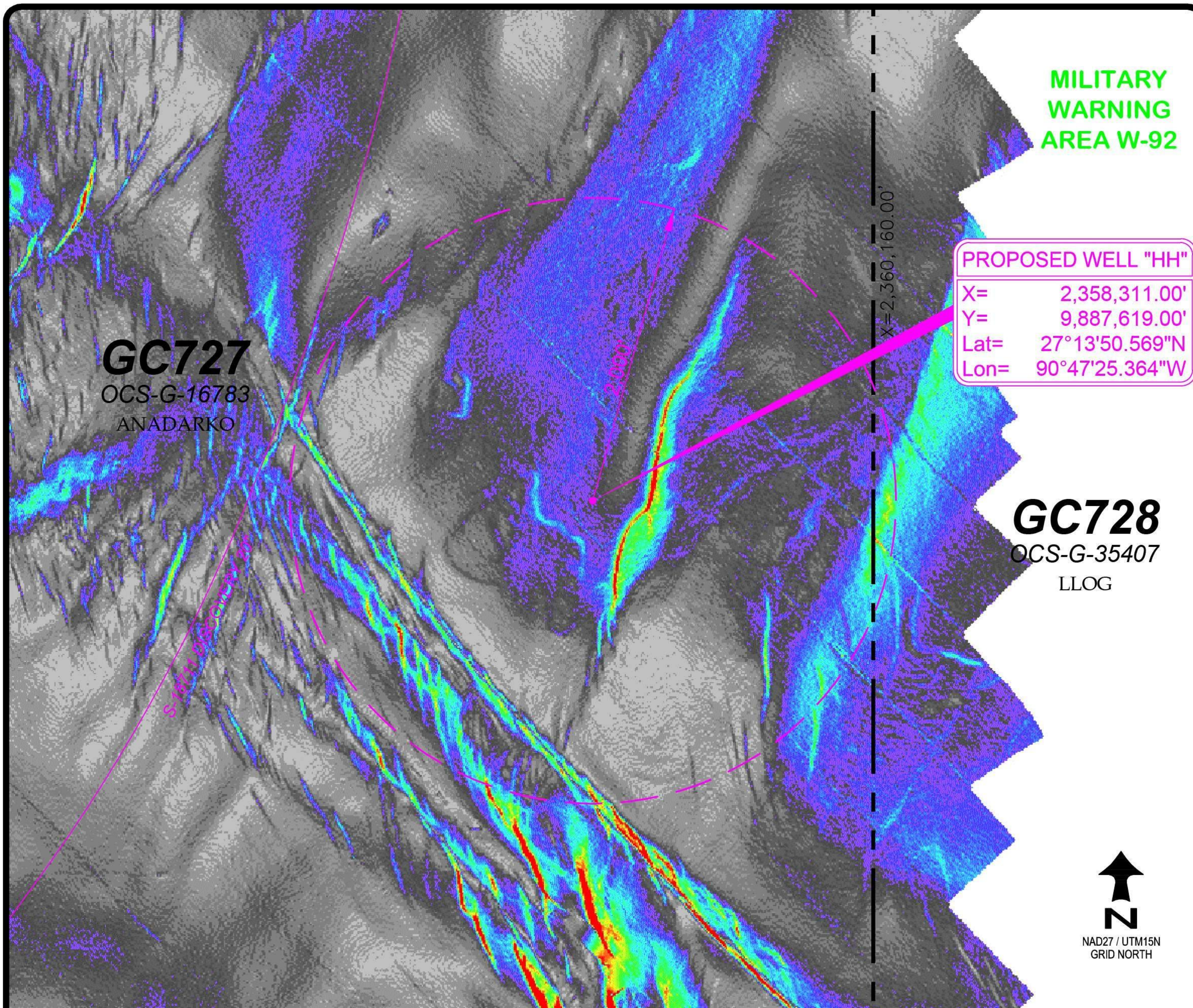
DATE: 04/27/2016 TIME: 11:35 FILENAME: Z:\151051\ACAD\151051_WELL-HH.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "HH"
COLOR SHADED BATHYMETRY MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 1 of 6	REV. 0
FILE: 151051_WELL-HH.DWG		



GRADIENT

Gradient is the first order derivative of the multibeam data.

Bin size = 3 meters (9.84 feet)

≥20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

SLOPE IN DEGREES

1,000' 0' 1,000'

SCALE IN US SURVEY FEET

DATE: 04/27/2016 TIME: 11:35 FILENAME: Z:\151051\ACAD\151051_WELL-HH.DWG

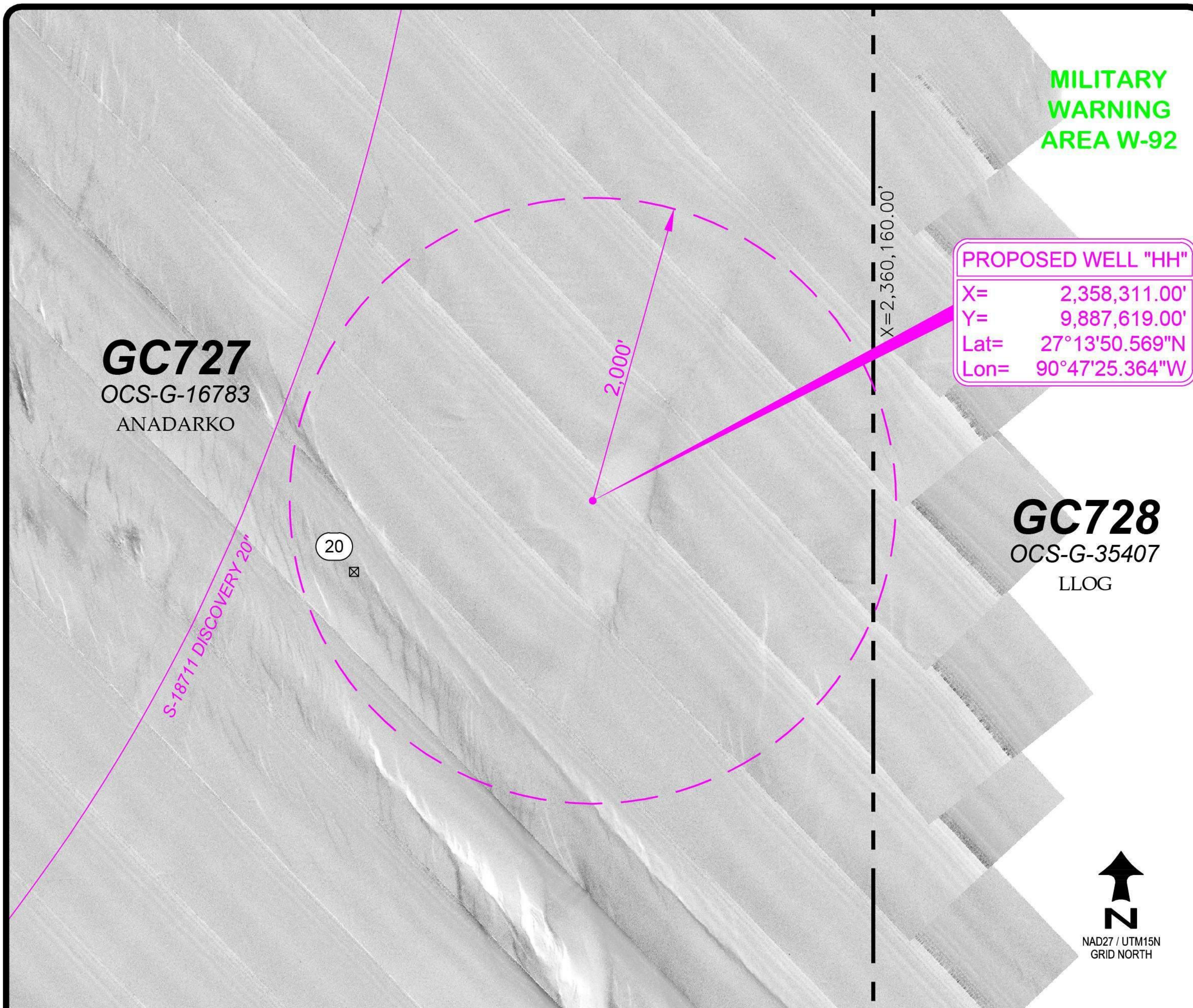
Anadarko Petroleum Corporation

PROPOSED WELL "HH"
SEAFLOOR GRADIENT MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®

730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016
DRAWN: A. McBride	SHEET 2 of 6
FILE: 151051_WELL-HH.DWG	REV. 0



SONAR MOSAIC
Dark returns represent higher seafloor reflectivity.

SONAR CONTACT

NUM.	DESCRIPTION	X COORDINATE	Y COORDINATE
20	17.2'x5.4'x2.7'	2,356,737'	9,887,150'

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

DATE: 04/27/2016 TIME: 11:36 FILENAME: Z:\151051\ACAD\151051_WELL-HH.DWG

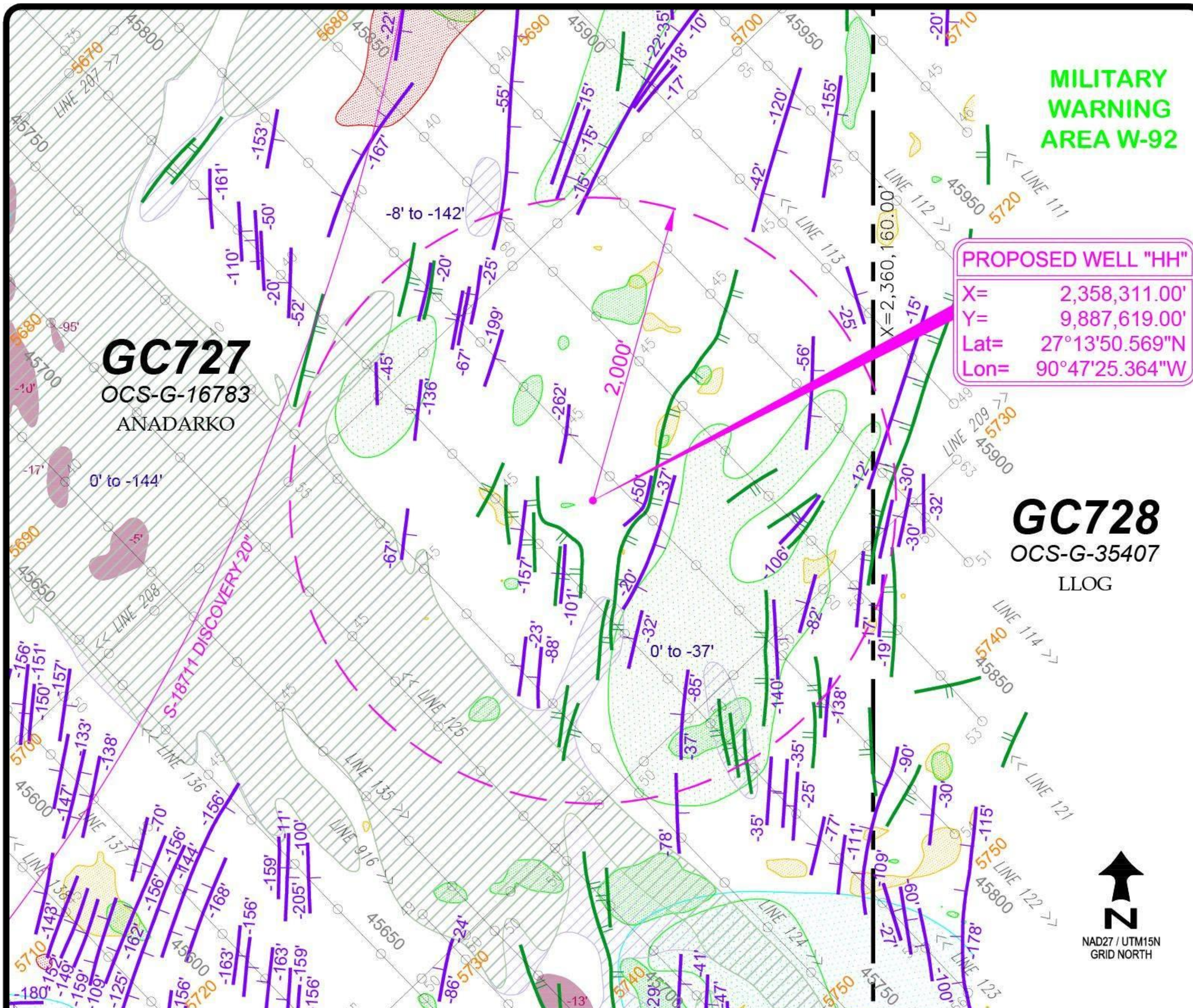
Anadarko Petroleum Corporation

PROPOSED WELL "HH"
SIDE SCAN SONAR MOSAIC MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®

730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016		
DRAWN: A. McBride	SHEET 3 of 6		REV. 0
FILE: 151051_WELL-HH.DWG			



<< LINE 201	AUV navigation trackline with name and direction run, fix and fix number		Mass transport deposit 1 (-4' to -10') / Mass transport deposit 3 (-12' to -63')
5550	Inline number for 3D seismic data Spacing = 30 meters (98.43 feet)	-13'	Acoustic void with depths below seafloor
46300	Crossline number for 3D seismic data Spacing = 25 meters (82.02 feet); Trace increment = 4		Amplitude anomalies within Unit B (1.810 sec. - 2.778 sec. BSL) 104' - 2,379' BML
	Fault scarp (Hachures on downthrown side)		Amplitude anomalies within Unit C (1.987 sec. - 2.757 sec. BSL) 434' - 3,543' BML
-10'	Normal fault with depth of burial (Hachures on downthrown side)		
0' to -144'	Fault zone with depth range of burial / Scarp zone		Amplitude anomalies within Unit D (2.133 sec. - 3.231 sec. BSL) 805' - 5,922' BML

DATE: 04/27/2016 TIME: 11:37 FILENAME: Z:\151051\ACAD\151051_WELL-HH.DWG

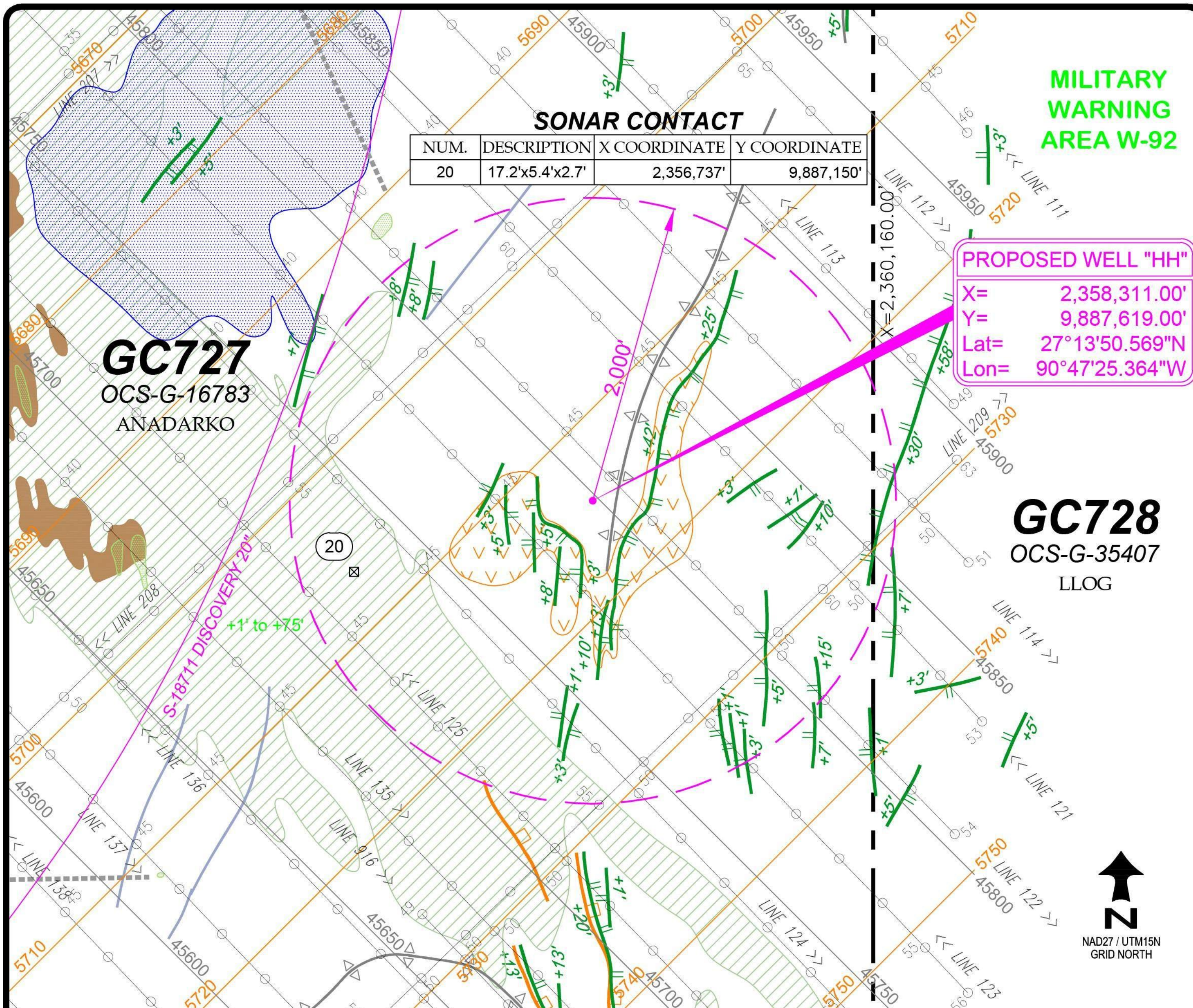
1,000' 0' 1,000'
SCALE IN US SURVEY FEET

Anadarko Petroleum Corporation

PROPOSED WELL "HH"
SUBSURFACE FEATURES MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 6 of 6	REV. 0
FILE: 151051_WELL-HH.DWG		



SONAR CONTACT

NUM.	DESCRIPTION	X COORDINATE	Y COORDINATE
20	17.2'x5.4'x2.7'	2,356,737'	9,887,150'

PROPOSED WELL "HH"

X=	2,358,311.00'
Y=	9,887,619.00'
Lat=	27°13'50.569"N
Lon=	90°47'25.364"W

<< LINE 201	AUV navigation trackline with name and direction run, fix and fix number	+10'	Fault scarp with seafloor displacement (Hachures on downthrown side)
5550	Inline and inline number for 3D seismic data Spacing = 30 meters (98.43 feet)	+1' to +75'	Scarp zone with seafloor displacement range
46300	Crossline and crossline number for 3D seismic data Spacing = 25 meters (82.02 feet); Trace increment = 4		Drag scar; Gullies / Channels
20	Sonar contact and reference number		Pockmarks; Slump
	Headwall scarp; Ridge		Hardgrounds / Outcrops; 3D seismic low amplitude anomaly

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

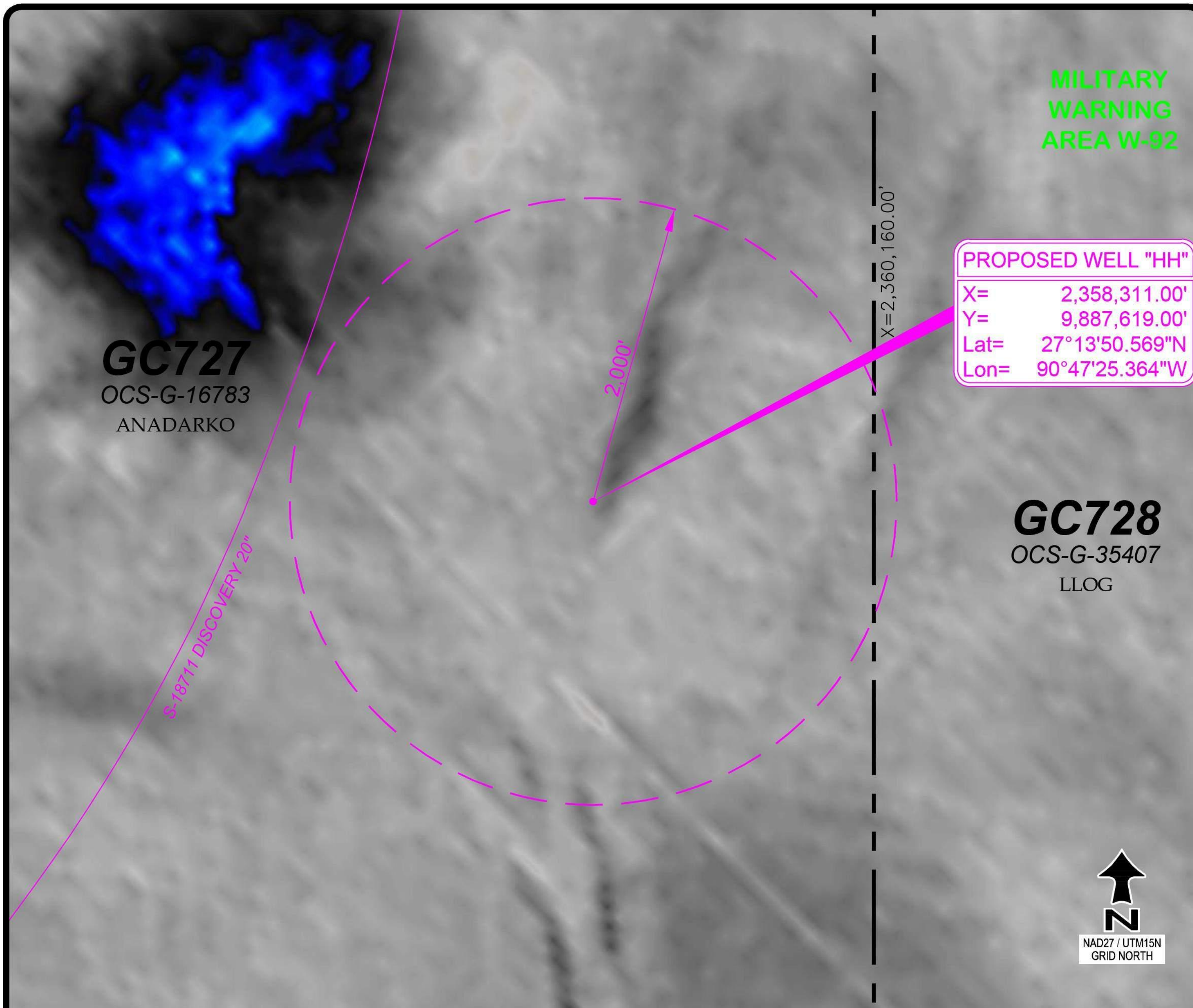
DATE: 04/27/2016 TIME: 11:37 FILENAME: Z:\151051\ACAD\151051_WELL-HH.DWG

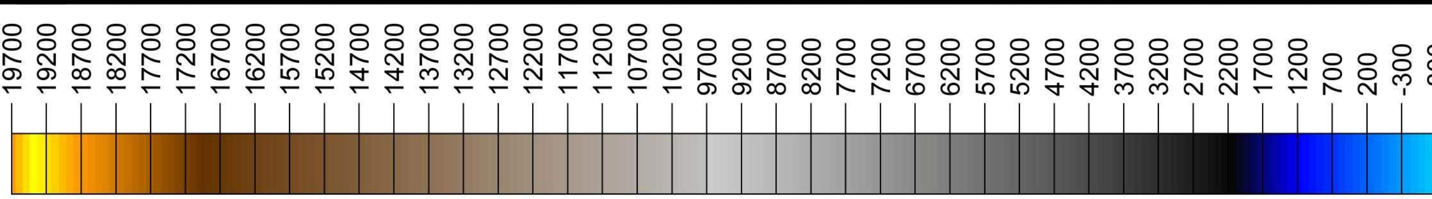
Anadarko Petroleum Corporation

PROPOSED WELL "HH"
SEAFLOOR FEATURES MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 5 of 6	REV. 0
FILE: 151051_WELL-HH.DWG		





RELATIVE AMPLITUDE
3D SEISMIC

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

DATE: 04/27/2016 TIME: 11:36 FILENAME: Z:\151051\ACAD\151051_WELL-HH.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "HH"
SEAFLOOR AMPLITUDE MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®	730 E. KALISTE SALOOM RD. LAFAYETTE, LA 70508 (337) 210-0000 LA Reg. No. 747	JOB No: 151051, 172082	DATE: Apr. 27, 2016
		DRAWN: A. McBride	SHEET 4 of 6 — REV. 0
		FILE: 151051_WELL-HH.DWG	

April 27, 2016

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

Attn: Mr. Rick Kincaid

Site Clearance Letter
Proposed Well "I"
Block 727 (OCS-G-16783)
Green Canyon Area

Mr. Rick,

INTRODUCTION

Anadarko Petroleum Corporation (Anadarko) contracted Oceaneering International, Inc. (OII) to prepare a well site clearance letter for the proposed Well "I" location of the Calpurnia Prospect in Block 727 (OCS-G-16783), Green Canyon (GC) Area. The data used for the site clearance letter is based on the interpretation of an exploration-quality 3D seismic volume and a high-resolution geophysical dataset collected with OII's Autonomous Underwater Vehicle (AUV) *C-Surveyor III*™. OII completed a geohazard assessment titled "*Shallow Hazard Report, Block 727 (OCS-G-16783) and 771 (OCS-G-33259), Green Canyon Area*" in March, 2016. This site clearance letter is based on the findings provided within that report.

This letter provides a top-hole drilling prognosis and addresses seafloor conditions within a 2,000-foot radius of the proposed surface location. The depth limit of investigation is approximately 2.0 seconds of two-way traveltime (~5,000 feet) below the mud line (BML), or to the salt/sediment interface if it is encountered less than 2.0 seconds below the seafloor. The reporting and mapping presented in this letter comply with the BOEM/BSEE guidelines provided in NTL No. 2008-G05 (Shallow Hazards Program) and No. 2009-G40 (Deepwater Benthic Communities).

METHODS

AUV Survey Data

OII's *C-Surveyor III*™ AUV provided multibeam bathymetric mapping, high-resolution side scan sonar imagery, and subbottom profiles. The AUV remote-sensing instruments include a Simrad EM 2040 Multibeam Echosounder (200, 300, and 400 kHz), an EdgeTech 2200-M Full Spectrum Chirp Dual Frequency Side Scan Sonar (120/410 kHz), and an EdgeTech DW106 Chirp Subbottom Profiler (1.5–4.5 kHz). All the raw digital data were logged utilizing proprietary software developed by OII. The multibeam system delivered a 3-meter gridded dataset with relative vertical accuracies within 20 centimeters.

The AUV survey grid in the study area consisted of 62 main tracklines (Lines 101–114 and 120–167) running northeast to southwest at 200-meter line spacing, 13 ties lines (Lines 201–213) running northwest to southeast at 900-meter line spacing, and 29 in-fill lines (Lines 901–929) run to fill in bathymetry data gaps caused by steep seafloor terrain. Navigation fixes (event marks) were annotated at 125-meter (410-foot) intervals along all survey lines. The survey grid

was designed to provide a representative sampling with the subbottom profiler system and overlapping coverage with side scan sonar and multibeam echosounder systems.

3D Seismic Data

The 3D seismic data used for this assessment was provided in SEG-Y format, and were loaded into IHS' Kingdom Suite 2d/3dPAK for interpretation. The 3D data were acquired by WesternGeco in 1999–2000, and reprocessing was completed in 2006 with Post-Stack Time Migration (PSTM). Inlines and crosslines are depicted on the Surface and Subsurface Features Maps (Sheets 5 and 6). The 3D data were provided at a four-millisecond sample rate and extend to the full data range of 13 seconds. The inlines of the data run southwest to northeast and are spaced at 30-meter (98.43-foot) intervals. The crosslines run southwest to northeast and are spaced at 25-meter (82.02-foot) intervals. Spectral whitening was applied to the 3D seismic dataset to amplify the higher frequencies. After applying the spectral whitening, a power spectrum generated at a few selected locations indicated the seismic data volume contains sufficiently high frequency content for a shallow hazards assessment (Figure 1).

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 (faults, salt, high acoustic impedance, stratigraphic horizons, etc.).

WELL LOCATION

The coordinates and calls for the proposed Well "I" surface location are tabulated below:

Table 1. Proposed Well "I"

Easting (feet)	Northing (feet)	Latitude	Longitude	Calls From Block 727, Green Canyon Area	
2,358,009.00'	9,890,686.00'	27°14'20.983"N	90°47'28.109"W	2,151.00' FEL	6,526.00' FSL

A 2,000-foot clearance radius is required for assessing deepwater benthic communities in proximity to the proposed Well "I".

The geodetic datum used for this project is the North American Datum 1927 (NAD27) with the Clarke 1866 Ellipsoid. The datum is projected using the Universal Transverse Mercator (UTM), Zone 15 North (15N) 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. Mapping and reporting units are in U.S. Survey Feet.

REGIONAL GEOLOGY

The Gulf of Mexico is a semi-enclosed basin that has been receiving sediment influx dominated by the Mississippi River since the Late Jurassic. Mesozoic and Cenozoic sediments have attained a thickness in excess of 9 miles (Coleman et al., 1991). The prograded shelf sequence consists of intercalated coastal plain, delta, estuarine, and marine sediments. Sediment deposition along the northern rim of the Gulf of Mexico resulted in particularly thick Tertiary

and Quaternary sections. These rapidly deposited sediments have prograded the Cretaceous shelf-edge up to 185 miles basinward. The exceptionally high rate of shelf-edge progradation is on the order of 3.0 to 3.7 miles per 1,000 years.

The near surface geology across the Gulf Coast region is the product of fluctuating sea levels associated with climatic variations over the past 20,000 years. During this time, low sea levels left the continental shelf exposed to subaerial weathering and other erosional processes. Streams and rivers meandered and cut into the exposed landmass, depositing bedloads along the modern-day shelf break. Fan systems were formed, and mass movement events were common as deltaic sediments were deposited on the steep upper continental slope. As the climate warmed, seas transgressed, and marine sediments were deposited on the shelf.

The proposed wellsite is located in the northern Gulf of Mexico in an area designated as the Green Canyon Area by the BOEM and BSEE. The study area is located on the middle Texas Louisiana Slope in GC727 and is characterized by extensive faulted/fractured sediments due to salt diapiric uplift.

BATHYMETRY AND SEAFLOOR GRADIENTS

The water depth at the proposed Well "I" location is 4,578 feet below mean sea level (MSL). Within the 2,000-foot radius centered at the proposed well location, the seafloor depth ranges from 4,450 feet in the east to 4,702 feet in the west (Sheet 1, Color Shaded Bathymetry Map).

The proposed well is situated near slightly undulating seafloor atop a relatively smooth section located in the southeast corner of GC727. The seafloor in the area surrounding the proposed well location slopes west-southwest at a gradient of 1° (Sheet 2, Seafloor Gradient Map).

SEAFLOOR HAZARDS

Low to moderate sonar and multibeam backscatter reflectivity occurs around the proposed well site indicating mostly fine-grained sediments. Higher acoustic reflectivity in the side scan sonar and backscatter images occur along fault scarps and represent coarser sediments (Figure 2; Sheet 3, Side Scan Sonar Mosaic Map).

The 3D seafloor amplitude image displays low to moderate acoustic amplitudes within the 2,000-foot radius area (Sheet 4, Seafloor Amplitude Map). These low to moderate seafloor amplitudes indicate finely textured seafloor sediments that are likely comprised of hemipelagic clay. One large low amplitude anomaly is located 1,125 feet west of the proposed site. No gas saturation or seafloor fluid expulsion occurs in association with the anomaly.

There were no sonar contacts identified within 2,000 feet of the proposed well location. One pipeline is located within the 2,000-foot radius. The S-18711 Discovery 20" Pipeline is located 977 feet west of the proposed site and travels north-south.

Several surface faults were observed within the 2,000-foot radius (Sheet 5, Seafloor Features Map). These faults typically trend north-south and exhibit seafloor displacement between 3 and 8 feet. The closest fault, located 500 feet east, exhibits 3 feet of seafloor relief.

POTENTIAL DEEPWATER BENTHIC COMMUNITIES

High or low-amplitude seismic seafloor anomalies are potential indicators of carbonates, benthic community habitats, and gas/fluid seepages. The seafloor at the proposed Well "I" and surrounding 2,000-foot radius contains one low amplitude seafloor anomaly, although this anomaly is not associated with any fluid expulsion or mounded carbonates representing potential benthic communities. The side scan sonar and multibeam backscatter agree with the seafloor amplitude image, and show no evidence of outcrops or fluid expulsion.

SUBSURFACE GEOHAZARDS AND STRATIGRAPHY

The AUV subbottom profiler data exhibit continuous, sharp bottom echoes with parallel to divergent, continuous reflectors throughout the well site area. The uppermost shallow sediments consist of a 15 foot thick acoustically semi-transparent hemipelagic clay drape. Sediments below this drape are characterized by parallel, low to moderate amplitude reflectors that represent cyclic deposition of hemipelagic clay and silty clays (Figure 3).

Four sedimentary units (Units A to D), each consisting of one or more distinctive sequences, were interpreted within the study area from the 3D seismic data to approximately 0.6 seconds of two-way traveltime (~2,000 feet) below the seafloor, the lower limit of investigation. Five horizons mark the upper and/or lower contacts of each of the successive units (Figures 3 and 4).

Subsurface faulting/fracturing occurs throughout the 2,000-foot vicinity, with most faults trending north-south (Sheet 6, Subsurface Features Map). The stratigraphy throughout the well site area is extremely faulted and fractured due to the shallow salt.

Two mass transport deposits (MTD) were identified within the 2,000-foot radius. The MTDs are generally characterized by chaotic and mixed sequences or lack of visible internal structure, which suggest the integrity of the internal sedimentary structures was lost while moving downslope. MTD 1 is located 1,830 feet northeast and is buried 25 feet, while MTD 3 is located 300 feet southeast of the well site and is buried 20 feet.

OII used check shot data from the BOEM web site for a nearby well with a series of time-depth pairs for the sediment column. The following polynomial equation was derived from Total Vertical Depth (TVD) (feet) and the corresponding two-way traveltime (seconds) using the time-depth values to calculate depths below the seafloor:

$$D = 186.45T^2 + 2{,}637.05T$$

where D = depth below sea level in feet and T = time below sea level in seconds.

A detailed description of the sequence units, beginning at the seafloor, can be found in the 2016 Geohazard Report. The Top-Hole Prognosis Chart (Figure 6) summarizes the stratigraphy.

<u>Unit A (Seafloor to Horizon 1)</u>

Unit A consists of low to moderate amplitude, parallel, semi-continuous reflectors and measures 318 feet thick at the proposed well location. The reflection patterns suggest the unit is comprised mostly of hemipelagic clay with a few interbedded mass transport deposits. No high amplitude anomalies occur within Unit A near the proposed well location. Fractured/faulted sediments were identified in the AUV subbottom data within this unit (Figure 3).

Unit B (Horizon 1 to Horizon 2)
Unit B consists of mostly low amplitude, sub-parallel reflectors and measures 547 feet thick at the proposed well location. The unit is interpreted as interbedded channel fill and mass transport deposits. One high-amplitude anomaly was identified 500 feet northwest of the proposed wellsite. Fractured/faulted sediments were identified in the 3D seismic data within this unit (Figures 4 and 5).

Unit C (Horizon 2 to Horizon 3)
Unit C consists of low to moderate amplitude, semi-continuous to sub-chaotic reflectors and measures 620 feet thick. This unit is interpreted as a interbedded coarse-grained channel fill and mass transport deposits. A few high amplitude anomalies occur within Unit C, most of which appear next to fault lines which may act as structural traps for the possible gas hazards. The closest of these anomalies is relatively small and is located 500 feet to the west. Fractures/faults were identified in the 3D data within this unit (Figures 4 and 5).

Unit D (Horizon 3 to Salt/Sediment Interface)
Unit D consists of low to moderate amplitude, semi-continuous to chaotic reflectors and measures 299 feet thick. This unit is interpreted as a coarser-grained channel fill and mass transport deposits. Several high amplitude anomalies occur within Unit D, most of which appear next to fault lines which may act as structural traps for the possible gas hazards. The closest of these anomalies is located 475 feet to the north-northeast. Fractures/faults were identified in the 3D data within this unit (Figures 4 and 5). The base of Unit D marks the salt/sediment interface at the proposed well site.

SHALLOW GAS

Anomalies of very high amplitude, commonly termed bright spots, are interpreted as potential regions of fluid saturation usually associated with porous sands. Seismic amplitude anomalies are mapped on a unit-by-unit basis to assess the potential risk of gas. Seismic amplitude anomalies are exhibited on the Subsurface Features Map when present.

The risk of gas refers to the risk of encountering shallow gas. The risk of gas is interpreted based on amplitude levels. Stratigraphic and structural settings may also be taken into account. The four risk levels of gas are:

- **Negligible**—No amplitude anomalies or other gas indicator present.
- **Low risk of gas**—Generally indicated by increased amplitude (2–3× 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× background level) and phase reversal.
- **High risk of gas**—Generally indicated by the highest amplitudes (in excess of 4× 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.

Amplitude anomalies were identified within Units C and D within 2,000 feet of the proposed Well "I" location. Units A and D are assessed as having a low risk of gas, while Units B and C are assessed as having a low to moderate risk of gas.

SHALLOW WATER FLOW

Several factors may contribute to shallow water flows. These include: high porosity and permeability, sand-prone aquifer, mechanism to pressurize, and seal. Additional details are described below:

- **Water depth and burial depth.** Significant water depths (> 500 feet below the seafloor) 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.

All of these factors occur within the study area. Since there is presently no method for quantifying the risk of shallow water flow, caution is recommended when drilling through units with shallow water flow potential. Sands with SWF potential often occur in unconsolidated, overpressured sands that lie below a seal. This seal prevents dewatering and compaction after deposition. The pressure rises with overburden causing a potentially disastrous hazard for drilling operations.

The nearest SWF event, according to information listed on the BOEM and BSEE website, is located approximately 15 miles northeast of the study area in GC644. This SWF event occurred at 644 feet below the seafloor and is listed as minor severity. Several other SWF events have been reported 25–40 miles east of the study area in GC783, GC823, GC825, and GC826. These SWF events are listed as occurring 1,274–5,527 feet below mudline and are all of low severity.

The assessment of seismic profiles suggests that Units A–D all exhibit a low risk of SWF. The numerous faults found in these units would serve to release pressures. 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 between the hydrate and free gas trapped at the base of the hydrate stability zone forms a Bottom Simulating Reflector (BSR) on seismic profiles. This BSR reflector cross cuts 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 deepwater benthic communities may all be found in close association. No indication of BSRs was found in the vicinity of the proposed well.

CONCLUSIONS

The proposed Well "I" location is situated on a slightly undulating seafloor at a water depth of 4,578 feet MSL. The seabed slopes to west-southwest at a gradient of 1°.

Several surface faults are located within 2,000 feet of the proposed well site, and typically exhibit between 3 and 8 feet of seafloor relief. The closest fault, located 500 feet east, exhibits 3 feet of seafloor relief.

There were no sonar contacts identified within 2,000 feet of the proposed well location. One pipeline is located within the 2,000- foot radius. The S-18711 Discovery 20" Pipeline is located 977 feet west of the proposed site and travels north-south.

One low seafloor amplitudes anomaly was identified 1,125 feet west of the proposed well site. This feature does not correlate with the occurrence of hardgrounds, carbonates, or expulsion features observed with the AUV data and therefore does not represent deepwater benthic communities.

Four (4) subsurface units interpreted from the 3D seismic data were assessed to approximately 2,500 feet BSF at the proposed Well "I" location (Units A to D). Unit A is comprised mostly of low to moderate amplitude, parallel, semi-continuous reflectors and consists of hemipelagic clays and interbedded mass transport deposits. Unit B is characterized by mostly low amplitude, sub-parallel reflectors and consists of interbedded channel fill and mass transport deposits. Unit C is comprised of low to moderate amplitude, semi-continuous to sub-chaotic reflectors and is interpreted as interbedded coarse-grained channel fill and mass transport deposits. Unit D is characterized by low to moderate amplitude, semi-continuous to chaotic reflectors and is interpreted as coarser-grained channel fill and mass transport deposits. Subsurface faults and fractures were identified within every unit due to the salt diapiric uplift in the area.

Subsurface amplitude anomalies were identified within Units C and D within 2,000 feet of the proposed Well "I" location. Units A and D are assessed as having a low risk of gas, while Units B and C have a low to moderate risk. No indication of gas hydrates was found within the study area.

Units A–D are all assessed as having a low risk of SWF, due to the numerous faults found in the units which would serve to release pressures.

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

Regards,

Christopher Baker
Senior Geologist

ENCLOSURES

Figure 1. Extracted wavelet and power spectrum at the proposed Well "I".
Figure 2. Backscatter image showing seafloor near the proposed Well "I".
Figure 3. Subbottom profiler Line 113 near the proposed Well "I".
Figure 4. 3D seismic Inline 5698 through the proposed Well "I".
Figure 5. 3D seismic Crossline 45881 through the proposed Well "I".
Figure 6. Top-Hole Prognosis Chart for the proposed Well "I".

Sheet 1.	Color Shaded Bathymetry Map, Proposed Well "I" Location	1"=1,000'
Sheet 2.	Seafloor Gradient Map, Proposed Well "I" Location	1"=1,000'
Sheet 3.	Side Scan Sonar Mosaic Map, Proposed Well "I" Location	1"=1,000'
Sheet 4.	Seafloor Amplitude Map, Proposed Well "I" Location	1"=1,000'
Sheet 5.	Seafloor Features Map, Proposed Well "I" Location	1"=1,000'
Sheet 6.	Subsurface Features Map, Proposed Well "I" Location	1"=1,000'

730 EAST KALISTE SALOOM ROAD, LAFAYETTE, LA 70508

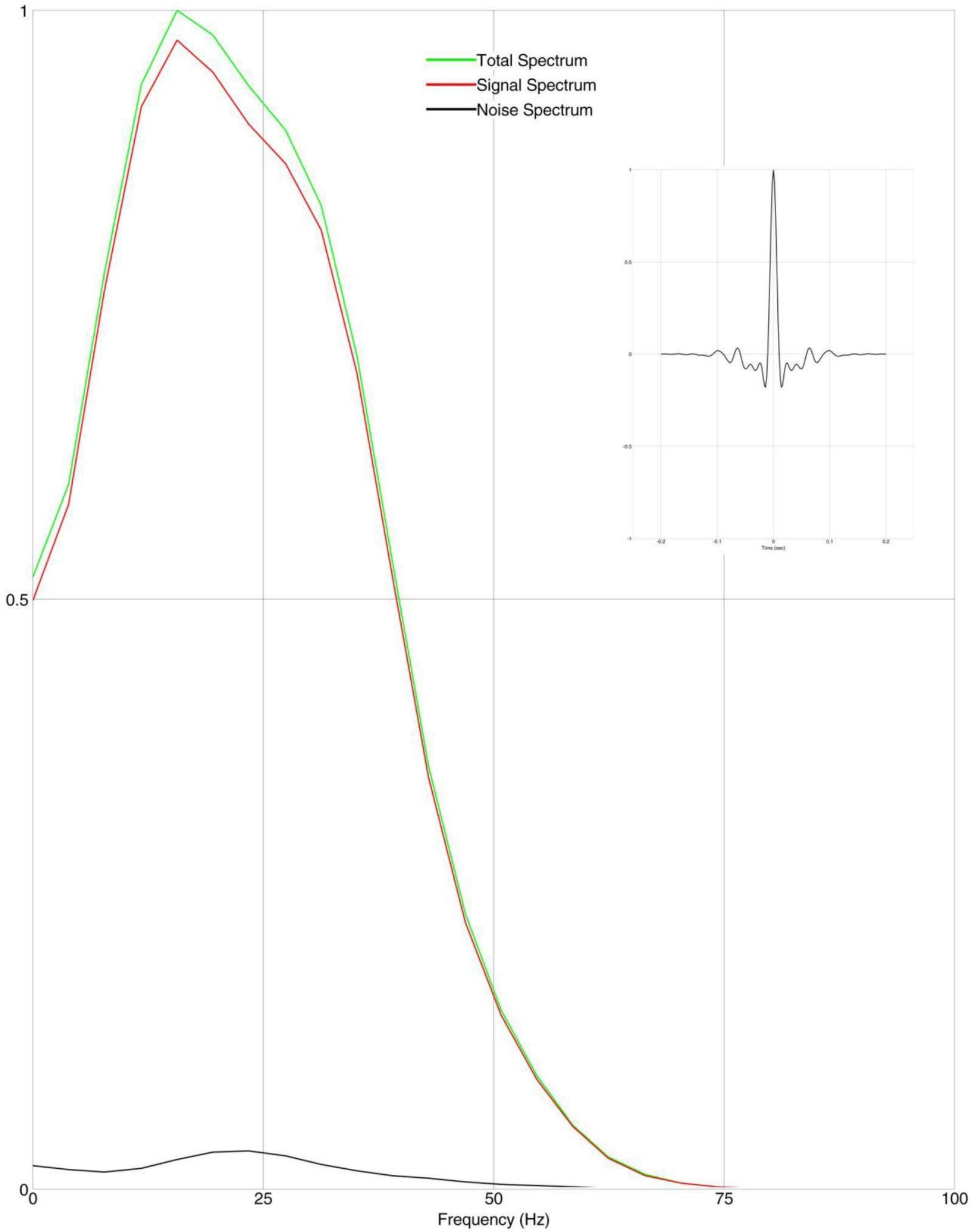


Figure 1. Extracted wavelet and power spectrum at the proposed Well "I" (1 second).

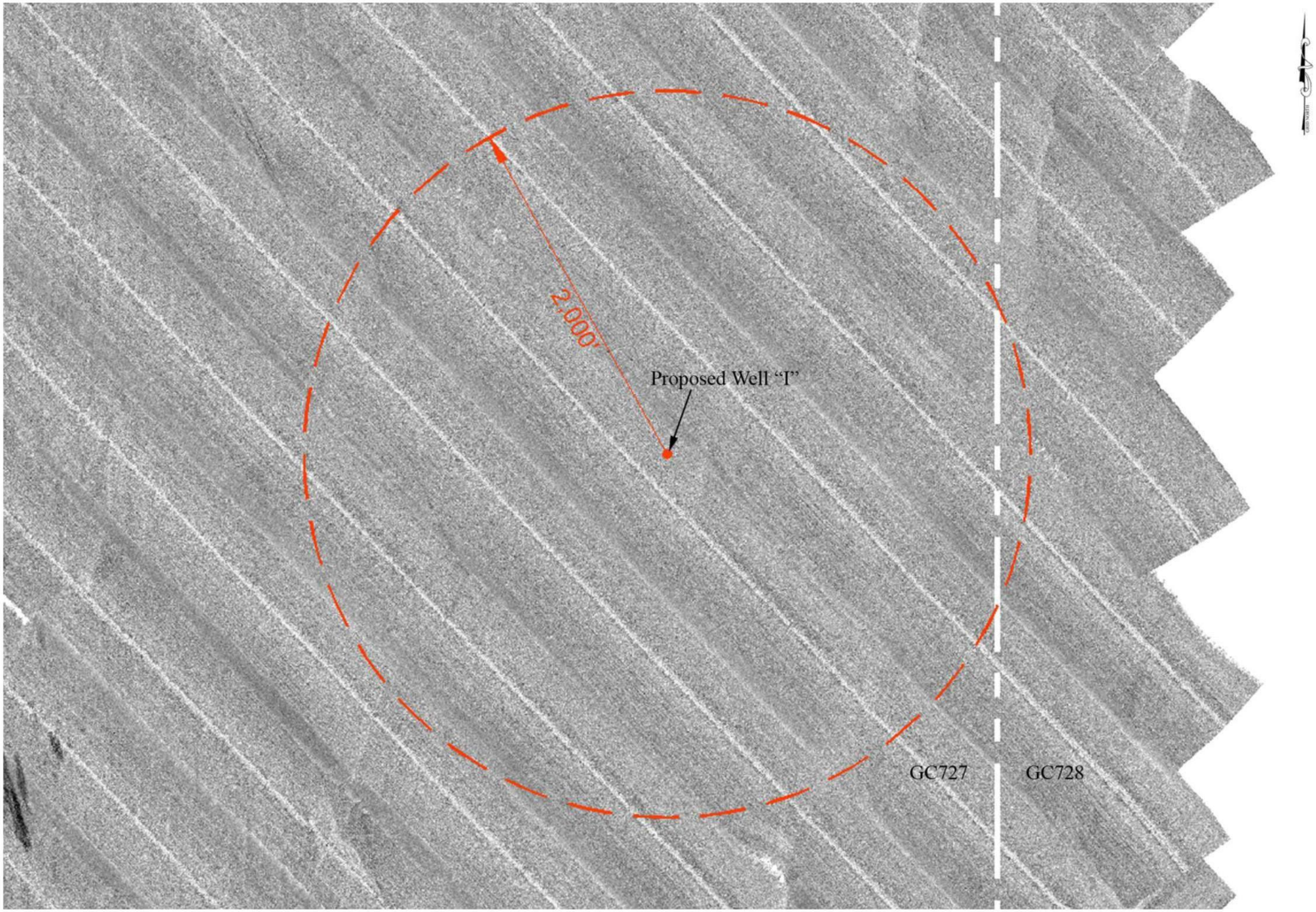


Figure 2. Backscatter image showing seafloor near the proposed Well "I".

Proposed Well "I"
GC727 (OCS-G-16783)
X = 2,358,009.00' Y = 9,890,686.00'
Line 113 (offset 262 feet southwest)

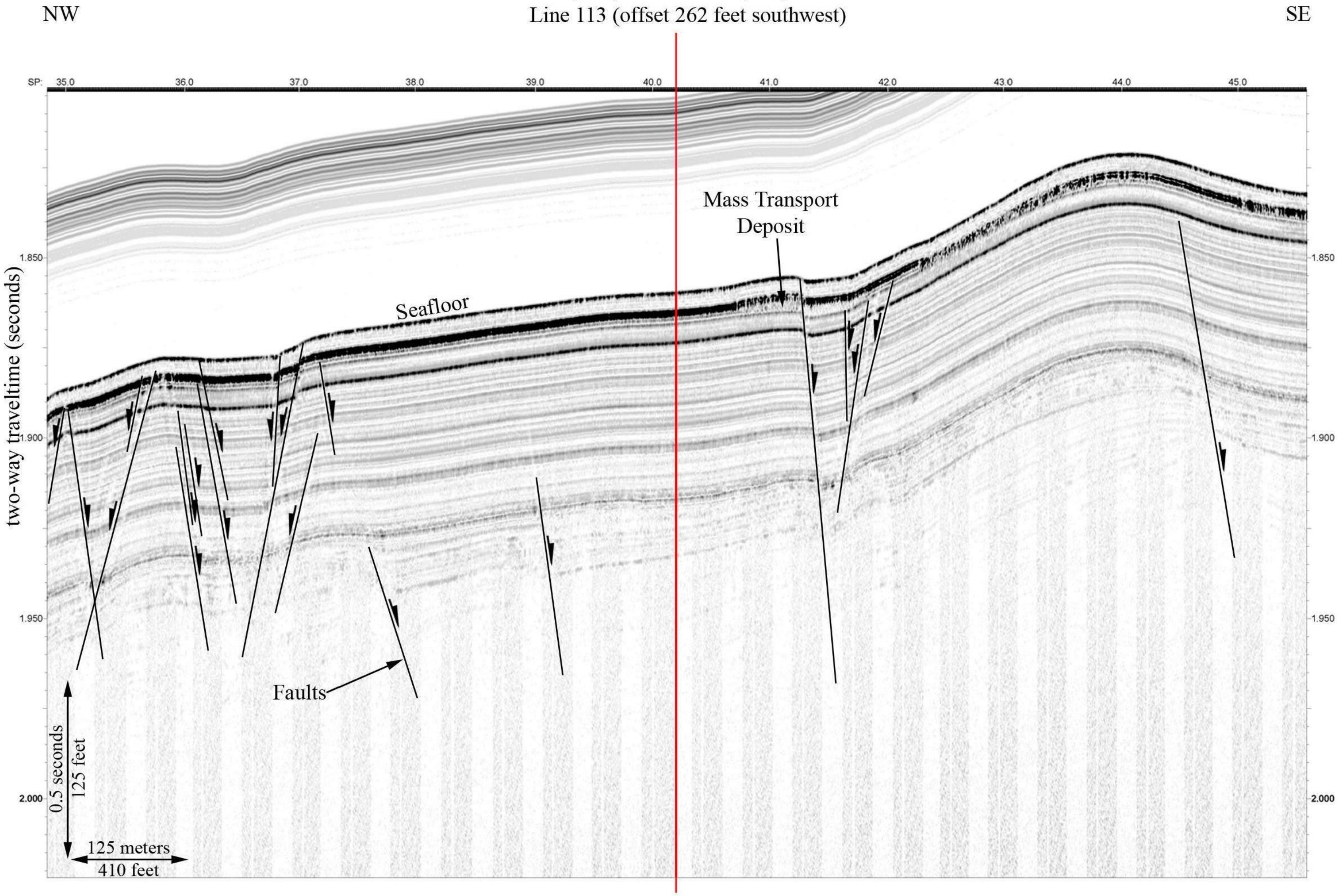


Figure 3. Subbottom profiler Line 113 near the proposed Well "I".

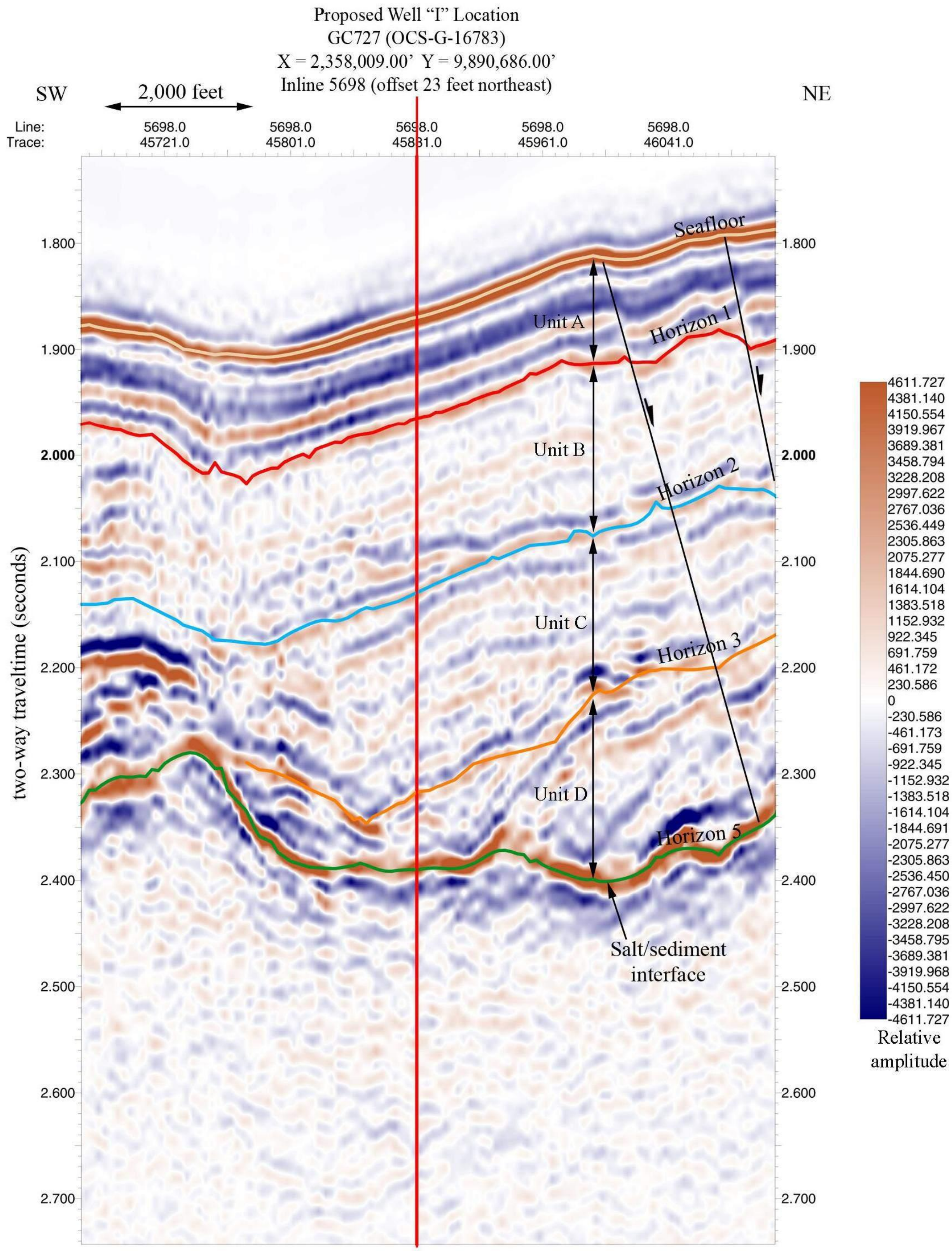


Figure 4. 3D seismic Inline 5698 through the proposed Well "I".

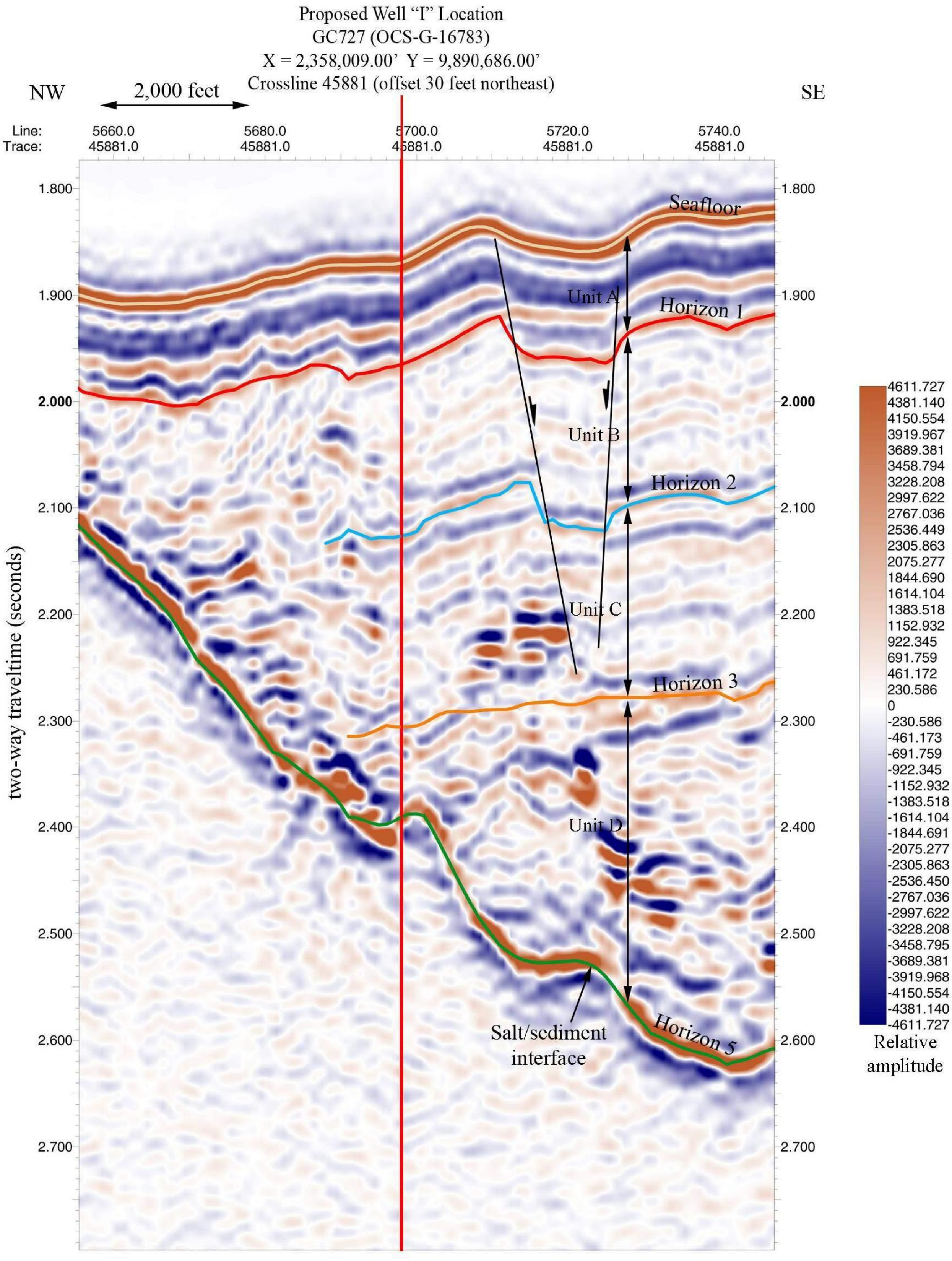
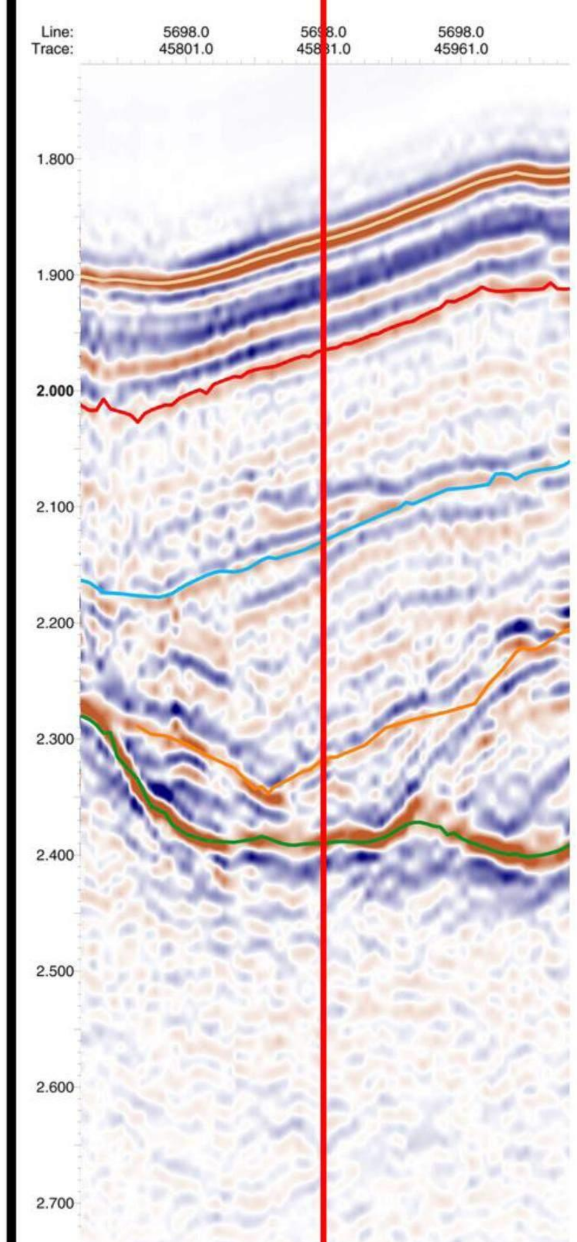


Figure 5. 3D seismic Crossline 45881 through the proposed Well "I".

Proposed Well "I" Location
GC727 (OCS-G-16783)
X = 2,358,009.00' Y = 9,890,686.00'
Inline 5698 (offset 23 feet northwest)

SW NE

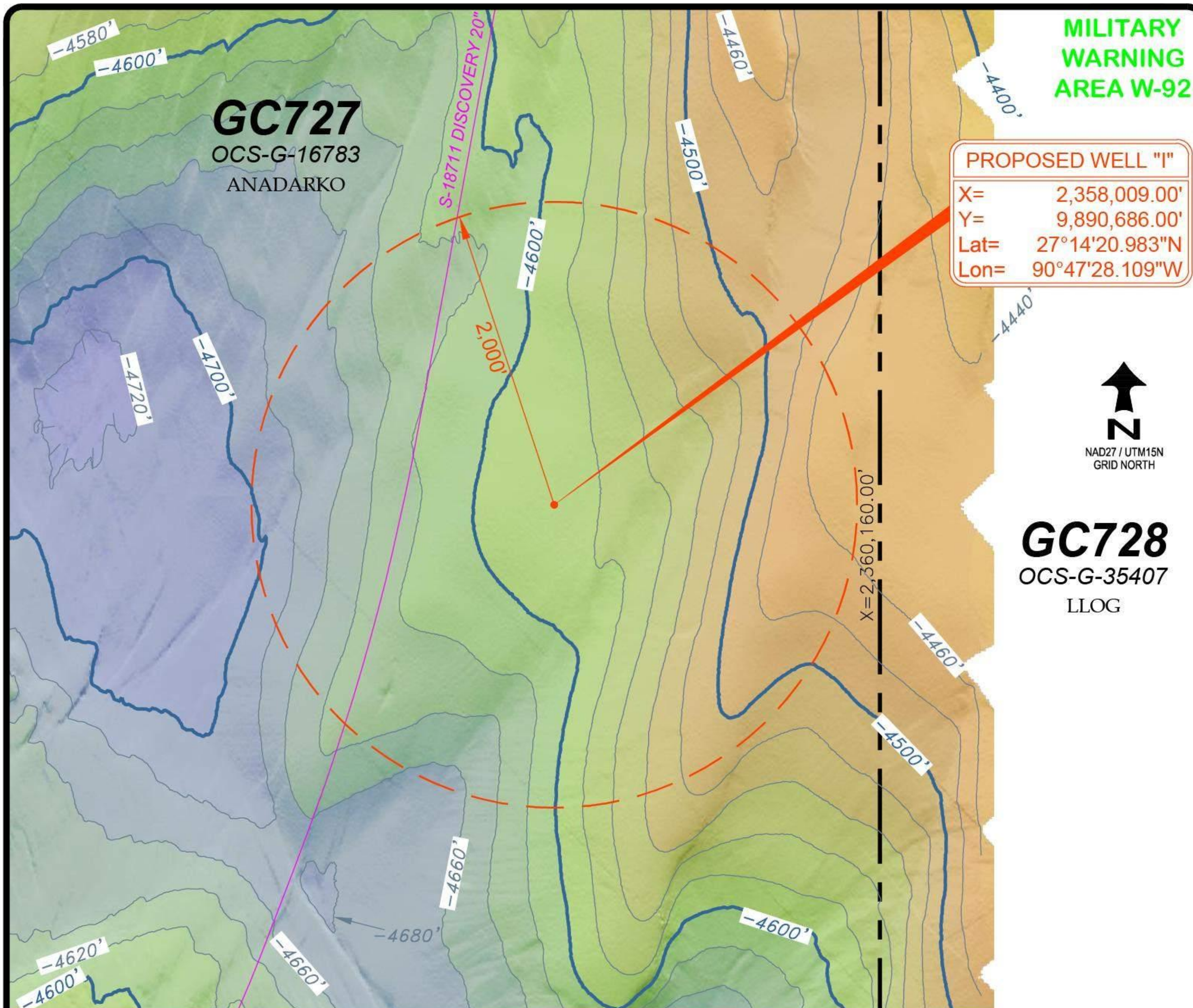


Note: Subsurface depths based on T-D equation
$D = 186.45T^2 + 2{,}637.05T$

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				4,578	1.870		
A	Horizon 1			318	4,896	1.965	318	Drape deposit of hemipelagic clays with interbedded fine-grained mass transport deposits.
B	Horizon 2			865	5,444	2.126	547	Interbedded channel fill and mass transport deposits.
C	Horizon 3			1,485	6,064	2.305	620	Interbedded channel fill and mass transport deposits.
D	Salt/Sediment Interface			1,784	6,362	2.390	299	Coarser-grained channel fill and mass transport deposits. The sediments within Unit D are highly fractured and faulted due to the salt diapiric uplift in the area.
	Depth of study							

Hazard Potential — Negligible: (blue) Low: (green) Moderate: (yellow) High: (red)

Figure 6. Top-Hole Prognosis Chart for the proposed Well "I".



Multibeam processing sequence

1. Water column velocity corrections applied
2. Tide corrections applied using Goddard Ocean Tide Model GOT99.2
3. Bin size = 3 meters (9.84 feet)
4. Median filter applied
5. Produced gridded-binned dataset using weighted-neighbor algorithm; search radius = 9 meters (29.53 feet)

Contour interval = 20 feet
Zero datum = Mean Sea Level

Color shaded image

Sun azimuth = 0°
Sun elevation = 30°

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

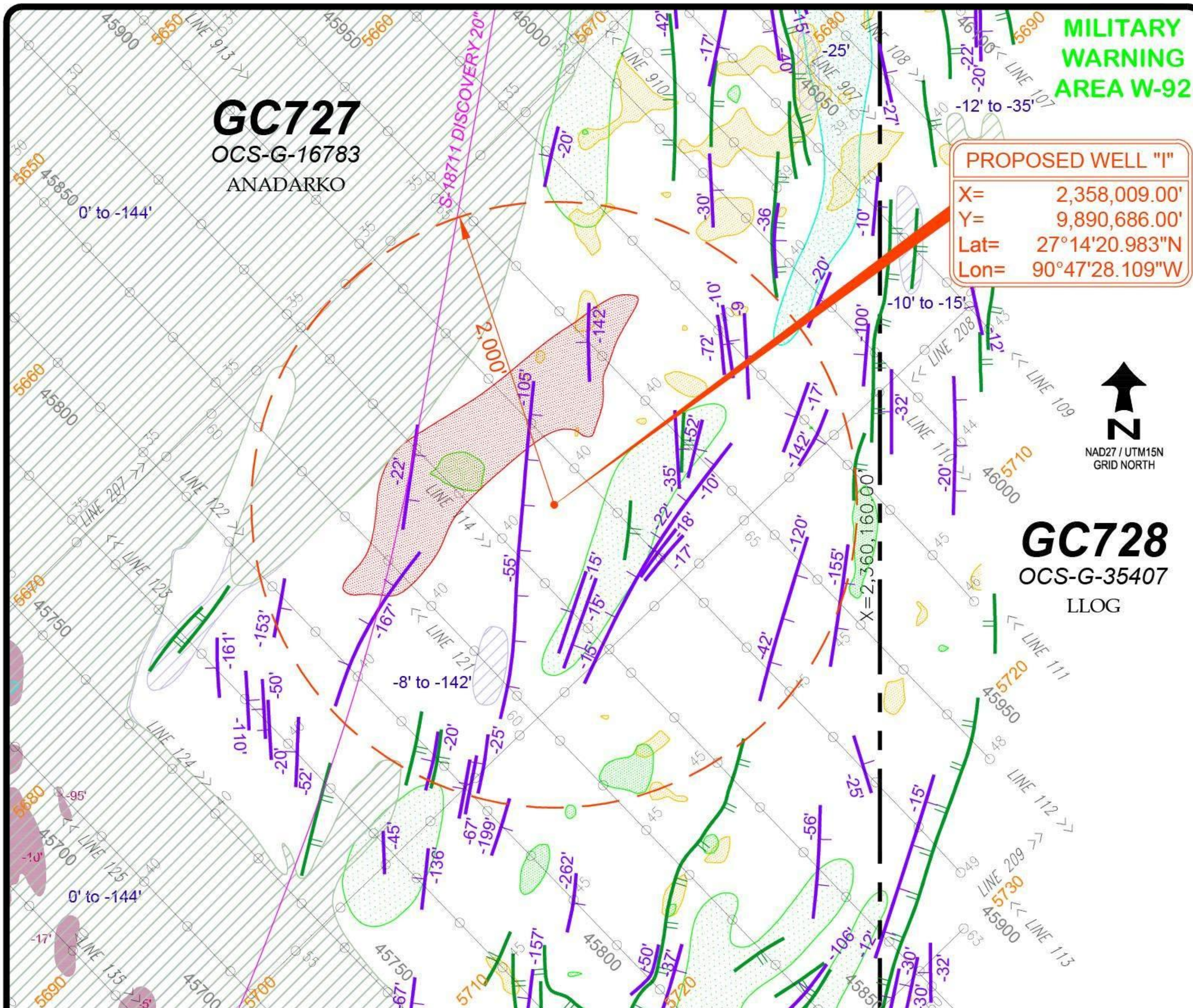
DATE: 04/27/2016 TIME: 11:40 FILENAME: Z:\151051\ACAD\151051_WELL-I.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "I"
COLOR SHADED BATHYMETRY MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016
DRAWN: A. McBride	SHEET 1 of 6 — REV. 0
FILE: 151051_WELL-I.DWG	



<< LINE 201	AUV navigation trackline with name and direction run, fix and fix number		Mass transport deposit 3 (-12' to -63')
5550	Inline number for 3D seismic data Spacing = 30 meters (98.43 feet)	10'	Acoustic void with depths below seafloor
46300	Crossline number for 3D seismic data Spacing = 25 meters (82.02 feet); Trace increment = 4		
	Fault scarp (Hachures on downthrown side)		Amplitude anomalies within Unit B (1.810 sec. - 2.778 sec. BSL) 104' - 2,379' BML
-10'	Normal fault with depth of burial (Hachures on downthrown side)		
0' to -144'	Fault zone with depth range of burial		Amplitude anomalies within Unit C (1.987 sec. - 2.757 sec. BSL) 434' - 3,543' BML
	Scarp zone		
	Mass transport deposit 1 (-4' to -10')		Amplitude anomalies within Unit D (2.133 sec. - 3.231 sec. BSL) 805' - 5,922' BML

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

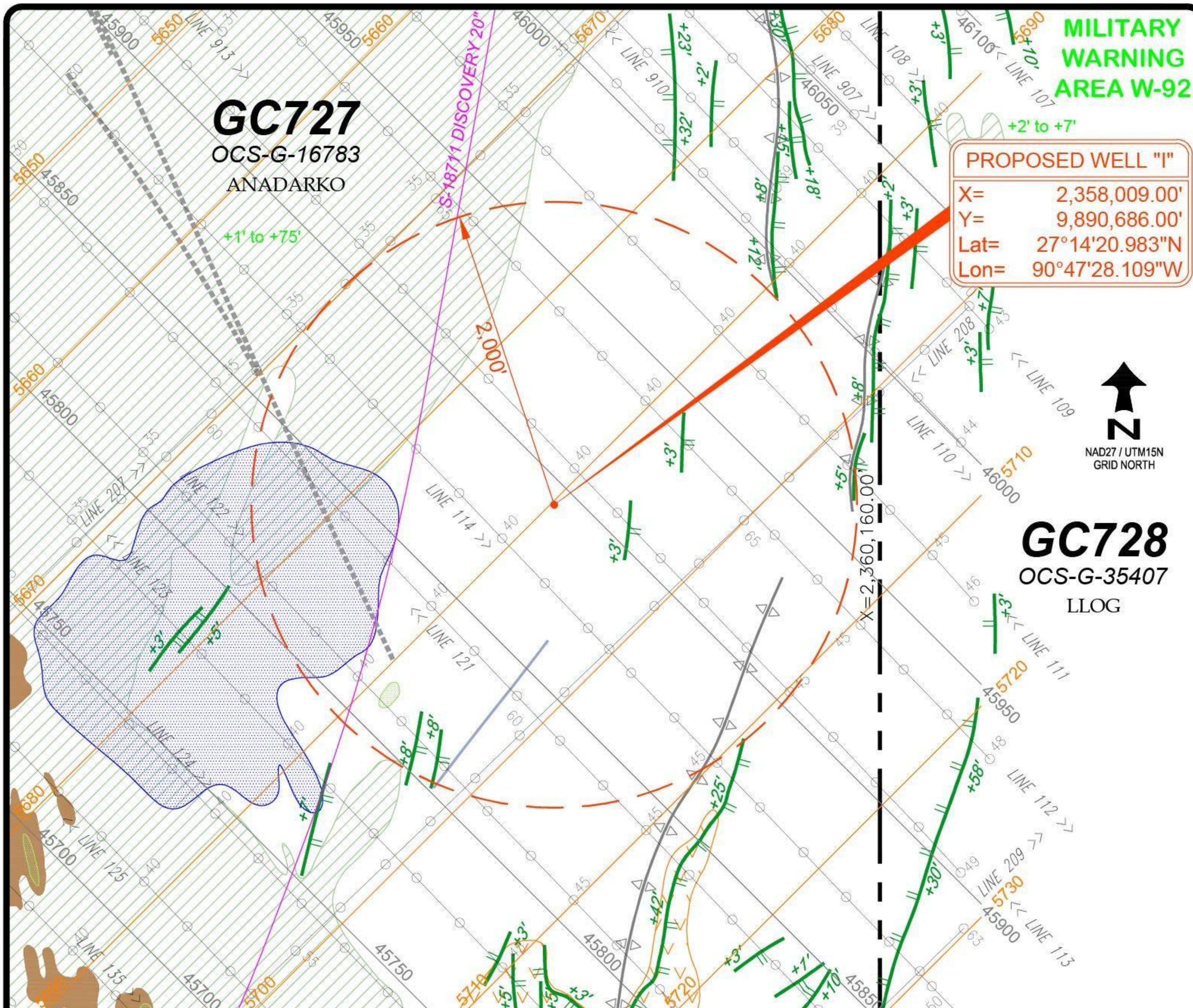
DATE: 04/27/2016 TIME: 11:42 FILENAME: Z:\151051\ACAD\151051_WELL-I.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "I"
SUBSURFACE FEATURES MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 6 of 6	REV. 0
FILE: 151051_WELL-I.DWG		



<< LINE 201	AUV navigation trackline with name and direction run, fix and fix number	+10'	Fault scarp with seafloor displacement (Hachures on downthrown side)
5550	Inline and inline number for 3D seismic data Spacing = 30 meters (98.43 feet)	+1' to +75'	Scarp zone with seafloor displacement range
46300	Crossline and crossline number for 3D seismic data Spacing = 25 meters (82.02 feet); Trace increment = 4		Slump
	Drag scar		Pockmarks
	Ridge / Gullies / Channels		Hardgrounds / Outcrops; 3D seismic low amplitude anomaly

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

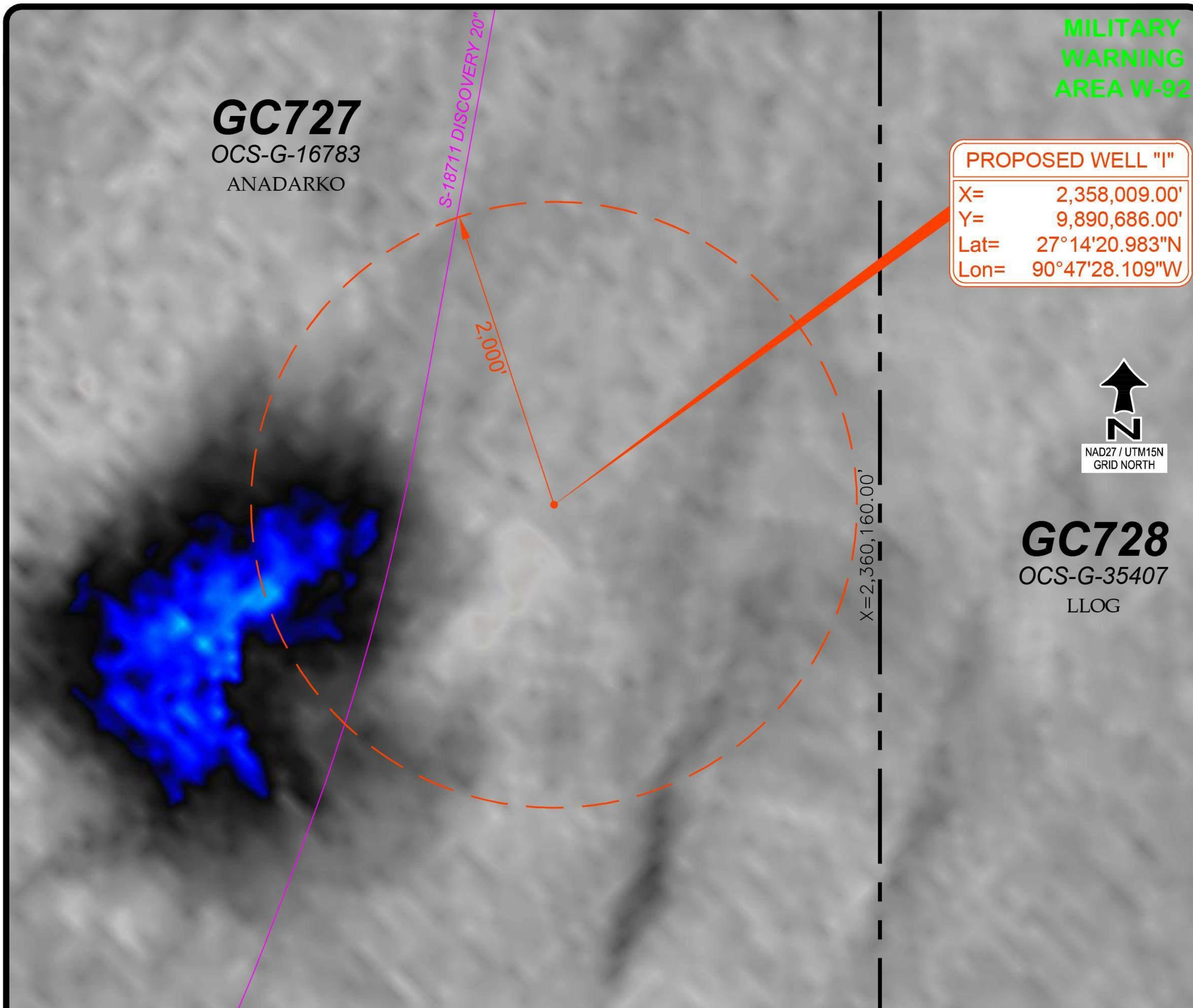
DATE: 04/27/2016 TIME: 11:41 FILENAME: Z:\151051\ACAD\151051_WELL-I.DWG

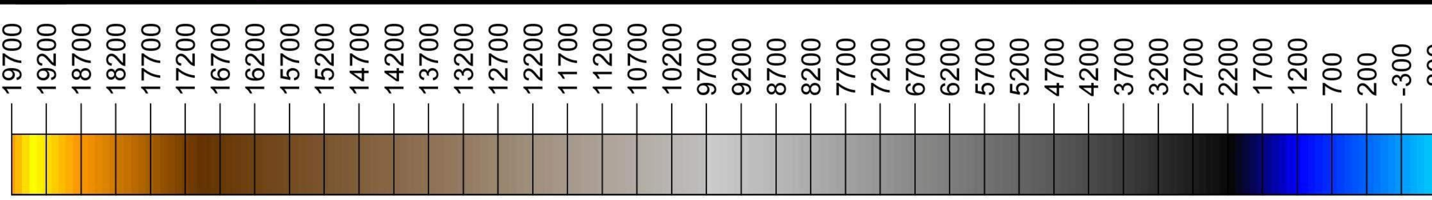
Anadarko Petroleum Corporation

PROPOSED WELL "I"
SEAFLOOR FEATURES MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 5 of 6	REV. 0
FILE: 151051_WELL-I.DWG		





RELATIVE AMPLITUDE
3D SEISMIC

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

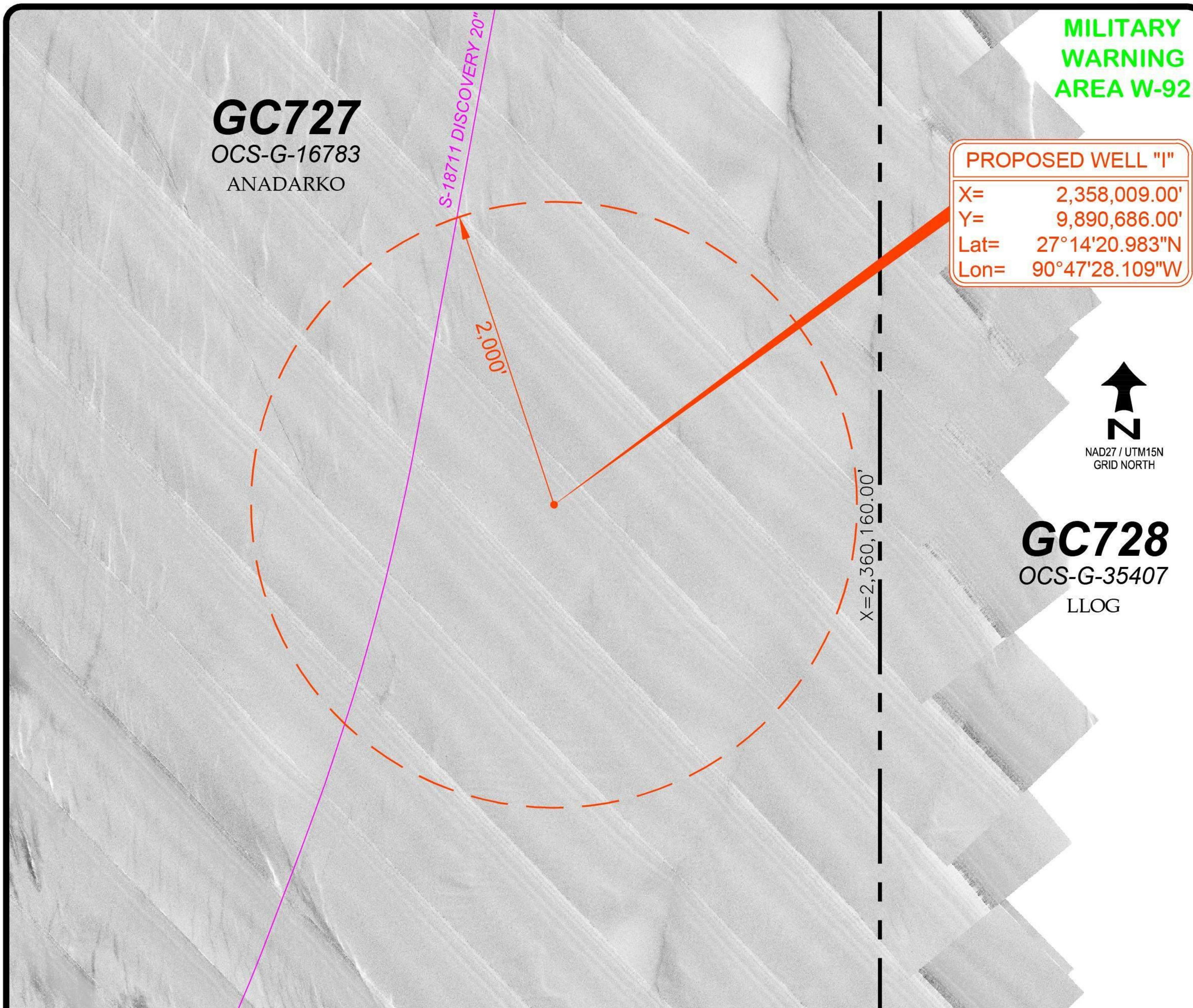
DATE: 04/27/2016 TIME: 11:41 FILENAME: Z:\151051\ACAD\151051_WELL-I.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "I"
SEAFLOOR AMPLITUDE MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016
DRAWN: A. McBride	SHEET 4 of 6 — REV. 0
FILE: 151051_WELL-I.DWG	



SONAR MOSAIC
Dark returns represent higher seafloor reflectivity.

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

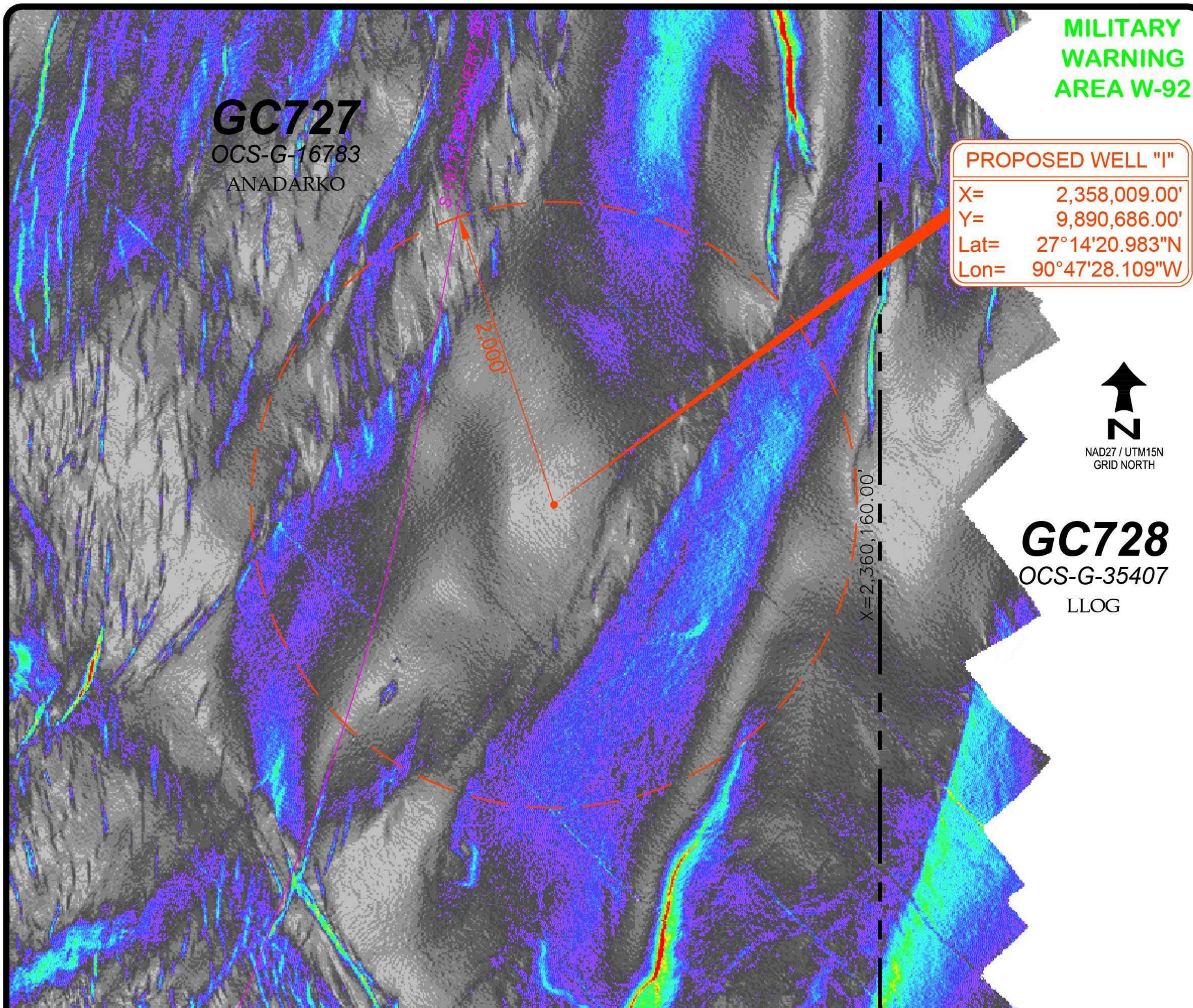
DATE: 04/27/2016 TIME: 11:41 FILENAME: Z:\151051\ACAD\151051_WELL-I.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "I"
SIDE SCAN SONAR MOSAIC MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016
DRAWN: A. McBride	SHEET 3 of 6 — REV. 0
FILE: 151051_WELL-I.DWG	



GRADIENT

Gradient is the first order derivative of the multibeam data.

Bin size = 3 meters (9.84 feet)

≥20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

SLOPE IN DEGREES

1,000' 0' 1,000'

SCALE IN US SURVEY FEET

DATE: 04/27/2016 TIME: 11:41 FILENAME: Z:\151051\ACAD\151051_WELL-I.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "I"
SEAFLOOR GRADIENT MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING® 730 E. KALISTE SALOOM RD. LAFAYETTE, LA 70508 (337) 210-0000 LA Reg. No. 747	JOB No: 151051, 172082	DATE: Apr. 27, 2016	
	DRAWN: A. McBride	SHEET 2 of 6	REV. 0
	FILE: 151051_WELL-I.DWG		

April 27, 2016

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

Attn: Mr. Rick Kincaid

Site Clearance Letter
Proposed Well "J"
Block 727 (OCS-G-16783)
Green Canyon Area

Mr. Rick,

INTRODUCTION

Anadarko Petroleum Corporation (Anadarko) contracted Oceaneering International, Inc. (OII) to prepare a well site clearance letter for the proposed Well "J" location of the Calpurnia Prospect in Block 727 (OCS-G-16783), Green Canyon (GC) Area. The data used for the site clearance letter is based on the interpretation of an exploration-quality 3D seismic volume and a high-resolution geophysical dataset collected with OII's Autonomous Underwater Vehicle (AUV) *C-Surveyor III*™. OII completed a geohazard assessment titled "*Shallow Hazard Report, Block 727 (OCS-G-16783) and 771 (OCS-G-33259), Green Canyon Area*" in March, 2016. This site clearance letter is based on the findings provided within that report.

This letter provides a top-hole drilling prognosis and addresses seafloor conditions within a 2,000-foot radius of the proposed surface location. The depth limit of investigation is approximately 2.0 seconds of two-way traveltime (~5,000 feet) below the mud line (BML), or to the salt/sediment interface if it is encountered less than 2.0 seconds below the seafloor. The reporting and mapping presented in this letter comply with the BOEM/BSEE guidelines provided in NTL No. 2008-G05 (Shallow Hazards Program) and No. 2009-G40 (Deepwater Benthic Communities).

METHODS

<u>AUV Survey Data</u>

OII's *C-Surveyor III*™ AUV provided multibeam bathymetric mapping, high-resolution side scan sonar imagery, and subbottom profiles. The AUV remote-sensing instruments include a Simrad EM 2040 Multibeam Echosounder (200, 300, and 400 kHz), an EdgeTech 2200-M Full Spectrum Chirp Dual Frequency Side Scan Sonar (120/410 kHz), and an EdgeTech DW106 Chirp Subbottom Profiler (1.5–4.5 kHz). All the raw digital data were logged utilizing proprietary software developed by OII. The multibeam system delivered a 3-meter gridded dataset with relative vertical accuracies within 20 centimeters.

The AUV survey grid in the study area consisted of 62 main tracklines (Lines 101–114 and 120–167) running northeast to southwest at 200-meter line spacing, 13 ties lines (Lines 201–213) running northwest to southeast at 900-meter line spacing, and 29 in-fill lines (Lines 901–929) run to fill in bathymetry data gaps caused by steep seafloor terrain. Navigation fixes (event marks) were annotated at 125-meter (410-foot) intervals along all survey lines. The survey grid

was designed to provide a representative sampling with the subbottom profiler system and overlapping coverage with side scan sonar and multibeam echosounder systems.

3D Seismic Data

The 3D seismic data used for this assessment was provided in SEG-Y format, and were loaded into IHS' Kingdom Suite 2d/3dPAK for interpretation. The 3D data were acquired by WesternGeco in 1999–2000, and reprocessing was completed in 2006 with Post-Stack Time Migration (PSTM). Inlines and crosslines are depicted on the Surface and Subsurface Features Maps (Sheets 5 and 6). The 3D data were provided at a four-millisecond sample rate and extend to the full data range of 13 seconds. The inlines of the data run southwest to northeast and are spaced at 30-meter (98.43-foot) intervals. The crosslines run southwest to northeast and are spaced at 25-meter (82.02-foot) intervals. Spectral whitening was applied to the 3D seismic dataset to amplify the higher frequencies. After applying the spectral whitening, a power spectrum generated at a few selected locations indicated the seismic data volume contains sufficiently high frequency content for a shallow hazards assessment (Figure 1).

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 (faults, salt, high acoustic impedance, stratigraphic horizons, etc.).

WELL LOCATION

The coordinates and calls for the proposed Well "J" surface location are tabulated below:

Table 1. Proposed Well "J"

Easting (feet)	Northing (feet)	Latitude	Longitude	Calls From Block 727, Green Canyon Area	
2,358,798.00'	9,892,271.00'	27°14'36.536"N	90°47'19.061"W	1,362.00' FEL	8,111.00' FSL

A 2,000-foot clearance radius is required for assessing deepwater benthic communities in proximity to the proposed Well "J".

The geodetic datum used for this project is the North American Datum 1927 (NAD27) with the Clarke 1866 Ellipsoid. The datum is projected using the Universal Transverse Mercator (UTM), Zone 15 North (15N) 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. Mapping and reporting units are in U.S. Survey Feet.

REGIONAL GEOLOGY

The Gulf of Mexico is a semi-enclosed basin that has been receiving sediment influx dominated by the Mississippi River since the Late Jurassic. Mesozoic and Cenozoic sediments have attained a thickness in excess of 9 miles (Coleman et al., 1991). The prograded shelf sequence consists of intercalated coastal plain, delta, estuarine, and marine sediments. Sediment deposition along the northern rim of the Gulf of Mexico resulted in particularly thick Tertiary

and Quaternary sections. These rapidly deposited sediments have prograded the Cretaceous shelf-edge up to 185 miles basinward. The exceptionally high rate of shelf-edge progradation is on the order of 3.0 to 3.7 miles per 1,000 years.

The near surface geology across the Gulf Coast region is the product of fluctuating sea levels associated with climatic variations over the past 20,000 years. During this time, low sea levels left the continental shelf exposed to subaerial weathering and other erosional processes. Streams and rivers meandered and cut into the exposed landmass, depositing bedloads along the modern-day shelf break. Fan systems were formed, and mass movement events were common as deltaic sediments were deposited on the steep upper continental slope. As the climate warmed, seas transgressed, and marine sediments were deposited on the shelf.

The proposed wellsite is located in the northern Gulf of Mexico in an area designated as the Green Canyon Area by the BOEM and BSEE. The study area is located on the middle Texas Louisiana Slope in GC727 and is characterized by extensive faulted/fractured sediments due to salt diapiric uplift.

BATHYMETRY AND SEAFLOOR GRADIENTS

The water depth at the proposed Well "J" location is 4,522 feet below mean sea level (MSL). Within the 2,000-foot radius centered at the proposed well location, the seafloor depth ranges from 4,417 feet in the east to 4,643 feet in the west (Sheet 1, Color Shaded Bathymetry Map).

The proposed well is situated near slightly undulating seafloor atop a relatively smooth section located in the southeast corner of GC727. The seafloor in the area surrounding the proposed well location slopes west-southwest at a gradient of between 4° and 5° (Sheet 2, Seafloor Gradient Map).

SEAFLOOR HAZARDS

Low to moderate sonar and multibeam backscatter reflectivity occurs around the proposed well site indicating mostly fine-grained sediments. Higher acoustic reflectivity in the side scan sonar and backscatter images occur along fault scarps and represent coarser sediments (Figure 2; Sheet 3, Side Scan Sonar Mosaic Map).

The 3D seafloor amplitude image displays low to moderate acoustic amplitudes within the 2,000-foot radius area (Sheet 4, Seafloor Amplitude Map). These low to moderate seafloor amplitudes indicate finely textured seafloor sediments that are likely comprised of hemipelagic clay. One large low amplitude anomaly is located 2,410 feet southwest of the proposed site.

There were no sonar contacts identified within 2,000 feet of the proposed well location. One pipeline is located within the 2,000-foot radius. The S-18711 Discovery 20" Pipeline is located 1,455 feet west of the proposed site and travels north-south.

Several surface faults were observed within the 2,000-foot radius (Sheet 5, Seafloor Features Map). These faults typically trend north-south and exhibit seafloor displacement between 2 and 12 feet. The closest fault, located 555 feet north, exhibits 32 feet of seafloor relief.

POTENTIAL DEEPWATER BENTHIC COMMUNITIES

High or low-amplitude seismic seafloor anomalies are potential indicators of carbonates, benthic community habitats, and gas/fluid seepages. The seafloor at the proposed Well "J" and surrounding 2,000-foot radius contains no high or low positive seafloor amplitude anomalies associated with fluid expulsion or mounded carbonates representing potential benthic communities. The side scan sonar and multibeam backscatter agree with the seafloor amplitude image, and show no evidence of outcrops or fluid expulsion.

SUBSURFACE GEOHAZARDS AND STRATIGRAPHY

The AUV subbottom profiler data exhibit continuous, sharp bottom echoes with parallel to divergent, continuous reflectors throughout the well site area. The uppermost shallow sediments consist of a 15 foot thick acoustically semi-transparent hemipelagic clay drape. Sediments below this drape are characterized by parallel, low to moderate amplitude reflectors that represent cyclic deposition of hemipelagic clay and silty clays (Figure 3).

Four sedimentary units (Units A to D), each consisting of one or more distinctive sequences, were interpreted within the study area from the 3D seismic data to approximately 0.6 seconds of two-way traveltime (~2,000 feet) below the seafloor, the lower limit of investigation. Five horizons mark the upper and/or lower contacts of each of the successive units (Figures 3 and 4).

Subsurface faulting/fracturing occurs throughout the 2,000-foot vicinity, with most faults trending north-south (Sheet 6, Subsurface Features Map). The stratigraphy throughout the well site area is extremely faulted and fractured due to the shallow salt.

Two mass transport deposits (MTD) were identified within the 2,000-foot radius. The MTDs are generally characterized by chaotic and mixed sequences or lack of visible internal structure, which suggest the integrity of the internal sedimentary structures was lost while moving downslope. MTD 1 is located 762 feet east and is buried 25 feet, while MTD 3 is located 950 feet south of the well site and is buried 20 feet.

OII used check shot data from the BOEM web site for a nearby well with a series of time-depth pairs for the sediment column. The following polynomial equation was derived from Total Vertical Depth (TVD) (feet) and the corresponding two-way traveltime (seconds) using the time-depth values to calculate depths below the seafloor:

$$D = 186.45T^2 + 2{,}637.05T$$

where D = depth below sea level in feet and T = time below sea level in seconds.

A detailed description of the sequence units, beginning at the seafloor, can be found in the 2016 Geohazard Report. The Top-Hole Prognosis Chart (Figure 6) summarizes the stratigraphy.

<u>Unit A (Seafloor to Horizon 1)</u>

Unit A consists of low to moderate amplitude, parallel, semi-continuous reflectors and measures 345 feet thick at the proposed well location. The reflection patterns suggest the unit is comprised mostly of hemipelagic clay with a few interbedded mass transport deposits. No high amplitude anomalies occur within Unit A near the proposed well location. Fractured/faulted sediments were identified in the AUV subbottom data within this unit (Figure 3).

Unit B (Horizon 1 to Horizon 2)
Unit B consists of mostly low amplitude, sub-parallel reflectors and measures 591 feet thick at the proposed well location. The unit is interpreted as interbedded channel fill and mass transport deposits. One high amplitude anomaly was identified within Unit B, located 320 feet southwest of the proposed wellsite. Fractured/faulted sediments were identified in the 3D seismic data within this unit (Figures 4 and 5).

Unit C (Horizon 2 to Horizon 3)
Unit C consists of low to moderate amplitude, semi-continuous to sub-chaotic reflectors and measures 432 feet thick. This unit is interpreted as a interbedded coarse-grained channel fill and mass transport deposits. A few high amplitude anomalies occur within Unit C, most of which appear next to fault lines which may act as structural traps for the possible gas hazards. The closest of these anomalies is relatively small and is located 1,140 feet to the north-northeast. Fractures/faults were identified in the 3D data within this unit (Figures 4 and 5).

Unit D (Horizon 3 to Salt/Sediment Interface)
Unit D consists of low to moderate amplitude, semi-continuous to chaotic reflectors and measures 374 feet thick. This unit is interpreted as a coarser-grained channel fill and mass transport deposits. Several high amplitude anomalies occur within Unit D, most of which appear next to fault lines which may act as structural traps for the possible gas hazards. The closest of these anomalies is located 240 feet to the northeast. Fractures/faults were identified in the 3D data within this unit (Figures 4 and 5). The base of Unit D marks the salt/sediment interface at the proposed well site.

SHALLOW GAS

Anomalies of very high amplitude, commonly termed bright spots, are interpreted as potential regions of fluid saturation usually associated with porous sands. Seismic amplitude anomalies are mapped on a unit-by-unit basis to assess the potential risk of gas. Seismic amplitude anomalies are exhibited on the Subsurface Features Map when present.

The risk of gas refers to the risk of encountering shallow gas. The risk of gas is interpreted based on amplitude levels. Stratigraphic and structural settings may also be taken into account. The four risk levels of gas are:

- **Negligible**—No amplitude anomalies or other gas indicator present.
- **Low risk of gas**—Generally indicated by increased amplitude (2–3× 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× background level) and phase reversal.
- **High risk of gas**—Generally indicated by the highest amplitudes (in excess of 4× 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.

Amplitude anomalies were identified within Units C and D within 2,000 feet of the proposed Well "J" location. Units A and C are assessed as having a low risk of gas, while Units B and D are assessed as having a low to moderate risk of gas.

SHALLOW WATER FLOW

Several factors may contribute to shallow water flows. These include: high porosity and permeability, sand-prone aquifer, mechanism to pressurize, and seal. Additional details are described below:

- **Water depth and burial depth.** Significant water depths (> 500 feet below the seafloor) 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.

All of these factors occur within the study area. Since there is presently no method for quantifying the risk of shallow water flow, caution is recommended when drilling through units with shallow water flow potential. Sands with SWF potential often occur in unconsolidated, overpressured sands that lie below a seal. This seal prevents dewatering and compaction after deposition. The pressure rises with overburden causing a potentially disastrous hazard for drilling operations.

The nearest SWF event, according to information listed on the BOEM and BSEE website, is located approximately 15 miles northeast of the study area in GC644. This SWF event occurred at 644 feet below the seafloor and is listed as minor severity. Several other SWF events have been reported 25–40 miles east of the study area in GC783, GC823, GC825, and GC826. These SWF events are listed as occurring 1,274–5,527 feet below mudline and are all of low severity.

The assessment of seismic profiles suggests that Units A–D all exhibit a low risk of SWF. The numerous faults found in these units would serve to release pressures. 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 between the hydrate and free gas trapped at the base of the hydrate stability zone forms a Bottom Simulating Reflector (BSR) on seismic profiles. This BSR reflector cross cuts 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 deepwater benthic communities may all be found in close association. No indication of BSRs was found in the vicinity of the proposed well.

CONCLUSIONS

The proposed Well "J" location is situated on a slightly undulating seafloor at a water depth of 4,522 feet MSL. The seabed slopes to west-southwest at a gradient between 4° and 5°.

Several surface faults are located within 2,000 feet of the proposed well site, and typically exhibit between 2 and 12 feet of seafloor relief. The closest fault, located 555 feet north, exhibits 32 feet of seafloor relief.

There were no sonar contacts identified within 2,000 feet of the proposed well location. One pipeline is located within the 2,000-foot radius. The S-18711 Discovery 20" Pipeline is located 1,455 feet west of the proposed site and travels north-south.

No high or low seafloor amplitudes anomalies that may indicate the occurrence of hardgrounds, carbonates, benthic communities or potential expulsions are found within 2,000 feet of the proposed Well "J" location.

Four (4) subsurface units interpreted from the 3D seismic data were assessed to approximately 2,500 feet BSF at the proposed Well "J" location (Units A to D). Unit A is comprised mostly of low to moderate amplitude, parallel, semi-continuous reflectors and consists of hemipelagic clays and interbedded mass transport deposits. Unit B is characterized by mostly low amplitude, sub-parallel reflectors and consists of interbedded channel fill and mass transport deposits. Unit C is comprised of low to moderate amplitude, semi-continuous to sub-chaotic reflectors and is interpreted as interbedded coarse-grained channel fill and mass transport deposits. Unit D is characterized by low to moderate amplitude, semi-continuous to chaotic reflectors and is interpreted as coarser-grained channel fill and mass transport deposits. Subsurface faults and fractures were identified within every unit due to the salt diapiric uplift in the area.

Subsurface amplitude anomalies were identified within Units C and D within 2,000 feet of the proposed Well "J" location. Units A and C are assessed as having a low risk of gas, while Units B and D have a low to moderate risk. No indication of gas hydrates was found within the study area.

Units A–D are all assessed as having a low risk of SWF, due to the numerous faults found in the units which would serve to release pressures.

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

Regards,

Christopher Baker
Senior Geologist

ENCLOSURES

Figure 1. Extracted wavelet and power spectrum at the proposed Well "J".
Figure 2. Backscatter image showing seafloor near the proposed Well "J".
Figure 3. Subbottom profiler Line 111 near the proposed Well "J".
Figure 4. 3D seismic Inline 5689 through the proposed Well "J".
Figure 5. 3D seismic Crossline 45953 through the proposed Well "J".
Figure 6. Top-Hole Prognosis Chart for the proposed Well "J".

Sheet 1.	Color Shaded Bathymetry Map, Proposed Well "J" Location	1"=1,000'
Sheet 2.	Seafloor Gradient Map, Proposed Well "J" Location	1"=1,000'
Sheet 3.	Side Scan Sonar Mosaic Map, Proposed Well "J" Location	1"=1,000'
Sheet 4.	Seafloor Amplitude Map, Proposed Well "J" Location	1"=1,000'
Sheet 5.	Seafloor Features Map, Proposed Well "J" Location	1"=1,000'
Sheet 6.	Subsurface Features Map, Proposed Well "J" Location	1"=1,000'

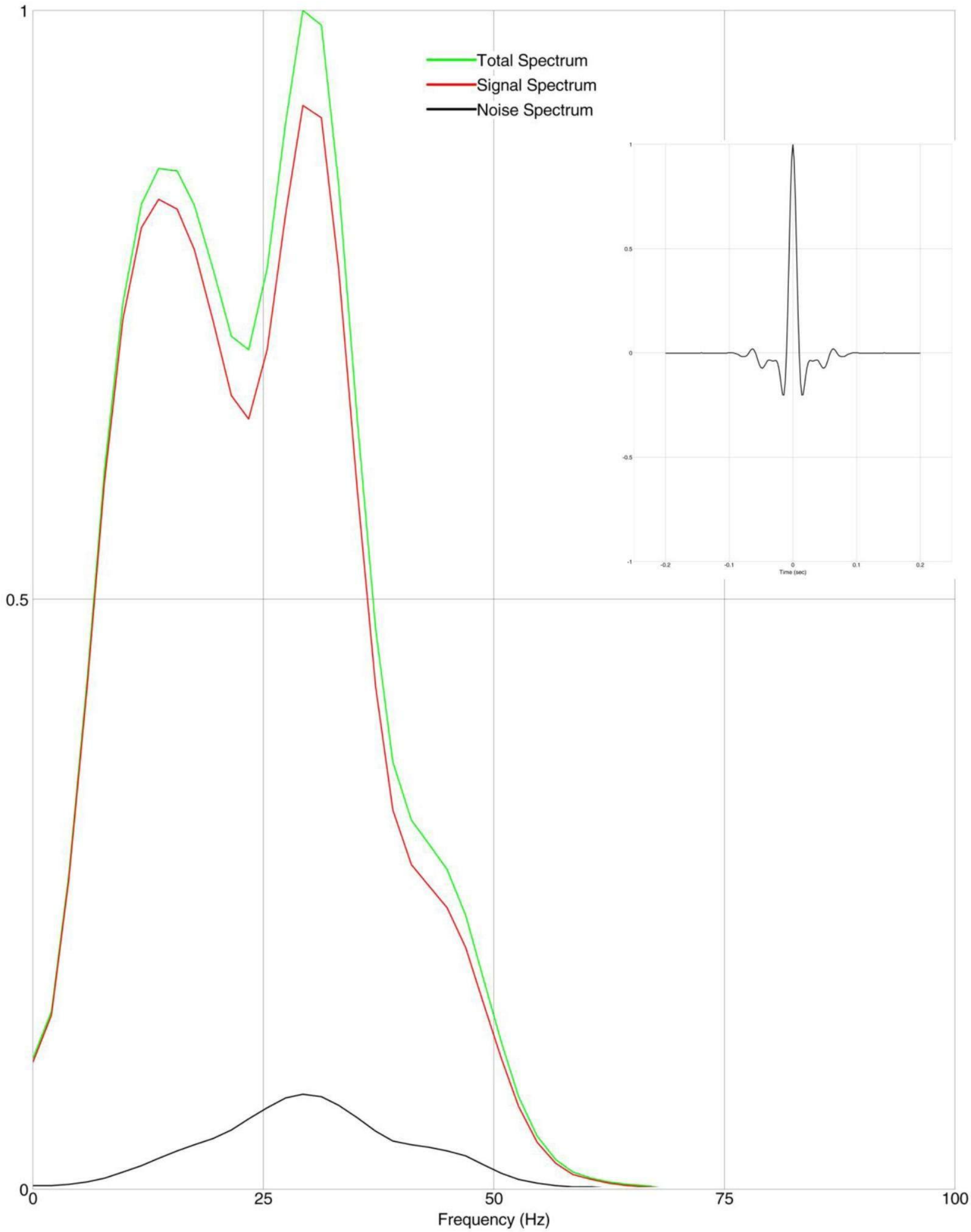


Figure 1. Extracted wavelet and power spectrum at the proposed Well "J" (1 second).

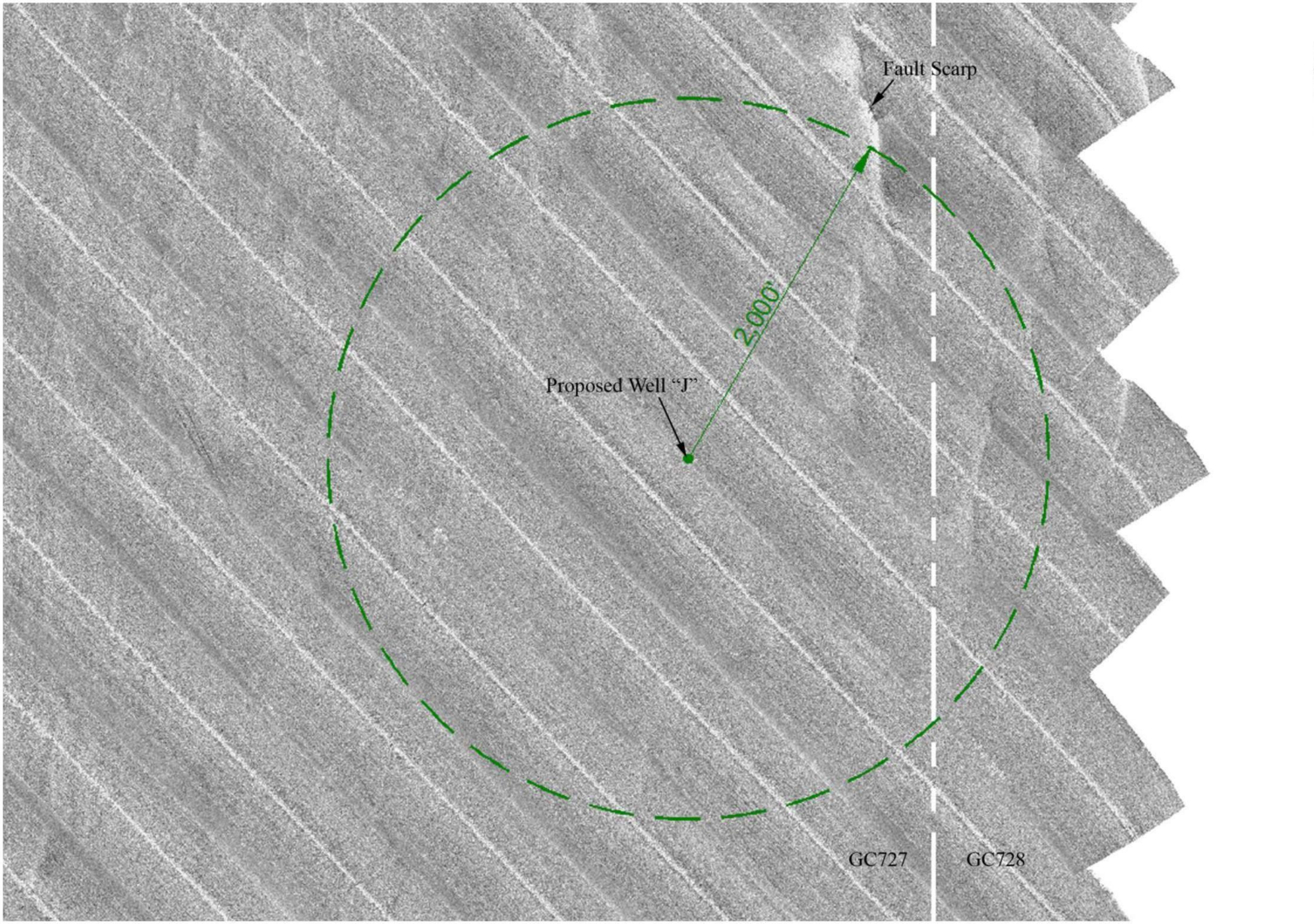


Figure 2. Backscatter image showing seafloor near the proposed Well "J".

730 E. KALISTE SALOOM ROAD, LAFAYETTE, LA 70508

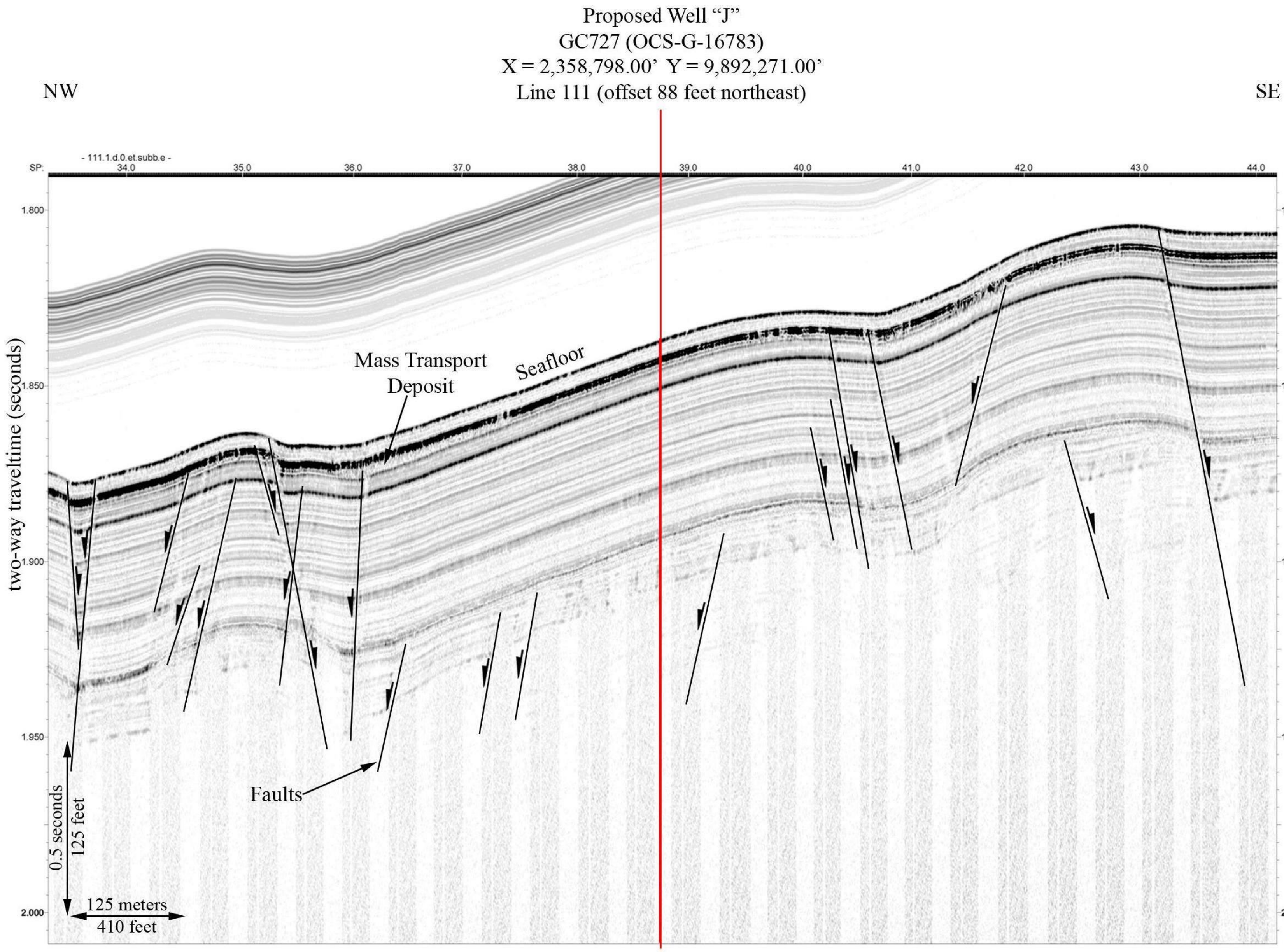


Figure 3. Subbottom profiler Line 111 near the proposed Well "J".

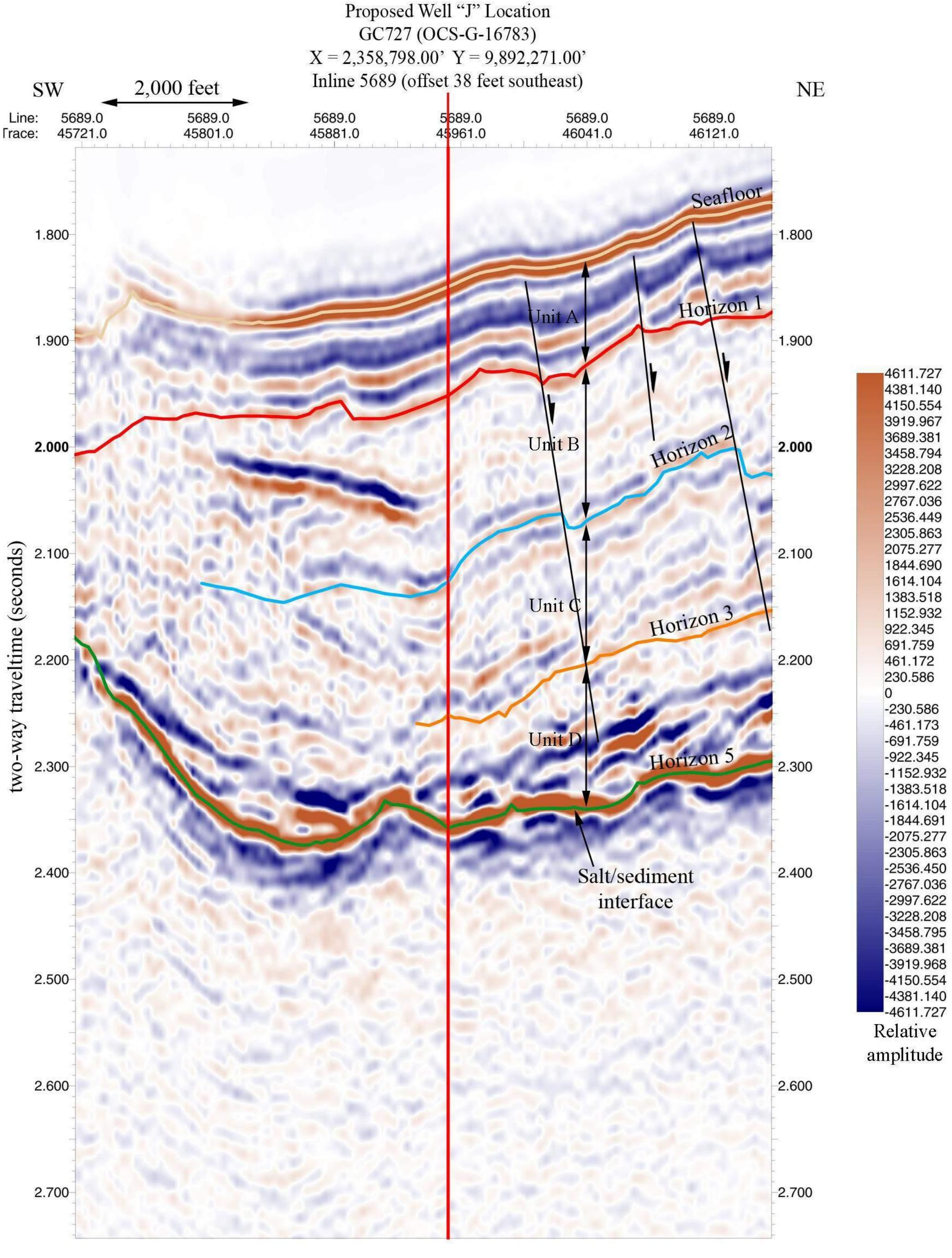


Figure 4. 3D seismic Inline 5689 through the proposed Well "J".

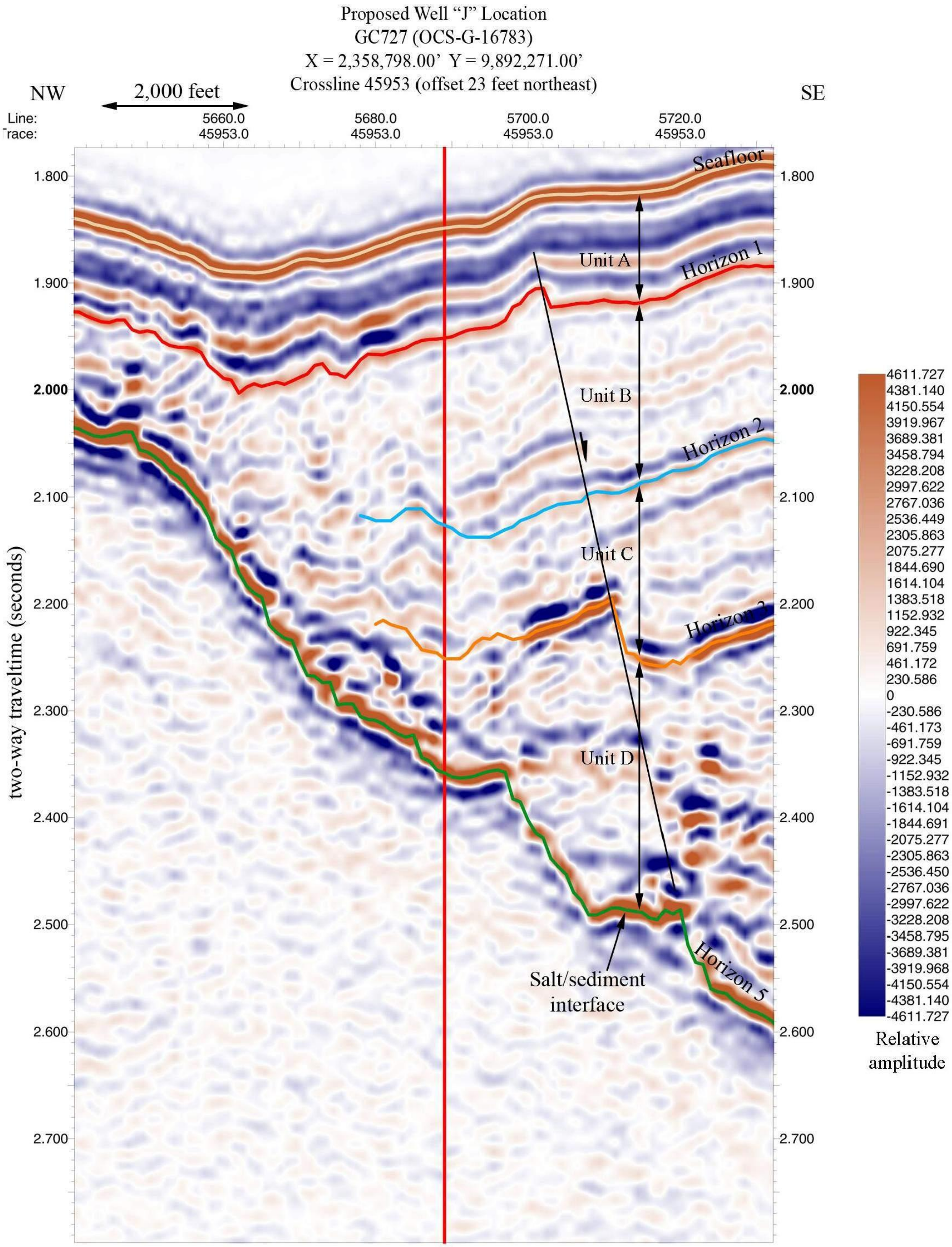
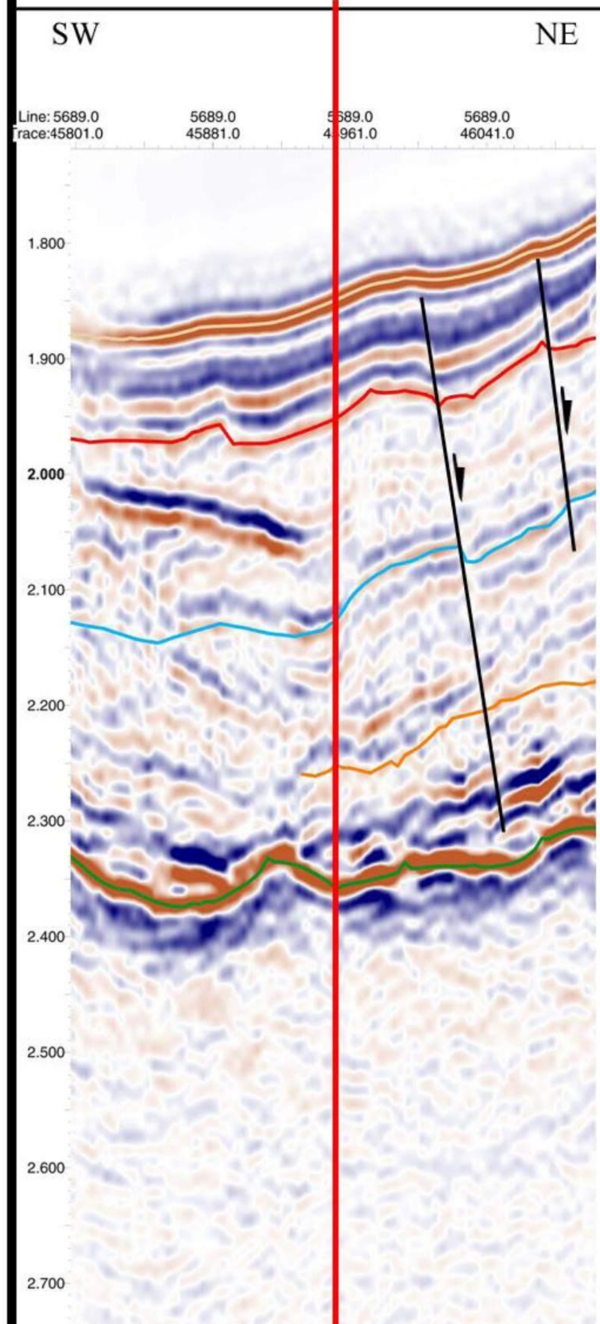


Figure 5. 3D seismic Crossline 45953 through the proposed Well "J".

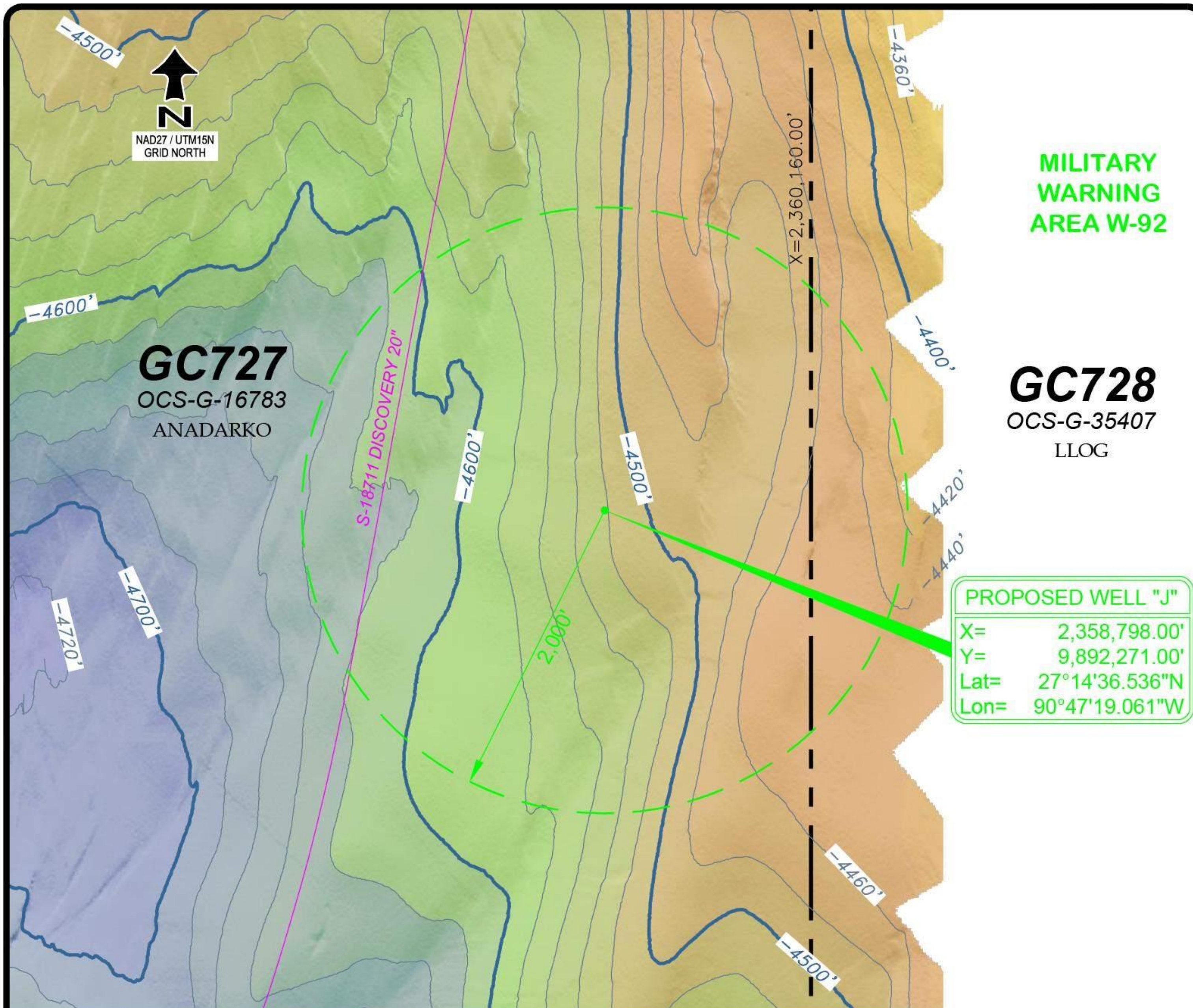
Proposed Well "J" Location GC727 (OCS-G-16783) X = 2,358,798.00' Y = 9,892,271.00' Inline 5689 (offset 38 feet southeast)	Subsurface Sequence (Well Intersect)		Water Flow and Gas Potential		Depth BML (feet)	Depth MSL (feet)	TWT BSL (sec)	Interval Thickness (feet)	Lithology Description
	Unit	Horizon	Gas	Water Flow					
		Seafloor				4,522	1.912		
	A	Horizon 1			345	4,867	1.965	345	Drape deposit of hemipelagic clays with interbedded fine-grained mass transport deposits.
	B	Horizon 2			936	5,458	2.126	591	Interbedded channel fill and mass transport deposits. The sediments within Unit B are highly fractured and faulted due to the salt diapiric uplift in the area.
	C	Horizon 3			1,368	5,889	2.305	432	Interbedded channel fill and mass transport deposits. The sediments within Unit C are highly fractured and faulted due to the salt diapiric uplift in the area.
	D	Salt/Sediment Interface			1,742	6,264	2.390	374	Coarser-grained channel fill and mass transport deposits. The sediments within Unit D are highly fractured and faulted due to the salt diapiric uplift in the area.
		Depth of study							



Note: Subsurface depths based on T-D equation
$D = 186.45T^2 + 2,637.05T$

Hazard Potential: Negligible: (blue) Low: (green) Moderate: (yellow) High: (red)

Figure 6. Top-Hole Prognosis Chart for the proposed Well "J".



Multibeam processing sequence

1. Water column velocity corrections applied
2. Tide corrections applied using Goddard Ocean Tide Model GOT99.2
3. Bin size = 3 meters (9.84 feet)
4. Median filter applied
5. Produced gridded-binned dataset using weighted-neighbor algorithm; search radius = 9 meters (29.53 feet)

Contour interval = 20 feet
Zero datum = Mean Sea Level

Color shaded image

Sun azimuth = 0°
Sun elevation = 30°

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

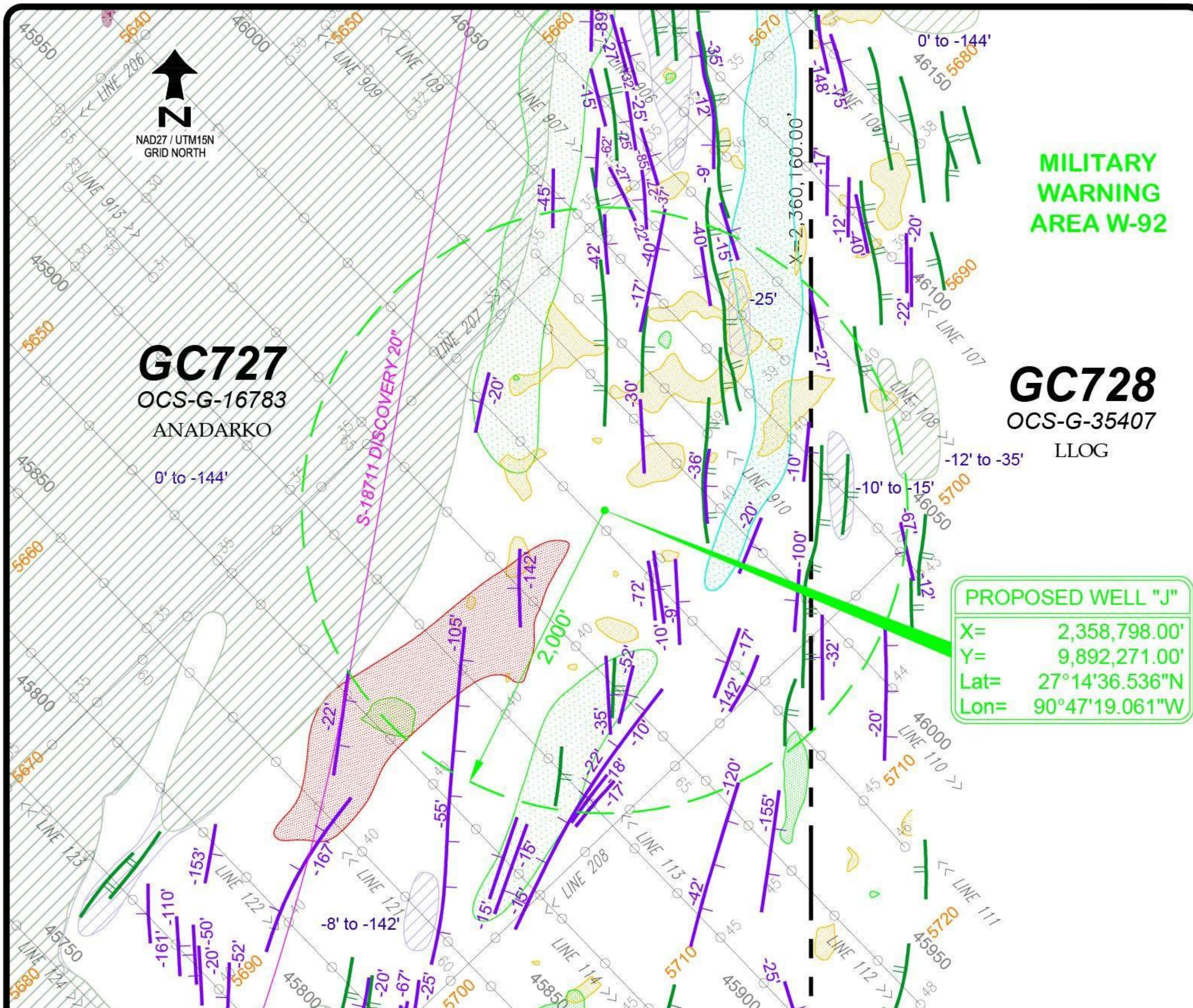
DATE: 04/27/2016 TIME: 11:44 FILENAME: Z:\151051\ACAD\151051_WELL-J.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "J"
COLOR SHADED BATHYMETRY MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 1 of 6	REV. 0
FILE: 151051_WELL-J.DWG		



<< LINE 201	AUV navigation trackline with name and direction run, fix and fix number
5550	Inline number for 3D seismic data Spacing = 30 meters (98.43 feet)
46300	Crossline number for 3D seismic data Spacing = 25 meters (82.02 feet); Trace increment = 4
	Fault scarp (Hachures on downthrown side)
-10'	Normal fault with depth of burial (Hachures on downthrown side)
0' to -144'	Fault zone with depth range of burial
	Scarp zone
	Mass transport deposit 1 (-4' to -10')
	Mass transport deposit 3 (-12' to -63')
10'	Acoustic void with depths below seafloor
	Amplitude anomalies within Unit B (1.810 sec. - 2.778 sec. BSL) 104' - 2,379' BML
	Amplitude anomalies within Unit C (1.987 sec. - 2.757 sec. BSL) 434' - 3,543' BML
	Amplitude anomalies within Unit D (2.133 sec. - 3.231 sec. BSL) 805' - 5,922' BML

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

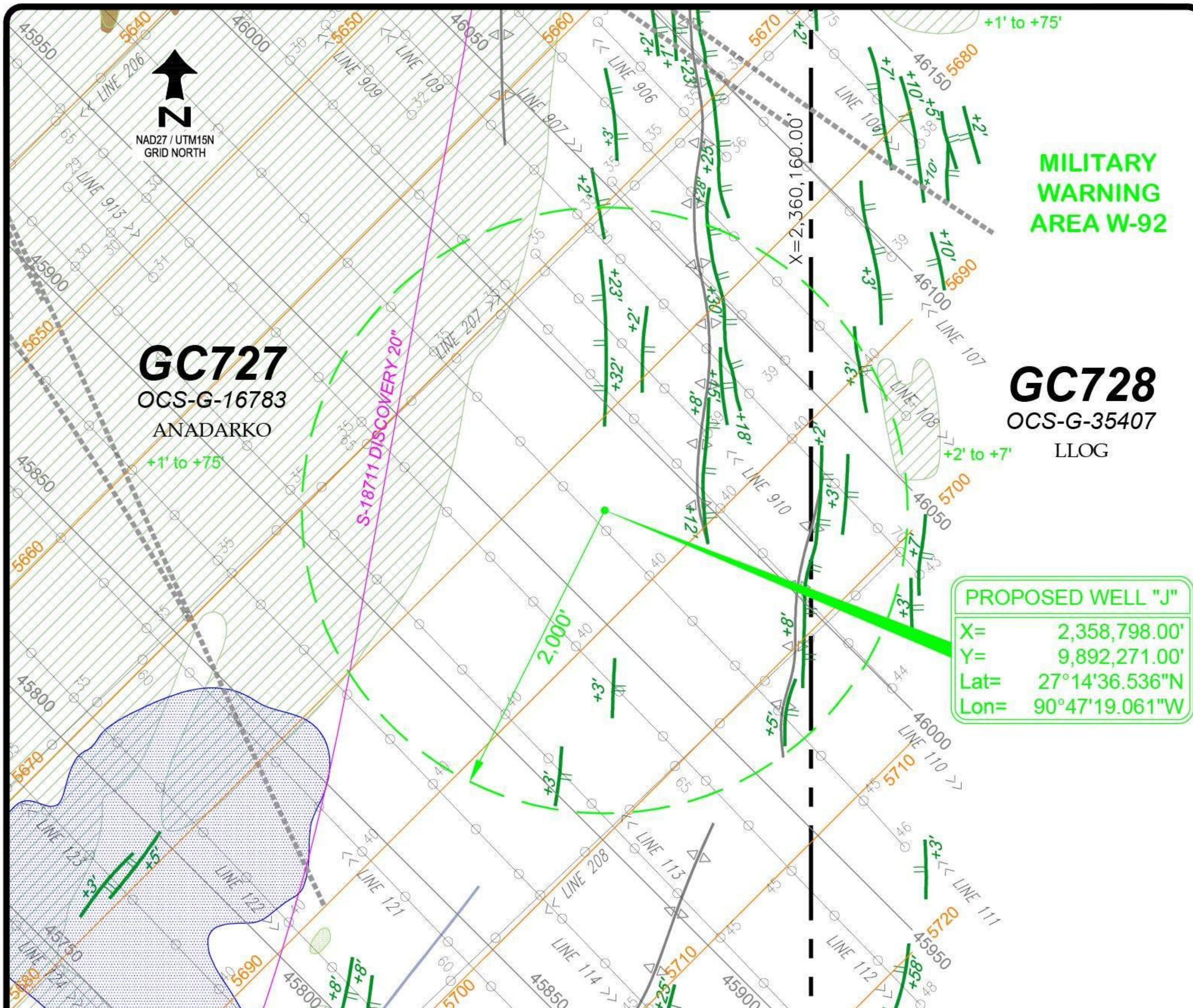
DATE: 04/27/2016 TIME: 11:46 FILENAME: Z:\151051\ACAD\151051_WELL-J.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "J"
SUBSURFACE FEATURES MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 6 of 6	REV. 0
FILE: 151051_WELL-J.DWG		



AUV navigation trackline with name and direction run, fix and fix number (<< LINE 201)	Fault scarp with seafloor displacement (Hachures on downthrown side) (+10')
Crossline and crossline number for 3D seismic data Spacing = 25 meters (82.02 feet); Trace increment = 4 (46300)	Scarp zone with seafloor displacement range (+1' to +75')
Inline and inline number for 3D seismic data Spacing = 30 meters (98.43 feet) (5550)	Pockmarks
Drag scar / Ridge	Hardgrounds / Outcrops
Gullies / Channels	3D seismic low amplitude anomaly

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

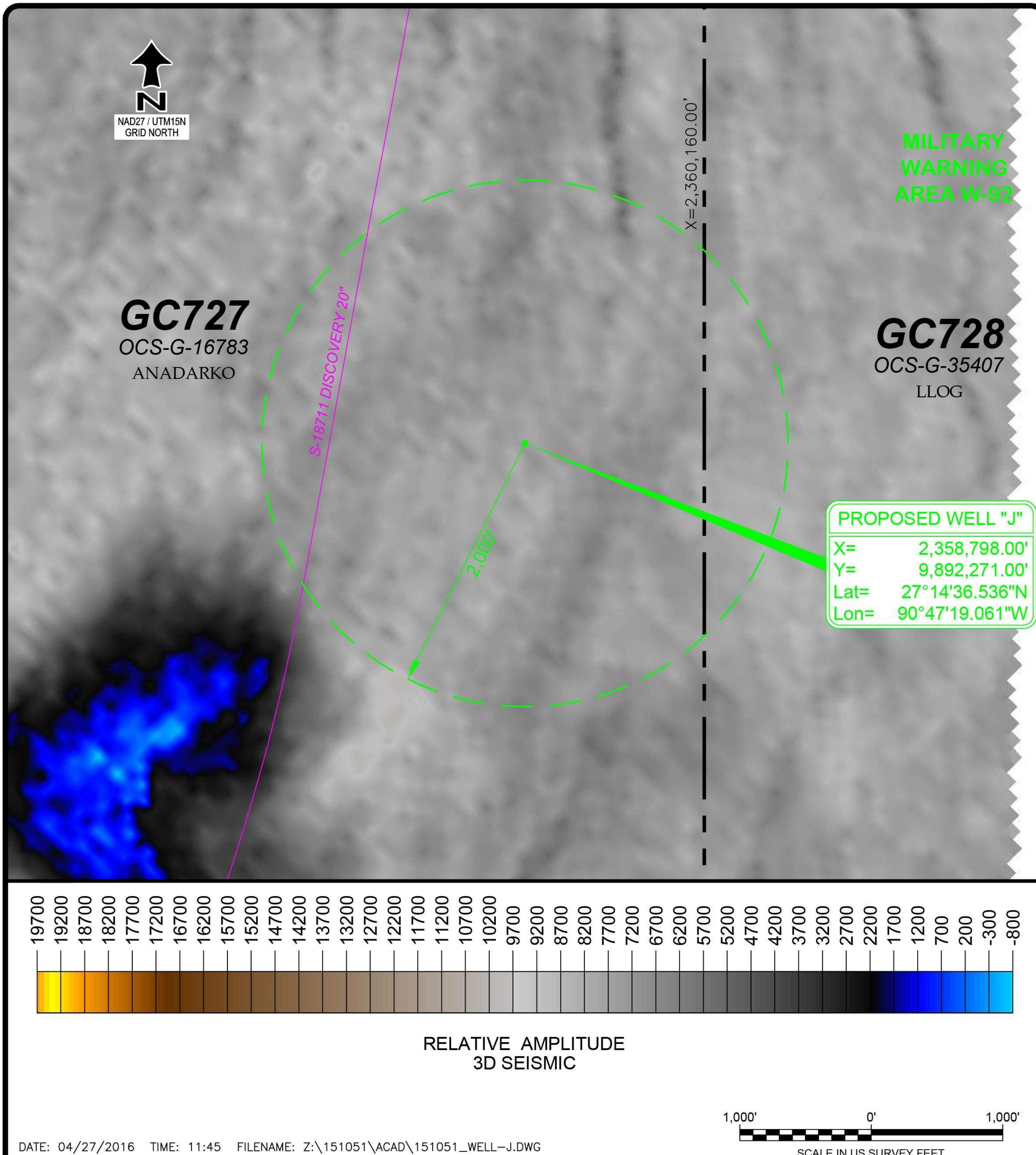
DATE: 04/27/2016 TIME: 11:46 FILENAME: Z:\151051\ACAD\151051_WELL-J.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "J"
SEAFLOOR FEATURES MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 5 of 6	REV. 0
FILE: 151051_WELL-J.DWG		



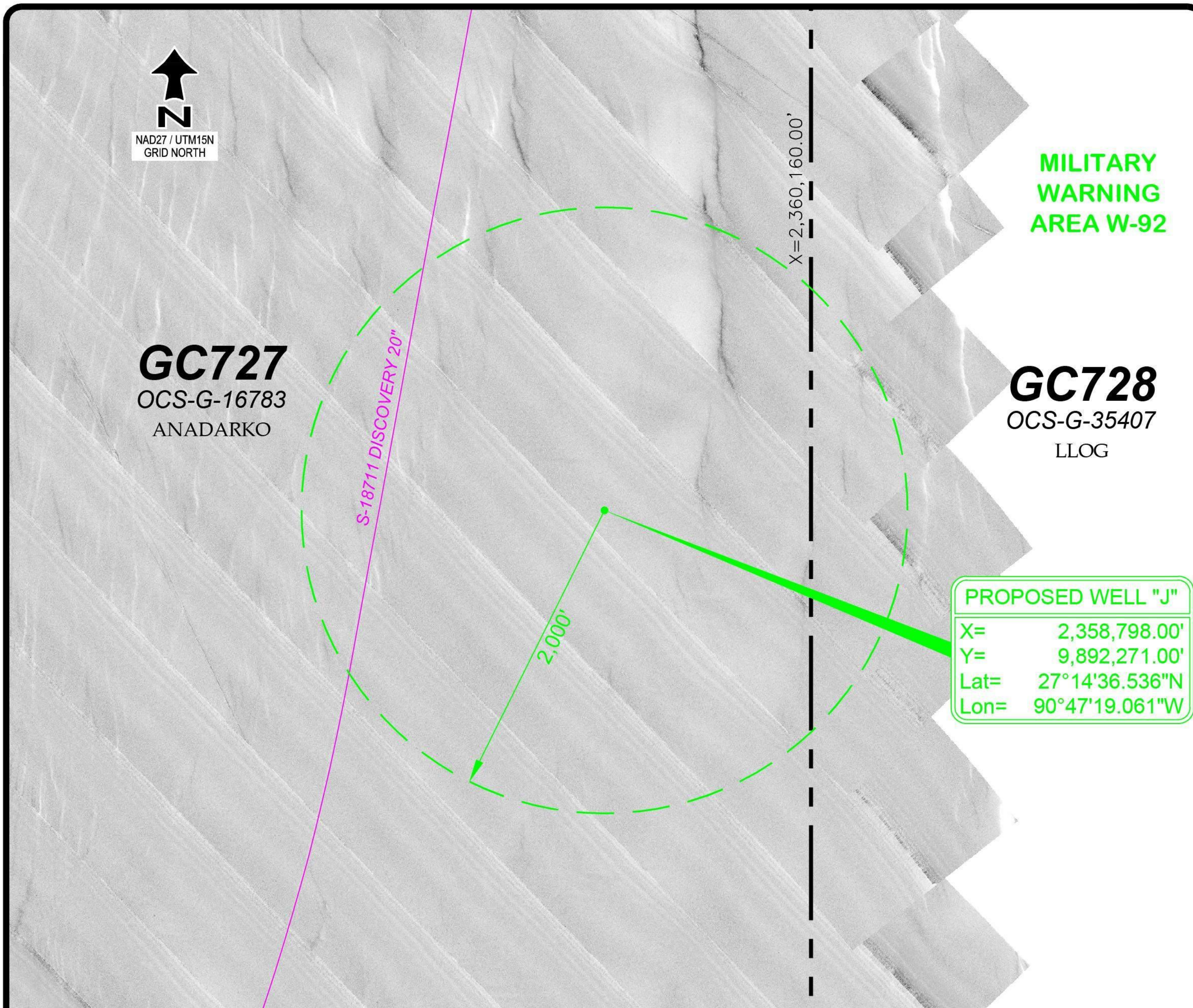
DATE: 04/27/2016 TIME: 11:45 FILENAME: Z:\151051\ACAD\151051_WELL-J.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "J"
SEAFLOOR AMPLITUDE MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 4 of 6	REV. 0
FILE: 151051_WELL-J.DWG		



SONAR MOSAIC

Dark returns represent higher seafloor reflectivity.

1,000' 0' 1,000'

SCALE IN US SURVEY FEET

DATE: 04/27/2016 TIME: 11:45 FILENAME: Z:\151051\ACAD\151051_WELL-J.DWG

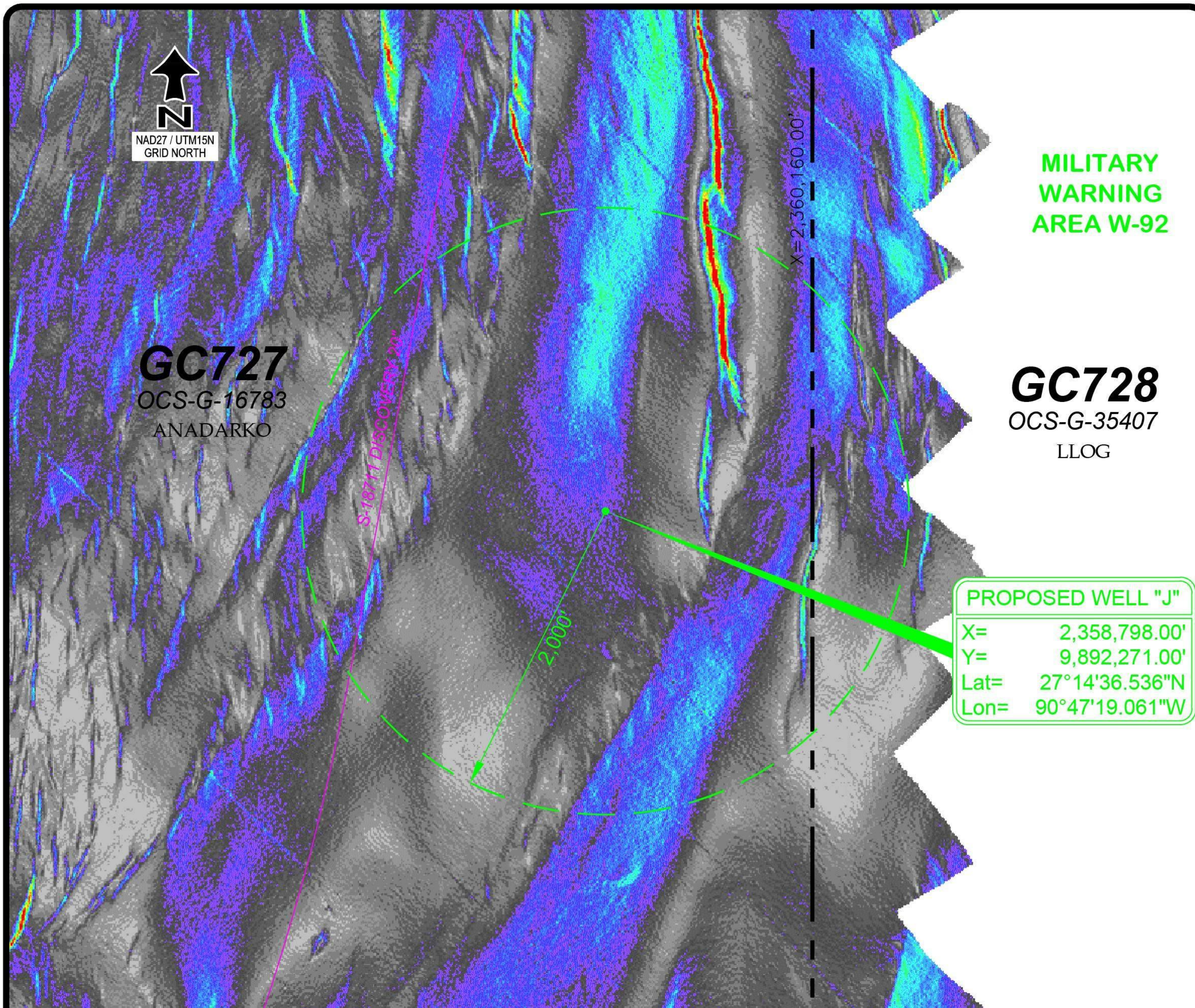
Anadarko Petroleum Corporation

PROPOSED WELL "J"
SIDE SCAN SONAR MOSAIC MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®

730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 3 of 6	REV. 0
FILE: 151051_WELL-J.DWG		



GRADIENT

Gradient is the first order derivative of the multibeam data.

Bin size = 3 meters (9.84 feet)

≥20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

SLOPE IN DEGREES

1,000' 0' 1,000'

SCALE IN US SURVEY FEET

DATE: 04/27/2016 TIME: 11:44 FILENAME: Z:\151051\ACAD\151051_WELL-J.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "J"
SEAFLOOR GRADIENT MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 2 of 6	REV. 0
FILE: 151051_WELL-J.DWG		

April 27, 2016

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

Attn: Mr. Rick Kincaid

Site Clearance Letter
Proposed Well "K"
Block 727 (OCS-G-16783)
Green Canyon Area

Mr. Rick,

INTRODUCTION

Anadarko Petroleum Corporation (Anadarko) contracted Oceaneering International, Inc. (OII) to prepare a well site clearance letter for the proposed Well "K" location of the Calpurnia Prospect in Block 727 (OCS-G-16783), Green Canyon (GC) Area. The data used for the site clearance letter is based on the interpretation of an exploration-quality 3D seismic volume and a high-resolution geophysical dataset collected with OII's Autonomous Underwater Vehicle (AUV) *C-Surveyor III*™. OII completed a geohazard assessment titled "*Shallow Hazard Report, Block 727 (OCS-G-16783) and 771 (OCS-G-33259), Green Canyon Area*" in March, 2016. This site clearance letter is based on the findings provided within that report.

This letter provides a top-hole drilling prognosis and addresses seafloor conditions within a 2,000-foot radius of the proposed surface location. The depth limit of investigation is approximately 2.0 seconds of two-way traveltime (~5,000 feet) below the mud line (BML), or to the salt/sediment interface if it is encountered less than 2.0 seconds below the seafloor. The reporting and mapping presented in this letter comply with the BOEM/BSEE guidelines provided in NTL No. 2008-G05 (Shallow Hazards Program) and No. 2009-G40 (Deepwater Benthic Communities).

METHODS

<u>AUV Survey Data</u>

OII's *C-Surveyor III*™ AUV provided multibeam bathymetric mapping, high-resolution side scan sonar imagery, and subbottom profiles. The AUV remote-sensing instruments include a Simrad EM 2040 Multibeam Echosounder (200, 300, and 400 kHz), an EdgeTech 2200-M Full Spectrum Chirp Dual Frequency Side Scan Sonar (120/410 kHz), and an EdgeTech DW106 Chirp Subbottom Profiler (1.5–4.5 kHz). All the raw digital data were logged utilizing proprietary software developed by OII. The multibeam system delivered a 3-meter gridded dataset with relative vertical accuracies within 20 centimeters.

The AUV survey grid in the study area consisted of 62 main tracklines (Lines 101–114 and 120–167) running northeast to southwest at 200-meter line spacing, 13 ties lines (Lines 201–213) running northwest to southeast at 900-meter line spacing, and 29 in-fill lines (Lines 901–929) run to fill in bathymetry data gaps caused by steep seafloor terrain. Navigation fixes (event marks) were annotated at 125-meter (410-foot) intervals along all survey lines. The survey grid

was designed to provide a representative sampling with the subbottom profiler system and overlapping coverage with side scan sonar and multibeam echosounder systems.

3D Seismic Data

The 3D seismic data used for this assessment was provided in SEG-Y format, and were loaded into IHS' Kingdom Suite 2d/3dPAK for interpretation. The 3D data were acquired by WesternGeco in 1999–2000, and reprocessing was completed in 2006 with Post-Stack Time Migration (PSTM). Inlines and crosslines are depicted on the Surface and Subsurface Features Maps (Sheets 5 and 6). The 3D data were provided at a four-millisecond sample rate and extend to the full data range of 13 seconds. The inlines of the data run southwest to northeast and are spaced at 30-meter (98.43-foot) intervals. The crosslines run southwest to northeast and are spaced at 25-meter (82.02-foot) intervals. Spectral whitening was applied to the 3D seismic dataset to amplify the higher frequencies. After applying the spectral whitening, a power spectrum generated at a few selected locations indicated the seismic data volume contains sufficiently high frequency content for a shallow hazards assessment (Figure 1).

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 (faults, salt, high acoustic impedance, stratigraphic horizons, etc.).

WELL LOCATION

The coordinates and calls for the proposed Well "K" surface location are tabulated below:

Table 1. Proposed Well "K"

Easting (feet)	Northing (feet)	Latitude	Longitude	Calls From Block 727, Green Canyon Area	
2,358,418.00'	9,886,238.00'	27°13'36.879"N	90°47'24.449"W	1,742.00' FEL	2,078.00' FSL

A 2,000-foot clearance radius is required for assessing deepwater benthic communities in proximity to the proposed Well "K".

The geodetic datum used for this project is the North American Datum 1927 (NAD27) with the Clarke 1866 Ellipsoid. The datum is projected using the Universal Transverse Mercator (UTM), Zone 15 North (15N) 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. Mapping and reporting units are in U.S. Survey Feet.

REGIONAL GEOLOGY

The Gulf of Mexico is a semi-enclosed basin that has been receiving sediment influx dominated by the Mississippi River since the Late Jurassic. Mesozoic and Cenozoic sediments have attained a thickness in excess of 9 miles (Coleman et al., 1991). The prograded shelf sequence consists of intercalated coastal plain, delta, estuarine, and marine sediments. Sediment deposition along the northern rim of the Gulf of Mexico resulted in particularly thick Tertiary

and Quaternary sections. These rapidly deposited sediments have prograded the Cretaceous shelf-edge up to 185 miles basinward. The exceptionally high rate of shelf-edge progradation is on the order of 3.0 to 3.7 miles per 1,000 years.

The near surface geology across the Gulf Coast region is the product of fluctuating sea levels associated with climatic variations over the past 20,000 years. During this time, low sea levels left the continental shelf exposed to subaerial weathering and other erosional processes. Streams and rivers meandered and cut into the exposed landmass, depositing bedloads along the modern-day shelf break. Fan systems were formed, and mass movement events were common as deltaic sediments were deposited on the steep upper continental slope. As the climate warmed, seas transgressed, and marine sediments were deposited on the shelf.

The proposed wellsite is located in the northern Gulf of Mexico in an area designated as the Green Canyon Area by the BOEM and BSEE. The study area is located on the middle Texas Louisiana Slope in GC727 and is characterized by extensive faulted/fractured sediments due to salt diapiric uplift.

BATHYMETRY AND SEAFLOOR GRADIENTS

The water depth at the proposed Well "K" location is 4,675 feet below mean sea level (MSL). Within the 2,000-foot radius centered at the proposed well location, the seafloor depth ranges from 4,548 feet in the north to 4,761 feet in the southeast (Sheet 1, Color Shaded Bathymetry Map).

The proposed well is situated near slightly irregular seafloor atop a relatively smooth section located in the southeast corner of GC727. The seafloor in the area surrounding the proposed well location slopes south at a gradient of 2° (Sheet 2, Seafloor Gradient Map).

SEAFLOOR HAZARDS

Low to moderate sonar and multibeam backscatter reflectivity occurs around the proposed well site indicating mostly fine-grained sediments. Higher acoustic reflectivity in the side scan sonar and backscatter images occur along fault scarps and represent coarser sediments (Figure 2; Sheet 3, Side Scan Sonar Mosaic Map).

The 3D seafloor amplitude image displays low to moderate acoustic amplitudes within the 2,000-foot radius area (Sheet 4, Seafloor Amplitude Map). These low to moderate seafloor amplitudes indicate finely textured seafloor sediments that are likely comprised of hemipelagic clay. One large low amplitude anomaly is located 3,400 feet northwest of the proposed site.

One sonar contact is located within 2,000 feet of the proposed well location. Sonar Contact No. 20 is located 1,910 feet northwest of the well site and measures 17.2 feet long, 5.4 feet wide, and has a height of 2.7 feet.

Multiple surface faults were identified within the 2,000-foot radius (Sheet 5, Seafloor Features Map). These faults typically trend north-south and exhibit seafloor displacement between 1 and 10 feet. One fault, located 395 feet to the north, shows 42 feet of seafloor relief. Slump deposits were noted along the downthrown sides of the fault scarps, and are characterized by slightly irregular and undulating topography and may represent unstable seafloor for construction activities.

POTENTIAL DEEPWATER BENTHIC COMMUNITIES

High or low-amplitude seismic seafloor anomalies are potential indicators of carbonates, benthic community habitats, and gas/fluid seepages. The seafloor at the proposed Well "K" and surrounding 2,000-foot radius contains no high or low positive seafloor amplitude anomalies associated with fluid expulsion or mounded carbonates representing potential benthic communities. The side scan sonar and multibeam backscatter agree with the seafloor amplitude image, and show no evidence of outcrops or fluid expulsion.

SUBSURFACE GEOHAZARDS AND STRATIGRAPHY

The AUV subbottom profiler data exhibit continuous, sharp bottom echoes with parallel to divergent, continuous reflectors throughout the well site area. The uppermost shallow sediments consist of a 15 foot thick acoustically semi-transparent hemipelagic clay drape. Sediments below this drape are characterized by parallel, low to moderate amplitude reflectors that represent cyclic deposition of hemipelagic clay and silty clays (Figure 3).

Four sedimentary units (Units A to D), each consisting of one or more distinctive sequences, were interpreted within the study area from the 3D seismic data to approximately 0.6 seconds of two-way traveltime (~2,000 feet) below the seafloor, the lower limit of investigation. Five horizons mark the upper and/or lower contacts of each of the successive units (Figures 3 and 4).

Subsurface faulting/fracturing occurs throughout the 2,000-foot vicinity, with most faults trending north-south (Sheet 6, Subsurface Features Map). The stratigraphy throughout the well site area is extremely faulted and fractured due to the shallow salt.

Two mass transport deposits (MTD) were identified within the 2,000-foot radius. The MTDs are generally characterized by chaotic and mixed sequences or lack of visible internal structure, which suggest the integrity of the internal sedimentary structures was lost while moving downslope. MTD 1 is located 1,370 feet southeast and is buried 4 to 10 feet, while MTD 3 is located at the well site and is buried 40 feet.

An acoustic void zone was noted 1,800 feet south of the proposed well site. This void zone is indicative of upward fluid/gas migration and is buried 13 feet below the seafloor.

OII used check shot data from the BOEM web site for a nearby well with a series of time-depth pairs for the sediment column. The following polynomial equation was derived from Total Vertical Depth (TVD) (feet) and the corresponding two-way traveltime (seconds) using the time-depth values to calculate depths below the seafloor:

$$D = 186.45T^2 + 2,637.05T$$

where D = depth below sea level in feet and T = time below sea level in seconds.

A detailed description of the sequence units, beginning at the seafloor, can be found in the 2016 Geohazard Report. The Top-Hole Prognosis Chart (Figure 6) summarizes the stratigraphy.

Unit A (Seafloor to Horizon 1)
Unit A consists of low to moderate amplitude, parallel, semi-continuous reflectors and measures 381 feet thick at the proposed well location. The reflection patterns suggest the unit is comprised mostly of hemipelagic clay with a few interbedded mass transport deposits. No high amplitude anomalies occur within Unit A near the proposed well location. Fractured/faulted sediments were identified in the AUV subbottom data within this unit (Figure 3).

Unit B (Horizon 1 to Horizon 2)
Unit B consists of mostly low amplitude, sub-parallel reflectors and measures 568 feet thick at the proposed well location. The unit is interpreted as interbedded channel fill and mass transport deposits. No high amplitude anomalies occur within Unit B near the proposed well location. Fractured/faulted sediments were identified in the 3D seismic data within this unit (Figures 4 and 5).

Unit C (Horizon 2 to Horizon 3)
Unit C consists of low to moderate amplitude, semi-continuous to sub-chaotic reflectors and measures 421 feet thick. This unit is interpreted as a interbedded coarse-grained channel fill and mass transport deposits. Several high amplitude anomalies occur within Unit C, most of which appear next to fault lines which may act as structural traps for the possible gas hazards. The closest of these anomalies is relatively small and is located 200 feet to the west. Fractures/faults were identified in the 3D data within this unit (Figures 4 and 5).

Unit D (Horizon 3 to Salt/Sediment Interface)
Unit D consists of low to moderate amplitude, semi-continuous to chaotic reflectors and measures 454 feet thick. This unit is interpreted as a coarser-grained channel fill and mass transport deposits. Several high amplitude anomalies occur within Unit D, most of which appear next to fault lines which may act as structural traps for the possible gas hazards. The closest of these anomalies is located 1,390 feet to the northwest. Fractures/faults were identified in the 3D data within this unit (Figures 4 and 5). The base of Unit D marks the salt/sediment interface at the proposed well site.

SHALLOW GAS
Anomalies of very high amplitude, commonly termed bright spots, are interpreted as potential regions of fluid saturation usually associated with porous sands. Seismic amplitude anomalies are mapped on a unit-by-unit basis to assess the potential risk of gas. Seismic amplitude anomalies are exhibited on the Subsurface Features Map when present.

The risk of gas refers to the risk of encountering shallow gas. The risk of gas is interpreted based on amplitude levels. Stratigraphic and structural settings may also be taken into account. The four risk levels of gas are:

730 EAST KALISTE SALOOM ROAD, LAFAYETTE, LA 70508

- **Negligible**—No amplitude anomalies or other gas indicator present.
- **Low risk of gas**—Generally indicated by increased amplitude (2–3× 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× background level) and phase reversal.
- **High risk of gas**—Generally indicated by the highest amplitudes (in excess of 4× 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.

Amplitude anomalies were identified within Units C and D within 2,000 feet of the proposed Well "K" location. Units A, B, and D are assessed as having a low risk of gas, while Unit C is assessed as having a low to moderate risk of gas.

SHALLOW WATER FLOW

Several factors may contribute to shallow water flows. These include: high porosity and permeability, sand-prone aquifer, mechanism to pressurize, and seal. Additional details are described below:

- **Water depth and burial depth.** Significant water depths (> 500 feet below the seafloor) 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.

All of these factors occur within the study area. Since there is presently no method for quantifying the risk of shallow water flow, caution is recommended when drilling through units with shallow water flow potential. Sands with SWF potential often occur in unconsolidated, overpressured sands that lie below a seal. This seal prevents dewatering and compaction after deposition. The pressure rises with overburden causing a potentially disastrous hazard for drilling operations.

The nearest SWF event, according to information listed on the BOEM and BSEE website, is located approximately 15 miles northeast of the study area in GC644. This SWF event occurred at 644 feet below the seafloor and is listed as minor severity. Several other SWF events have been reported 25–40 miles east of the study area in GC783, GC823, GC825, and GC826. These SWF events are listed as occurring 1,274–5,527 feet below mudline and are all of low severity.

The assessment of seismic profiles suggests that Units A–D all exhibit a low risk of SWF. The numerous faults found in these units would serve to release pressures. 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 between the hydrate and free gas trapped at the base of the hydrate stability zone forms a Bottom Simulating Reflector (BSR) on seismic profiles. This BSR reflector cross cuts 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 deepwater benthic communities may all be found in close association. No indication of BSRs was found in the vicinity of the proposed well.

CONCLUSIONS

The proposed Well "K" location is situated on a slightly irregular seafloor atop a ridge at a water depth of 4,675 feet MSL. The seabed slopes to south at a gradient of 2°.

Numerous surface faults are located within 2,000 feet of the proposed well site, and typically exhibit between 1 and 10 feet of seafloor relief. One fault, located 395 feet north, measures 42 feet of relief. Slump deposits were noted along the downthrown sides of the fault scarps, and may represent unstable seafloor for construction activities.

One sonar contact (Sonar Contact No. 20) was identified 1,910 feet northwest of the proposed Well "K" location.

No high or low seafloor amplitudes anomalies that may indicate the occurrence of hardgrounds, carbonates, benthic communities or potential expulsions are found within 2,000 feet of the proposed Well "K" location.

Four (4) subsurface units interpreted from the 3D seismic data were assessed to approximately 2,500 feet BSF at the proposed Well "K" location (Units A to D). Unit A is comprised mostly of low to moderate amplitude, parallel, semi-continuous reflectors and consists of hemipelagic clays and interbedded mass transport deposits. Unit B is characterized by mostly low amplitude, sub-parallel reflectors and consists of interbedded channel fill and mass transport deposits. Unit C is comprised of low to moderate amplitude, semi-continuous to sub-chaotic reflectors and is interpreted as interbedded coarse-grained channel fill and mass transport deposits. Unit D is characterized by low to moderate amplitude, semi-continuous to chaotic reflectors and is interpreted as coarser-grained channel fill and mass transport deposits. Subsurface faults and fractures were identified within every unit due to the salt diapiric uplift in the area.

Subsurface amplitude anomalies were identified within Units C and D within 2,000 feet of the proposed Well "K" location. Units A, B, and D are assessed as having a low risk of gas, while Unit C has a low to moderate risk. No indication of gas hydrates was found within the study area.

Units A–D are all assessed as having a low risk of SWF, due to the numerous faults found in the units which would serve to release pressures.

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

Regards,

Christopher Baker
Senior Geologist

ENCLOSURES

Figure 1. Extracted wavelet and power spectrum at the proposed Well "K".
Figure 2. Backscatter image showing seafloor near the proposed Well "K".
Figure 3. Subbottom profiler Line 124 near the proposed Well "K".
Figure 4. 3D seismic Inline 5730 through the proposed Well "K".
Figure 5. 3D seismic Crossline 45733 through the proposed Well "K".
Figure 6. Top-Hole Prognosis Chart for the proposed Well "K".

Sheet 1.	Color Shaded Bathymetry Map, Proposed Well "K" Location	1"=1,000'
Sheet 2.	Seafloor Gradient Map, Proposed Well "K" Location	1"=1,000'
Sheet 3.	Side Scan Sonar Mosaic Map, Proposed Well "K" Location	1"=1,000'
Sheet 4.	Seafloor Amplitude Map, Proposed Well "K" Location	1"=1,000'
Sheet 5.	Seafloor Features Map, Proposed Well "K" Location	1"=1,000'
Sheet 6.	Subsurface Features Map, Proposed Well "K" Location	1"=1,000'

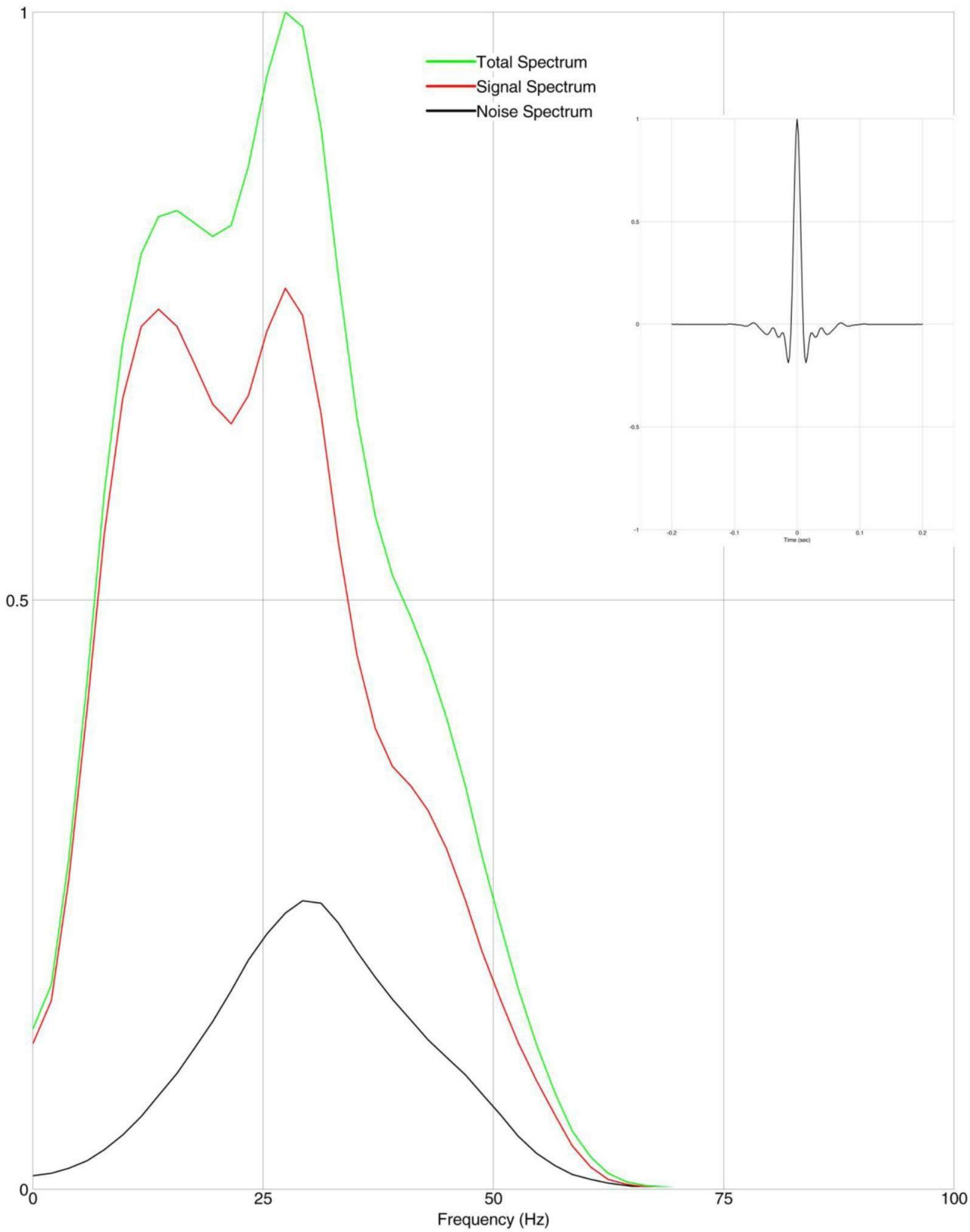


Figure 1. Extracted wavelet and power spectrum at the proposed Well "K" (1 second).

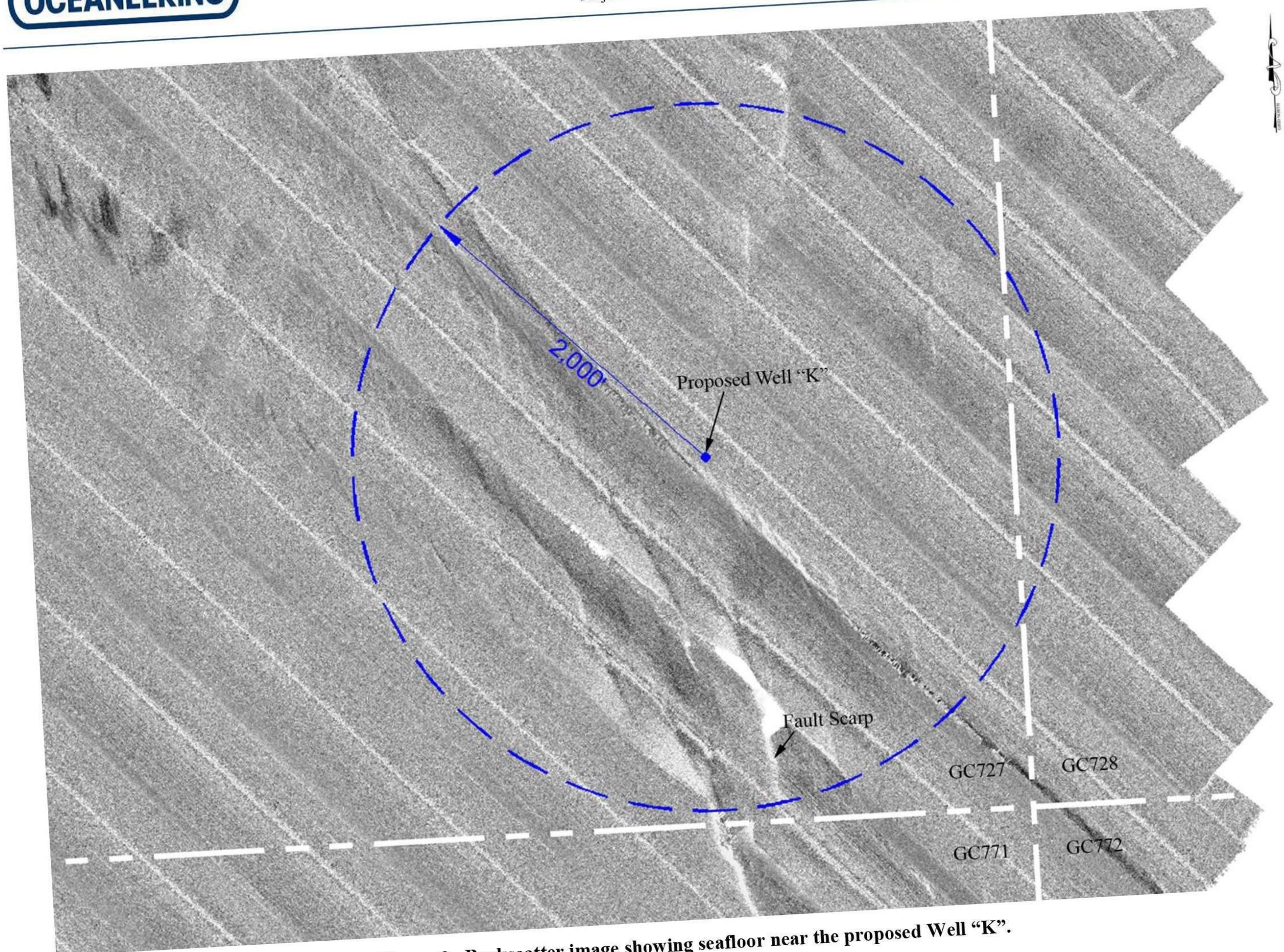


Figure 2. Backscatter image showing seafloor near the proposed Well "K".

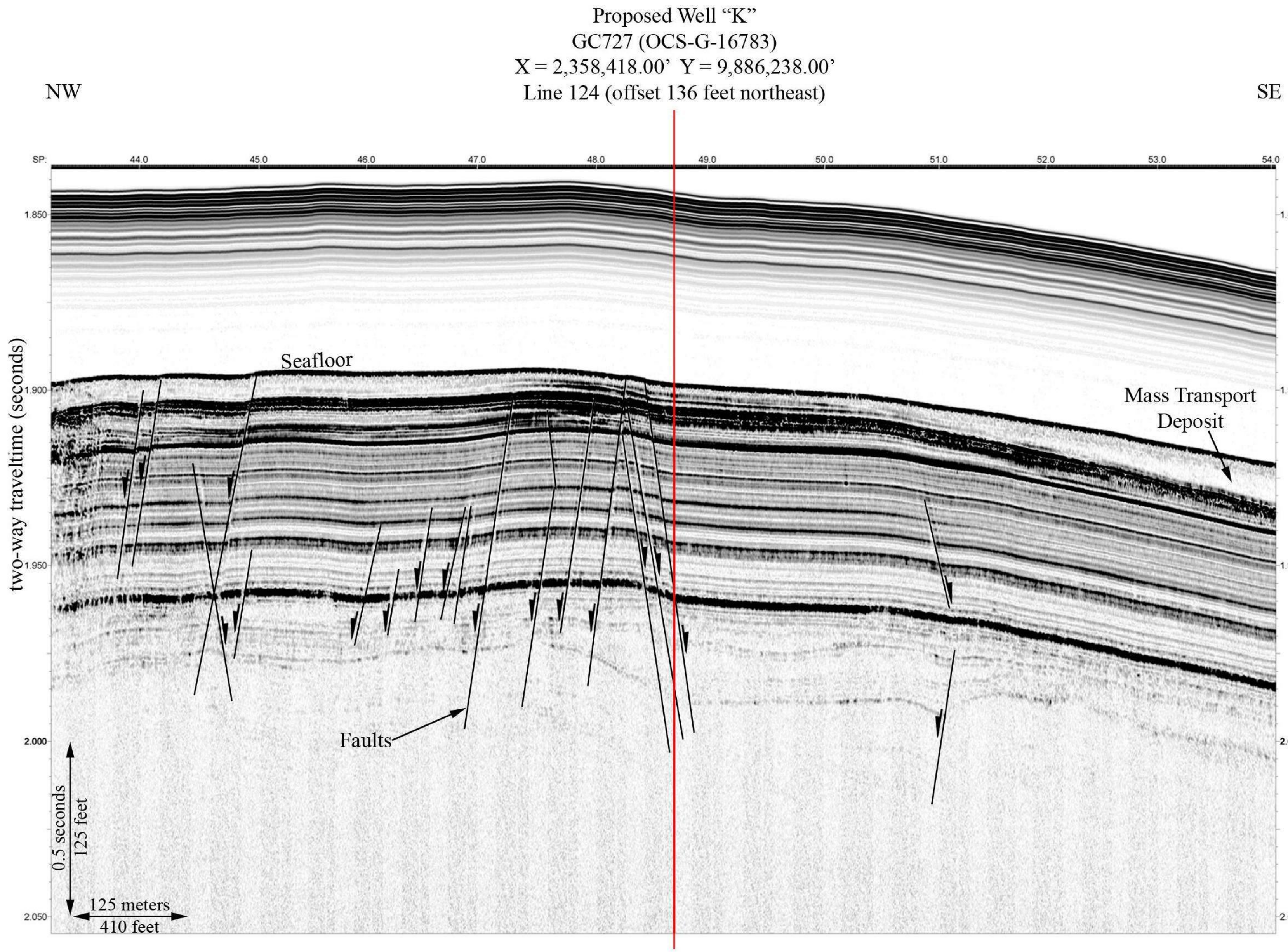


Figure 3. Subbottom profiler Line 124 near the proposed Well "K".

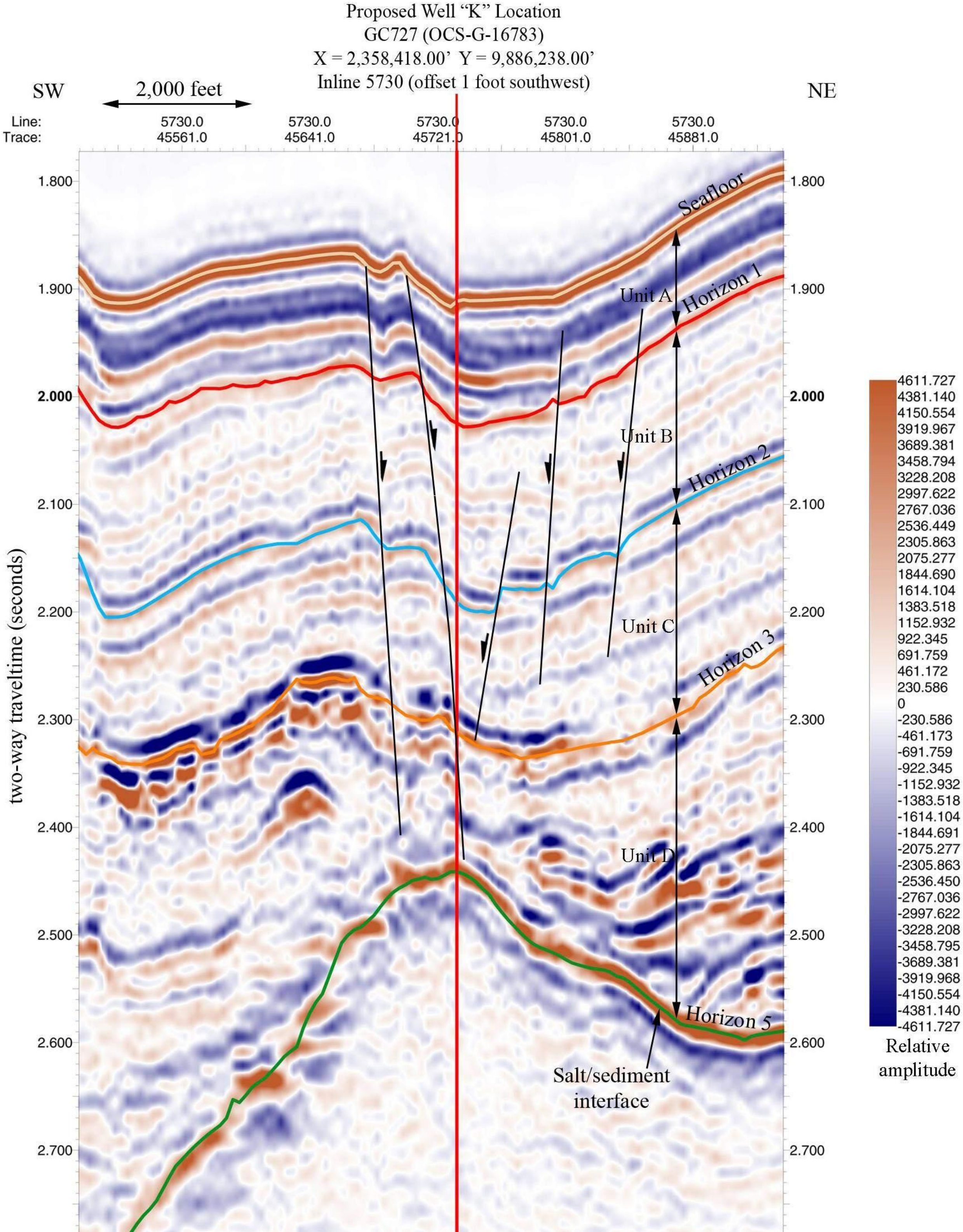


Figure 4. 3D seismic Inline 5730 through the proposed Well "K".

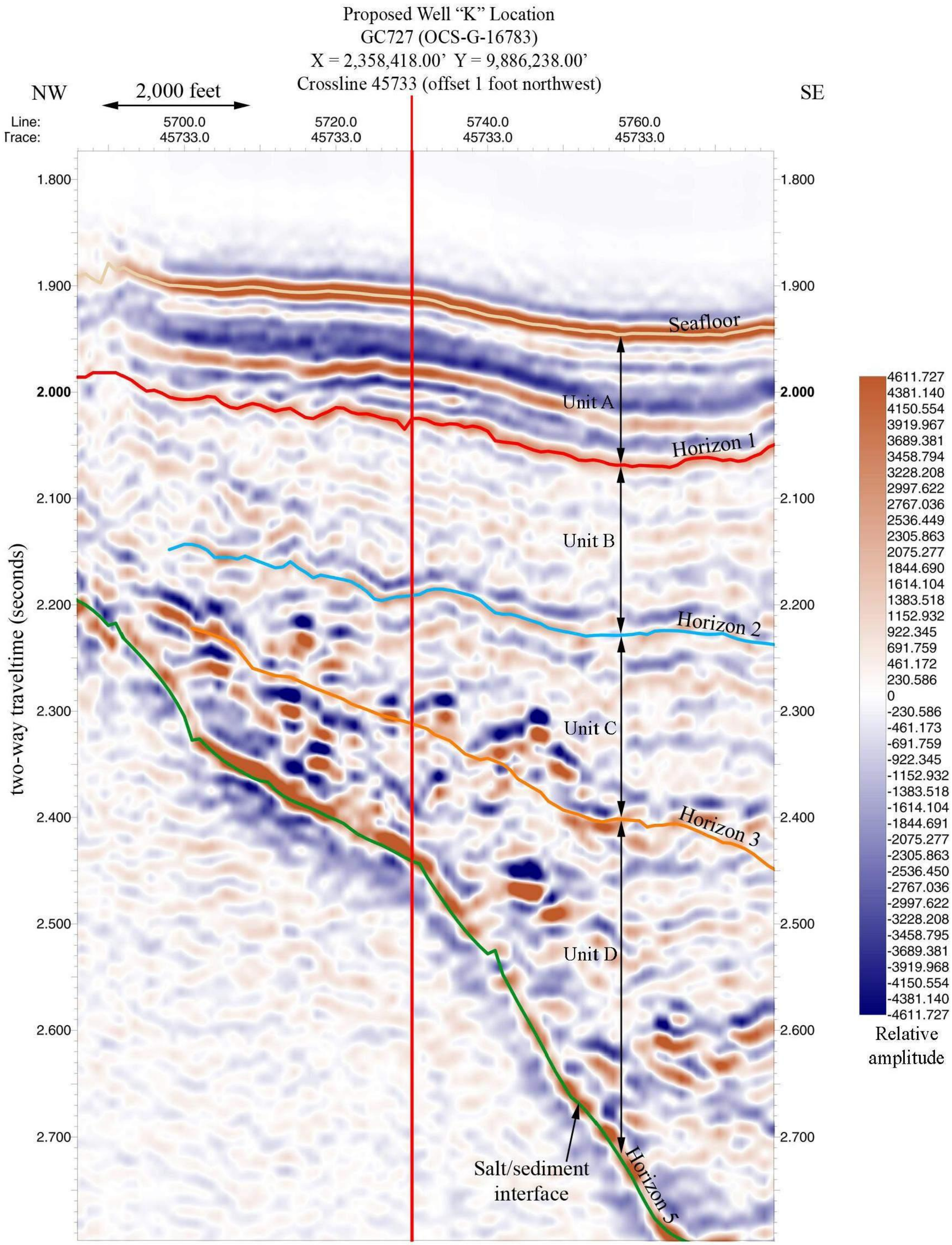
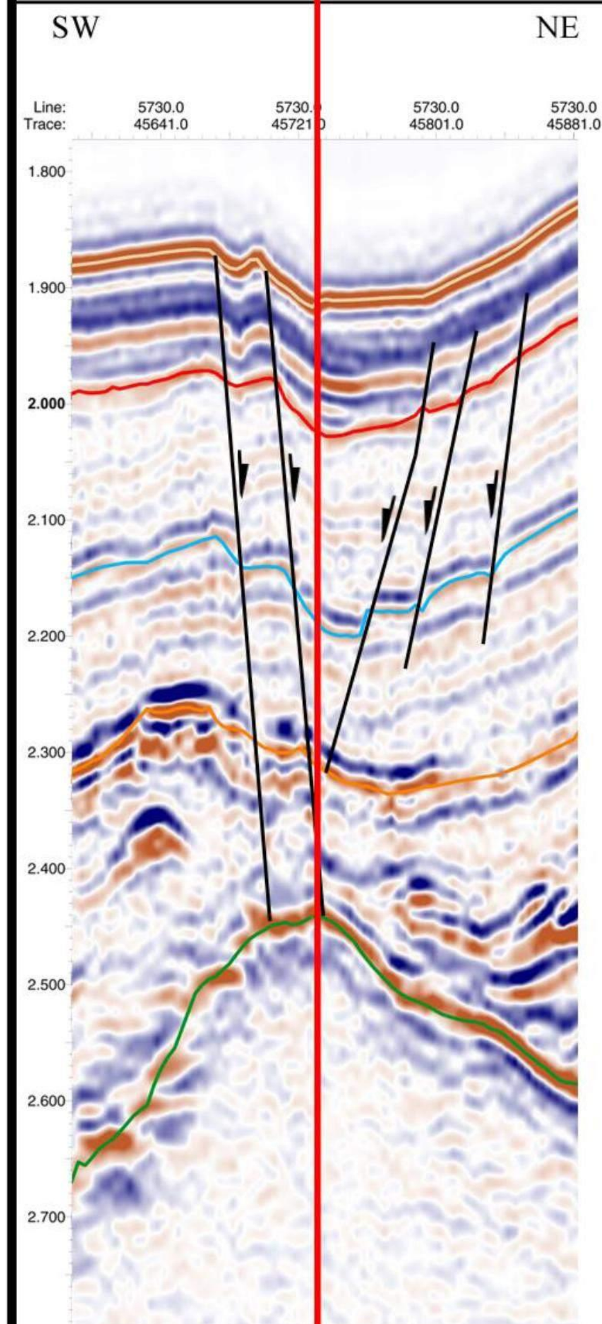


Figure 5. 3D seismic Crossline 45733 through the proposed Well "K".

Proposed Well "K" Location
GC727 (OCS-G-16783)
X = 2,358,418.00' Y = 9,886,238.00'
Inline 5730 (offset 1 foot southwest)



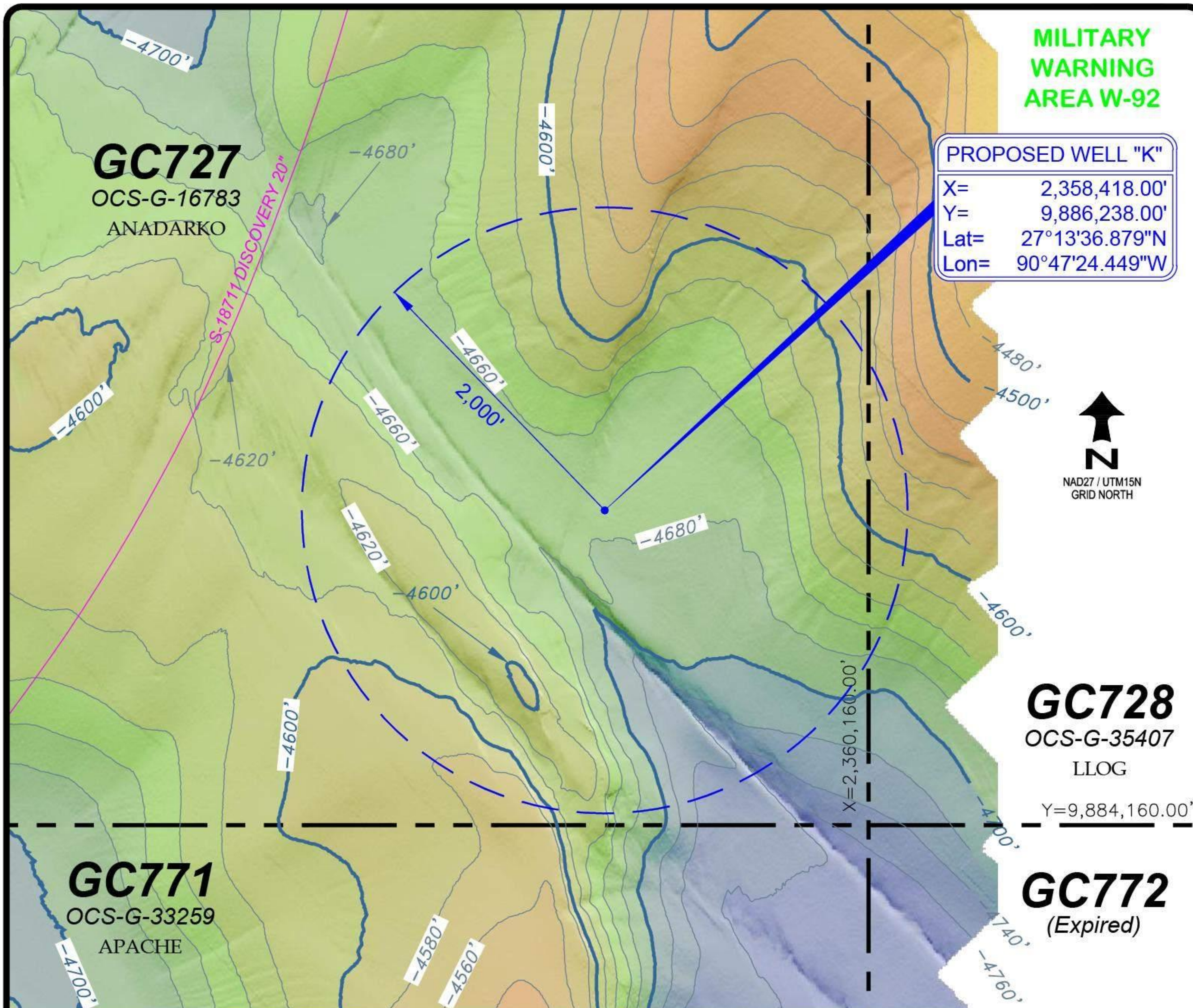
Note: Subsurface depths based on T-D equation
$D = 186.45T^2 + 2,637.05T$

Unit	Horizon	Gas	Water Flow	Depth BML (feet)	Depth MSL (feet)	TWT BSL (sec)	Interval Thickness (feet)	Lithology Description
	Seafloor				4,675	1.912		
A	Horizon 1	Low	Low	381	5,056	1.965	381	Drape deposit of hemipelagic clays with interbedded fine-grained mass transport deposits.
B	Horizon 2	Low	Low	949	5,624	2.126	568	Interbedded channel fill and and mass transport deposits. The sediments within Unit B are highly fractured and faulted due to the salt diapiric uplift in the area.
C	Horizon 3	Low / Moderate	Low	1,370	6,045	2.305	421	Interbedded channel fill and mass transport deposits. The sediments within Unit C are highly fractured and faulted due to the salt diapiric uplift in the area.
D	Salt/Sediment Interface	Low	Low	1,824	6,499	2.390	454	Coarser-grained channel fill and mass transport deposits. The sediments within Unit D are highly fractured and faulted due to the salt diapiric uplift in the area.
	Depth of study							

Subsurface Sequence (Well Intersect); Water Flow and Gas Potential

Hazard Potential — Negligible: (blue) Low: (green) Moderate: (yellow) High: (red)

Figure 6. Top-Hole Prognosis Chart for the proposed Well "K".



Multibeam processing sequence

1. Water column velocity corrections applied
2. Tide corrections applied using Goddard Ocean Tide Model GOT99.2
3. Bin size = 3 meters (9.84 feet)
4. Median filter applied
5. Produced gridded-binned dataset using weighted-neighbor algorithm; search radius = 9 meters (29.53 feet)

Contour interval = 20 feet
Zero datum = Mean Sea Level

Color shaded image

Sun azimuth = 0°
Sun elevation = 30°

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

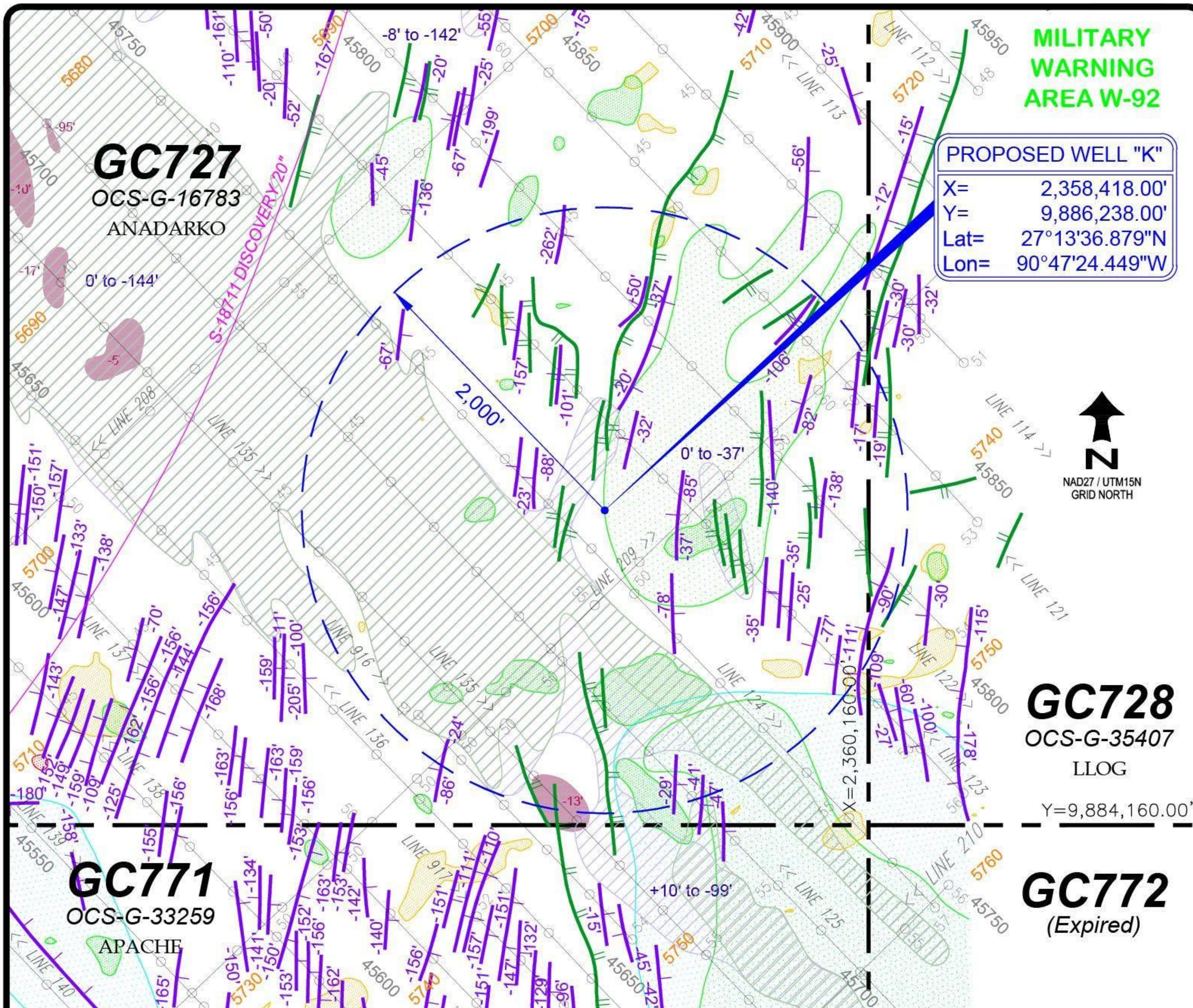
DATE: 04/27/2016 TIME: 11:48 FILENAME: Z:\151051\ACAD\151051_WELL-K.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "K"
COLOR SHADED BATHYMETRY MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 1 of 6	REV. 0
FILE: 151051_WELL-K.DWG		



<< LINE 201 — AUV navigation trackline with name and direction run, fix and fix number	Mass transport deposit 1 (-4' to -10')
	Mass transport deposit 3 (-12' to -63')
5550 — Inline number for 3D seismic data Spacing = 30 meters (98.43 feet)	10' — Acoustic void with depths below seafloor
46300 — Crossline number for 3D seismic data Spacing = 25 meters (82.02 feet); Trace increment = 4	
Fault scarp (Hachures on downthrown side)	Amplitude anomalies within Unit B (1.810 sec. - 2.778 sec. BSL) 104' - 2,379' BML
-10' — Normal fault with depth of burial (Hachures on downthrown side)	Amplitude anomalies within Unit C (1.987 sec. - 2.757 sec. BSL) 434' - 3,543' BML
0' to -144' — Fault zone with depth range of burial; Scarp zone	Amplitude anomalies within Unit C (1.987 sec. - 2.757 sec. BSL) 434' - 3,543' BML

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

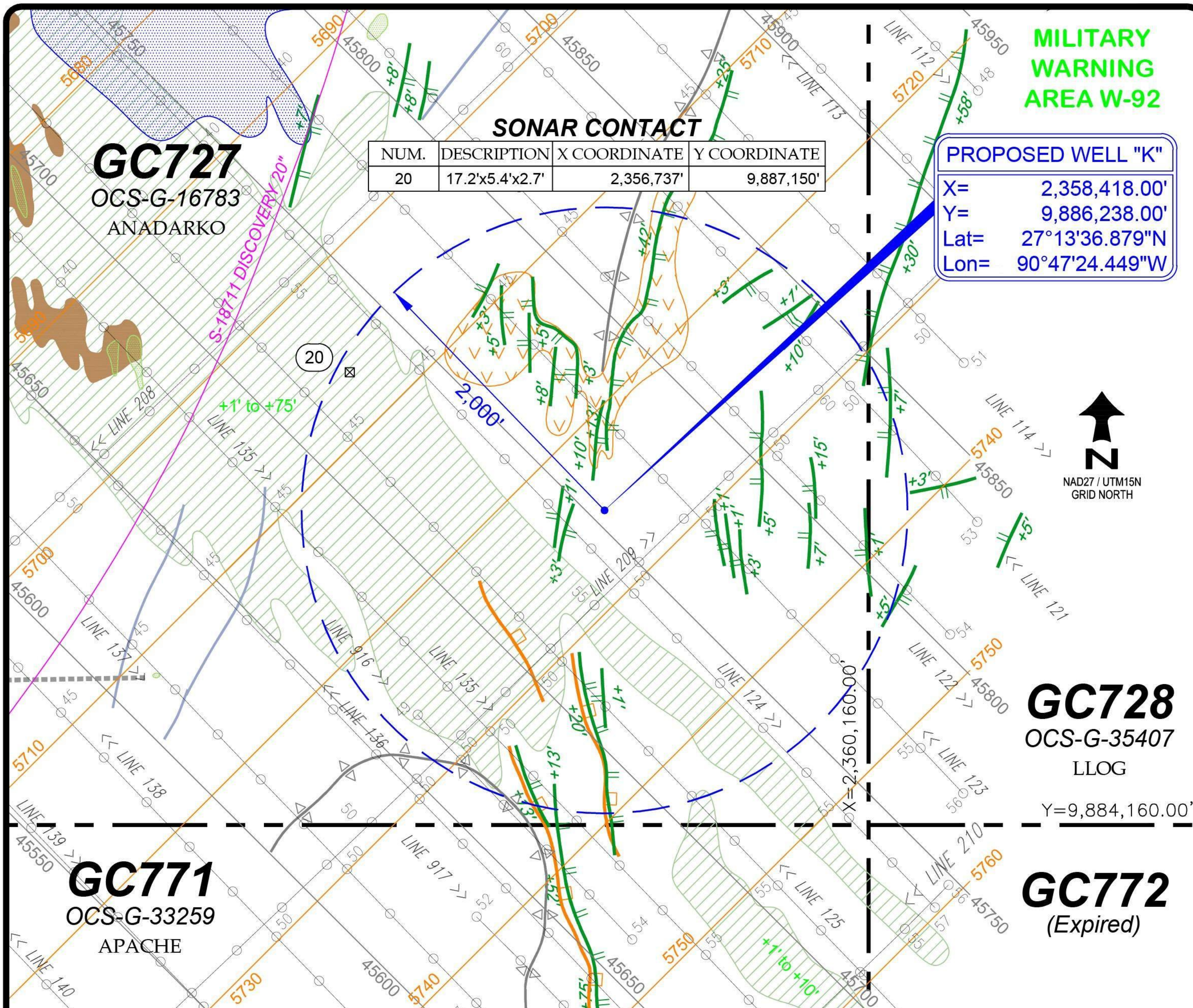
DATE: 04/27/2016 TIME: 11:49 FILENAME: Z:\151051\ACAD\151051_WELL-K.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "K"
SUBSURFACE FEATURES MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 6 of 6	REV. 0
FILE: 151051_WELL-K.DWG		



SONAR CONTACT

NUM.	DESCRIPTION	X COORDINATE	Y COORDINATE
20	17.2'x5.4'x2.7'	2,356,737'	9,887,150'

Symbol	Description	Symbol	Description
<< LINE 201	AUV navigation trackline with name and direction run, fix and fix number	+10'	Fault scarp with seafloor displacement (Hachures on downthrown side)
5550	Inline and inline number for 3D seismic data Spacing = 30 meters (98.43 feet)	+1' to +75'	Scarp zone with seafloor displacement range
46300	Crossline and crossline number for 3D seismic data Spacing = 25 meters (82.02 feet); Trace increment = 4		Drag scar; Gullies / Channels
20	Sonar contact and reference number		Pockmarks; Slump
	Headwall scarp; Ridge		Hardgrounds / Outcrops; 3D seismic low amplitude anomaly

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

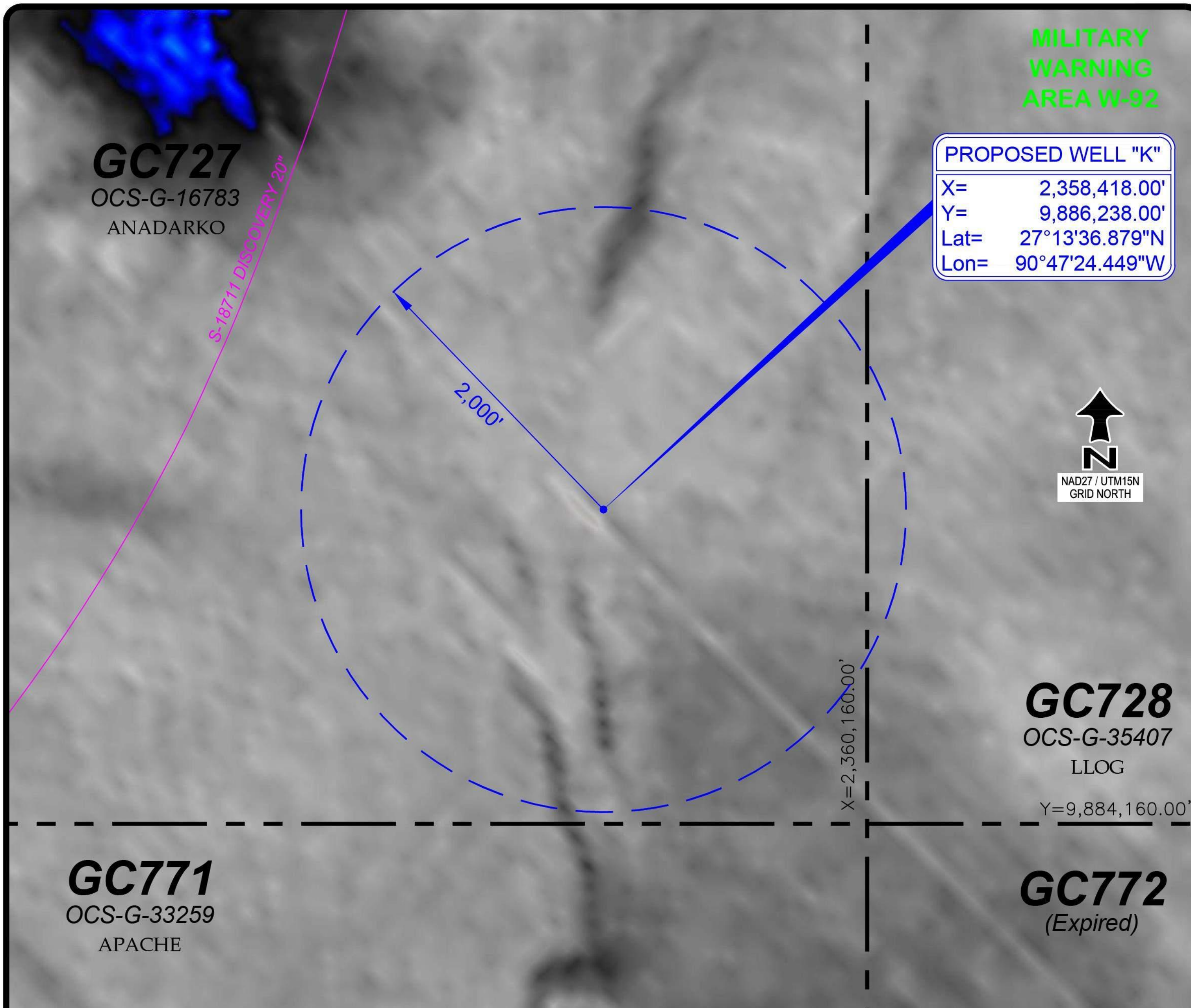
DATE: 04/27/2016 TIME: 11:49 FILENAME: Z:\151051\ACAD\151051_WELL-K.DWG

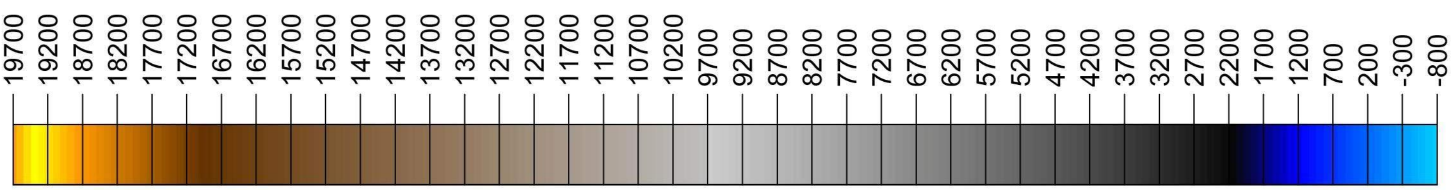
Anadarko Petroleum Corporation

PROPOSED WELL "K"
SEAFLOOR FEATURES MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 5 of 6	REV. 0
FILE: 151051_WELL-K.DWG		





RELATIVE AMPLITUDE
3D SEISMIC

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

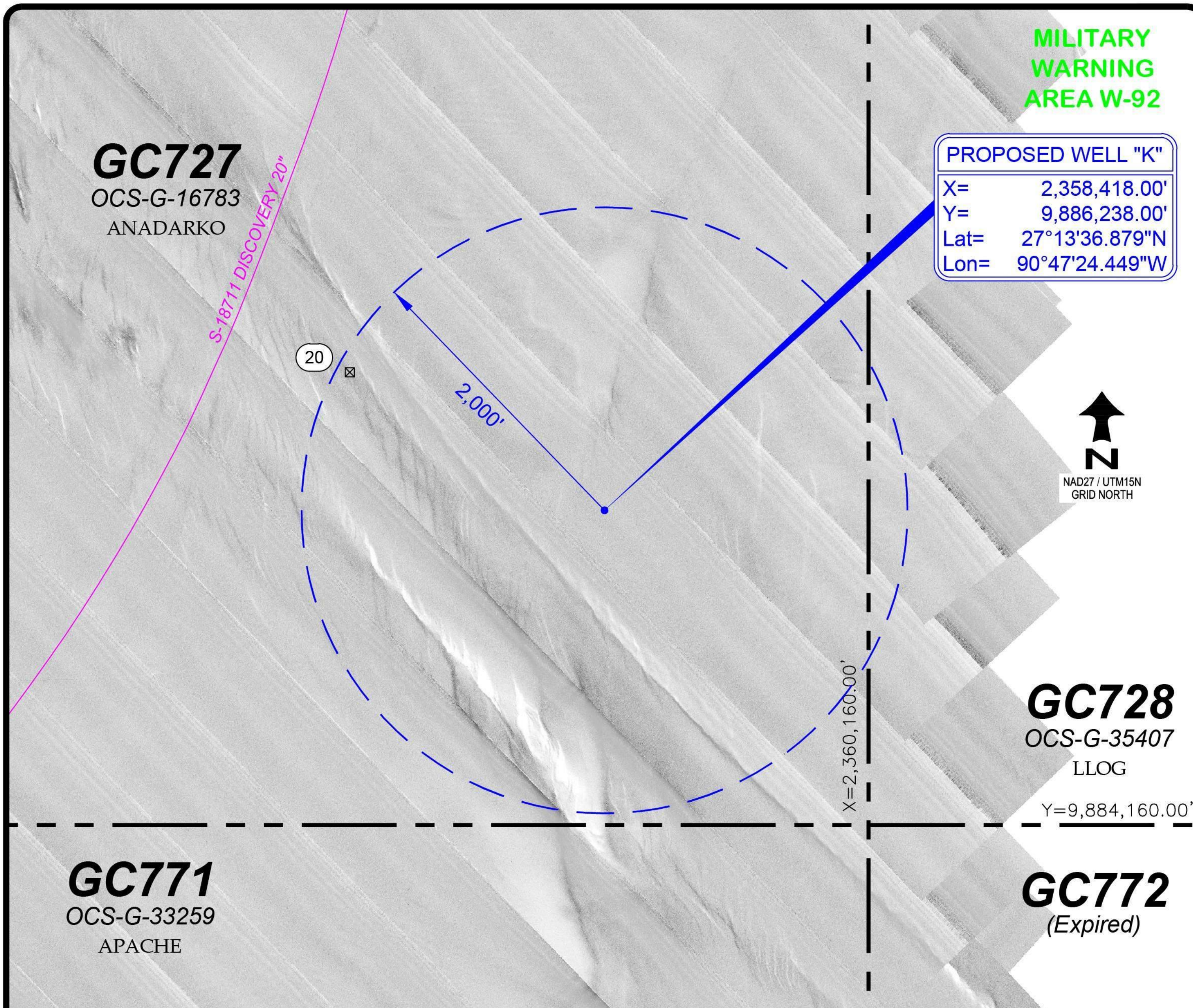
DATE: 04/27/2016 TIME: 11:49 FILENAME: Z:\151051\ACAD\151051_WELL-K.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "K"
SEAFLOOR AMPLITUDE MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016
DRAWN: A. McBride	SHEET 4 of 6 — REV. 0
FILE: 151051_WELL-K.DWG	



SONAR MOSAIC
Dark returns represent higher seafloor reflectivity.

SONAR CONTACT

NUM.	DESCRIPTION	X COORDINATE	Y COORDINATE
20	17.2'x5.4'x2.7'	2,356,737'	9,887,150'

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

DATE: 04/27/2016 TIME: 11:49 FILENAME: Z:\151051\ACAD\151051_WELL-K.DWG

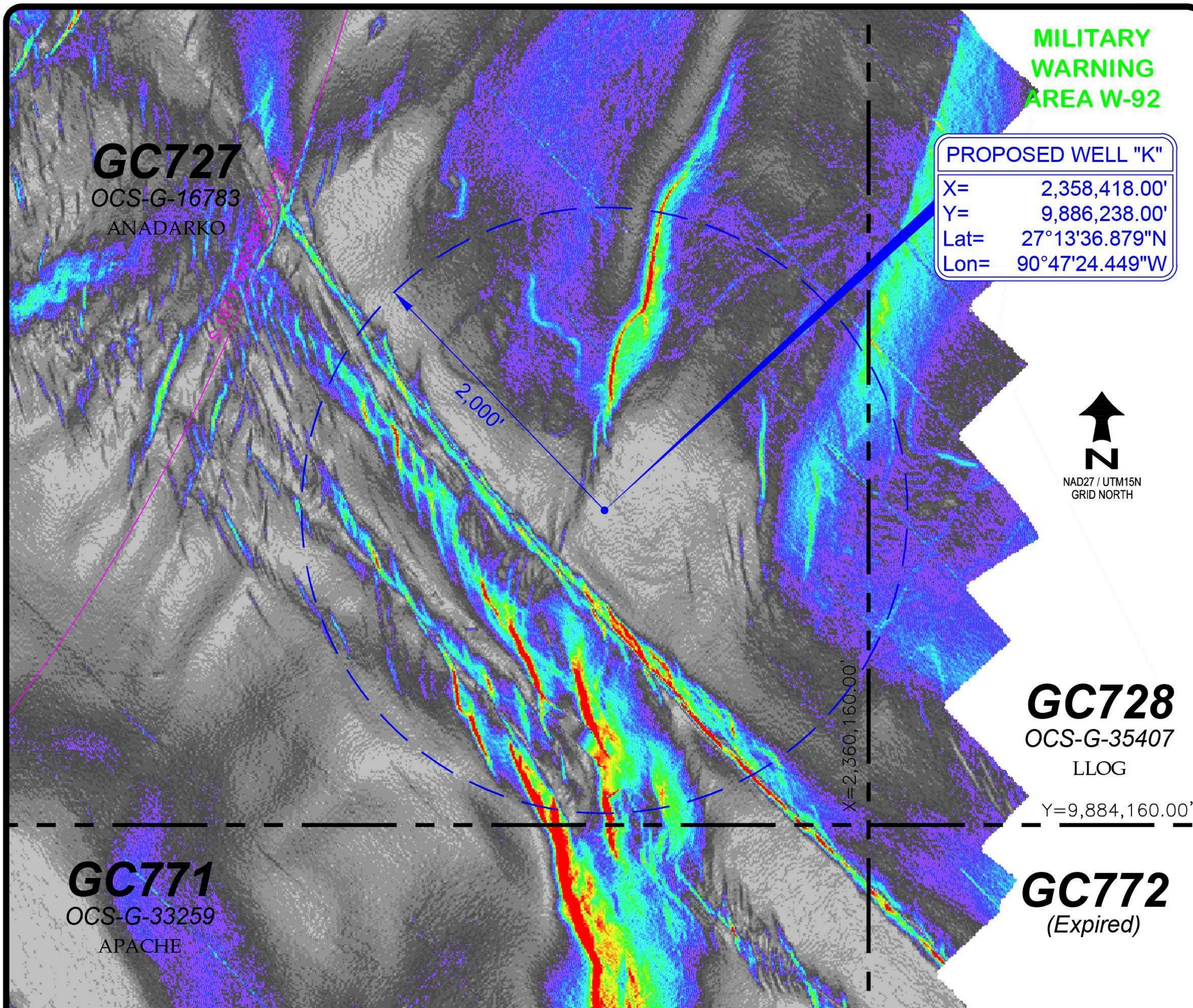
Anadarko Petroleum Corporation

PROPOSED WELL "K"
SIDE SCAN SONAR MOSAIC MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®

730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 3 of 6	REV. 0
FILE: 151051_WELL-K.DWG		



GRADIENT

Gradient is the first order derivative of the multibeam data.

Bin size = 3 meters (9.84 feet)

≥20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

SLOPE IN DEGREES

1,000' 0' 1,000'

SCALE IN US SURVEY FEET

DATE: 04/27/2016 TIME: 11:48 FILENAME: Z:\151051\ACAD\151051_WELL-K.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "K"
SEAFLOOR GRADIENT MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®

730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 2 of 6	REV. 0
FILE: 151051_WELL-K.DWG		

April 27, 2016

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

Attn: Mr. Rick Kincaid

Site Clearance Letter
Proposed Well "KK"
Block 727 (OCS-G-16783)
Green Canyon Area

Mr. Rick,

INTRODUCTION

Anadarko Petroleum Corporation (Anadarko) contracted Oceaneering International, Inc. (OII) to prepare a well site clearance letter for the proposed Well "KK" location of the Calpurnia Prospect in Block 727 (OCS-G-16783), Green Canyon (GC) Area. The data used for the site clearance letter is based on the interpretation of an exploration-quality 3D seismic volume and a high-resolution geophysical dataset collected with OII's Autonomous Underwater Vehicle (AUV) *C-Surveyor III*™. OII completed a geohazard assessment titled "*Shallow Hazard Report, Block 727 (OCS-G-16783) and 771 (OCS-G-33259), Green Canyon Area*" in March, 2016. This site clearance letter is based on the findings provided within that report.

This letter provides a top-hole drilling prognosis and addresses seafloor conditions within a 2,000-foot radius of the proposed surface location. The depth limit of investigation is approximately 2.0 seconds of two-way traveltime (~5,000 feet) below the mud line (BML), or to the salt/sediment interface if it is encountered less than 2.0 seconds below the seafloor. The reporting and mapping presented in this letter comply with the BOEM/BSEE guidelines provided in NTL No. 2008-G05 (Shallow Hazards Program) and No. 2009-G40 (Deepwater Benthic Communities).

METHODS

<u>AUV Survey Data</u>

OII's *C-Surveyor III*™ AUV provided multibeam bathymetric mapping, high-resolution side scan sonar imagery, and subbottom profiles. The AUV remote-sensing instruments include a Simrad EM 2040 Multibeam Echosounder (200, 300, and 400 kHz), an EdgeTech 2200-M Full Spectrum Chirp Dual Frequency Side Scan Sonar (120/410 kHz), and an EdgeTech DW106 Chirp Subbottom Profiler (1.5–4.5 kHz). All the raw digital data were logged utilizing proprietary software developed by OII. The multibeam system delivered a 3-meter gridded dataset with relative vertical accuracies within 20 centimeters.

The AUV survey grid in the study area consisted of 62 main tracklines (Lines 101–114 and 120–167) running northeast to southwest at 200-meter line spacing, 13 ties lines (Lines 201–213) running northwest to southeast at 900-meter line spacing, and 29 in-fill lines (Lines 901–929) run to fill in bathymetry data gaps caused by steep seafloor terrain. Navigation fixes (event marks) were annotated at 125-meter (410-foot) intervals along all survey lines. The survey grid

was designed to provide a representative sampling with the subbottom profiler system and overlapping coverage with side scan sonar and multibeam echosounder systems.

3D Seismic Data

The 3D seismic data used for this assessment was provided in SEG-Y format, and were loaded into IHS' Kingdom Suite 2d/3dPAK for interpretation. The 3D data were acquired by WesternGeco in 1999–2000, and reprocessing was completed in 2006 with Post-Stack Time Migration (PSTM). Inlines and crosslines are depicted on the Surface and Subsurface Features Maps (Sheets 5 and 6). The 3D data were provided at a four-millisecond sample rate and extend to the full data range of 13 seconds. The inlines of the data run southwest to northeast and are spaced at 30-meter (98.43-foot) intervals. The crosslines run southwest to northeast and are spaced at 25-meter (82.02-foot) intervals. Spectral whitening was applied to the 3D seismic dataset to amplify the higher frequencies. After applying the spectral whitening, a power spectrum generated at a few selected locations indicated the seismic data volume contains sufficiently high frequency content for a shallow hazards assessment (Figure 1).

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 (faults, salt, high acoustic impedance, stratigraphic horizons, etc.).

WELL LOCATION

The coordinates and calls for the proposed Well "KK" surface location are tabulated below:

Table 1. Proposed Well "KK"

Easting (feet)	Northing (feet)	Latitude	Longitude	Calls From Block 727, Green Canyon Area	
2,358,354.00'	9,886,161.00'	27°13'36.127"N	90°47'25.173"W	1,806.00' FEL	2,001.00' FSL

A 2,000-foot clearance radius is required for assessing deepwater benthic communities in proximity to the proposed Well "KK".

The geodetic datum used for this project is the North American Datum 1927 (NAD27) with the Clarke 1866 Ellipsoid. The datum is projected using the Universal Transverse Mercator (UTM), Zone 15 North (15N) 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. Mapping and reporting units are in U.S. Survey Feet.

REGIONAL GEOLOGY

The Gulf of Mexico is a semi-enclosed basin that has been receiving sediment influx dominated by the Mississippi River since the Late Jurassic. Mesozoic and Cenozoic sediments have attained a thickness in excess of 9 miles (Coleman et al., 1991). The prograded shelf sequence consists of intercalated coastal plain, delta, estuarine, and marine sediments. Sediment deposition along the northern rim of the Gulf of Mexico resulted in particularly thick Tertiary

and Quaternary sections. These rapidly deposited sediments have prograded the Cretaceous shelf-edge up to 185 miles basinward. The exceptionally high rate of shelf-edge progradation is on the order of 3.0 to 3.7 miles per 1,000 years.

The near surface geology across the Gulf Coast region is the product of fluctuating sea levels associated with climatic variations over the past 20,000 years. During this time, low sea levels left the continental shelf exposed to subaerial weathering and other erosional processes. Streams and rivers meandered and cut into the exposed landmass, depositing bedloads along the modern-day shelf break. Fan systems were formed, and mass movement events were common as deltaic sediments were deposited on the steep upper continental slope. As the climate warmed, seas transgressed, and marine sediments were deposited on the shelf.

The proposed wellsite is located in the northern Gulf of Mexico in an area designated as the Green Canyon Area by the BOEM and BSEE. The study area is located on the middle Texas Louisiana Slope in GC727 and is characterized by extensive faulted/fractured sediments due to salt diapiric uplift.

BATHYMETRY AND SEAFLOOR GRADIENTS

The water depth at the proposed Well "KK" location is 4,675 feet below mean sea level (MSL). Within the 2,000-foot radius centered at the proposed well location, the seafloor depth ranges from 4,548 feet in the north to 4,761 feet in the southeast (Sheet 1, Color Shaded Bathymetry Map).

The proposed well is situated near slightly irregular seafloor atop a relatively smooth section located in the southeast corner of GC727. The seafloor in the area surrounding the proposed well location slopes south at a gradient of 2° (Sheet 2, Seafloor Gradient Map).

SEAFLOOR HAZARDS

Low to moderate sonar and multibeam backscatter reflectivity occurs around the proposed well site indicating mostly fine-grained sediments. Higher acoustic reflectivity in the side scan sonar and backscatter images occur along fault scarps and represent coarser sediments (Figure 2; Sheet 3, Side Scan Sonar Mosaic Map).

The 3D seafloor amplitude image displays low to moderate acoustic amplitudes within the 2,000-foot radius area (Sheet 4, Seafloor Amplitude Map). These low to moderate seafloor amplitudes indicate finely textured seafloor sediments that are likely comprised of hemipelagic clay. One large low amplitude anomaly is located 3,400 feet northwest of the proposed site.

One sonar contact is located within 2,000 feet of the proposed well location. Sonar Contact No. 20 is located 1,910 feet northwest of the well site and measures 17.2 feet long, 5.4 feet wide, and has a height of 2.7 feet.

Multiple surface faults were identified within the 2,000-foot radius (Sheet 5, Seafloor Features Map). These faults typically trend north-south and exhibit seafloor displacement between 1 and 10 feet. One fault, located 395 feet to the north, shows 42 feet of seafloor relief. Slump deposits were noted along the downthrown sides of the fault scarps, and are characterized by slightly irregular and undulating topography and may represent unstable seafloor for construction activities.

POTENTIAL DEEPWATER BENTHIC COMMUNITIES

High or low-amplitude seismic seafloor anomalies are potential indicators of carbonates, benthic community habitats, and gas/fluid seepages. The seafloor at the proposed Well "KK" and surrounding 2,000-foot radius contains no high or low positive seafloor amplitude anomalies associated with fluid expulsion or mounded carbonates representing potential benthic communities. The side scan sonar and multibeam backscatter agree with the seafloor amplitude image, and show no evidence of outcrops or fluid expulsion.

SUBSURFACE GEOHAZARDS AND STRATIGRAPHY

The AUV subbottom profiler data exhibit continuous, sharp bottom echoes with parallel to divergent, continuous reflectors throughout the well site area. The uppermost shallow sediments consist of a 15 foot thick acoustically semi-transparent hemipelagic clay drape. Sediments below this drape are characterized by parallel, low to moderate amplitude reflectors that represent cyclic deposition of hemipelagic clay and silty clays (Figure 3).

Four sedimentary units (Units A to D), each consisting of one or more distinctive sequences, were interpreted within the study area from the 3D seismic data to approximately 0.6 seconds of two-way traveltime (~2,000 feet) below the seafloor, the lower limit of investigation. Five horizons mark the upper and/or lower contacts of each of the successive units (Figures 3 and 4).

Subsurface faulting/fracturing occurs throughout the 2,000-foot vicinity, with most faults trending north-south (Sheet 6, Subsurface Features Map). The stratigraphy throughout the well site area is extremely faulted and fractured due to the shallow salt.

Two mass transport deposits (MTD) were identified within the 2,000-foot radius. The MTDs are generally characterized by chaotic and mixed sequences or lack of visible internal structure, which suggest the integrity of the internal sedimentary structures was lost while moving downslope. MTD 1 is located 1,370 feet southeast and is buried 4 to 10 feet, while MTD 3 is located at the well site and is buried 40 feet.

An acoustic void zone was noted 1,800 feet south of the proposed well site. This void zone is indicative of upward fluid/gas migration and is buried 13 feet below the seafloor.

OII used check shot data from the BOEM web site for a nearby well with a series of time-depth pairs for the sediment column. The following polynomial equation was derived from Total Vertical Depth (TVD) (feet) and the corresponding two-way traveltime (seconds) using the time-depth values to calculate depths below the seafloor:

$$D = 186.45T^2 + 2{,}637.05T$$

where D = depth below sea level in feet and T = time below sea level in seconds.

A detailed description of the sequence units, beginning at the seafloor, can be found in the 2016 Geohazard Report. The Top-Hole Prognosis Chart (Figure 6) summarizes the stratigraphy.

Unit A (Seafloor to Horizon 1)
Unit A consists of low to moderate amplitude, parallel, semi-continuous reflectors and measures 369 feet thick at the proposed well location. The reflection patterns suggest the unit is comprised mostly of hemipelagic clay with a few interbedded mass transport deposits. No high amplitude anomalies occur within Unit A near the proposed well location. Fractured/faulted sediments were identified in the AUV subbottom data within this unit (Figure 3).

Unit B (Horizon 1 to Horizon 2)
Unit B consists of mostly low amplitude, sub-parallel reflectors and measures 561 feet thick at the proposed well location. The unit is interpreted as interbedded channel fill and mass transport deposits. No high amplitude anomalies occur within Unit B near the proposed well location. Fractured/faulted sediments were identified in the 3D seismic data within this unit (Figures 4 and 5).

Unit C (Horizon 2 to Horizon 3)
Unit C consists of low to moderate amplitude, semi-continuous to sub-chaotic reflectors and measures 420 feet thick. This unit is interpreted as a interbedded coarse-grained channel fill and mass transport deposits. Several high amplitude anomalies occur within Unit C, most of which appear next to fault lines which may act as structural traps for the possible gas hazards. The closest of these anomalies is relatively small and is located 200 feet to the west. Fractures/faults were identified in the 3D data within this unit (Figures 4 and 5).

Unit D (Horizon 3 to Salt/Sediment Interface)
Unit D consists of low to moderate amplitude, semi-continuous to chaotic reflectors and measures 444 feet thick. This unit is interpreted as a coarser-grained channel fill and mass transport deposits. Several high amplitude anomalies occur within Unit D, most of which appear next to fault lines which may act as structural traps for the possible gas hazards. The closest of these anomalies is located 1,390 feet to the northwest. Fractures/faults were identified in the 3D data within this unit (Figures 4 and 5). The base of Unit D marks the salt/sediment interface at the proposed well site.

SHALLOW GAS
Anomalies of very high amplitude, commonly termed bright spots, are interpreted as potential regions of fluid saturation usually associated with porous sands. Seismic amplitude anomalies are mapped on a unit-by-unit basis to assess the potential risk of gas. Seismic amplitude anomalies are exhibited on the Subsurface Features Map when present.

The risk of gas refers to the risk of encountering shallow gas. The risk of gas is interpreted based on amplitude levels. Stratigraphic and structural settings may also be taken into account. The four risk levels of gas are:

- **Negligible**—No amplitude anomalies or other gas indicator present.
- **Low risk of gas**—Generally indicated by increased amplitude (2–3× 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× background level) and phase reversal.
- **High risk of gas**—Generally indicated by the highest amplitudes (in excess of 4× 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.

Amplitude anomalies were identified within Units C and D within 2,000 feet of the proposed Well "KK" location. Units A, B, and D are assessed as having a low risk of gas, while Unit C is assessed as having a low to moderate risk of gas.

SHALLOW WATER FLOW

Several factors may contribute to shallow water flows. These include: high porosity and permeability, sand-prone aquifer, mechanism to pressurize, and seal. Additional details are described below:

- **Water depth and burial depth.** Significant water depths (> 500 feet below the seafloor) 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.

All of these factors occur within the study area. Since there is presently no method for quantifying the risk of shallow water flow, caution is recommended when drilling through units with shallow water flow potential. Sands with SWF potential often occur in unconsolidated, overpressured sands that lie below a seal. This seal prevents dewatering and compaction after deposition. The pressure rises with overburden causing a potentially disastrous hazard for drilling operations.

The nearest SWF event, according to information listed on the BOEM and BSEE website, is located approximately 15 miles northeast of the study area in GC644. This SWF event occurred at 644 feet below the seafloor and is listed as minor severity. Several other SWF events have been reported 25–40 miles east of the study area in GC783, GC823, GC825, and GC826. These SWF events are listed as occurring 1,274–5,527 feet below mudline and are all of low severity.

The assessment of seismic profiles suggests that Units A–D all exhibit a low risk of SWF. The numerous faults found in these units would serve to release pressures. 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 between the hydrate and free gas trapped at the base of the hydrate stability zone forms a Bottom Simulating Reflector (BSR) on seismic profiles. This BSR reflector cross cuts 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 deepwater benthic communities may all be found in close association. No indication of BSRs was found in the vicinity of the proposed well.

CONCLUSIONS

The proposed Well "KK" location is situated on a slightly irregular seafloor atop a ridge at a water depth of 4,675 feet MSL. The seabed slopes to south at a gradient of 2°.

Numerous surface faults are located within 2,000 feet of the proposed well site, and typically exhibit between 1 and 10 feet of seafloor relief. One fault, located 395 feet north, measures 42 feet of relief. Slump deposits were noted along the downthrown sides of the fault scarps, and may represent unstable seafloor for construction activities.

One sonar contact (Sonar Contact No. 20) was identified 1,910 feet northwest of the proposed Well "KK" location.

No high or low seafloor amplitudes anomalies that may indicate the occurrence of hardgrounds, carbonates, benthic communities or potential expulsions are found within 2,000 feet of the proposed Well "KK" location.

Four (4) subsurface units interpreted from the 3D seismic data were assessed to approximately 2,500 feet BSF at the proposed Well "KK" location (Units A to D). Unit A is comprised mostly of low to moderate amplitude, parallel, semi-continuous reflectors and consists of hemipelagic clays and interbedded mass transport deposits. Unit B is characterized by mostly low amplitude, sub-parallel reflectors and consists of interbedded channel fill and mass transport deposits. Unit C is comprised of low to moderate amplitude, semi-continuous to sub-chaotic reflectors and is interpreted as interbedded coarse-grained channel fill and mass transport deposits. Unit D is characterized by low to moderate amplitude, semi-continuous to chaotic reflectors and is interpreted as coarser-grained channel fill and mass transport deposits. Subsurface faults and fractures were identified within every unit due to the salt diapiric uplift in the area.

Subsurface amplitude anomalies were identified within Units C and D within 2,000 feet of the proposed Well "KK" location. Units A, B, and D are assessed as having a low risk of gas, while Unit C has a low to moderate risk. No indication of gas hydrates was found within the study area.

Units A–D are all assessed as having a low risk of SWF, due to the numerous faults found in the units which would serve to release pressures.

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

Regards,

Christopher Baker
Senior Geologist

ENCLOSURES

Figure 1. Extracted wavelet and power spectrum at the proposed Well "KK".
Figure 2. Backscatter image showing seafloor near the proposed Well "KK".
Figure 3. Subbottom profiler Line 124 near the proposed Well "KK".
Figure 4. 3D seismic Inline 5730 through the proposed Well "KK".
Figure 5. 3D seismic Crossline 45729 through the proposed Well "KK".
Figure 6. Top-Hole Prognosis Chart for the proposed Well "KK".

Sheet 1.	Color Shaded Bathymetry Map, Proposed Well "KK" Location	1"=1,000'
Sheet 2.	Seafloor Gradient Map, Proposed Well "KK" Location	1"=1,000'
Sheet 3.	Side Scan Sonar Mosaic Map, Proposed Well "KK" Location	1"=1,000'
Sheet 4.	Seafloor Amplitude Map, Proposed Well "KK" Location	1"=1,000'
Sheet 5.	Seafloor Features Map, Proposed Well "KK" Location	1"=1,000'
Sheet 6.	Subsurface Features Map, Proposed Well "KK" Location	1"=1,000'

730 EAST KALISTE SALOOM ROAD, LAFAYETTE, LA 70508

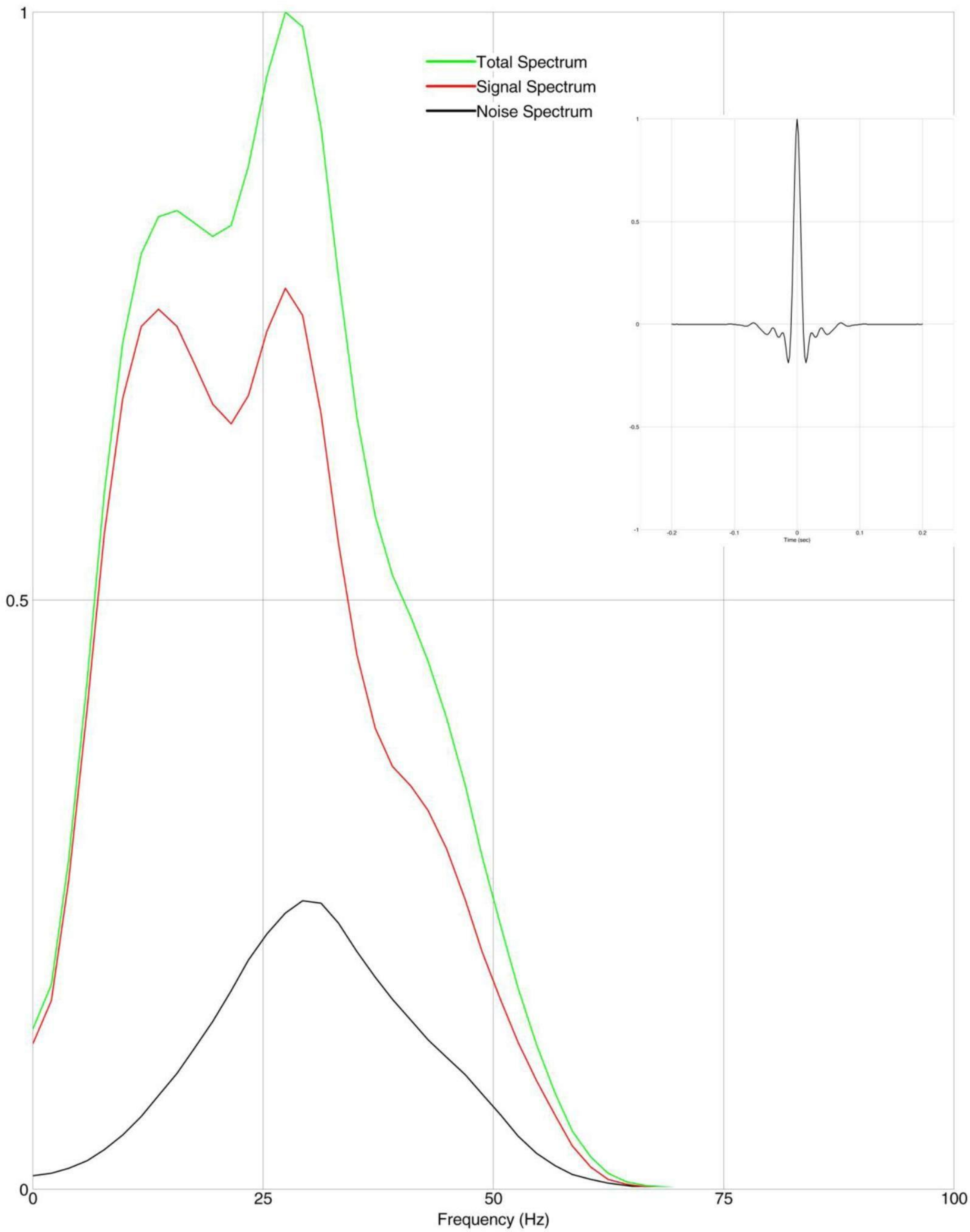


Figure 1. Extracted wavelet and power spectrum at the proposed Well "KK" (1 second).

730 EAST KALISTE SALOOM ROAD, LAFAYETTE, LA 70508

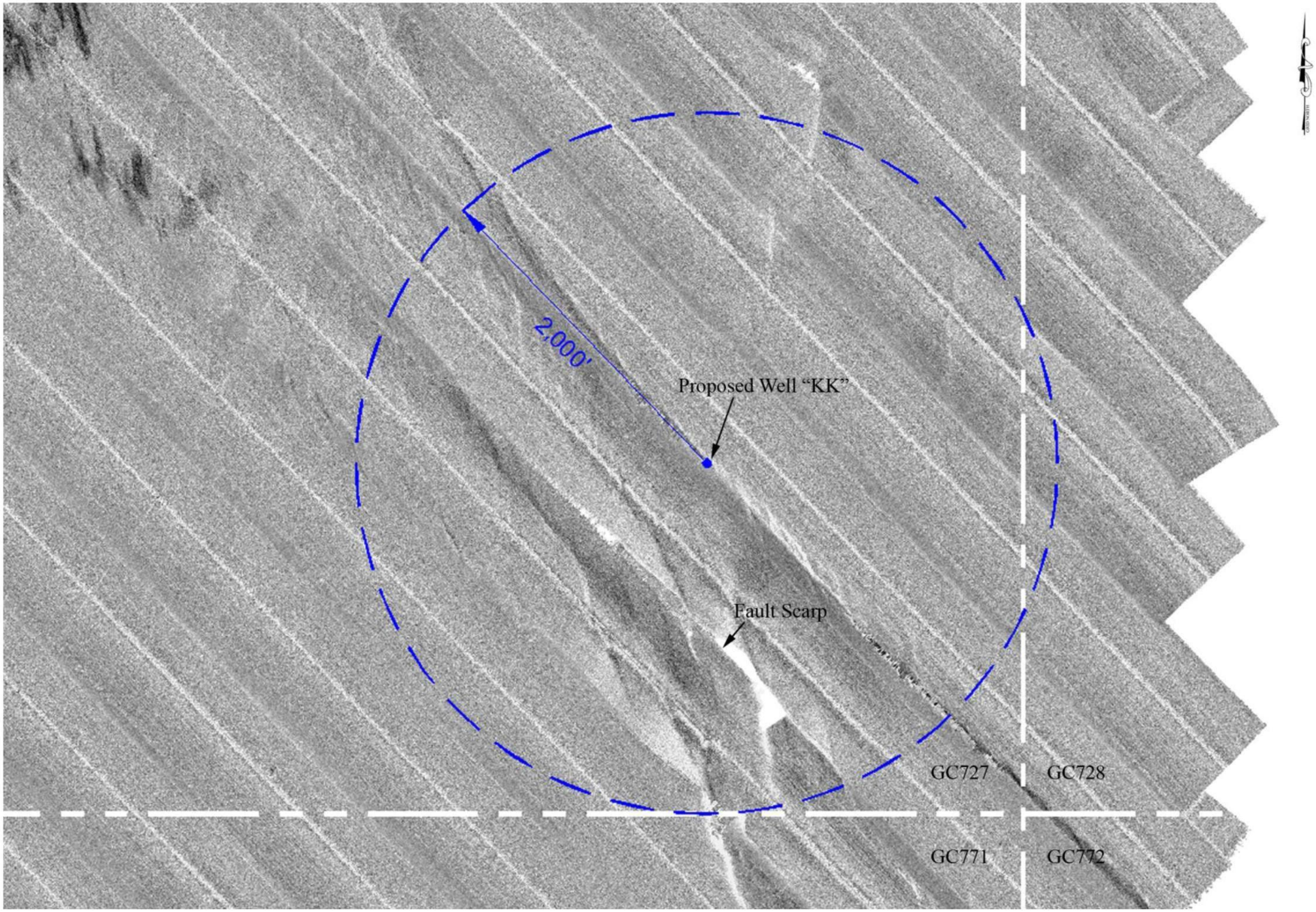


Figure 2. Backscatter image showing seafloor near the proposed Well "KK".

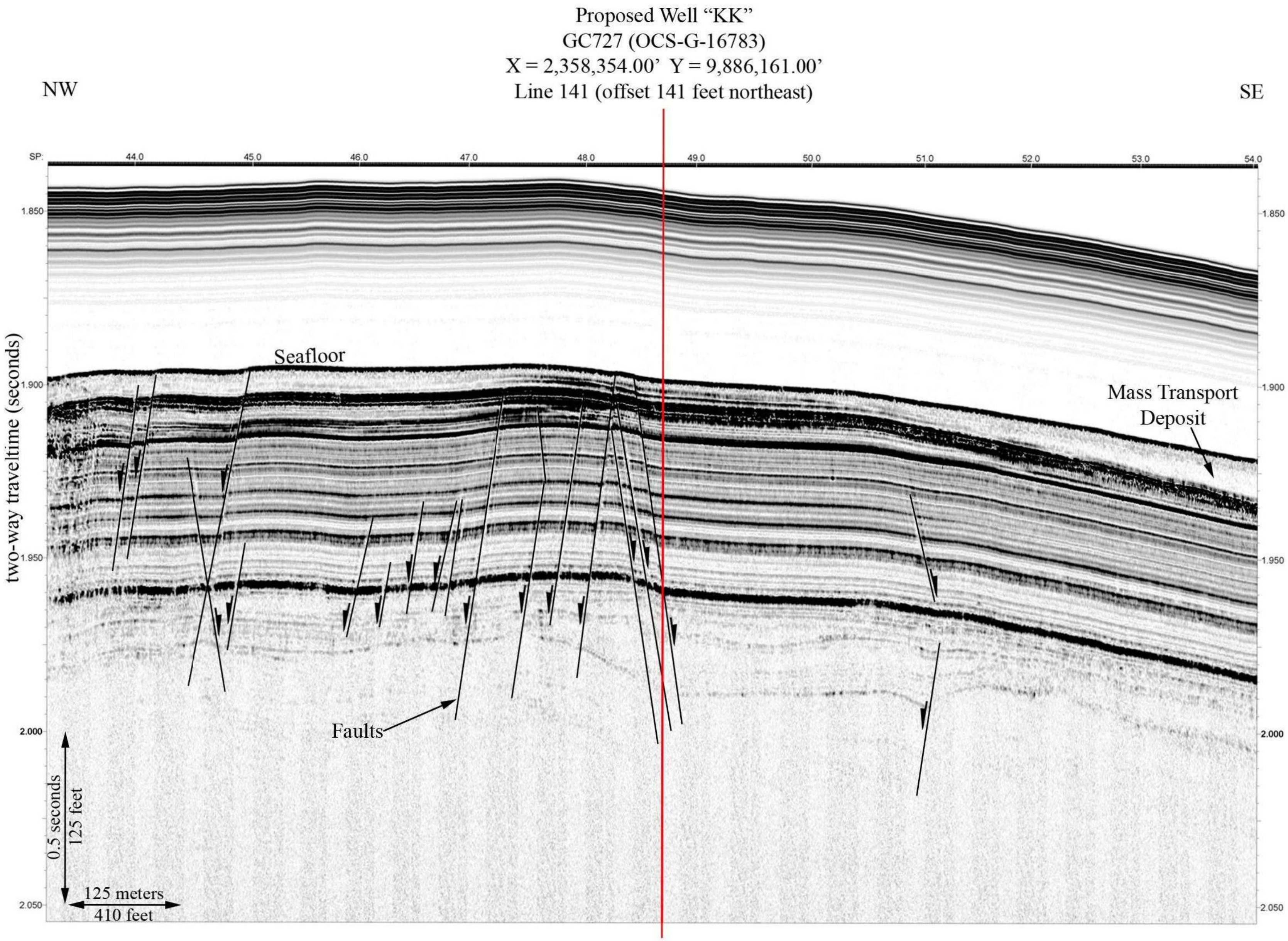


Figure 3. Subbottom profiler Line 124 near the proposed Well "KK".

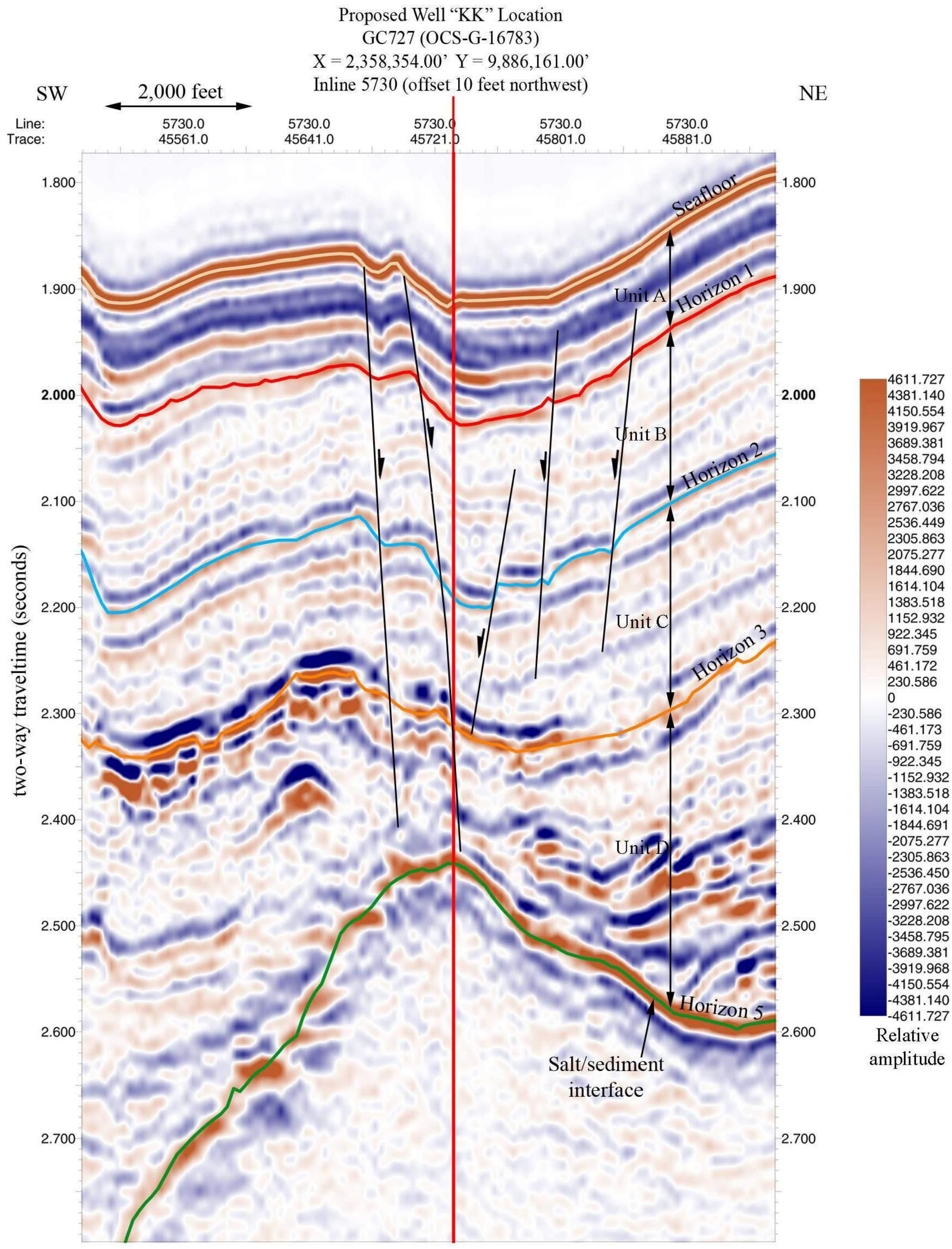


Figure 4. 3D seismic Inline 5730 through the proposed Well "KK".

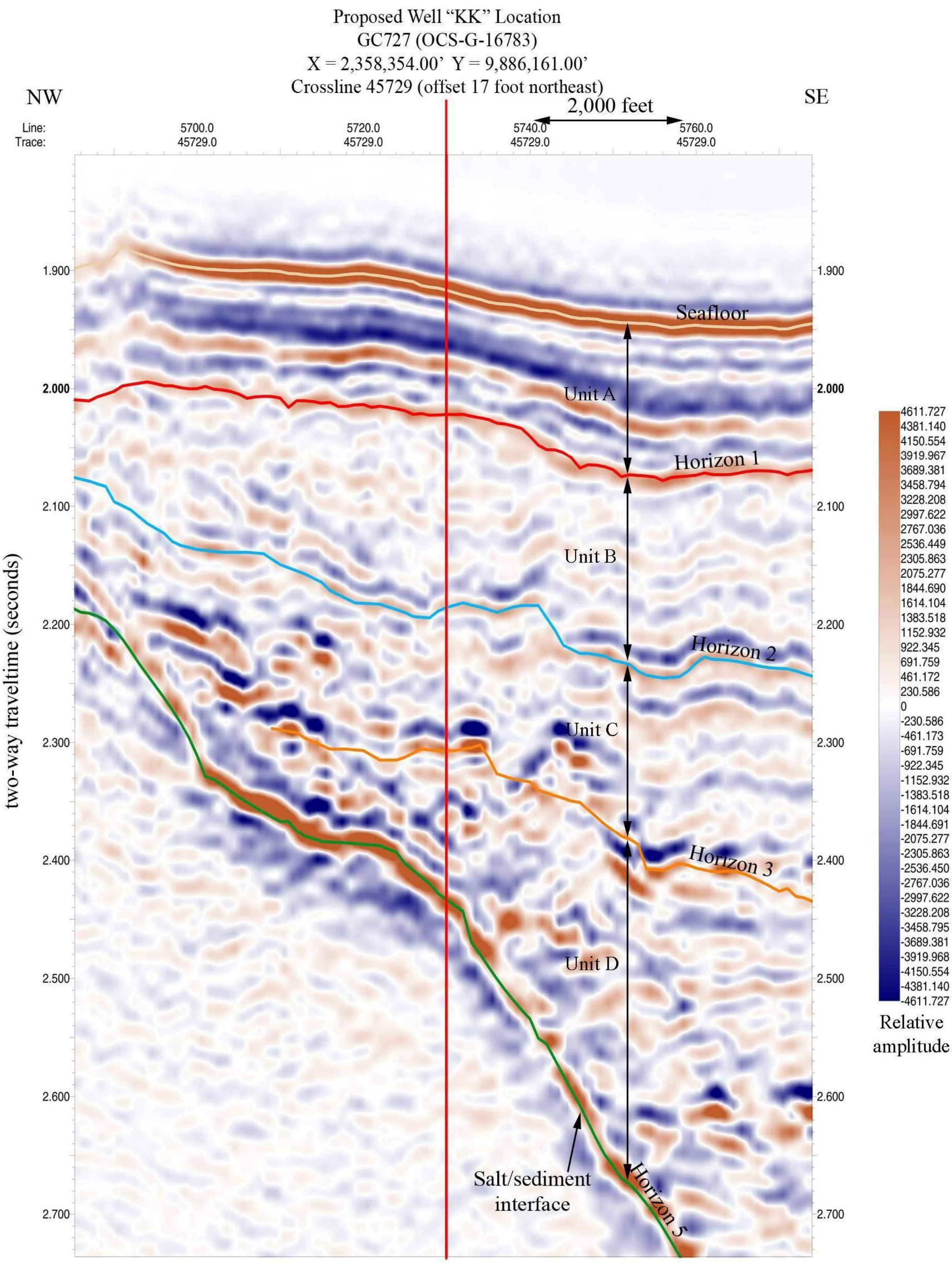
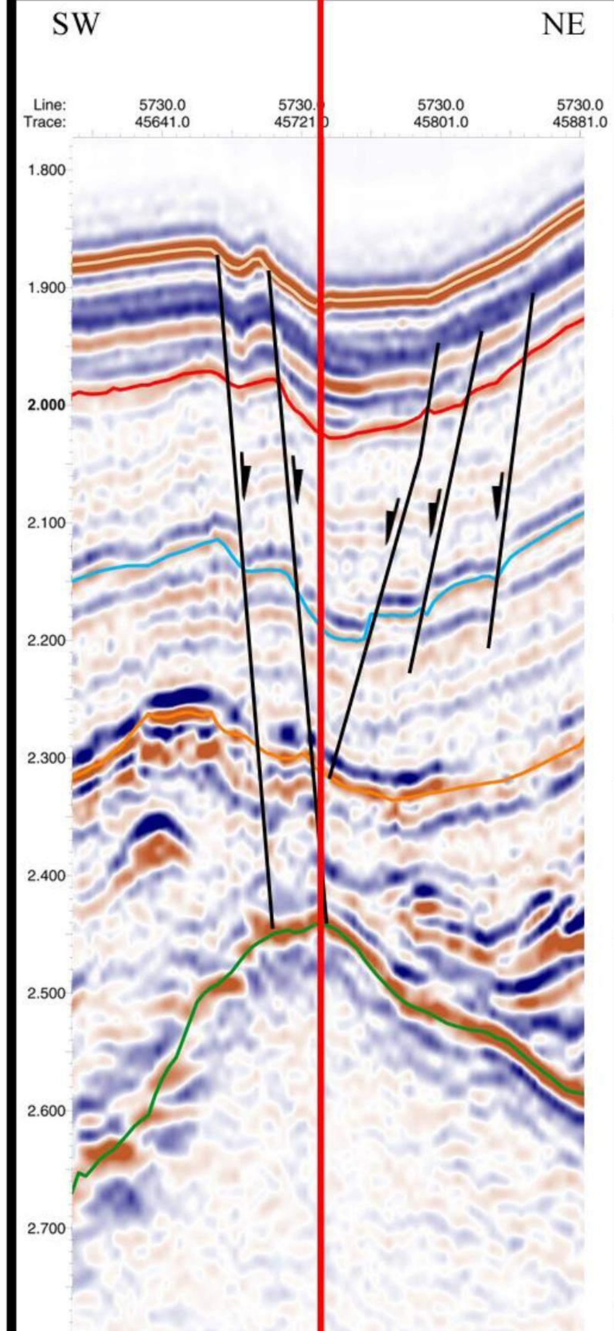


Figure 5. 3D seismic Crossline 45729 through the proposed Well "KK".

Proposed Well “KK” Location
GC727 (OCS-G-16783)
X = 2,358,354.00’ Y = 9,886,161.00’
Inline 5730 (offset 10 feet northwest)

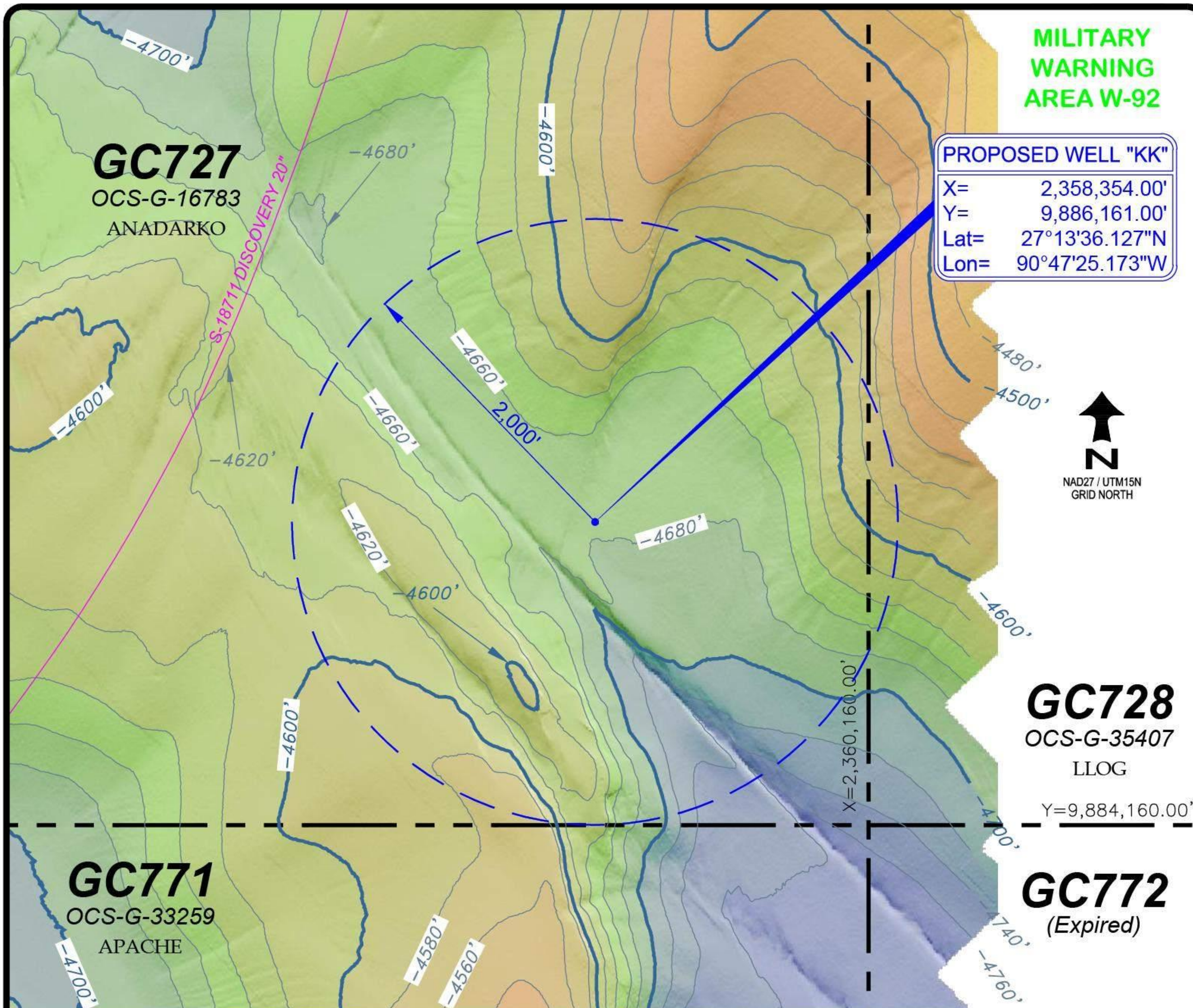


Note: Subsurface depths based on T-D equation
$D = 186.45T^2 + 2,637.05T$

Unit	Horizon	Gas	Water Flow	Depth BML (feet)	Depth MSL (feet)	TWT BSL (sec)	Interval Thickness (feet)	Lithology Description
Subsurface Sequence (Well Intersect)		Water Flow and Gas Potential						
	Seafloor				4,677	1.917		
A	Horizon 1			369	5,046	2.022	369	Drape deposit of hemipelagic clays with interbedded fine-grained mass transport deposits.
B	Horizon 2			930	5,607	2.186	561	Interbedded channel fill and and mass transport deposits. The sediments within Unit B are highly fractured and faulted due to the salt diapiric uplift in the area.
C	Horizon 3			1,351	6,027	2.307	420	Interbedded channel fill and mass transport deposits. The sediments within Unit C are highly fractured and faulted due to the salt diapiric uplift in the area.
D	Salt/Sediment Interface			1,794	6,471	2.433	444	Coarser-grained channel fill and mass transport deposits. The sediments within Unit D are highly fractured and faulted due to the salt diapiric uplift in the area.
	Depth of study							

Hazard Potential: Negligible: (blue) Low: (green) Moderate: (yellow) High: (red)

Figure 6. Top-Hole Prognosis Chart for the proposed Well “KK”.



Multibeam processing sequence

1. Water column velocity corrections applied
2. Tide corrections applied using Goddard Ocean Tide Model GOT99.2
3. Bin size = 3 meters (9.84 feet)
4. Median filter applied
5. Produced gridded-binned dataset using weighted-neighbor algorithm; search radius = 9 meters (29.53 feet)

Contour interval = 20 feet
Zero datum = Mean Sea Level

Color shaded image

Sun azimuth = 0°
Sun elevation = 30°

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

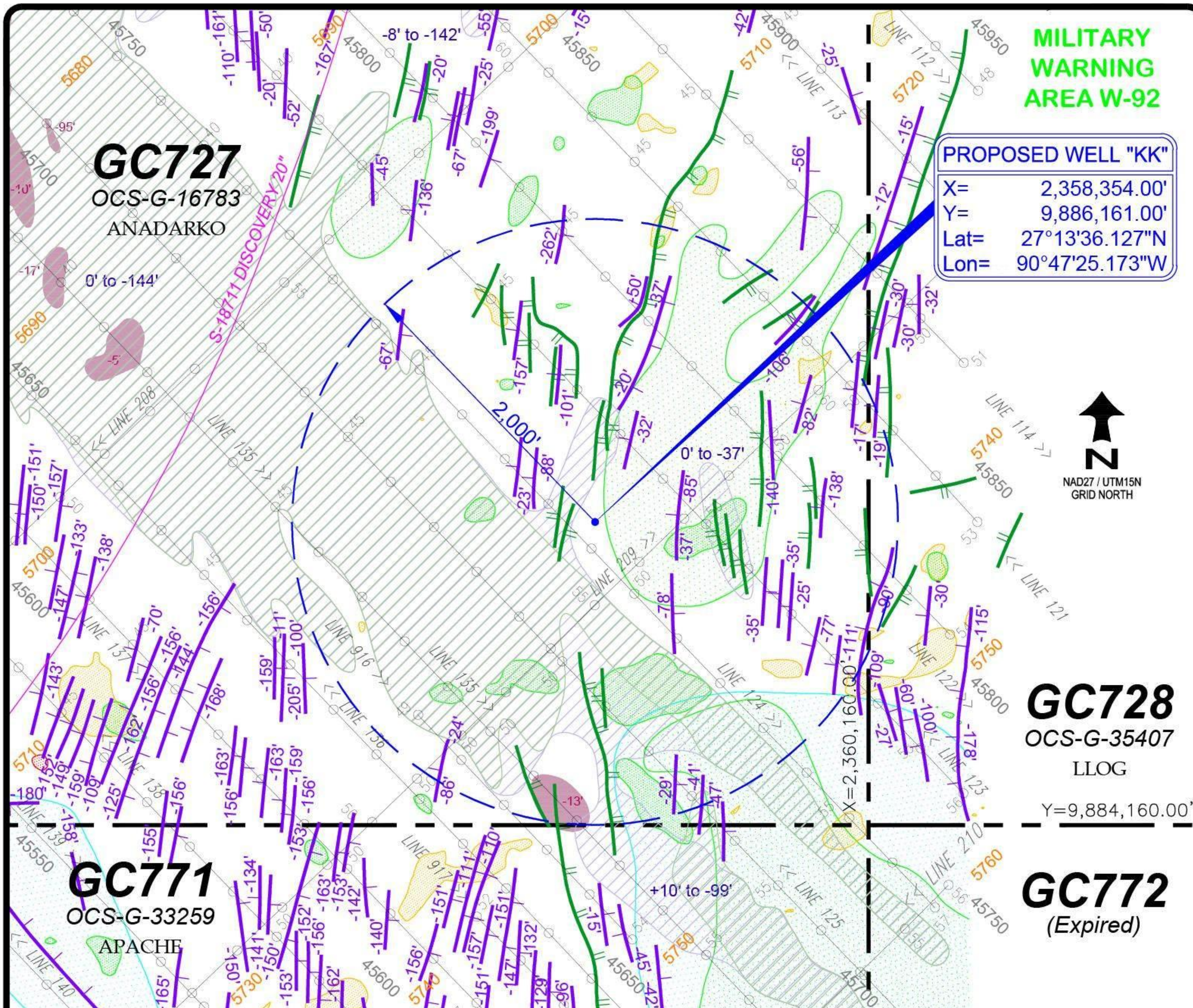
DATE: 04/27/2016 TIME: 13:19 FILENAME: Z:\151051\ACAD\151051_WELL-KK.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "KK"
COLOR SHADED BATHYMETRY MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 1 of 6	REV. 0
FILE: 151051_WELL-KK.DWG		



<< LINE 201 — AUV navigation trackline with name and direction run, fix and fix number	Mass transport deposit 1 (-4' to -10')
	Mass transport deposit 3 (-12' to -63')
5550 — Inline number for 3D seismic data Spacing = 30 meters (98.43 feet)	10' — Acoustic void with depths below seafloor
46300 — Crossline number for 3D seismic data Spacing = 25 meters (82.02 feet); Trace increment = 4	
Fault scarp (Hachures on downthrown side)	Amplitude anomalies within Unit B (1.810 sec. - 2.778 sec. BSL) 104' - 2,379' BML
-10' — Normal fault with depth of burial (Hachures on downthrown side)	Amplitude anomalies within Unit C (1.987 sec. - 2.757 sec. BSL) 434' - 3,543' BML
0' to -144' — Fault zone with depth range of burial; Scarp zone	Amplitude anomalies within Unit C (1.987 sec. - 2.757 sec. BSL) 434' - 3,543' BML

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

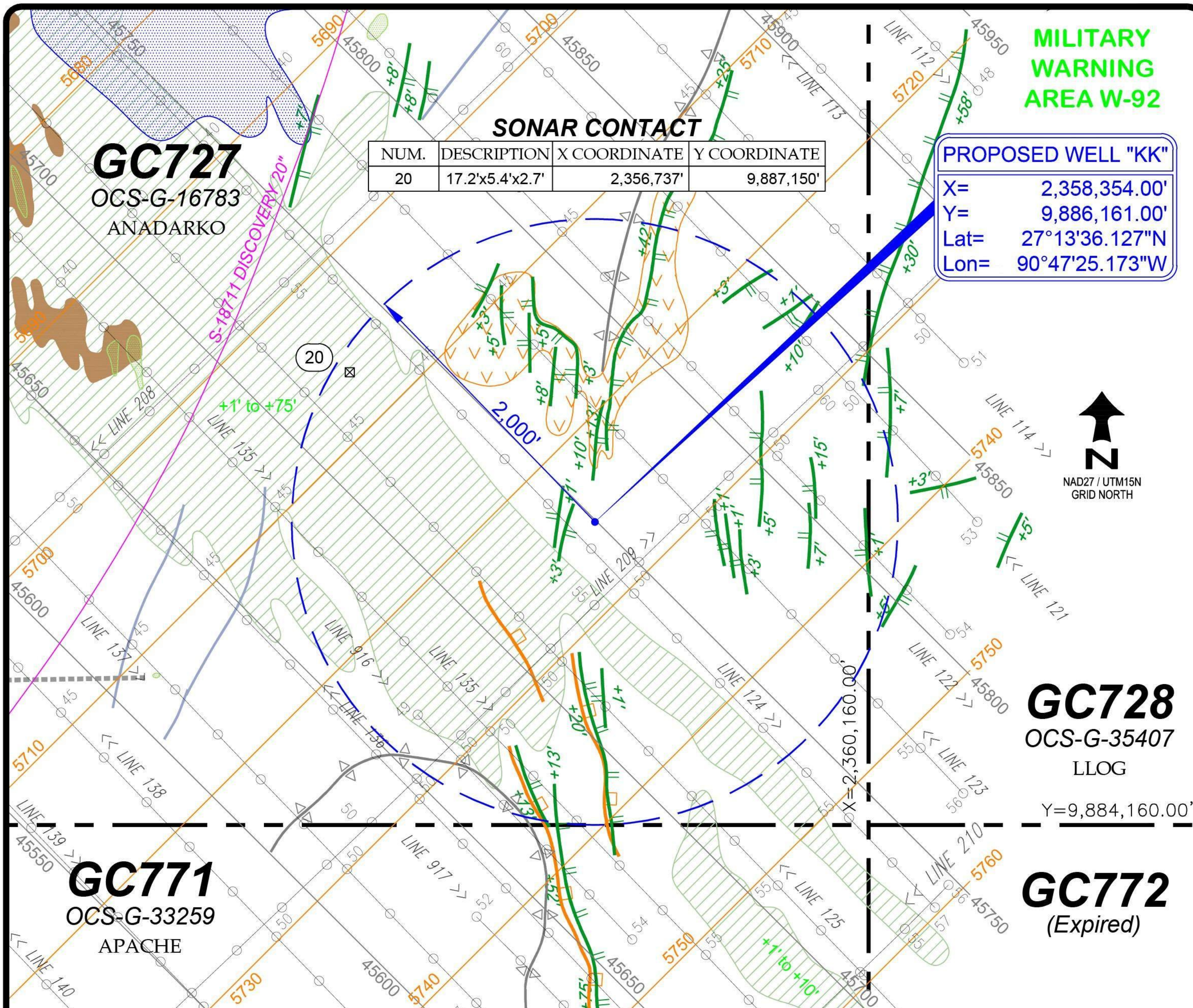
DATE: 04/27/2016 TIME: 13:20 FILENAME: Z:\151051\ACAD\151051_WELL-KK.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "KK"
SUBSURFACE FEATURES MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 6 of 6	REV. 0
FILE: 151051_WELL-KK.DWG		



SONAR CONTACT

NUM.	DESCRIPTION	X COORDINATE	Y COORDINATE
20	17.2'x5.4'x2.7'	2,356,737'	9,887,150'

<< LINE 201	AUV navigation trackline with name and direction run, fix and fix number	+10'	Fault scarp with seafloor displacement (Hachures on downthrown side)
5550	Inline and inline number for 3D seismic data Spacing = 30 meters (98.43 feet)	+1' to +75'	Scarp zone with seafloor displacement range
46300	Crossline and crossline number for 3D seismic data Spacing = 25 meters (82.02 feet); Trace increment = 4		Drag scar; Gullies / Channels
20	Sonar contact and reference number		Pockmarks; Slump
	Headwall scarp; Ridge		Hardgrounds / Outcrops; 3D seismic low amplitude anomaly

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

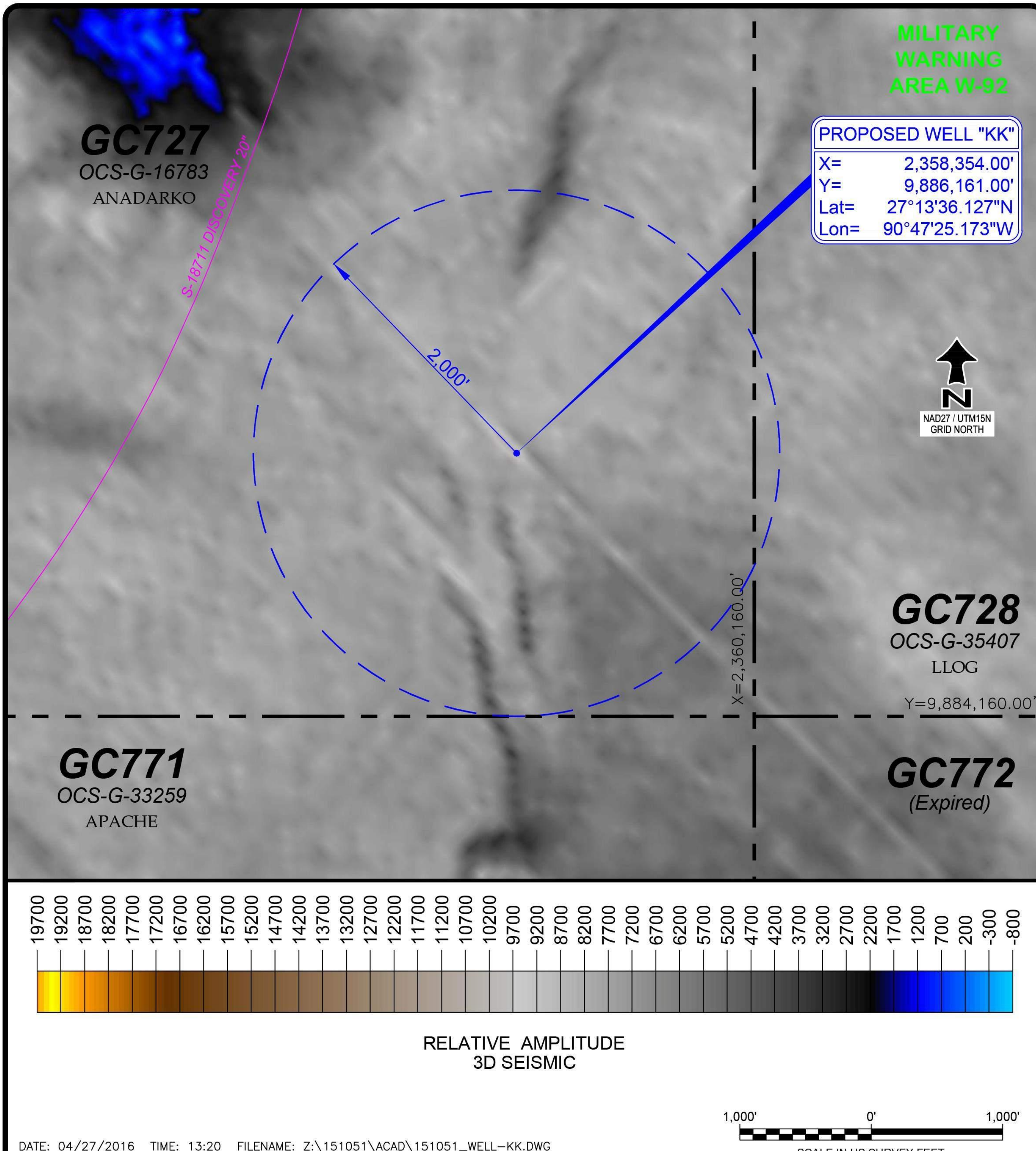
DATE: 04/27/2016 TIME: 13:20 FILENAME: Z:\151051\ACAD\151051_WELL-KK.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "KK"
SEAFLOOR FEATURES MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016
DRAWN: A. McBride	SHEET 5 of 6 — REV. 0
FILE: 151051_WELL-KK.DWG	



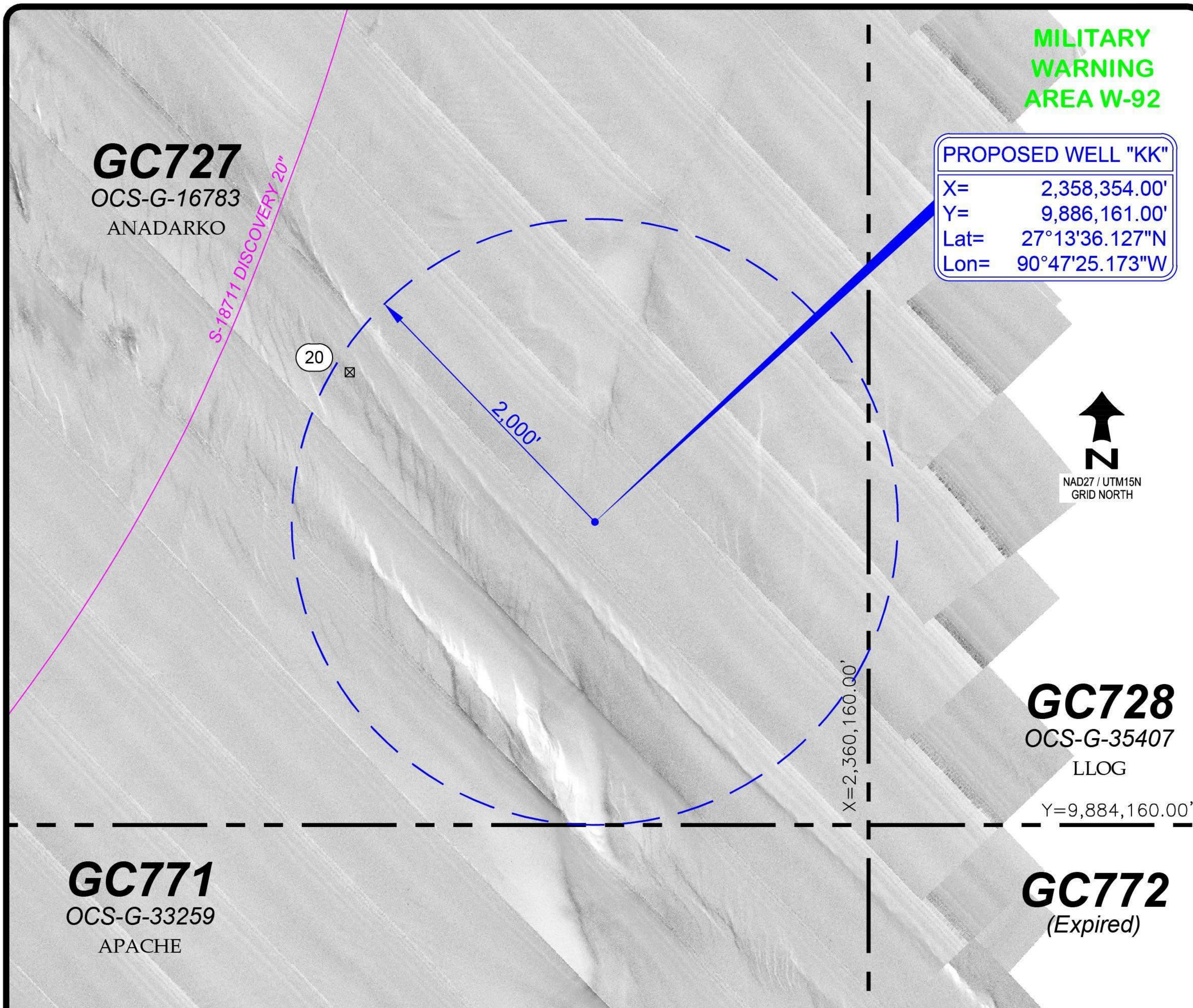
DATE: 04/27/2016 TIME: 13:20 FILENAME: Z:\151051\ACAD\151051_WELL-KK.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "KK"
SEAFLOOR AMPLITUDE MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 4 of 6	REV. 0
FILE: 151051_WELL-KK.DWG		



SONAR MOSAIC
Dark returns represent higher seafloor reflectivity.

SONAR CONTACT

NUM.	DESCRIPTION	X COORDINATE	Y COORDINATE
20	17.2'x5.4'x2.7'	2,356,737'	9,887,150'

1,000' 0' 1,000'
SCALE IN US SURVEY FEET

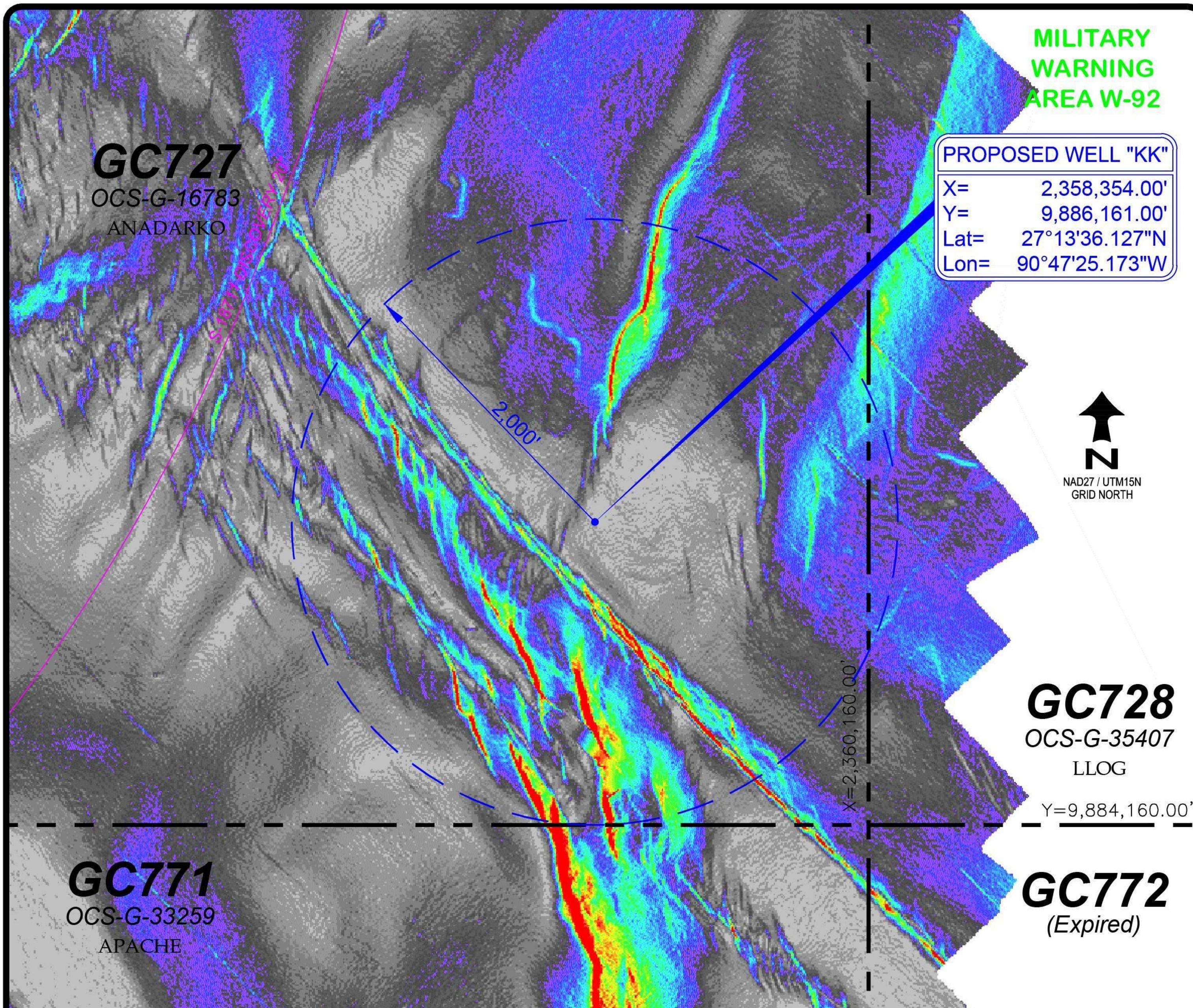
DATE: 04/27/2016 TIME: 13:19 FILENAME: Z:\151051\ACAD\151051_WELL-KK.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "KK"
SIDE SCAN SONAR MOSAIC MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®
730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016
DRAWN: A. McBride	SHEET 3 of 6 — REV. 0
FILE: 151051_WELL-KK.DWG	



GRADIENT

Gradient is the first order derivative of the multibeam data.

Bin size = 3 meters (9.84 feet)

≥20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

SLOPE IN DEGREES

1,000' 0' 1,000'

SCALE IN US SURVEY FEET

DATE: 04/27/2016 TIME: 13:19 FILENAME: Z:\151051\ACAD\151051_WELL-KK.DWG

Anadarko Petroleum Corporation

PROPOSED WELL "KK"
SEAFLOOR GRADIENT MAP
Block 727 (OCS-G-16783)
Green Canyon Area

PREPARED BY: OCEANEERING®

730 E. KALISTE SALOOM RD.
LAFAYETTE, LA 70508
(337) 210-0000
LA Reg. No. 747

JOB No: 151051, 172082	DATE: Apr. 27, 2016	
DRAWN: A. McBride	SHEET 2 of 6	REV. 0
FILE: 151051_WELL-KK.DWG		

D
HYDROGEN SULFIDE INFORMATION

The proposed GC 727 wells will test a new stratigraphic section in the Caesar/Tonga basin. Geochemical studies suggest that the basin has only one source rock, and so hydrocarbons already being produced on the GC 726 and GC 727 blocks should be similar, if not identical, to any fluids encountered by this test. The supra-salt section has previously been penetrated by the Chevron GC 727-1 within 2 miles of the proposed wells and had no recorded amounts of Hydrogen Sulfide. The sub-salt section has been penetrated by up to 20 wells (including sidetracks) in GC 726, 727 and 683 (the Caesar/Tonga field). These wells range from 2-5 miles from the current test.

None of these penetrations encountered any Hydrogen Sulfide within the supra or sub-salt section. **Since no (H2S) was encountered in any of these wells we request the area be classified as a "zone where the absence of H2s has been confirmed."**

E
BIOLOGICAL, PHYSICAL, AND SOCIOECONOMIC INFORMATION

(a) Chemosynthetic Communities Report

The seafloor disturbing activities proposed in this plan are in approximately 4,522' – 4,675' of water. The wells will be drilled with a DP Drillship or DP Semisubmersible drilling unit.

Maps

A map prepared using 3-D seismic data to depict bathymetry, seafloor and shallow geological features, and surface location of the proposed well is included in Section A.

Analysis

Features or areas that could support high-density chemosynthetic communities are not located within 2000 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.

(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:

pecies	Scientific Name	Status	Potential Presence		Critical Habitat Designated in Gulf of Mexico
			Lease Area	Coastal	
Marine Mammals					
Sei whale	*Balaenoptera borealis*	E	X[a]	--	None
Blue whale	*Balaenoptera musculus*	E	X[a]	--	None
Fin whale	*Balaenoptera physalus*	E	X[a]	--	None
North Atlantic right whale	*Eubalaena glacialis*	E	X[a]	--	None
Humpback whale	*Megaptera novaeangliae*	E	X[a]	--	None
Sperm whale	*Physeter macrocephalus*	E	X	--	None
West Indian manatee	*Trichechus manatus latirostris*	E	--	X	Florida (Peninsular)
Sea Turtles					
Loggerhead turtle	*Caretta caretta*	T	X	X	None
Green turtle	*Chelonia mydas*	T, E[b]	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)
Smalltooth sawfish	*Pristis pectinata*	E	--	X	Southwest Florida and the Florida Keys
Invertebrates					
Elkhorn coral	*Acropora palmata*	E	--	X	Flower Garden Banks
Terrestrial Mammals					
Beach mice (Alabama, Choctawhatchee, Perdido Key, St. Andrew)	*Peromyscus polionotus*	E	--	X	Alabama and Florida (Panhandle) beaches

Abbreviations: E = endangered; T = threatened.

[a] The blue, fin, humpback, North Atlantic right, and sei whales are rare or extralimital in the Gulf of Mexico and are unlikely to be present in the lease area.

[b] The green sea turtle is threatened, except for the Florida breeding population, which is listed as endangered.

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

(h) Archaeological Report

Green Canyon Block 727 is not located in an area designated as having high archaeological potential and, as such, an Archaeological Report is not required per NTL No. 2011-JOINT-G01. However, an Archaeological Report prepared by C&C Technologies Survey Services covering the proposed well locations is being submitted along with this Supplemental Exploration Plan. The survey was conducted in accordance with the latest guidelines established by the BOEMRE in 2011.

(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.

(a) Projected Generated Wastes

Type of Waste	Composition	Projected Amount	Treatment/Storage/Disposal
Synthetic-based drilling fluids	Synthetic-based drilling muds	20,000 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	5,000 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)	80,000 bbls/well**	Discharge overboard or at seafloor
Cuttings wetted with water-based fluids	Cuttings coated with water-based drilling muds/fluids	2,000 bbls/well	Discharge overboard
Chemical product waste (well treatment fluids)	Ethylene glycol Methanol	2,800 bbls 700 bbls	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	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	1,400 bbls total	Transport to shore in disposal bags by vessel to shorebase for pickup by municipal operations.
Sanitary Wastes*	Treated human body waste	4,200,000 gals total	Chlorinate and discharge overboard
Domestic Waste*	Gray water	4,200,000 gals total	Chlorinate and discharge overboard
Deck drainage	Platform washings and rainwater	2,940,000 bbls total	Treat for oil and grease and discharge overboard
Produced water	N/A	N/A	N/A
Desalinization Unit	Seawater	294,000 bbls total	Discharge overboard
Wash water	Drill water (fresh)	42,000 bbls total	Discharge overboard
Blowout preventer fluid	Blend (3% Stack Magic & Filtered Fresh Water)	111,000 gals total	Discharge at seafloor
Ballast water	Seawater	47,650 m3/year	Discharge overboard

Bilge water	Seawater	266,280 bbls total	Discharge overboard through 15 ppm equipment
Excess cement at the seafloor	Nitrified cement slurry	1,200 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	3,010 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 28,000 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 80,000 bbls/well (NOTE: there will be six wells drilled for a total of 480,000 bbls).*

(b) Projected Ocean Discharges

Type of Waste	Total Amount to be Discharged	Discharge Rate	Discharge Method
Sanitary Wastes*	4,200,000 gals total	25 gals per person daily	Chlorinate and discharge overboard
Domestic waste*	4,200,000 gals total	25 gals per person daily	Chlorinate and discharge overboard
Deck drainage	2,940,000 bbls total	3500 bbls/day	Treat for oil and grease and discharge overboard
Blowout preventer fluid	111,000 gals total	925 gals/week/well; Vents on a weekly basis	Discharge at seafloor
Desalinization Unit	294,000 bbls total	350 bbls/day	Discharge overboard
Wash water	42,000 bbls total	50 bbls/day	Discharge overboard
Ballast water	47,650 m3/year	Not continuous	Discharge overboard
Bilge water	266,280 bbls total	317 bbls/day	Discharge overboard through 15 ppm equipment
Excess cement at the seafloor	7,200 bbls total	20 bbls/min	Discharge at seafloor
Fire water	115,199,280 bbls total	137,142 bbls/day	Discharge overboard
Cooling water	115,199,280 bbls total	137,142 bbls/day	Discharge overboard
Cuttings wetted with Water-based fluids	12,000 bbls total	1,000 bbls/hr max	Discharge overboard
Water-based drilling fluids**	480,000 bbls total**	1,000 bbls/hr max	Discharge at seafloor or overboard
Cuttings wetted with Synthetic-based fluids	30,000 bbls total	NA	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 28,000 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 80,000 bbls/well (NOTE: there will be six wells drilled for a total of 480,000 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 *Noble Bob Douglas*. The *Noble Bob Douglas* 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, therefore Anadarko has opted to calculate the plan emission amounts based on the total horsepower rating and 40% average engine load. The complex total amounts bring forward emissions approved under previous plans to reflect current assumptions. 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:

If drilled with a DP Drillship or DP Semi (Horsepower equal to or less than the Noble Bob Douglas):

Air Pollutant		Plan Emission Amounts[1] (tons)	Calculated Exemption Amounts[2] (tons)		Calculated Complex Total Emission Amounts[3] (tons)
Particulate matter (PM)		42.78	4062.60		100.91
Sulphur dioxide (SO_2)		196.28	4062.60		462.97
Nitrogen oxides (NO_x)		1472.09	4062.60		3471.79
Volatile organic compounds (VOC)		45.33	4062.60		106.48
Carbon monoxide (CO)		328.64	83634.50		772.40

The air emission calculations were calculated by:

Teri Powell
Regulatory Analyst
(832) 636-1261
teri.powell@anadarko.com

OMB Control No. 1010-0151
OMB Approval Expires: 12/31/14

EXPLORATION PLAN (EP)
AIR QUALITY SCREENING CHECKLIST

COMPANY	Anadarko Petroleum Corporation
AREA	Green Canyon
BLOCK	GC 727
LEASE	OCS-G 16783
PLATFORM	N/A
WELL	GC 727 H, HH, I, J, K, KK
COMPANY CONTACT	Teri Powell
TELEPHONE NO.	832-636-1261
REMARKS	Drill and Complete 6 Wells with Surface Locations in GC 727

EMISSIONS FACTORS

Fuel Usage Conversion Factors	Natural Gas Turbines		Natural Gas Engines		Diesel Recip. Engine		REF.	DATE
	SCF/hp-hr	9.524	SCF/hp-hr	7.143	GAL/hp-hr	0.0483	AP42 3.2-1	4/76 & 8/84

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	1.468	14	1.12	3.03	AP42 3.3-1	10/96
Diesel Recip. > 600 hp.	gms/hp-hr	0.32	1.468	11	0.33	2.4	AP42 3.4-1	10/96
Diesel Boiler	lbs/bbl	0.084	2.42	0.84	0.008	0.21	AP42 1.3-12,14	9/98
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	0.4	% weight
Produced Gas(Flares)	3.33	ppm
Produced Oil (Liquid Flaring)	1	% weight

EMISSIONS CALCULATIONS 1ST YEAR

COMPANY	AREA	BLOCK	LEASE		PLATFORM	WELL		CONTACT	PHONE	REMARKS
Anadarko Petroleum Co	Green Canyon	GC 727	OCS-G 16783		N/A	GC 727 H, HH, I, J, K, KK		Teri Powell	832-636-1261	Added additional completion vessels & dedicated work boat (see assumptions under Emission 1 t

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	64370	1243.6284	40%	29847.08	24	140	18.15	83.26	623.85	18.72	136.11	30.49	139.87	1048.07	31.44	228.67
	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	0	18.15	83.26	623.85	18.72	136.11	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BURNER diesel	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	AUXILIARY EQUIP<600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 trips/week	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	60	5.22	23.94	179.36	5.38	39.13	3.76	17.23	129.14	3.87	28.18
2 trips/week	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	40	3.27	14.98	112.25	3.37	24.49	1.57	7.19	53.88	1.62	11.76
Flowback Vessel 1	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 2	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Workboat	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Stim Boat	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
	VESSELS>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FACILITY	DERRICK BARGE diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INSTALLATION	MATERIAL TUG diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(crew)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(supply)	0	0		0.00	0	0	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	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		833333			24	2		0.49	59.50	50.25	323.75		0.01	1.43	1.21	7.77
2017 YEAR TOTAL								76.64	352.10	2694.16	129.29	898.58	42.78	196.28	1472.09	45.33	328.64
EXEMPTION CALCULATION	DISTANCE FROM LAND IN MILES												4062.60	4062.60	4062.60	4062.60	83634.50
	122.0																

EMISSIONS CALCULATIONS 1ST YEAR

COMPANY	AREA	BLOCK	LEASE		PLATFORM	WELL		CONTACT			PHONE	REMARKS					
Anadarko Petroleum Corporat	Green Canyon	GC 727	OCS-G 16783		N/A	GC 727 H, HH, I, J, K, KK			Teri Powell		832-636-1261	Added additional completion vessels & dedicated work boat (see assumptions under Emission 1 tab)					
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 S-7791	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	140	18.15	83.26	623.85	18.72	136.11	30.49	139.87	1048.07	31.44	228.67
	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	0	18.15	83.26	623.85	18.72	136.11	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BURNER diesel	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	AUXILIARY EQUIP<600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 trips/week	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	60	5.22	23.94	179.36	5.38	39.13	3.76	17.23	129.14	3.87	28.18
2 trips/week	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	40	3.27	14.98	112.25	3.37	24.49	1.57	7.19	53.88	1.62	11.76
Flowback Vessel 1	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 2	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Workboat	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Stim Boat	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
	VESSELS>600hp diesel(tugs)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FACILITY	DERRICK BARGE diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INSTALLATION	MATERIAL TUG diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(crew)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(supply)	0	0		0.00	0	0	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	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		833333			24	2		0.49	59.50	50.25	323.75		0.01	1.43	1.21	7.77
2018 YEAR TOTAL								**76.64**	**352.10**	**2694.16**	**129.29**	**898.58**	**42.78**	**196.28**	**1472.09**	**45.33**	**328.64**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**												**4062.60**	**4062.60**	**4062.60**	**4062.60**	**83634.50**
	122.0																

EMISSIONS CALCULATIONS 1ST YEAR

COMPANY	AREA	BLOCK	LEASE		PLATFORM	WELL		CONTACT	PHONE	REMARKS
Anadarko Petroleum Corpora	Green Canyon	GC 727	OCS-G 16783		N/A	GC 727 H, HH, I, J, K, KK		Teri Powell	832-636-1261	Added additional completion vessels & dedicated work boat (see assumptions under Emission 1 tab)

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 S-7791	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	140	18.15	83.26	623.85	18.72	136.11	30.49	139.87	1048.07	31.44	228.67
	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	0	18.15	83.26	623.85	18.72	136.11	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BURNER diesel	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	AUXILIARY EQUIP<600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 trips/week	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	60	5.22	23.94	179.36	5.38	39.13	3.76	17.23	129.14	3.87	28.18
2 trips/week	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	40	3.27	14.98	112.25	3.37	24.49	1.57	7.19	53.88	1.62	11.76
Flowback Vessel 1	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 2	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Workboat	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Stim Boat	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
	VESSELS>600hp diesel(tugs)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FACILITY	DERRICK BARGE diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INSTALLATION	MATERIAL TUG diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(crew)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(supply)	0	0		0.00	0	0	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	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		833333			24	2		0.49	59.50	50.25	323.75		0.01	1.43	1.21	7.77
2019 YEAR TOTAL								**76.64**	**352.10**	**2694.16**	**129.29**	**898.58**	**42.78**	**196.28**	**1472.09**	**45.33**	**328.64**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**												**4062.60**	**4062.60**	**4062.60**	**4062.60**	**83634.50**
	122.0																

EMISSIONS CALCULATIONS 1ST YEAR

COMPANY	AREA	BLOCK	LEASE		PLATFORM	WELL		CONTACT	PHONE	REMARKS
Anadarko Petroleum Cor	Green Canyon	GC 727	OCS-G 16783		N/A	GC 727 H, HH, I, J, K, KK		Teri Powell	832-636-1261	Added additional completion vessels & dedicated work boat (see assumptions under Emission 1 tab)

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 S-7791	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	140	18.15	83.26	623.85	18.72	136.11	30.49	139.87	1048.07	31.44	228.67
	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	0	18.15	83.26	623.85	18.72	136.11	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BURNER diesel	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	AUXILIARY EQUIP<600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 trips/week	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	60	5.22	23.94	179.36	5.38	39.13	3.76	17.23	129.14	3.87	28.18
2 trips/week	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	40	3.27	14.98	112.25	3.37	24.49	1.57	7.19	53.88	1.62	11.76
Flowback Vessel 1	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 2	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Workboat	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Stim Boat	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
	VESSELS>600hp diesel(tugs)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FACILITY	DERRICK BARGE diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INSTALLATION	MATERIAL TUG diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(crew)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(supply)	0	0		0.00	0	0	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	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		833333			24	**2**		0.49	59.50	50.25	323.75		0.01	1.43	1.21	7.77
2020	**YEAR TOTAL**							**76.64**	**352.10**	**2694.16**	**129.29**	**898.58**	**42.78**	**196.28**	**1472.09**	**45.33**	**328.64**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**												**4062.60**	**4062.60**	**4062.60**	**4062.60**	**83634.50**
	122.0																

EMISSIONS CALCULATIONS 1ST YEAR

COMPANY	AREA	BLOCK	LEASE		PLATFORM	WELL		CONTACT	PHONE	REMARKS
Anadarko Petroleum Corp	Green Canyon	GC 727	OCS-G 16783		N/A	GC 727 H, HH, I, J, K, KK		Teri Powell	832-636-1261	Added additional completion vessels & dedicated work boat (see assumptions under Emission 1 tab)

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	64370	1243.6284	40%	29847.08	24	140	18.15	83.26	623.85	18.72	136.11	30.49	139.87	1048.07	31.44	228.67
	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	0	18.15	83.26	623.85	18.72	136.11	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BURNER diesel	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	AUXILIARY EQUIP<600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 trips/week	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	60	5.22	23.94	179.36	5.38	39.13	3.76	17.23	129.14	3.87	28.18
2 trips/week	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	40	3.27	14.98	112.25	3.37	24.49	1.57	7.19	53.88	1.62	11.76
Flowback Vessel 1	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 2	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Workboat	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Stim Boat	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
	VESSELS>600hp diesel(tugs)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FACILITY	DERRICK BARGE diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INSTALLATION	MATERIAL TUG diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(crew)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(supply)	0	0		0.00	0	0	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	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		833333			24	**2**		0.49	59.50	50.25	323.75		0.01	1.43	1.21	7.77
2021	**YEAR TOTAL**							**76.64**	**352.10**	**2694.16**	**129.29**	**898.58**	**42.78**	**196.28**	**1472.09**	**45.33**	**328.64**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**												**4062.60**	**4062.60**	**4062.60**	**4062.60**	**83634.50**
	122.0																

EMISSIONS CALCULATIONS 1ST YEAR

COMPANY	AREA	BLOCK	LEASE		PLATFORM	WELL		CONTACT	PHONE	REMARKS
Anadarko Petroleum Corp	Green Canyon	GC 727	OCS-G 16783		N/A	GC 727 H, HH, I, J, K, KK		Teri Powell	832-636-1261	Added additional completion vessels & dedicated work boat (see assumptions under Emission 1 tab)

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	64370	1243.6284	40%	29847.08	24	140	18.15	83.26	623.85	18.72	136.11	30.49	139.87	1048.07	31.44	228.67
	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	0	18.15	83.26	623.85	18.72	136.11	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BURNER diesel	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	AUXILIARY EQUIP<600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 trips/week	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	60	5.22	23.94	179.36	5.38	39.13	3.76	17.23	129.14	3.87	28.18
2 trips/week	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	40	3.27	14.98	112.25	3.37	24.49	1.57	7.19	53.88	1.62	11.76
Flowback Vessel 1	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 2	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Workboat	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Stim Boat	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
	VESSELS>600hp diesel(tugs)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FACILITY	DERRICK BARGE diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INSTALLATION	MATERIAL TUG diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(crew)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(supply)	0	0		0.00	0	0	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	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		833333			24	**2**		0.49	59.50	50.25	323.75		0.01	1.43	1.21	7.77
2022	**YEAR TOTAL**							**76.64**	**352.10**	**2694.16**	**129.29**	**898.58**	**42.78**	**196.28**	**1472.09**	**45.33**	**328.64**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**												**4062.60**	**4062.60**	**4062.60**	**4062.60**	**83634.50**
	122.0																

SUMMARY

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL
Anadarko Petro	Green Canyon	GC 727	OCS-G 16783	N/A	GC 727 H, HH, I, J, K, KK

Year	Emitted Substance				
	PM	SOx	NOx	VOC	CO
2017	42.78	196.28	1472.09	45.33	328.64
2018	42.78	196.28	1472.09	45.33	328.64
2019	42.78	196.28	1472.09	45.33	328.64
2020	42.78	196.28	1472.09	45.33	328.64
2021	42.78	196.28	1472.09	45.33	328.64
2022	42.78	196.28	1472.09	45.33	328.64
2023	0.00	0.00	0.00	0.00	0.00
2024	0.00	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00	0.00
2026	0.00	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00	0.00
2028	0.00	0.00	0.00	0.00	0.00
2029	0.00	0.00	0.00	0.00	0.00
2030	0.00	0.00	0.00	0.00	0.00
2031	0.00	0.00	0.00	0.00	0.00
2032	0.00	0.00	0.00	0.00	0.00
2033	0.00	0.00	0.00	0.00	0.00
2034	0.00	0.00	0.00	0.00	0.00
2035	0.00	0.00	0.00	0.00	0.00
2036	0.00	0.00	0.00	0.00	0.00
2037	0.00	0.00	0.00	0.00	0.00
Allowable	4062.60	4062.60	4062.60	4062.60	83634.50

OMB Control No. 1010-0151
OMB Approval Expires: 12/31/14

EXPLORATION PLAN (EP)
AIR QUALITY SCREENING CHECKLIST

COMPANY	Anadarko Petroleum Corporation
AREA	Green Canyon
BLOCK	GC 727
LEASE	OCS-G 16783
PLATFORM	N/A
WELL	GC 727 H, HH, I, J, K, KK
COMPANY CONTACT	Teri Powell
TELEPHONE NO.	832-636-1261
REMARKS	Complex Totals: Drill and Complete 6 Wells with Surface Locations in GC 727 combined with previously approved locations under S-7791. Emissions are being brought forward from S-7791.

EMISSIONS FACTORS

Fuel Usage Conversion Factors	Natural Gas Turbines		Natural Gas Engines		Diesel Recip. Engine		REF.	DATE
	SCF/hp-hr	9.524	SCF/hp-hr	7.143	GAL/hp-hr	0.0483	AP42 3.2-1	4/76 & 8/84

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	1.468	14	1.12	3.03	AP42 3.3-1	10/96
Diesel Recip. > 600 hp.	gms/hp-hr	0.32	1.468	11	0.33	2.4	AP42 3.4-1	10/96
Diesel Boiler	lbs/bbl	0.084	2.42	0.84	0.008	0.21	AP42 1.3-12,14	9/98
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	0.4	% weight
Produced Gas(Flares)	3.33	ppm
Produced Oil (Liquid Flaring)	1	% weight

EMISSIONS CALCULATIONS 1ST YEAR

COMPANY	AREA	BLOCK	LEASE		PLATFORM	WELL		CONTACT	PHONE	REMARKS
Anadarko Petroleum Corporation	Green Canyon	GC 727	OCS-G 16783		N/A	GC 727 H, HH, I, J, K, KK		Teri Powell	832-636-1261	Added additional completion vessels & dedicated work boat

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 S-7791	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	200	18.15	83.26	623.85	18.72	136.11	43.56	199.81	1497.24	44.92	326.67
DRILLING	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	140	18.15	83.26	623.85	18.72	136.11	30.49	139.87	1048.07	31.44	228.67
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BURNER diesel	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	AUXILIARY EQUIP<600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 trips/week S-7791	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	86	5.22	23.94	179.36	5.38	39.13	5.37	24.62	184.48	5.53	40.25
3 trips/week	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	60	5.22	23.94	179.36	5.38	39.13	3.76	17.23	129.14	3.87	28.18
2 trips/week S-7791	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	57	3.27	14.98	112.25	3.37	24.49	2.24	10.27	76.97	2.31	16.79
2 trips/week	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	40	3.27	14.98	112.25	3.37	24.49	1.57	7.19	53.88	1.62	11.76
Flowback Vessel 1 S-7791	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 1	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 2 S-7791	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Flowback Vessel 2	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Support Vessel S-7791	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Workboat S-7791	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Workboat	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Stim Boat S-7791	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
Stim Boat	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
	VESSELS>600hp diesel(tugs)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FACILITY	DERRICK BARGE diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INSTALLATION	MATERIAL TUG diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(crew)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(supply)	0	0		0.00	0	0	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	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		833333			24	4		0.49	59.50	50.25	323.75		0.02	2.86	2.41	15.54
2017 YEAR TOTAL								116.99	537.20	4081.11	170.90	1201.19	100.91	462.97	3471.79	106.48	772.40
EXEMPTION CALCULATION	DISTANCE FROM LAND IN MILES												4062.60	4062.60	4062.60	4062.60	83634.50
	122.0																

EMISSIONS CALCULATIONS 1ST YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL	CONTACT	PHONE	REMARKS
Anadarko Petroleum Corporation	Green Canyon	GC 727	OCS-G 16783	N/A	GC 727 H, HH, I, J, K, KK	Teri Powell	832-636-1261	Added additional completion vessels & dedicated work boat

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 S-7791	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	200	18.15	83.26	623.85	18.72	136.11	43.56	199.81	1497.24	44.92	326.67
DRILLING	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	140	18.15	83.26	623.85	18.72	136.11	30.49	139.87	1048.07	31.44	228.67
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BURNER diesel	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	AUXILIARY EQUIP<600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 trips/week S-7791	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	86	5.22	23.94	179.36	5.38	39.13	5.37	24.62	184.48	5.53	40.25
3 trips/week	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	60	5.22	23.94	179.36	5.38	39.13	3.76	17.23	129.14	3.87	28.18
2 trips/week S-7791	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	57	3.27	14.98	112.25	3.37	24.49	2.24	10.27	76.97	2.31	16.79
2 trips/week	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	40	3.27	14.98	112.25	3.37	24.49	1.57	7.19	53.88	1.62	11.76
Flowback Vessel 1 S-7791	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 1	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 2 S-7791	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Flowback Vessel 2	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Support Vessel S-7791	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Workboat S-7791	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Workboat	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Stim Boat S-7791	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
Stim Boat	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
	VESSELS>600hp diesel(tugs)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FACILITY	DERRICK BARGE diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INSTALLATION	MATERIAL TUG diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(crew)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(supply)	0	0		0.00	0	0	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	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		833333			24	4		0.49	59.50	50.25	323.75		0.02	2.86	2.41	15.54
2018	YEAR TOTAL							116.99	537.20	4081.11	170.90	1201.19	100.91	462.97	3471.79	106.48	772.40
EXEMPTION CALCULATION	DISTANCE FROM LAND IN MILES												4062.60	4062.60	4062.60	4062.60	83634.50
	122.0																

EMISSIONS CALCULATIONS 1ST YEAR

COMPANY	AREA	BLOCK	LEASE		PLATFORM	WELL		CONTACT	PHONE	REMARKS
Anadarko Petroleum Corporation	Green Canyon	GC 727	OCS-G 16783		N/A	GC 727 H, HH, I, J, K, KK		Teri Powell	832-636-1261	Added additional completion vessels & dedicated work boat

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 S-7791	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	200	18.15	83.26	623.85	18.72	136.11	43.56	199.81	1497.24	44.92	326.67
DRILLING	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	140	18.15	83.26	623.85	18.72	136.11	30.49	139.87	1048.07	31.44	228.67
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BURNER diesel	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	AUXILIARY EQUIP<600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 trips/week S-7791	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	86	5.22	23.94	179.36	5.38	39.13	5.37	24.62	184.48	5.53	40.25
3 trips/week	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	60	5.22	23.94	179.36	5.38	39.13	3.76	17.23	129.14	3.87	28.18
2 trips/week S-7791	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	57	3.27	14.98	112.25	3.37	24.49	2.24	10.27	76.97	2.31	16.79
2 trips/week	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	40	3.27	14.98	112.25	3.37	24.49	1.57	7.19	53.88	1.62	11.76
Flowback Vessel 1 S-7791	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 1	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 2 S-7791	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Flowback Vessel 2	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Support Vessel S-7791	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Workboat S-7791	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Workboat	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Stim Boat S-7791	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
Stim Boat	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
	VESSELS>600hp diesel(tugs)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FACILITY	DERRICK BARGE diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INSTALLATION	MATERIAL TUG diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(crew)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(supply)	0	0		0.00	0	0	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	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		833333			24	4		0.49	59.50	50.25	323.75		0.02	2.86	2.41	15.54
2019 YEAR TOTAL								**116.99**	**537.20**	**4081.11**	**170.90**	**1201.19**	**100.91**	**462.97**	**3471.79**	**106.48**	**772.40**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**												**4062.60**	**4062.60**	**4062.60**	**4062.60**	**83634.50**
	122.0																

EMISSIONS CALCULATIONS 1ST YEAR

COMPANY	AREA	BLOCK	LEASE		PLATFORM	WELL		CONTACT	PHONE	REMARKS
Anadarko Petroleum Corporation	Green Canyon	GC 727	OCS-G 16783		N/A	GC 727 H, HH, I, J, K, KK		Teri Powell	832-636-1261	Added additional completion vessels & dedicated work boat

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 S-7791	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	200	18.15	83.26	623.85	18.72	136.11	43.56	199.81	1497.24	44.92	326.67
DRILLING	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	140	18.15	83.26	623.85	18.72	136.11	30.49	139.87	1048.07	31.44	228.67
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BURNER diesel	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	AUXILIARY EQUIP<600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 trips/week S-7791	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	86	5.22	23.94	179.36	5.38	39.13	5.37	24.62	184.48	5.53	40.25
3 trips/week	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	60	5.22	23.94	179.36	5.38	39.13	3.76	17.23	129.14	3.87	28.18
2 trips/week S-7791	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	57	3.27	14.98	112.25	3.37	24.49	2.24	10.27	76.97	2.31	16.79
2 trips/week	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	40	3.27	14.98	112.25	3.37	24.49	1.57	7.19	53.88	1.62	11.76
Flowback Vessel 1 S-7791	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 1	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 2 S-7791	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Flowback Vessel 2	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Support Vessel S-7791	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Workboat S-7791	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Workboat	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Stim Boat S-7791	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
Stim Boat	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
	VESSELS>600hp diesel(tugs)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FACILITY	DERRICK BARGE diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INSTALLATION	MATERIAL TUG diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(crew)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(supply)	0	0		0.00	0	0	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	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		833333			24	4		0.49	59.50	50.25	323.75		0.02	2.86	2.41	15.54
	2020 YEAR TOTAL							116.99	537.20	4081.11	170.90	1201.19	100.91	462.97	3471.79	106.48	772.40
EXEMPTION CALCULATION	DISTANCE FROM LAND IN MILES												4062.60	4062.60	4062.60	4062.60	83634.50
	122.0																

EMISSIONS CALCULATIONS 1ST YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL	CONTACT	PHONE	REMARKS
Anadarko Petroleum Corporation	Green Canyon	GC 727	OCS-G 16783	N/A	GC 727 H, HH, I, J, K, KK	Teri Powell	832-636-1261	Added additional completion vessels & dedicated work boat

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 S-7791	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	200	18.15	83.26	623.85	18.72	136.11	43.56	199.81	1497.24	44.92	326.67
DRILLING	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	140	18.15	83.26	623.85	18.72	136.11	30.49	139.87	1048.07	31.44	228.67
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BURNER diesel	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	AUXILIARY EQUIP<600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 trips/week S-7791	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	86	5.22	23.94	179.36	5.38	39.13	5.37	24.62	184.48	5.53	40.25
3 trips/week	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	60	5.22	23.94	179.36	5.38	39.13	3.76	17.23	129.14	3.87	28.18
2 trips/week S-7791	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	57	3.27	14.98	112.25	3.37	24.49	2.24	10.27	76.97	2.31	16.79
2 trips/week	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	40	3.27	14.98	112.25	3.37	24.49	1.57	7.19	53.88	1.62	11.76
Flowback Vessel 1 S-7791	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 1	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 2 S-7791	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Flowback Vessel 2	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Support Vessel S-7791	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Workboat S-7791	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Workboat	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Stim Boat S-7791	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
Stim Boat	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
	VESSELS>600hp diesel(tugs)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FACILITY	DERRICK BARGE diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INSTALLATION	MATERIAL TUG diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(crew)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(supply)	0	0		0.00	0	0	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	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		833333			24	4		0.49	59.50	50.25	323.75		0.02	2.86	2.41	15.54
2021 YEAR TOTAL								**116.99**	**537.20**	**4081.11**	**170.90**	**1201.19**	**100.91**	**462.97**	**3471.79**	**106.48**	**772.40**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**												**4062.60**	**4062.60**	**4062.60**	**4062.60**	**83634.50**
	122.0																

EMISSIONS CALCULATIONS 1ST YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL	CONTACT	PHONE	REMARKS
Anadarko Petroleum Corporation	Green Canyon	GC 727	OCS-G 16783	N/A	GC 727 H, HH, I, J, K, KK	Teri Powell	832-636-1261	Added additional completion vessels & dedicated work boat

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 S-7791	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	200	18.15	83.26	623.85	18.72	136.11	43.56	199.81	1497.24	44.92	326.67
DRILLING	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	140	18.15	83.26	623.85	18.72	136.11	30.49	139.87	1048.07	31.44	228.67
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BURNER diesel	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	AUXILIARY EQUIP<600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 trips/week S-7791	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	86	5.22	23.94	179.36	5.38	39.13	5.37	24.62	184.48	5.53	40.25
3 trips/week	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	60	5.22	23.94	179.36	5.38	39.13	3.76	17.23	129.14	3.87	28.18
2 trips/week S-7791	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	57	3.27	14.98	112.25	3.37	24.49	2.24	10.27	76.97	2.31	16.79
2 trips/week	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	40	3.27	14.98	112.25	3.37	24.49	1.57	7.19	53.88	1.62	11.76
Flowback Vessel 1 S-7791	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 1	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 2 S-7791	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Flowback Vessel 2	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Support Vessel S-7791	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Support Vessel	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Workboat S-7791	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Workboat	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	140	3.27	14.98	112.25	3.37	24.49	5.49	25.17	188.59	5.66	41.15
Stim Boat S-7791	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
Stim Boat	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
	VESSELS>600hp diesel(tugs)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FACILITY	DERRICK BARGE diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
INSTALLATION	MATERIAL TUG diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(crew)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(supply)	0	0		0.00	0	0	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	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		833333			24	4		0.49	59.50	50.25	323.75		0.02	2.86	2.41	15.54
2022 YEAR TOTAL								**116.99**	**537.20**	**4081.11**	**170.90**	**1201.19**	**100.91**	**462.97**	**3471.79**	**106.48**	**772.40**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**												**4062.60**	**4062.60**	**4062.60**	**4062.60**	**83634.50**
	122.0																

EMISSIONS CALCULATIONS 1ST YEAR

COMPANY	AREA	BLOCK	LEASE		PLATFORM	WELL		CONTACT	PHONE	REMARKS
Anadarko Petroleum Corporation	Green Canyon	GC 727	OCS-G 16783		N/A	GC 727 H, HH, I, J, K, KK		Teri Powell	832-636-1261	Added additional completion vessels & dedicated work boat

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 S-7791	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	200	18.15	83.26	623.85	18.72	136.11	43.56	199.81	1497.24	44.92	326.67
	PRIME MOVER>600hp diesel	0	0		0.00	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BURNER diesel	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	AUXILIARY EQUIP<600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 trips/week S-7791	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	86	5.22	23.94	179.36	5.38	39.13	5.37	24.62	184.48	5.53	40.25
2 trips/week S-7791	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	57	3.27	14.98	112.25	3.37	24.49	2.24	10.27	76.97	2.31	16.79
Flowback Vessel 1 S-7791	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 2 S-7791	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Support Vessel S-7791	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Workboat S-7791	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	200	3.27	14.98	112.25	3.37	24.49	7.84	35.95	269.41	8.08	58.78
Stim Boat S-7791	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
	VESSELS>600hp diesel(tugs)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FACILITY INSTALLATION	DERRICK BARGE diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	MATERIAL TUG diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(crew)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(supply)	0	0		0.00	0	0	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	0				0.00					0.00	
DRILLING WELL TEST	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
	GAS FLARE		833333			24	**2**		0.49	59.50	50.25	323.75		0.01	1.43	1.21	7.77
2023 YEAR TOTAL								**58.50**	**268.85**	**2070.30**	**110.57**	**762.47**	**60.48**	**277.48**	**2080.52**	**63.58**	**461.39**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES** 122.0												**4062.60**	**4062.60**	**4062.60**	**4062.60**	**83634.50**

EMISSIONS CALCULATIONS 1ST YEAR

COMPANY	AREA	BLOCK	LEASE		PLATFORM	WELL		CONTACT	PHONE	REMARKS
Anadarko Petroleum Corporation	Green Canyon	GC 727	OCS-G 16783		N/A	GC 727 H, HH, I, J, K, KK		Teri Powell	832-636-1261	Added additional completion vessels & dedicated work boat

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 S-7791	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	200	18.15	83.26	623.85	18.72	136.11	43.56	199.81	1497.24	44.92	326.67
	PRIME MOVER>600hp diesel	0	0		0.00	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BURNER diesel	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	AUXILIARY EQUIP<600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 trips/week S-7791	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	86	5.22	23.94	179.36	5.38	39.13	5.37	24.62	184.48	5.53	40.25
2 trips/week S-7791	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	57	3.27	14.98	112.25	3.37	24.49	2.24	10.27	76.97	2.31	16.79
Flowback Vessel 1 S-7791	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 2 S-7791	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Support Vessel S-7791	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Workboat S-7791	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	200	3.27	14.98	112.25	3.37	24.49	7.84	35.95	269.41	8.08	58.78
Stim Boat S-7791	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
	VESSELS>600hp diesel(tugs)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FACILITY INSTALLATION	DERRICK BARGE diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	MATERIAL TUG diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(crew)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(supply)	0	0		0.00	0	0	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	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		833333			24	**2**		0.49	59.50	50.25	323.75		0.01	1.43	1.21	7.77
2024	**YEAR TOTAL**							**58.50**	**268.85**	**2070.30**	**110.57**	**762.47**	**60.48**	**277.48**	**2080.52**	**63.58**	**461.39**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**												**4062.60**	**4062.60**	**4062.60**	**4062.60**	**83634.50**
	122.0																

EMISSIONS CALCULATIONS 1ST YEAR

COMPANY	AREA	BLOCK	LEASE		PLATFORM	WELL		CONTACT		PHONE	REMARKS						
Anadarko Petroleum Corporation	Green Canyon	GC 727	OCS-G 16783		N/A	GC 727 H, HH, I, J, K, KK		Teri Powell		832-636-1261	Added additional completion vessels & dedicated work boat						
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 S-7791	PRIME MOVER>600hp diesel	64370	1243.6284	40%	29847.08	24	200	18.15	83.26	623.85	18.72	136.11	43.56	199.81	1497.24	44.92	326.67
	PRIME MOVER>600hp diesel	0	0		0.00	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	PRIME MOVER>600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	BURNER diesel	0				0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	AUXILIARY EQUIP<600hp diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 trips/week S-7791	VESSELS>600hp diesel(crew)	14805	715.0815	50%	17161.96	24	86	5.22	23.94	179.36	5.38	39.13	5.37	24.62	184.48	5.53	40.25
2 trips/week S-7791	VESSELS>600hp diesel(supply)	9266	447.5478	50%	10741.15	24	57	3.27	14.98	112.25	3.37	24.49	2.24	10.27	76.97	2.31	16.79
Flowback Vessel 1 S-7791	VESSELS>600hp diesel	6247	301.7301	50%	7241.52	24	5	2.20	10.10	75.68	2.27	16.51	0.13	0.61	4.54	0.14	0.99
Flowback Vessel 2 S-7791	VESSELS>600hp diesel (backup)	12217	590.0811	50%	14161.95	24	5	4.31	19.75	148.00	4.44	32.29	0.26	1.19	8.88	0.27	1.94
Support Vessel S-7791	VESSELS>600hp diesel	27493	1327.9119	50%	31869.89	24	3	9.69	44.45	333.06	9.99	72.67	0.35	1.60	11.99	0.36	2.62
Workboat S-7791	VESSELS>600hp diesel	9266	447.5478	50%	10741.15	24	200	3.27	14.98	112.25	3.37	24.49	7.84	35.95	269.41	8.08	58.78
Stim Boat S-7791	VESSELS>600hp diesel	43991	2124.7653	40%	50994.37	24	5	12.40	56.90	426.34	12.79	93.02	0.74	3.41	25.58	0.77	5.58
	VESSELS>600hp diesel(tugs)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FACILITY INSTALLATION	DERRICK BARGE diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	MATERIAL TUG diesel	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(crew)	0	0		0.00	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	VESSELS>600hp diesel(supply)	0	0		0.00	0	0	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	0				0.00					0.00	
DRILLING WELL TEST	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
	GAS FLARE		833333			24	**2**		0.49	59.50	50.25	323.75		0.01	1.43	1.21	7.77
2025	**YEAR TOTAL**							**58.50**	**268.85**	**2070.30**	**110.57**	**762.47**	**60.48**	**277.48**	**2080.52**	**63.58**	**461.39**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**												**4062.60**	**4062.60**	**4062.60**	**4062.60**	**83634.50**
	122.0																

SUMMARY

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL
Anadarko Petro	Green Canyon	GC 727	OCS-G 16783	N/A	GC 727 H, HH, I, J, K, KK

Year	Emitted Substance				
	PM	SOx	NOx	VOC	CO
2017	100.91	462.97	3471.79	106.48	772.40
2018	100.91	462.97	3471.79	106.48	772.40
2019	100.91	462.97	3471.79	106.48	772.40
2020	100.91	462.97	3471.79	106.48	772.40
2021	100.91	462.97	3471.79	106.48	772.40
2022	100.91	462.97	3471.79	106.48	772.40
2023	60.48	277.48	2080.52	63.58	461.39
2024	60.48	277.48	2080.52	63.58	461.39
2025	60.48	277.48	2080.52	63.58	461.39
2026	0.00	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00	0.00
2028	0.00	0.00	0.00	0.00	0.00
2029	0.00	0.00	0.00	0.00	0.00
2030	0.00	0.00	0.00	0.00	0.00
2031	0.00	0.00	0.00	0.00	0.00
2032	0.00	0.00	0.00	0.00	0.00
2033	0.00	0.00	0.00	0.00	0.00
2034	0.00	0.00	0.00	0.00	0.00
2035	0.00	0.00	0.00	0.00	0.00
2036	0.00	0.00	0.00	0.00	0.00
2037	0.00	0.00	0.00	0.00	0.00
Allowable	4062.60	4062.60	4062.60	4062.60	83634.50

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) last approved on August 14, 2015 for Anadarko Petroleum Corporation and its subsidiaries, Anadarko US Offshore Corporation and Anadarko E&P Company L.P. (Company Numbers 00981, 02219 and 00148, respectively) in accordance with 30 CFR Part 254.

(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)	WR 51	GC 727
Facility Designation	WR 51"E"	GC 727 #002
Distance to Nearest Shoreline	153 miles	122 miles
Storage Tanks (total)	N/A	N/A
Flowlines (on facility)	N/A	N/A
Pipelines	N/A	N/A
Uncontrolled Blowout	420,334 BOPD	340,281 BOPD
Type of Oil(s)	Oil	Oil
API Gravity	36.0°	28.9°

Anadarko has determined that the worst-case scenario from the activities proposed in this Supplemental EP do not supersede the worst-case scenario for Walker Ridge Block 51.

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, 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 2015-N01. A Supplemental EP (Control No. S-7509) was previously approved for Green Canyon Block 727 on September 4, 2011. This supplemental plan included the information necessary to comply with NTL No. 2015-N01. Within the approved Supplemental EP, the highest WCD volume for Green Canyon Block 727 was determined to be 340,281 BOPD. The supplemental well locations requested under this plan do not exceed the previously approved WCD for the lease, however additional WCD volume assumptions for well location "I" have been included to address target sands not previously included.

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

(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 340,281 BOPD with an API gravity of 28.9°. 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.

Green Canyon Block 727 is located within Launch Area 46. According to the BOEMRE OSRAM, the trajectory indicates a 3% probability of potential impact to the shoreline in Cameron and/or Plaquemines Parish, Louisiana. The results are shown in Table H-2.

Cameron and/or Plaquemines Parish are identified as the most probable potential impacted parish or county within the Gulf of Mexico for this operation. Cameron Parish is located in Louisiana and includes Cameron Prairie National Wildlife Refuge (NWR), East Cove Unit (a part of the Cameron Prairie NWR), Lacassine NWR, and Sabine NWR. Plaquemines Parish is also located in Louisiana and includes Delta NWR, Pass-a-Loutre Wildlife Management Area (WMA) and Bohemia State WMA.

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 340,281 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% (37,431 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% (17,014 bbls) of the total initial worst case discharge could be burned.

Although unlikely in a spill lasting thirty (30) days, potential shoreline impact in Cameron and/or 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 302,850 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:		**Block 727**
i.	Type of Oil (crude, condensate, diesel)	Crude
ii.	API Gravity	28.9°
iii.	EP Location Used for NTL No. 2015-N01 WCD for GC 727	SEP GC 727 well "2"
iv.	Largest Anticipated WCD Rate during blowout	340,281 BOPD
v.	**WCD Total for Drilling Operations for GC 727 (> 10 miles from shore):**	340,281 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 BOEMRE Oil Spill Risk Analysis Model (OSRAM) for the Central Gulf of Mexico. This information can be found on the BOEMRE 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
Green Canyon Block 727 Drilling (122 miles from shore)	G16783	LA 46 Central Planning Area	Matagorda County, TX Brazoria County, TX Galveston County, TX Jefferson County, TX **Cameron Parish, LA** Vermilion Parish, LA Lafourche Parish, LA Terrebonne Parish, LA **Plaquemines Parish, LA**	-- -- -- -- -- -- -- -- --	-- -- -- -- -- -- -- -- --	1 1 2 1 **3** 1 1 1 **3**

Table H-3

WCD Scenario Drilling Activities – Based on a single well uncontrolled blowout (122 miles from shore)
Green Canyon Block 727
340,281 BOPD (initial volume)
302,850 BOPD (after evaporation/dispersion)
API Gravity 28.9°

Offshore Equipment from Spill Detection to Equipment Deployment Response Time: Green Canyon Block 727

Dispersants/Surveillance

Dispersant/Surveillance	Dispersant Capacity (gal)	Storage Capacity	Persons Req.	From	Hrs to Procure	Hrs to Loadout	Travel to site	Total Hrs
CGA								
Basler 67T	2000	NA	2	Houma	1	1	0.9	2.9
ASI								
DC 3	1200	NA	2	Houma	1	1	1.1	3.1
DC 3	1200	NA	2	Houma	1	1	1.1	3.1
Aero Commander	NA	NA	2	Houma	1	1	0.9	2.9

Offshore Response

Offshore Equipment Pre-determined Staging	EDRC	Storage Capacity	VOO	Persons Req.	From	Hrs to Procure	Hrs to Loadout	Hrs to GOM	Travel to Spill Site	Hrs to Deploy	Total Hrs
CGA											
HOSS Barge	43000	4000	3 Tugs	5	Harvey	7	0	5	15.0	1	28.0
Boom Barge (CGA-3000 42" Auto Boom (25000')	NA	NA	1 Tug 50 Crew	4 (Barge) 2 (Per Crew)	Leeville	4	0	6	18.6	1.5	30.1
T&T Marine (available through contract with CGA)											
Koseq Skimming Arms (5)	89145	10000	5 Utility	30	Galveston	4	12	4	23.3	2	45.3
Koseq Skimming Arms (3)	53487	6000	3 Utility	18	Leeville	4	12	10	10.8	2	38.8
Koseq Skimming Arms (1)	17829	2000	1 Utility	6	Fourchon	4	12	9.5	10.8	2	38.3
Koseq Skimming Arms (2)	35658	4000	2 Utility	12	Venice	4	12	11	11.7	2	40.7
Enterprise Marine Services LLC (available through contract with CGA)											
CTCo 2604	NA	20000	1 Tug	6	Amelia	4	12	4	18.13	1	39.13
CTCo 2605	NA	20000	1 Tug	6	Amelia	4	12	4	18.13	1	39.13
CTCo 2606	NA	20000	1 Tug	6	Amelia	4	12	4	18.13	1	39.13
CTCo 2607	NA	23000	1 Tug	6	Amelia	4	12	4	18.13	1	39.13
CTCo 5001	NA	47000	1 Tug	6	Amelia	4	12	4	18.13	1	39.13
K-Sea Operating (available through contract with CGA)											
Pacific 996165	NA	80000	1 Tug	6	Fourchon	4	12	2	16.25	1	35.25
DBL 76 1212984	NA	83937	1 Tug	6	Fourchon	4	12	2	16.25	1	35.25
DBL 101 1119760	NA	107285	1 Tug	6	Fourchon	4	12	2	16.25	1	35.25

Spill Team Area Responders (STARS) called out by Marine Spill Response Corporation (MSRC)
Vessel of Opportunity=VOO
EMS=Enterprise Marine Services
K-Sea=K-Sea Operating Partnership

Offshore Equipment Pre-determined Staging	EDRC	Storage Capacity	VOO	Persons Required	From	Hrs to Procure	Hrs to Loadout	Hrs to GOM	Travel to Spill Site	Hrs to Deploy	Total Hrs
MSRC											
Louisiana Responder Transrec 350 + OSRV *2,640' 44" Sea Sentry II Boom* *5,280' 67" LAMOR*	10567	4000	NA	14	Fort Jackson	2	0	1	5.6	1	9.6
MSRC 452 Offshore Barge 1 Crucial Disk 88/30 *1,980' 44" Sea Sentry II Boom* *660 ' 67" LAMOR*	11122	45000	3 Tugs	6	Fort Jackson	2	0	2	20	1	25
Mississippi Responder Transrec 350 + OSRV *5,280' 44" Sea Sentry II Boom* *2,640' 67" LAMOR*	10567	4000	NA	14	Pascagoula	2	0	1	10	1	14
MSRC 402 Offshore Barge 2 Crucial Disk 88/30 *660' 44" Sea Sentry II Boom* *1,980' 67" LAMOR*	22244	40300	3 Tugs	6	Pascagoula	2	0	2	35.7	1	40.7
Deep Blue Responder LFF 100 Brush + OSRV *6,600' 44" Sea Sentry II Boom* *660' 67" LAMOR*	18086	4000	NA	14	Fourchon	2	0	1	5.2	1	9.2
PSV – HOS Centerline 1 Crucial Disk 88/30 *1,320' EFC (cont inflate)*	11122	24300	NA	14	Fourchon	12	12	1	10.8	1	36.8
PSV – HOS Strongline 1 Crucial Disk 88/30 *1,320' EFC (cont inflate)*	11122	24300	NA	14	Fourchon	12	12	1	10.8	1	36.8
PSV – C-Freedom 1 LFF 100 Brush *1,320' EFC (cont inflate)*	18086	11756	NA	14	Fourchon	12	12	1	10.8	1	36.8
MSRC Lightning 2 LORI Brush Pack	5000	50	3 Tugs	6	Tampa	2	0	2	20	1	25
MSRC 360 Offshore Barge 1 Crucial Disk 88/30 *1,320' 44" Sea Sentry II Boom*	11122	36000	3 Tugs	6	Tampa	2	0	2	71.4	1	76.4

Offshore Equipment Pre-determined Staging	EDRC	Storage Capacity	VOO	Persons Required	From	Hrs to Procure	Hrs to Loadout	Hrs to GOM	Travel to Spill Site	Hrs to Deploy	Total Hrs
MSRC											
Gulf Coast Responder Transrec 350 + OSRV *5,280' 44" Sea Sentry II Boom* *2,640' 67" LAMOR*	10567	4000	NA	14	Lake Charles	2	0	1	9.2	1	13.2
Texas Responder Transrec 350 + OSRV *4,620' 44" Sea Sentry II Boom* *3,300' 67" LAMOR*	10567	4000	NA	14	Galveston	2	0	1	11.2	1	15.2
MSRC 570 Offshore Barge 2 Crucial Disk 88/30 *2,640' 44" Sea Sentry II Boom*	22244	56900	3 Tugs	6	Galveston	2	0	2	40	1	45
Southern Responder Transrec 350 + OSRV *4,290' 44" Sea Sentry II Boom* *2,970' 67" LAMOR*	10567	4000	NA	14	Ingleside	2	0	1	15.2	1	19.2
MSRC 403 Offshore Barge 1 Crucial Disk 88/30 *660' 44" Sea Sentry II Boom* *660' 67" LAMOR*	11122	40300	3 Tugs	6	Ingleside	2	0	2	54.3	1	59.3
MSRC Quick Strike 2 LORI Brush Pack	5000	50	3 Tugs	6	Ingleside	2	0	2	15.2	1	20.2

Staging Area: Fourchon

Offshore Equipment Preferred Staging	EDRC	Storage Capacity	VOO	Persons Req.	From	Hrs to Procure	Hrs to Loadout	Travel to Staging	Travel to Site	Hrs to Deploy	Total Hrs
T&T Marine (Available through contract with CGA)											
Aqua Guard Triton RBS (2)	45560	4000	2 Utility	12	Galveston	4	12	6	23.3	1	46.3
CGA											
FRU (1) + 100 bbl Tank (2)	4251	200	1 Utility	6	Galveston	1	2	6	10.0	1	20.0
FRU (1) + 100 bbl Tank (1)	4251	100	1 Utility	6	Harvey	1	2	1.25	10.0	1	15.3
FRU (1) + 100 bbl Tank (2)	4251	200	1 Utility	6	Ingleside	1	2	9	10.0	1	23.0
FRU (1) + 100 bbl Tank (2)	4251	200	1 Utility	6	Lake Charles	1	2	3	10.0	1	17.0
FRU (2) + 100 bbl Tank (2)	8502	400	2 Utility	12	Leeville	1	2	1.25	10.0	1	15.3
FRU (1) + 100 bbl Tank (2)	4251	200	1 Utility	6	Morgan City	1	2	0.75	10.0	1	14.8
FRU (2) + 100 bbl Tank (4)	8502	400	2 Utility	12	Venice	1	2	3	10.0	1	17.0
MSRC											
Stress I (1) + Storage Bladder	15840	500	1 Utility	6	Ingleside	1	2	9.5	10.8	1	24.3
Stress I (1) + Storage Bladder	15840	500	1 Utility	6	Galveston	1	2	7	10.8	1	21.8
Stress I (1) + Storage Bladder	15840	500	1 Utility	6	Lake Charles	1	2	4	10.8	1	18.8
Stress I (1) + Storage Bladder	15840	500	1 Utility	6	Fourchon	1	2	0	10.8	1	14.8
Stress I (1) + Storage Bladder	15840	500	1 Utility	6	Fort Jackson	1	2	3.75	10.8	1	18.55
Stress I (1) + Storage Bladder	15840	500	1 Utility	6	Pascagoula	1	2	4	10.8	1	18.8
Stress I (1) + Storage Bladder	15840	500	1 Utility	6	Tampa	1	2	13	10.8	1	27.8
LFF 100 Brush (1) + Storage Bladder	18086	500	1 Utility	6	Lake Charles	1	2	4	10.8	1	18.8
LFF 100 Brush (2) + Storage Bladder	36172	6000	2 Utility	12	Fourchon	1	2	0	10.8	1	14.8
Crucial Disk 88/30 + Storage Bladder	11122	500	1 Utility	6	Fourchon	1	2	0	10.8	1	14.8
GT-185 w Adap + Storage Bladder	1371	500	1 Utility	6	Fourchon	1	2	0	10.8	1	14.8
Desmi Ocean + Storage Bladder	3017	500	1 Utility	6	Fort Jackson	1	2	0	10.8	1	14.8
Foilex 200 + Storage Bladder	1989	500	1 Utility	6	Fort Jackson	1	2	0	10.8	1	14.8

Offshore Equipment Preferred Staging	EDRC	Storage Capacity	VOO	Persons Req.	From	Hrs to Procure	Hrs to Loadout	Travel to Staging	Travel to Site	Hrs to Deploy	Total Hrs
CGA											
Hydro-Fire Boom	NA	NA	8 Utility	40	Harvey (HFB)	1	4	1.25	10.0	6	22.3
MSRC											
44" Sea Sentry II Boom (2860')	NA	NA	6 Crew	12	Ingleside	1	2	9.5	10.8	1	24.3
44" Sea Sentry II Boom (4290')	NA	NA	10 Crew	20	Galveston	1	2	7	10.8	1	21.8
44" Sea Sentry II Boom (6679')	NA	NA	10 Crew	20	Lake Charles	1	2	4	10.8	1	18.8
44" Sea Sentry II Boom (1980')	NA	NA	6 Crew	12	Fort Jackson	1	2	3.75	10.8	1	18.55
44" Sea Sentry II Boom (3190')	NA	NA	10 Crew	20	Pascagoula	1	2	4	10.8	1	18.8
2000' Hydro-Fire Boom	NA	NA	16 Utility	80	Lake Charles	1	2	4	10.8	1	18.8

Nearshore Equipment from Spill Detection to Equipment Deployment Response Time: Green Canyon Block 726 & 727

Nearshore Response

Nearshore Equipment Pre-determined Staging	EDRC	Storage Capacity	VOO	Persons Required	From	Hrs to Procure	Hrs to Loadout	Hrs to GOM	Travel to Site	Hrs to Deploy	Total Hrs
					CGA						
46' FRV	5000	65	NA	4	Galveston	1	0	0	11.2	0	12.2
46' FRV	5000	65	NA	4	Leeville	1	0	2	5.2	0	8.2
46' FRV	5000	65	NA	4	Lake Charles	1	0	1	9.2	0	11.2
46' FRV	5000	65	NA	4	Venice	1	0	1	5.6	0	7.6
Trinity SWS	21500	249	NA	4	Galveston	1	2	2	11.2	0	16.2
Trinity SWS	21500	249	NA	4	Leeville	1	2	2	5.2	0	10.2
Trinity SWS	21500	249	NA	4	Morgan City	1	2	2	5.2	0	10.2
Trinity SWS	21500	249	NA	4	Venice	1	2	2	5.6	0	10.6
					K-Sea Operating (available through contract with CGA)						
DBL 82 1137538	NA	86948	1 Tug	6	Houma	4	12	2	16.88	1	35.88
					Enterprise Marine Services LLC (available through contract with CGA)						
CTCo 2603	NA	25000	1 Tug	6	Amelia	4	12	4	18.13	1	39.13
CTCo 2608	NA	23000	1 Tug	6	Amelia	4	12	4	18.13	1	39.13
CTCo 2609	NA	23000	1 Tug	6	Amelia	4	12	4	18.13	1	39.13

Staging Area: Fourchon

Nearshore Equipment Preferred Staging	EDRC	Storage Capacity	VOO	Persons Req.	From	Hrs to Procure	Hrs to Load Out	Travel to Staging	Travel to Deployment	Hrs to Deploy	Total Hrs
					CGA						
SWS Egmopol	3000	100	NA	3	Galveston	1	2	6.5	2	0	11.5
SWS Egmopol	3000	100	NA	3	Morgan City	1	2	1.8	2	0	6.8
SWS Marco	3588	20	NA	3	Lake Charles	1	2	4	2	0	9
SWS Marco	3588	34	NA	3	Leeville	1	2	.3	2	0	5.3
Rope Mop	77	2	0	3	Harvey	1	2	2	2	0	7

Nearshore Equipment Preferred Staging	EDRC	Storage Capacity	VOO	Persons Req.	From	Hrs to Procure	Hrs to Load Out	Travel to Staging	Travel to Deployment	Hrs to Deploy	Total Hrs
					MSRC						
Foilex 250 Skimmer+ Storage Bladder	3977	500	1 Crew	3	Fort Jackson	2	.5	3	2	.5	8
Foilex 250 Skimmer+ Storage Bladder	3977	500	1 Crew	3	Lake Charles	2	.5	4	2	.5	9
Foilex 250 Skimmer+ Storage Bladder	3977	500	1 Crew	3	Galveston	2	.5	6.5	2	.5	11.5
Foilex 250 Skimmer+ Storage Bladder	3977	500	1 Crew	3	Ingleside	2	.5	9	2	.5	14
WP-1 Skimmer+ Storage Bladder	3017	500	1 Utility	3	Ingleside	2	.5	9	2	.5	14
Aardvac 800 Skimmer+ Storage Bladder	3840	500	NA	3	Pascagoula	2	.5	3.5	2	.5	8.5

Shoreline Protection

Staging Area: Cameron

Shoreline Protection Boom	VOO	Persons Req.	Storage/Warehouse Location	Hrs to Procure	Hrs to Load Out	Travel to Staging	Travel to Deployment	Hrs to Deploy	Total Hrs
OMI Environmental (available through MSA)									
10,000' 18" Boom	4 Crew	10	New Iberia, LA	1	1	3.5	2	3	10.5
10,000' 18" Boom	4 Crew	10	Houston, TX	1	1	7	2	3	14
10,000' 18" Boom	4 Crew	10	Port Arthur, TX	1	1	5.75	2	3	12.75
20,000' 18" Boom	8 Crew	20	Belle Chasse, LA	1	1	3	2	6	13
10,000' 18" Boom	4 Crew	10	Port Allen, LA	1	1	3.5	2	3	10.5
10,000' 18" Boom	4 Crew	10	Houma, LA	1	1	2	2	3	9
15,000' 18" Boom	6 Crew	14	Gretna, LA (Warehouse)	2	2	2.75	2	4	12.75
AMPOL (available through MSA)									
42,000' 18" Boom	16 Crew	40	New Iberia, LA	2	2	3.5	2	12	21.5
20,000' 18" Boom	8 Crew	20	New Orleans, LA	2	2	2.75	2	6	14.75
ES&H									
50,000' 18" Shoreline	20 Crew	50	Houston, TX	.5	.5	7	2	15	25
50,000' 18" Shoreline	20 Crew	50	Lake Charles, LA	.5	.5	5	2	15	23
20,000' 18" Shoreline	8 Crew	20	New Iberia, LA	.5	.5	3.5	2	6	12.5
1,000' 18" Shoreline	2 Crew	6	Morgan City, LA	.5	.5	2.5	2	1	6.5
20,000' 18" Shoreline	8 Crew	20	Belle Chasse, LA	.5	.5	3	2	6	12
15,000' 18" Shoreline	6 Crew	14	Mobile, AL	.5	.5	5	2	4	12
5,000' 18" Shoreline	2 Crew	6	Dallas Ft. Worth, TX	.5	.5	9.75	2	2	14.75
50,000' 18" Shoreline	20 Crew	50	Houma, LA	.5	.5	2	2	15	20

Beach Boom	EDRC	Storage Capacity	VOO	Persons Req.	From	Hrs to Procure	Hrs to Load Out	Travel to Staging	Travel to Deployment	Hrs to Deploy	Total Hrs
CGA											
Beach Boom (2000')	NA	NA	NA	6	Galveston	1	2	6	1	2	12
Beach Boom (1000')	NA	NA	NA	4	Ingleside	1	2	9	1	2	15
Beach Boom (2000')	NA	NA	NA	6	Pascagoula	1	2	3	1	2	9

Wildlife Response	EDRC	Storage Capacity	VOO	Persons Req.	From	Hrs to Procure	Hrs to Load Out	Travel to Staging	Travel to Deployment	Hrs to Deploy	Total Hrs
CGA											
Wildlife Support Trailer	NA	NA	NA	2	Houma	1	2	0	1	2	6
Bird Scare Guns (24)	NA	NA	NA	2	Belle Chasse	1	2	1.25	1	2	7.25
Bird Scare Guns (12)	NA	NA	NA	2	Galveston	1	2	6	1	2	12
Bird Scare Guns (24)	NA	NA	NA	2	Houma	1	2	0	1	2	6
Bird Scare Guns (12)	NA	NA	NA	2	Ingleside	1	2	9	1	2	15
Bird Scare Guns (24)	NA	NA	NA	2	Lake Charles	1	2	3	1	2	9
Bird Scare Guns (24)	NA	NA	NA	2	Pascagoula	1	2	3	1	2	9

Response Asset	Total
Offshore EDRC	704,680
Offshore Recovered Oil Storage	747,878
Nearshore / Shallow Water EDRC	142,018
Nearshore / Shallow Water Recovered Oil Storage	162,460

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

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. 2012-G02 – "Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program"
BSEE NTL No. 2012-G01 "Marine Trash and Debris Awareness and Elimination", and
JOINT NTL No. 2012-G01 "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting"

J
LEASE STIPULATIONS INFORMATION

Lease Sale # 157:

Military Area: Green Canyon Block 727 is located within Military Warning Area W-92. Anadarko will contact the Naval Air Station, Air Operations Department, New Orleans, Louisiana in order to coordinate and control the electromagnetic emissions during these proposed operations.

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
Work Boat	70,000 gallons	1	Duration of operation
Flowback Vessel	123,980 gallons	1-2	5 days total/well
Backup Flowback Vessel	302,500 gallons	1-2	5 days total/well
Support Vessel	450,698 gallons	1	3 days total/well
Stim Boat	250,000 gallons	1	5 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:	6 miles from Port Fourchon to the mouth of Bayou Lafourche, then approximately 122 miles to GC 727

(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 Green Canyon Block 727 will be transported by 1-2 flowback vessels. Anadarko will also flare a max volume of 20 MMSCF/well total during the 48 hour flow test period. Flow tests will not exceed 48 hours/well without further approval.

Transport Method	Vessel Capacity	Average Volume to be Loaded (per transfer)	No. of Transfers (Yearly Average)
Flowback Vessel	3,000 – 7,000 bbls	5,000 – 15,000 BOPD	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. The well will be produced / cleaned up and measured using various meters through portable surface well test equipment including a separator to a maximum rate of 15,000 bpd and 18,000 mcfpd. 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 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	120,000 bbls	20,000 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	1,500– 3,000 bbls	250 – 500 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	2,800 bbls 700 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	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	1,400 bbls	50 bbls/month/well	Transport to shore in disposal bags 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	3,010 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 & completing 6 wells with 840 Total No. of Days (140 days to drill & complete each well)

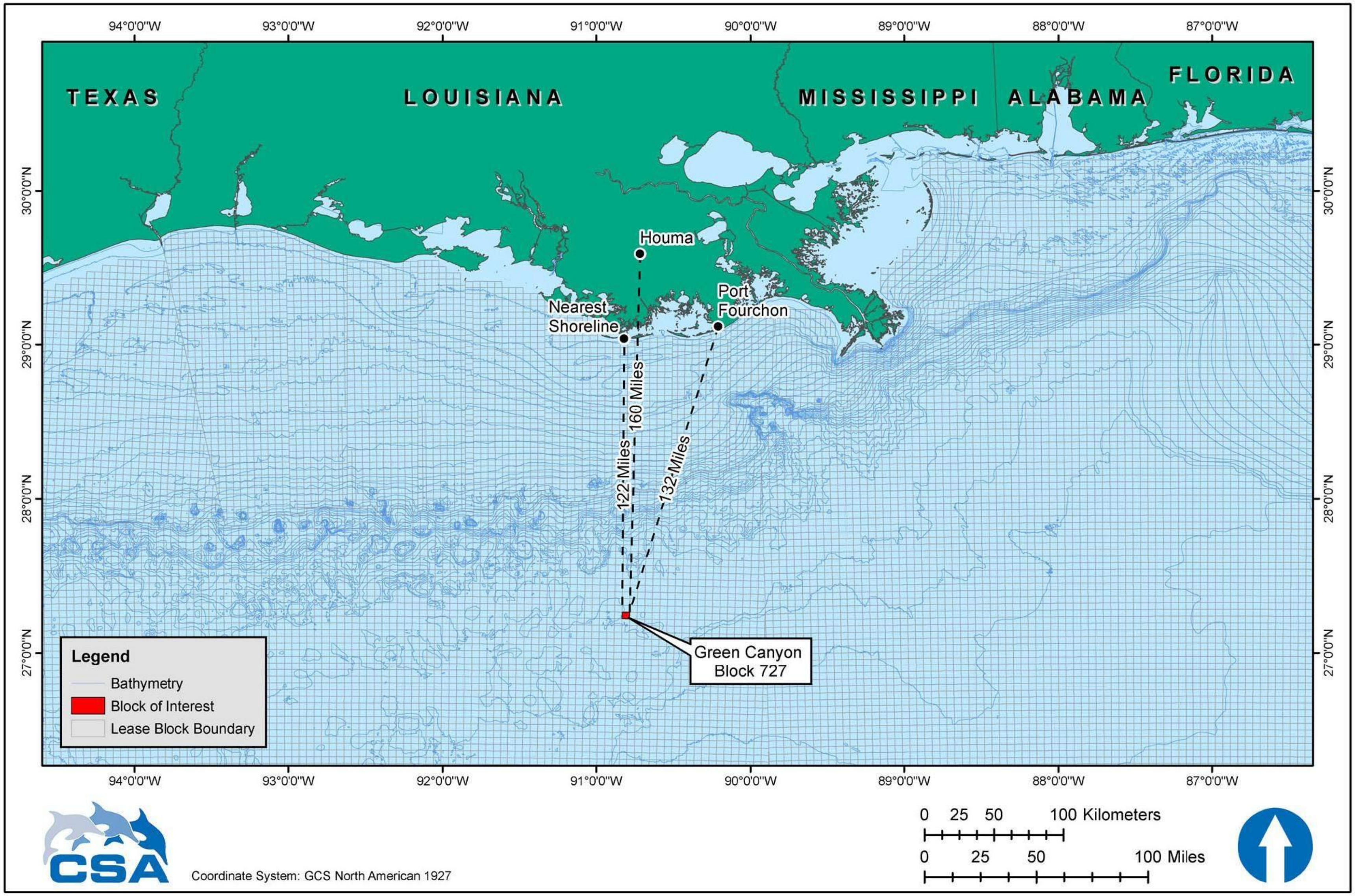


Figure 1. Location of Green Canyon Block 727, offshore Louisiana.

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 only**

(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	120,000 bbls	20,000 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	1,500–3,000 bbls	250 – 500 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	2,800 bbls 700 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	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	1,400 bbls	50 bbls/month/well	Transport to shore in disposal bags 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	3,010 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 & completing 6 wells with 840 Total No. of Days (140 days to drill & complete each well)

M
COASTAL ZONE MANAGEMENT ACT INFORMATION

Consistency reviews from the Texas, Louisiana, and Mississippi Coastal Zone Management Offices were conducted under previously approved Exploration and Development Plans for Green Canyon Block 727; therefore, additional state consistency reviews of this supplemental plan are not required.

N
ENVIRONMENTAL IMPACT ANALYSIS

Environmental Impact Analysis

SUPPLEMENTAL EXPLORATION PLAN

for

Green Canyon Block 727

(OCS-G 16783)

Offshore Louisiana

June 2016

CSA-Anadarko-FL-16-3015-01-REP-01-FIN

Prepared for:

Teri Powell
Regulatory Analyst
Anadarko Petroleum Corporation
1201 Lake Robbins Drive
The Woodlands, Texas 77380
Telephone: (832) 636-1554

Prepared by:

CSA Ocean Sciences Inc.
8502 SW Kansas Avenue
Stuart, Florida 34997
Telephone: (772) 219-3000

CSA Ocean Sciences Inc.

Environmental Impact Analysis

SUPPLEMENTAL EXPLORATION PLAN
for
Green Canyon Block 727
(OCS-G 16783)

DOCUMENT NO. CSA-ANADARKO-FL-16-3015-01-REP-01-FIN

VERSION	DATE	DESCRIPTION	PREPARED BY:	REVIEWED BY:	APPROVED BY:
01	06/15/2016	Initial Draft for Review	J. Tiggelaar	S. Watson	J. Tiggelaar
02	06/20/2016	Draft	J. Tiggelaar	L. Weekes	J. Tiggelaar
FIN	06/20/2016	Final	J. Tiggelaar	n/a	J. Tiggelaar

The electronic PDF version of this document is the Controlled Master Copy at all times. A printed copy is considered to be uncontrolled and it is the holder's responsibility to ensure that they have the current version. Controlled copies are available upon request from the Document Production Department.

Contents

Contents
(Continued)

Page

List of Tables

List of Figures

Acronyms and Abbreviations

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

Introduction

Anadarko Petroleum Corporation (Anadarko) is submitting a Supplemental Exploration Plan (SEP) for Green Canyon (GC) Block 727. Under this SEP, Anadarko proposes to drill and complete six wells: GC 727-H, GC 727-HH, GC 727-I, GC 727-J, GC 727-K, and GC 727-KK. This Environmental Impact Analysis (EIA) provides information on potential environmental impacts of Anadarko's proposed drilling activities for these six exploration wells.

The lease area is approximately 122 miles (196 km) from the nearest shoreline (Louisiana), 132 miles (212 km) from the onshore support base at Port Fourchon, Louisiana, and 160 miles (257 km) from the helicopter base at Houma, Louisiana (**Figure 1**). Water depths at the proposed wellsites range from approximately 4,522 to 4,675 ft (1,378 to 1,425 m). The surface hole location (SHL) and bottom hole location (BHL) of each wellsite is located within GC 727. 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 140 days per well, inclusive of both drilling and completion activities.

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

All the proposed activities and facilities discussed in the SEP are covered by Anadarko's Gulf of Mexico Regional Oil Spill Response Plan (OSRP) last approved on 14 August 2015 for Anadarko and its subsidiaries, Anadarko U.S. Offshore Corporation and Anadarko E&P Company L.P. (Company Numbers 00981, 02219, and 00148, respectively), in accordance with 30 CFR Part 254. 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 and notifications to be taken in the event of a spill.

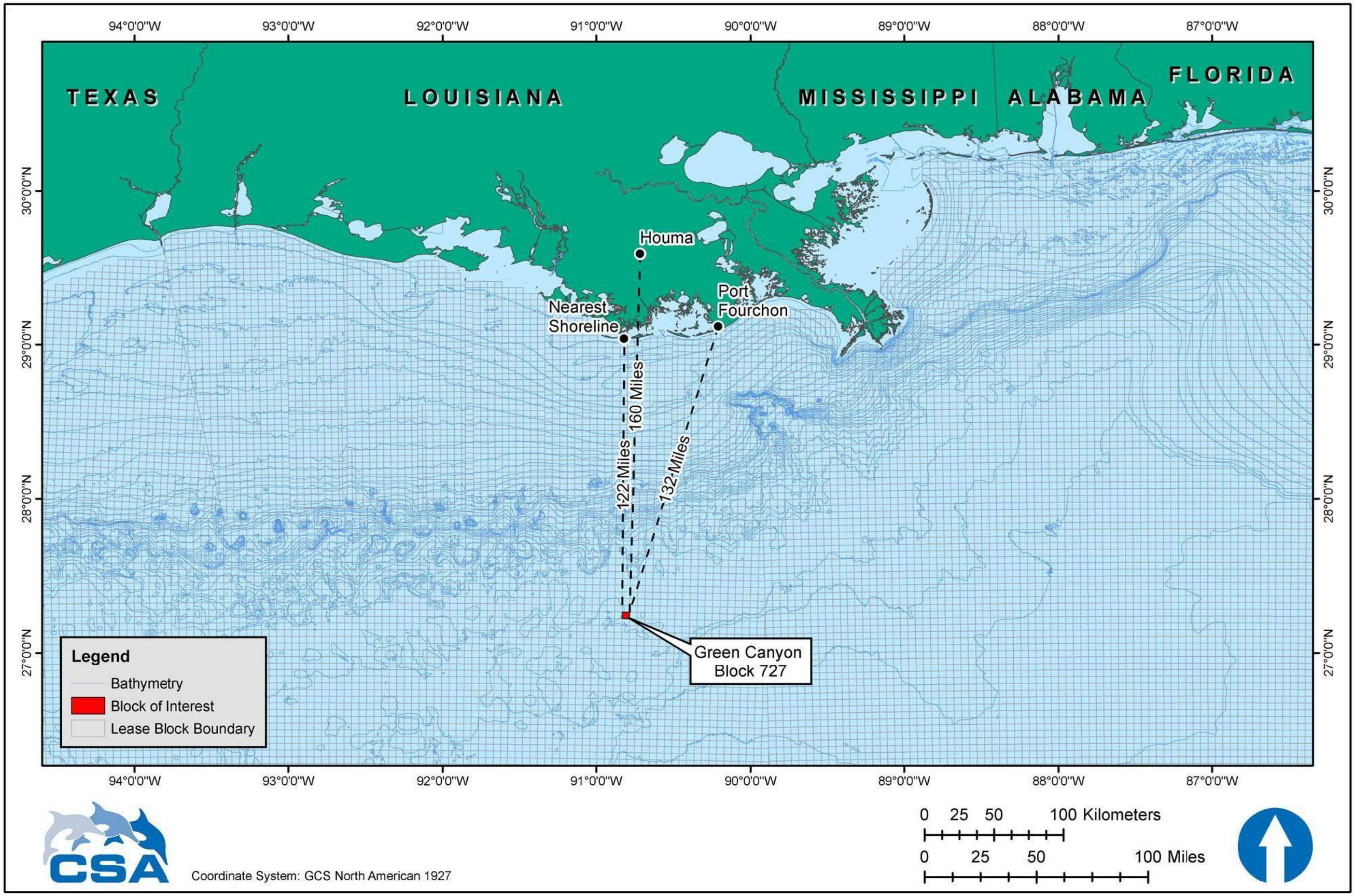


Figure 1. Location of Green Canyon Block 727, offshore Louisiana.

This EIA is organized into **Sections A** through **I**, corresponding to the information required by NTLs 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 applicable to this EIA.

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

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

Table 1. (Continued).

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

A. Impact-Producing Factors

Table 2 is a matrix of impact-producing factors (IPFs) and potentially affected environmental resources adapted from Form BOEM-0142. An "X" indicates that an IPF could reasonably be expected to affect a certain resource (i.e. detectable impacts to resources are to be expected), and a dash (--) indicates no impact or negligible impact (i.e. no significant consequences are expected). Where there may be an effect, an analysis is provided in **Section C**. Potential IPFs for the proposed activity are listed here and briefly discussed in the following sections.

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

A.1 MODU Presence (Including Noise and Lights)

The exploration wells proposed in this SEP 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 MODU 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 locations at which mooring or anchoring is impractical or not feasible. The MODU will be on site for an estimated 140 days per well and will maintain exterior lighting for navigational and aviation safety in accordance with applicable federal safety regulations.

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

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

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

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

Table 2 Footnotes and Applicability to this Program:

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

(1) *Activities that may affect a marine sanctuary or topographic feature. Specifically, if the well, rig site, or any anchors will be on the seafloor within the following:*

 (a) *4-mile zone of the Flower Garden Banks or the 3-mile zone of Stetson Bank;*

 (b) *1,000-m, 1-mile, or 3-mile zone of any topographic feature (submarine bank) protected by the Topographic Features Stipulation attached to an Outer Continental Shelf (OCS) lease;*

 (c) *Essential Fish Habitat (EFH) criteria of 500 ft from any no-activity zone; or*

 (d) *Proximity of any submarine bank (500-ft buffer zone) with relief greater than 2 m that is not protected by the Topographic Features Stipulation attached to an OCS lease.*

- Not applicable. The lease is not within or near any marine sanctuary, topographic feature, or no-activity zone. There are no named submarine banks in the lease 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 lease area.

(3) *Activities within any Eastern Gulf OCS block where seafloor habitats are protected by the Live Bottom (Low-Relief) Stipulation attached to an OCS lease.*

- The Live Bottom (Low-Relief) Stipulation is not applicable to the lease area.

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

- No impacts on high-density deepwater benthic communities are anticipated. There is no geophysical evidence of high-density chemosynthetic communities within 2,000 ft (610 m) the proposed wellsites (Oceaneering International Inc, 2016).

(5) *Exploration or production activities where hydrogen sulfide (H_2S) concentrations greater than 500 parts per million (ppm) might be encountered.*

- The proposed wells are located in a block that was previously classified as H_2S absent under an approved Initial Exploration Plan.

(6) *All activities that could result in an accidental spill of produced liquid hydrocarbons or diesel fuel that would potentially impact these environmental resources. If the proposed action is located a sufficient distance from a resource that no impact would occur, the EIA can note that in a sentence or two.*

- Accidental hydrocarbon spills could affect the resources marked (X) in the matrix, and potential impacts are analyzed in **Section C**.

(7) *All activities that involve seafloor disturbances, including anchor emplacements, in any OCS block designated by the BOEM as having high probability for the occurrence of shipwrecks or prehistoric sites, including such blocks that will be affected that are adjacent to the lease block in which your planned activity will occur. If the proposed activities are located a sufficient distance from a shipwreck or prehistoric site that no impact would occur, the EIA can note that in a sentence or two.*

- No impacts on archaeological resources are expected. The lease area is not on BOEM's list of archaeology survey blocks (BOEM, 2011) and is well beyond the 60-m (197-ft) depth contour used by BOEM as the seaward extent for prehistoric archaeological site potential in the Gulf of Mexico. A dynamically positioned MODU will be used; therefore, seafloor disturbances due to anchoring will not occur.

(8) *All activities that you determine might have an adverse effect on endangered or threatened marine mammals or sea turtles or their critical habitats.*

- Impact-producing factors that may affect marine mammals, sea turtles, or their critical habitats include MODU presence, support vessel and helicopter traffic, and accidents. See **Section C**.

(9) *Production activities that involve transportation of produced fluids to shore using shuttle tankers or barges.*

- Not applicable.

A.2 Physical Disturbance to the Seafloor

In water depths of 600 m (1,969 ft) or greater, DP MODUs disturb a small area of the seafloor around the wellbore where the bottom template and blowout preventer (BOP) are located. Depending on the specific well configuration, this area generally is 0.25 ha (0.62 ac) per well (BOEM, 2012b). For the six wells proposed in this SEP, the total potential area of seafloor disturbance could be 1.5 ha (3.7 ac). However, the total area of disturbance will likely be less, due to overlapping areas of seafloor disturbance as a result of the close proximity of the proposed wellsites.

A.3 Air Pollutant Emissions

Offshore air pollutant emissions will result from MODU operations as well as support vessel (both supply and crew vessels) and helicopter activities. These emissions occur mainly from combustion of diesel fuel. 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 **SEP Section G**) prepared in accordance with BOEM requirements demonstrates that the projected emissions are below exemption levels set by the applicable regulations in 30 CFR 550.303. Based on this and the distance from shore, it can be concluded that the emissions will not significantly affect the air quality of the onshore area for any of the criteria pollutants. No further analysis or control measures are required.

A.4 Effluent Discharges

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

Water-based drilling muds and cuttings will be released at the seafloor during initial well-drilling intervals in which the marine riser that enables the return of muds and cuttings to the surface vessel has not been set. Excess cement slurry also will be released at the seafloor during casing installation for the riserless portion of the drilling operations. Synthetic-based drilling muds (SBMs) will be collected on the MODU after riser emplacement and will either 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 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 frilling fluid and cement volumes for the proposed activities have not been determined.

A.5 Water Intake

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

A.6 Onshore Waste Disposal

Wastes generated during the proposed activities are tabulated in **SEP Section F**. A total of approximately 1,400 bbl of trash will be generated over the life of the project. Trash will be transported to shore in disposal bags for final disposal by municipal operators in accordance with applicable regulations. Other wastes transported to shore for re-use, recycling, or disposal includes SBM and associated cuttings, chemical product waste (well treatment fluids), completion fluids, workover fluids, and used oil. All wastes will be transported to shore in containers approved by the U.S. Department of Transportation for re-use, recycling, or disposal in accordance with applicable regulations.

A.7 Marine Debris

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

A.8 Support Vessel and Helicopter Traffic

The project will be supported by one crew vessel and one supply vessel. The crew vessel will make an estimated three round trips per week and the supply vessel will make an estimated two round trips per week between Port Fourchon and the lease area. The vessels typically will move to the project area via the most direct route from the shorebase.

Anadarko will use existing shorebase facilities at Port Fourchon, Louisiana, for onshore support for crew and supply vessel activities. No terminal expansion or construction is planned.

Offshore support vessels associated with the proposed project would contribute to the overall noise environment by transmitting noise through both air and water. Vessel noise is a combination of narrow-band (tonal) and broadband sound (Richardson et al., 1995, Hildebrand, 2009, McKenna et al., 2012). Tones typically dominate up to approximately 50 Hz, whereas broadband sounds may extend to 100 kHz. The primary sources of vessel noise are propeller cavitation, propeller singing, and propulsion; other sources include auxiliary engine noise, flow noise from water dragging along the hull, and bubbles breaking in the vessel's wake (Richardson et al., 1995). The intensity of noise from support vessels is roughly related to ship size, weight, and speed. Broadband source levels for smaller boats (a category that include supply and other service vessels) are in the range of 150 to 180 dB re 1 µPa at 1 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 MODU and the heliport in Houma. 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 lease area when air traffic and weather conditions permit. Helicopters typically maintain a minimum altitude of 213 m (700 ft) while in transit offshore, 305 m (1,000 ft) over unpopulated areas or across coastlines, and 610 m (2,000 ft) over populated areas and sensitive habitats such as wildlife refuges and park properties (BOEM, 2012b). Additional guidelines and regulations specify that helicopters maintain an altitude of 305 m (1,000 ft) within 91 m (300 ft) of marine mammals (BOEM, 2012b). Anadarko will use existing air transportation (helicopter) facilities in Houma, Louisiana. No terminal expansion or construction is planned.

Penetration of aircraft noise below the sea surface is greatest directly below the aircraft; at angles greater than 13 degrees from vertical, much of the sound is reflected from the sea surface and so does not penetrate into the water (Richardson et al., 1995). The duration of underwater sound from passing aircraft is much shorter in water than air; for example, a helicopter passing at an altitude of 500 ft (152 m) that is audible in air for 4 minutes may be detectable under water for only 38 seconds at 10 ft (3 m) depth and for 11 seconds at 59 ft (18 m) depth (Richardson et al., 1995).

A.9 Accidents

A.9.1 Types of Accidents Evaluated

This EIA focuses on two potential accidents:

- a small diesel fuel spill, which is the most likely type of spill during OCS activities (discussed in **Section A.9.2**); and
- a large oil spill, up to and including the WCD for this SEP (as detailed in **SEP Section H**), which is an oil spill resulting from an uncontrolled blowout (discussed in **Section A.9.3)**.

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

Recent EISs (BOEM, 2012b, c, 2013, 2014, 2015, 2016) analyzed three other types of accidents relevant to drilling operations that could lead to potential impacts on the marine environment:

loss of well control, vessel collision, and chemical and drilling fluid spills. These types of accidents, along with a hydrogen sulfide (H_2S), release are discussed briefly in **Section A.9.4**.

A.9.2 Small Diesel Fuel Spill

Spill Size. According to the analysis by BOEM (2012b), the most likely type of small spill (<1,000 bbl) resulting from OCS activities is a minor diesel fuel spill. Historically, most diesel spills have been ≤1 bbl, and this is predicted to be the most common size in ongoing and future OCS activities in the Western and Central Gulf of Mexico Planning Areas (Anderson et al., 2012). As the spill size increases, the incident rate declines dramatically (BOEM, 2012b). The median size for spills ≤1 bbl is 0.024 bbl, and the median size for spills of 1 to 10 bbl is 3 bbl (BOEM, 2012b). BOEM (2016) reviewed previously presented data (Anderson et al., 2012, BOEM, 2012b) and found that small spill rates from 2011 to 2013 were consistent with those presented in the BOEM (2012b) multisale EIS. For this 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, 2012b).

Spill Fate. The fate of a small diesel fuel spill in the lease area would depend on meteorological and oceanographic conditions at the time of the spill as well as the effectiveness of spill response activities. However, given the open ocean location of the lease area and response actions required to be implemented by the responsible party, it is expected that impacts from a small spill would be minimal (BOEM, 2012a).

The water-soluble fractions of diesel 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 will not sink to the seafloor. Diesel dispersed in the water column can adhere to suspended sediments, but this generally occurs only in coastal areas with high suspended solids loads (National Research Council, 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 has reported that diesel oil is readily and completely degraded by naturally occurring microbes (NOAA, 2006).

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

The ADIOS2 results, coupled with spill trajectory information discussed below for a large spill, indicate that a small diesel fuel spill would not have any impacts on coastal or shoreline resources as the lease area is 122 miles (196 km) from the nearest shoreline. Modeling results indicate that a spill in the lease area would have less than 0.5% conditional probability of reaching coastal areas of Louisiana or Texas within 10 days following a spill. By that time, essentially 100% of a small diesel fuel spill would have dispersed or evaporated through natural processes, without taking into account Anadarko's response measures. Slicks from diesel spills within the marine environment are expected to persist for relatively short periods of time, ranging from minutes (for a <1 bbl spill) to hours (for a <10 bbl spill to a few days (for a 10 to 1,000 bbl spill), and rapidly spread out, evaporate, and disperse into the water column (BOEM, 2012b). Because of the distance of these potential spills on the OCS and their lack of persistence, it is unlikely that a spill would make landfall prior to dissipation (BOEM, 2012b).

Spill Response. In the unlikely event that shipboard prevention procedures fail to avoid a fuel spill, response equipment and trained personnel would be activated so that any spill effects would be localized and result only in short-term environmental consequences. **SEP Section 9b** provides a detailed discussion of Anadarko's response to a spill.

A.9.3 Large Oil Spill (Worst Case Discharge)

Spill Size. The worst case discharge (WCD) scenario for this project is defined as an uncontrollable oil discharge from the subsea wellbore resulting from a blowout incident during drilling operations. The 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. In accordance with NTL 2015-N01 and as required by 30 CFR 550.219(a)(2)(iv), the maximum hydrocarbon discharge volume for in case of a WCD has been calculated by Anadarko to be 340,281 bbl per day. The maximum total volume during a blowout could potentially be 41,174,001 bbl, assuming 121 days for the maximum duration of a blowout, multiplied by the worst case daily uncontrolled blowout volume of 340,281 bbl per day.

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 provided within this SEP (BOEM, 2012b). An estimate of 7 to 21 days is required to suspend operations on a deepwater Gulf of Mexico well and begin drilling of the relief well. This assumes 0 to 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 90 to 100 days, for a total estimated time of 107 to 121 days from the blowout to finishing the relief well.

The detailed analysis of the WCD calculations can be found in **SEP Section H**, as required by NTL 2015-N01 and 30 CFR 550.219(a)(2)(iv), including descriptions of measures to be undetaken by Anadarko to prevent a blowout, reduce the likelihood of a blowout, and conduct effective and early intervention in the event of a blowout. Anadarko will also comply with NTL 2010-N10 and the Final Drilling Safety Rule, which specify additional safety measures for OCS activities.

Spill Probability. Holand (1997) estimated a probability of 0.0021 for a deep drilling blowout during exploration drilling based on U.S. Gulf of Mexico data. The International Association of Oil & Gas Producers (2010) conducted an analysis using the SINTEF[1] database and estimated a blowout frequency of 0.0017 per exploratory well for non-North Sea locations. BOEM has updated OCS spill frequencies to include the Macondo incident and found that spill rates (barrels spilled per barrels produced) for OCS platform spills were unchanged for spills >1,000 bbl compared with previously published data (Anderson et al., 2012). According to BSEE's Final

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

Drilling Safety Rule (75 *Federal Register* [FR] 63365) issued following the Macondo spill, the baseline risk of a catastrophic blowout is estimated to be once every 26 years.

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

The results for Launch Area 46 (where GC 727 is located) are presented in **Table 3**. The model predicts a less than 0.5% chance of shoreline contact within 10 days of a spill. Shoreline contact is predicted within 30 days of a spill for shorelines ranging from Matagorda County, Texas, to Plaquemines Parish, Louisiana. The conditional probability of shoreline contact is low (1% to 3%) for all shorelines with predicted contact within 30 days (**Table 3**).

Table 3. Conditional probabilities of an oil spill in the lease area contacting shoreline segments. From: Ji et al. (2004). Values are conditional probabilities that a hypothetical spill in the lease area (represented by Oil Spill Risk Analysis[OSRA] Launch Area 46) could contact shoreline segments within 3, 10, or 30 days.

Shoreline Segment	County or Parish and State	Conditional Probability[1] of Contact (%)		
		3 Days	10 Days	30 Days
C08	Matagorda County, Texas	--	--	1
C09	Brazoria County, Texas	--	--	1
C10	Galveston County, Texas	--	--	2
C12	Jefferson County, Texas	--	--	1
C13	Cameron Parish, Louisiana	--	--	3
C14	Vermilion Parish, Louisiana	--	--	1
C17	Terrebonne Parish, Louisiana	--	--	1
C18	Lafourche Parish, Louisiana	--	--	1
C20	Plaquemines Parish, Louisiana	--	--	3

[1] Conditional probability refers to the probability of contact within the stated time period, assuming that a spill has occurred (-- indicates <0.5%). Values are conditional probabilities that a hypothetical spill in Green Canyon Block 727 (represented by OSRA Launch Area 46) could contact shoreline segments within 3, 10, or 30 days.

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

BOEM (2014) 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, 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, 2014). The spatial resolution is limited, with five launch points in the entire Western and Central Planning Areas of the Gulf of Mexico. These launch points were deliberately located in areas identified as having a high possibility of containing large oil reserves. The launch point most appropriate for modeling a spill in the lease area is Launch Point 3. The 60-day OSRA results for Launch Point 3 are presented in **Table 4**.

Table 4. Conditional probabilities of an oil spill starting at Launch Point 3 contacting shoreline segments based on the 60-day Oil Spill Risk Analysis (OSRA). Values are conditional probabilities that a hypothetical spill in the lease area could contact shoreline segments within 120 days. Modified from: BOEM (2014), Appendix C.

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

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

From this launch point, potential shoreline contacts within 60 days range from Cameron County, Texas (at the Texas-Mexico border), to Miami-Dade County in southeastern Florida. Based on statewide contact probabilities within 60 days, Texas and Louisiana have the highest likelihood of contact during all four seasons, with Louisiana having higher probabilities in spring (52%) and Texas having higher probabilities during summer, fall, and winter (ranging from 21% to 44% within 60 days). The model predicts a 1% probability of a spill contacting Mississippi shorelines during spring and summer, and a 1% probability of a spill contacting Alabama shorelines during spring. Florida shorelines are predicted to be contacted in any season with a probability up to 5% in spring. Based on the 60-day trajectories, counties or parishes with greater than 10% contact probability during any season include Matagorda County, Texas; and Cameron, Terrebonne, and Plaquemines Parishes in Louisiana (**Table 4**).

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

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

Weathering decreases the concentration of oil and produces changes in its chemical composition, physical properties, and toxicity. The more toxic, light aromatic and aliphatic hydrocarbons are lost rapidly by evaporation and dissolution from a slick on the water surface. Evaporated hydrocarbons are degraded rapidly by sunlight. Biodegradation of oil on the water surface and in the water column by marine bacteria removes first the alkanes and then the light aromatics from the oil. Other petroleum components are biodegraded more slowly. Photo-oxidation attacks 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. The OSRP provides a detailed plan for Anadarko to respond to 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 four 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 nine 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 four 1,000-bbl recovered oil storage tanks built into the hull where oil can be separated and offloaded. Skimming operations are conducted from the control room overlooking the skimmer deck. The estimated daily recovery capacity for the HOSS barge is approximately 43,000 bbl.

CGA is currently adding to its equipment stockpile and has acquired 11 sets of Koseq skimming arms and two Aqua Guard skimmers. In addition, an x-band radar/infrared tracking system is installed on the HOSS barge. Additional CGA equipment can be referenced online at http://www.cleangulfassoc.com/equipment.

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 7 oil spill response vessels, 2 fast response vessels, 5 oil spill response barges, 5 platform supply vessels, and 15 shallow water barges. Various equipment is outfitted with x-band radar and infrared technology for detecting surface oil.

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

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 3,048 m (10,000 ft) 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 3,000 m (9,843 ft). The two 8 ft × 20 ft (2.4 x 6.1 m) containers that 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 3,000-m (9,843 ft) long cable, customized for the instruments in the containers.

The containers are designed to enable rapid mobilization of required 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 **SEP Section H** for a detailed description of Anadarko's site-specific spill response measures for this plan.

A.9.4 Other Accidents Not Analyzed in Detail

BOEM (2012b, 2015, 2016) discuss other types of accidents that could lead to potential impacts on the marine environment, including loss of well control, vessel collisions, and chemical and drilling fluid spills. The information from the EISs on these topics remains valid and is incorporated by reference into this document. These accidents along with an H_2S release are discussed briefly in the following subsections. There are no other site-specific issues for the activities proposed in this SEP.

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

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 the SEP, 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 Final Drilling Safety Rule and NTL 2010-N10, which specify additional safety measures for OCS activities.

Vessel Collisions. BOEM data show that there were 255 OCS-related collisions between 1996 and 2012 (BOEM, 2013). Most collision mishaps are the result of support vessels colliding with platforms or vessel collisions with pipeline risers. Approximately 10% of vessel collisions with platforms in the OCS resulted in diesel spills, and in several collision incidents, fires resulted from hydrocarbon releases. To date, the largest diesel spill associated with a collision occurred in 1979 when an anchor-handling vessel collided with a drilling platform in the Main Pass lease area, spilling 1,500 bbl of diesel fuel. Diesel fuel is the product most frequently spilled, but oil, natural gas, corrosion inhibitor, hydraulic fluid, and lube oil also have been released as a result of vessel collisions. Human error accounted for approximately half of all reported vessel collisions from 2006 to 2010. As summarized by BOEM (2012b), vessel collisions occasionally occur during routine operations. 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.

Chemical Spills. Chemicals are stored and used for pipeline hydrostatic testing and during drilling and in well completion operations. The relative quantities of their use is reflected in the largest volumes spilled (BOEM, 2012b). Completion fluids are the largest quantity 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.

H_2S Release. GC 727 has been classified as H_2S absent under a previously approved Initial Exploration Plan.

B. Affected Environment

The lease area is in the central Gulf of Mexico, 122 miles (196 km) from the nearest shoreline (Louisiana), 132 miles (212 km) from the onshore support base at Port Fourchon, Louisiana, and 160 miles (257 km) from the helicopter base at Houma, Louisiana (**Figure 1**). The water depths at the proposed wellsites range from approximately 4,522 to 4,675 ft (1,378 to 1,425 m) (**Figure 2**).

Based on the site clearance letters for the proposed wellsites (Oceaneering International Inc, 2016), the S-18711 Discovery 20-in. pipeline is located approximately 977 ft (298 m) west of proposed wellsite GC 727-I and approximately 1,455 ft west of proposed wellsite GC 727-J. Inspection of the seafloor at the proposed wellsites immediately before commencing project activities using a remotely operated vehicle is recommended to confirm that there are no seafloor obstructions. No seafloor conditions that may adversely affect the proposed activities were identified in the site clearance letters (Oceaneering International Inc, 2016). The seafloor in the area is relatively smooth, with some areas exhibiting slightly irregular and undulating surface sediments. Some surface faulting is present in the vicinity of the proposed wellsites due to salt diapiric uplift. The site clearance surveys did not identify any evidence of high-density deepwater benthic or chemosynthetic communities within 610 m (2,000 ft) of the project area. One low-amplitude anomaly was identified within 2,000 ft (610 m) of proposed wellsite GC 727-I, but did not show any evidence of outcrops, fluid expulsion, or mounded carbonates representing benthic communities (Oceaneering International Inc, 2016). One sonar contact was identified approximately 1,700 ft (518 m) west of proposed wellsite GC 727-H, approximately 1,630 ft (497 m) west of wellsite GC 727-HH, and approximately 1,910 ft (582 m) northwest of wellsites GC 727-K and GC 727-KK.

An archaeological resources survey report was submitted with the Initial Exploration Plan for GC 727. It is not expected that archaeologically significant artifacts or shipwrecks are present near the location of the proposed activities.

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

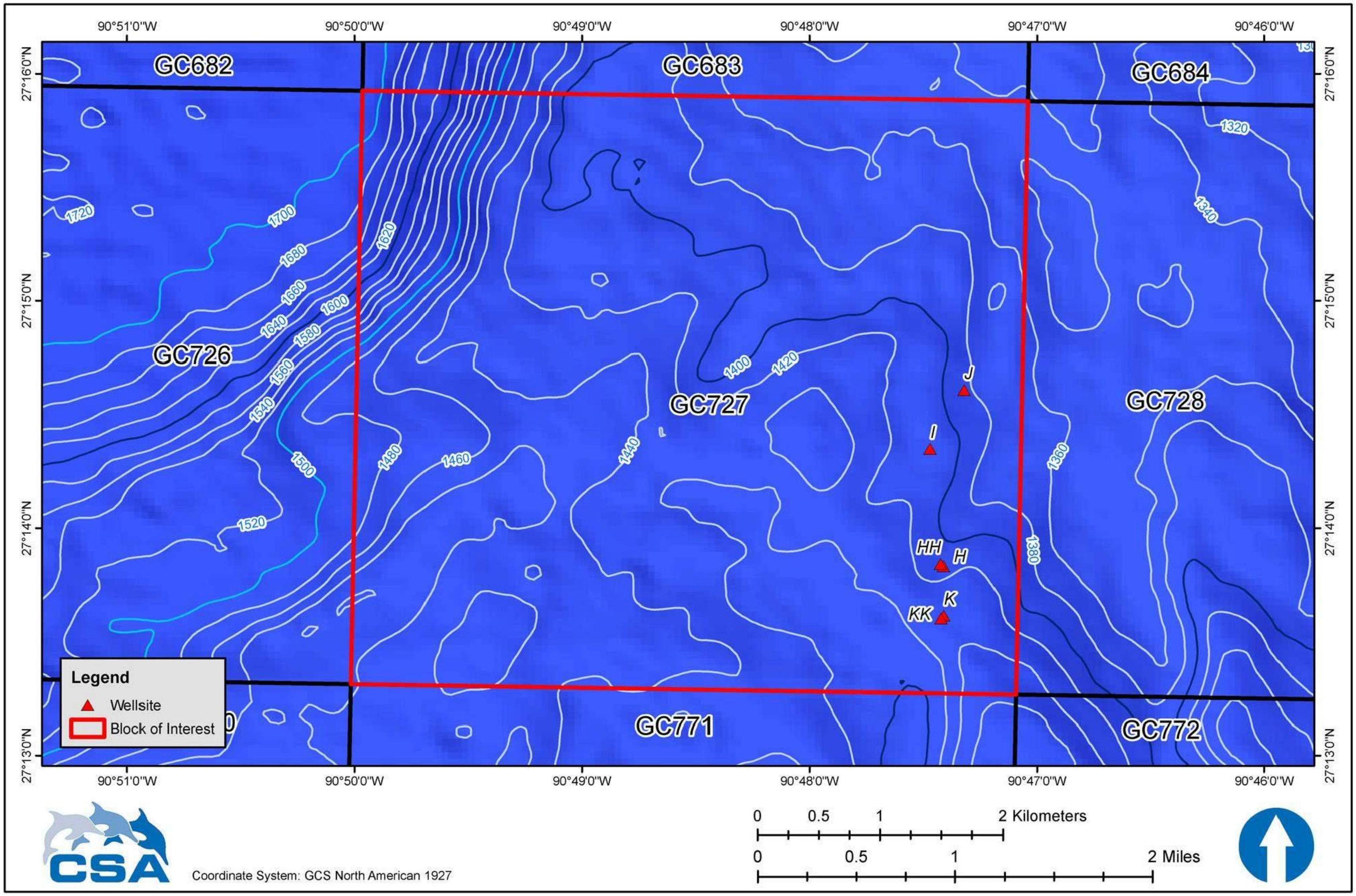


Figure 2. Bathymetric profile of the lease area showing the surface hole locations of the proposed wellsites in Green Canyon (GC) Block 727.

C. Impact Analysis

This section analyzes the potential direct and indirect impacts of routine activities and accidents. Impacts have been analyzed extensively in multisale EISs for the Western and Central Gulf of Mexico Planning Areas (BOEM, 2012b, 2013, 2014, 2015, 2016). The information in these documents is incorporated by reference. Potential site-specific issues are addressed in this section. The following sections are organized by the Environmental Resources identified in **Table 2**, and address each potential IPF. Potential site-specific issues are addressed in this section.

C.1 Physical/Chemical Environment

C.1.1 Air Quality

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

In general, ambient air quality of coastal counties along the Gulf of Mexico is relatively good (BOEM, 2012b). As of 22 April 2016, Mississippi, Alabama, and Florida Panhandle coastal counties are in attainment of the National Ambient Air Quality Standards (NAAQS) for all criteria pollutants. St. Bernard Parish in Louisiana is a nonattainment area for sulfur dioxide based on the 2010 standard. One coastal metropolitan area in Florida (Tampa) is a nonattainment area for lead based on the 2008 standard and for sulfur dioxide based on the 2010 standard (USEPA, 2016a).

As noted earlier, based on calculations made pursuant to applicable regulations, emissions from drilling and completion activities are not expected to be significant because they are below exemption levels. Therefore, the only potential effects to air quality would be from routine air pollutant emissions, a small diesel fuel spill, and a large oil spill.

BOEM (2016) reexamined its previous analysis for air quality in BOEM (2012b) based on additional information and in consideration of the Macondo oil spill event. BOEM (2016) determined that no substantial new information was found that would alter the potential impacts on air quality presented by BOEM (2012b).

Impacts of Air Pollutant Emissions

Offshore air pollutant emissions are the only routine IPF likely to affect air quality. Offshore air pollutant emissions will result from MODU, helicopter, and support vessels operations. These emissions occur mainly from combustion or burning of diesel 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 (2012b), 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 resulting anticipated pollutant concentrations. The Air Quality

Emissions Report (see **SEP 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 activities described in Anadarko's proposed SEP are not likely to contribute to violations of any NAAQS on shore. Therefore, according to 30 CFR 550.303, the emissions will not significantly affect the air quality of the onshore area for any of the criteria pollutants.

Greenhouse gas emissions contribute to climate change, with important impacts on temperature, rainfall, frequency of severe weather, ocean acidification, and sea level rise (Intergovernmental Panel on Climate Change, 2014). Greenhouse gas emissions from the proposed project represent a negligible contribution to the total greenhouse gas emissions from reasonably foreseeable activities in the Gulf of Mexico area and would not significantly alter any climate change impacts evaluated in the Programmatic EIS (BOEM, 2012a). 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, b), estimated CO_2 emissions from OCS oil and gas sources represent 0.4% of the U.S. total. All OCS activities combined contribute approximately 0.005% to total global CO_2 emissions (BOEM, 2012b). 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, 2012a).

The Breton Wilderness Area, which is part of the Breton National Wildlife Refuge (NWR), is designated under the Clean Air Act as a Prevention of Significant Deterioration Class I air quality area. BOEM is required to notify the National Park Service and U.S. Fish and Wildlife Service (USFWS) if emissions from proposed projects may affect the Breton Class I area. Additional review and mitigation measures may be required for sources 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 lease area is approximately 179 miles (288 km) from the Breton Wilderness Area. Based on Anadarko's Air Quality Emissions report (**SEP 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 (2012b, 2015, 2016). The probability of a small spill occuring would 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 Regional OSRP could reduce the potential impacts. **SEP Section H** includes a detailed discussion of the spill response measures that would be employed. Given the open ocean location of the lease area, the extent and duration of air quality impacts from a small spill would not be significant.

A small diesel fuel spill would affect air quality near the spill site by introducing VOCs through evaporation. The ADIOS2 model (see **Section A.9.2**) indicates that more than 90% of a small diesel spill would evaporate or disperse within 24 hours. The sea surface area covered with small diesel fuel would range from 0.5 to 5 ha (1.2 to 12 ac), depending on sea state and weather conditions.

A small diesel fuel spill would not affect coastal air quality because the spill would not be expected to make landfall or reach coastal waters prior to natural dispersion (see **Section A.9.2**).

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 (2012b, 2015, 2016).

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

Based on the 30-day OSRA modeling (**Table 3**), Cameron and Plaquemines Parishes in Louisiana are the coastal area most likely to be affected (3% probability within 30 days). However, due to the lease area's distance from the nearest shoreline, most air quality impacts would occur in offshore waters, and substantial impacts to onshore air quality are not expected.

C.1.2 Water Quality

There are no site-specific water quality data for the lease area. Due to the lease location in deep, offshore waters, water quality is expected to be good, with low levels of contaminants. Deepwater areas in the northern Gulf of Mexico are relatively homogeneous with respect to temperature, salinity, and oxygen (BOEM, 2012b). 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. No natural seeps in the vicinity of the proposed wellsites were noted during the shallow hazard survey (Oceaneering International Inc, 2016).

The lease area is located approximately 178 miles (286 km) from the Macondo spill site. Based on the general circulation pattern observed in the Gulf of Mexico and in satellite imagery, the surface slick from that discharge did not extend over the lease area during the spill, and local water quality should not have been affected.

IPFs that could affect water quality are effluent discharges and two types of accidents – a small diesel fuel spill and a large oil spill.

Impacts of Effluent Discharges

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

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

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

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

Other discharges in accordance with the NPDES permit, such as non-pollutant completion fluids, BOP fluid, uncontaminated wash, ballast, and bilge water; and noncontact 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 diesel spill on water quality are expected to be consistent with those analyzed and discussed by BOEM (2012b, 2015, 2016). The probability of a small spill occuring would 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 Regional OSRP could help mitigate and reduce the impacts. **SEP Section H** provides detail on spill response measures in addition to the summary information provided in this EIA.

A small diesel fuel spill in offshore waters would produce a slick on the water surface and increase the concentrations of petroleum hydrocarbons and their degradation products in the affected water. The extent and persistence of impacts would depend on the meteorological and oceanographic conditions at the time and the effectiveness of spill response measures. However, it is estimated that more than 90% of a small diesel spill would evaporate or disperse within 24 hours (see **Section A.9.2**). The sea surface area covered with diesel fuel would range from 0.5 to 5 ha (1.2 to 12 ac), depending on sea state and weather conditions.

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. Because the density of diesel is less than the density of seawater, diesel will not sink and pool on the seafloor. 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. Diesel oil is readily and completely degraded by naturally occurring microbes (NOAA, 2006). Given the open ocean location of the lease area, the extent and duration of water quality impacts from a small spill would not be significant.

A small diesel fuel spill would not affect coastal water quality because the spill would not be expected to make landfall or reach coastal waters due to both response efforts that would be undertaken as well as natural attenuation (see **Section A.9.2**).

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 (2012b, 2015, 2016). A large spill would affect water quality by producing a slick on the water surface and increasing the concentrations of petroleum hydrocarbons and their degradation products. The extent and persistence of impacts would depend on the meteorological and oceanographic conditions at the time and the effectiveness of spill response measures. Real-time wind and current data from the project area would be available at the time of a spill and would be used to assess the fate and effects of VOCs released. Additional air quality impacts could occur if response measures included *in situ* burning of the floating oil. Burning would generate a plume of black smoke and result in emissions of NO_x, SO_x, CO, and PM as well as greenhouse gases. However, *in situ* burning would occur only if authorized by the USEPA. Most of the oil would be expected to form a slick at the surface, although new 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). However, subsea dispersants would be applied only after approval from the USEPA. Small droplets in the water may adhere to suspended sediments and be removed from the water column (Operational Science Advisory Team, 2010).

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

Because of the lease area's distance from the nearest shoreline, it is expected that most water quality impacts would occur in offshore waters. Depending on the spill trajectory and the effectiveness of spill response measures, coastal water quality could be affected. Based on the 30-day OSRA modeling estimates (**Table 3**), nearshore waters and embayments of Cameron and Plaquemines Parishes, Louisiana, are the coastal areas with the most potential for water quality to be affected. However, the 60-day OSRA estimates potential shoreline contacts ranging from Cameron County, Texas, to Miami-Dade County, Florida (BOEM, 2014).

C.2 Seafloor Habitats and Biota

According to BOEM (2012b), existing information for the deepwater Gulf of Mexico indicates that the seafloor is composed primarily of soft sediments; hard bottom communities are rare. The water depths at the proposed wellsites range from approximately 4,522 to 4,675 ft (1,378 to 1,425 m). Based on the site clearance letters for the proposed wellsites (Oceaneering International Inc, 2016), 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.

C.2.1 Soft Bottom Benthic Communities

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

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

Station	Faunal Zone	Water Depth (m)	Abundance		
			Meiofauna (individuals m^{-2})	Macroinfauna (individuals m^{-2})	Megafauna (individuals ha^{-1})
WC12	2W	1,300	218,447	1,787	2,941
C4	2E	1,463	273,585	3,045	743

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

Densities of meiofauna (animals passing through a 0.5-mm sieve but retained on a 0.062-mm sieve) in water depths representative of the lease area typically range from approximately 218,000 to 274,000 individuals m^{-2} (Rowe and Kennicutt, 2009). Nematodes, nauplii (crustacean larvae), and harpacticoid copepods were the three dominant meiofaunal groups, accounting for approximately 90% of total abundance.

The benthic macroinfauna is characterized by small mean individual sizes and low densities, both of which reflect the intrinsically low primary production in Gulf of Mexico surface waters (Wei, 2006). Based on an equation presented by Wei (2006) in which densities decrease exponentially with water depth, macroinfaunal density at a water depth of 4,600 ft (1,403 m) is expected to be approximately 2,400 individuals m^{-2}; however, actual densities at the proposed project location are unknown.

Polychaetes typically are the most abundant macroinfaunal group on the northern Gulf of Mexico continental slope, followed by amphipods, tanaids, bivalves, and isopods.Carvalho et al. (2013) found polychaete abundance to be higher in the central region compared to the eastern and western regions. Wei (2006) recognized four depth-dependent faunal zones (1 through 4), two of which are divided horizontally. The lease area is in Zone 3W, which consists of stations on the mid Texas-Louisiana Slope.The most abundant species in Zone 3W were the polychaetes

Levinsenia uncinata, *Paraonella monilaris*, and *Tachytrypane* sp. A; the bivalve *Heterodonta* sp. B; and the isopod *Macrostylis* sp.

Megafaunal densities from stations near the lease area and in similar water depths ranged from 743 to 2,941 individuals ha^{-1} (**Table 5**). Common megafauna included motile groups such as decapods, ophiuroids, holothurians, and demersal fishes as well as sessile groups such as sponges and anemones.

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

The only IPFs affecting benthic communities from this project are the physical disturbance to the seafloor around the wellbore where the bottom template and BOP are located, from seafloor effluent discharges, and a large oil spill (WCD) resulting from a well blowout at the seafloor. Effluent discharges at the surface and a small diesel fuel spill would not affect benthic communities because both would float and dissipate on the sea surface.

Impacts of Physical Disturbance to the Seafloor

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

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

Impacts of Effluent Discharges

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

Discharges of washed SBM cuttings from the MODU may affect benthic communities, primarily within several hundred meters of the wellsite. The fate and effects of SBM cuttings have been reviewed by Neff et al. (2000), and monitoring studies have been conducted in the Gulf of Mexico by Continental Shelf Associates (2004, 2006). In general, washed cuttings with adhering SBMs tend to clump together and form thick cuttings piles close to the drillsite. Areas of 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, benthic infaunal communities may be adversely affected due to 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 muds and cuttings discharges will be small; the typical effect radius is approximately 1,640 ft (500 m) around each wellsite. Although soft bottom communities are ubiquitous along the northern Gulf of Mexico continental slope (Gallaway, 1988, Gallaway et al., 2003, Rowe and Kennicutt, 2009), the impact radius of drilling discharges during this project is an extremely small footprint compared to the extensive geographic coverage of these communities and is not expected to have a significant regional impact on the soft bottom benthic communities in the region.

Impacts of a Large Oil Spill

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

While impacts on benthic communities from large oil spills are anticipated to be confined to the immediate vicinity of the wellhead, depending on the specific circumstances of the incident, additional benthic community impacts could extend beyond the immediate vicinity of the wellhead (BOEM, 2012c). During the Macondo spill, the use of subsea dispersants at the wellhead caused the formation of subsurface plumes (NOAA, 2011c). The subsurface plumes were reported in water depths of approximately 1,100 m (3,600 ft), extending at least 22 miles (35 km) from the wellsite and persisting for more than a month (Camilli et al., 2010). The subsurface plumes apparently resulted from the use of subsea dispersants at the wellhead (NOAA, 2011c, Spier et al., 2013). Montagna et al. (2013) mapped the benthic footprint of the Macondo spill and estimated that the most severe impacts to soft bottom benthic communities (e.g., reduction of faunal abundance and diversity) extended 3 km from the wellhead in all directions, covering an area of approximately 24 km^2. Moderate impacts were observed up to 17 km to the southwest and 8.5 km to the northeast of the wellhead, covering an area of 148 km^2. NOAA (2016b) documented a footprint of over 2,000 km^2 of impacts to benthic habitats surrounding the Macondo spill site. The analysis also identified a larger area of approximately 9,200 km^2 of potential exposure and uncertain impacts to benthic communities (NOAA, 2016b).

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

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

C.2.2 High-Density Deepwater Benthic Communities

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

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

Based on the site clearance letters for the proposed wellsites (Oceaneering International Inc, 2016), there is no evidence of the presence of high-density deepwater benthic or chemosynthetic communities within 610 m (2,000 ft) of the project area. Oceaneering International Inc (2016) noted a low amplitude seafloor anomaly within 2,000 ft (610 m) of proposed wellsite GC 727-I, but no fluid explusion or mounded carbonates were noted that could represent potential benthic communities. Side-scan sonar and multibeam backscatter data confirmed that no outrcrops or fluid expulsion were present. The nearest known high-density deepwater benthic community site is approximately 27 miles (43 km) north of the project area in Garden Banks 287 (MacDonald et al., 1995, U.S. Geological Survey, 2011, BOEM, nd).

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

Impacts of a Large Oil Spill

A large oil spill caused by a seafloor blowout could cause direct physical alteration of the seafloor (e.g., formation of a caldera) within approximately 300 m (984 ft) of the wellhead (BOEM, 2012b, 2013). Based on the site clearance letters for the proposed wellsites

(Oceaneering International Inc, 2016), there is no evidence of the presence of high-density deepwater benthic or chemosynthetic communities within the vicinity of the proposed wellsites. Therefore, this type of impact is expected to be avoided.

Additional benthic community impacts could extend beyond the immediate vicinity of the wellhead, depending on the specific circumstances (BOEM, 2012b). During the Macondo spill, subsurface plumes were reported at a water depth of approximately 1,100 m (3,600 ft), extending at least 22 miles (35 km) from the wellsite and persisting for more than a month (Camilli et al., 2010). The subsurface plumes apparently resulted from the use of subsea dispersants at the wellhead (NOAA, 2011c). While the behavior and impacts of subsurface plumes are not well known, a subsurface plume could have the potential to contact high-density deepwater benthic communities beyond the 300-m (984-ft) radius estimated by BOEM (2012b), 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, 2012b). 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.

The biological effects and expected fate of the oil remaining in the Gulf of Mexico from the blowout are still being researched due to the depth and magnitude of the event. Hazen et al. (2010) reported changes in plume hydrocarbon composition with distance from the source. Incubation experiments with environmental isolates demonstrated faster than expected hydrocarbon biodegradation rates at 5°C. Based on these results, Hazen et al. (2010) suggested the potential exists for intrinsic bioremediation of the oil plume in the deep water column without substantial oxygen drawdown.

Potential impacts of oil on high-density deepwater benthic communities are discussed in recent EISs (BOEM, 2012b, 2015, 2016). Although chemosynthetic communities live among hydrocarbon seeps, natural seepage is very consistent and occurs at low rates compared to the potential rates of oil releasefrom a blowout. In addition, seep organisms also require unrestricted access to oxygenated water at the same time as exposure to hydrocarbon energy sources (MacDonald, 2002). Oil droplets or oiled sediment particles could come into contact with chemosynthetic organisms or deepwater corals. As discussed by BOEM (2012b, 2015, 2016), 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, 2012b, 2015, 2016). Based on information learned from the Macondo spill, a few patches of habitats may be affected by a large oil spill, but the Gulf-wide ecosystem of live bottom communities would not be expected to suffer significant effects (BOEM, 2016).

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

C.2.3 Designated Topographic Features

The lease area is not within or near a designated topographic feature or a no-activity zone as identified in NTL 2009-G39. The nearest designated Topographic Feature Stipulation Block is located approximately 51 miles (82 km) north of the lease area. There are no IPFs associated with routine operations that could cause impacts to designated topographic features.

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

C.2.4 Pinnacle Trend Area Live Bottoms

The lease area is not covered by the Live Bottom (Pinnacle Trend) Stipulation. As defined by NTL 2009-G39, the nearest Pinnacle Stipulation Block is located approximately 194 miles (312 km) northeast of the lease area. There are no IPFs associated with routine operations that could cause impacts to pinnacle trend area live bottoms due to the distance from the lease area.

Due to the distance from the lease area, it is unlikely that pinnacle trend live bottom areas would be affected by accidental spills. 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 not contact these seafloor features. If a subsurface plume were to occur, impacts on these features would be unlikely due to the distance and the difference in water depth. Near-bottom currents in the region are predicted to flow along the isobaths (Nowlin et al., 2001) and typically would not be expected to carry a plume up onto the continental shelf edge. This assumption is consistent with the deposition patterns inferred by Valentine et al. (2014) for the subsurface plume from the Macondo spill. Although there are mechanisms that could result in oil contacting these features, it is expected that most of the oil would rise to the surface and that the most heavily oiled sediments would likely be deposited before reaching these features (BOEM, 2012b).

C.2.5 Eastern Gulf Live Bottoms

The lease area is not covered by the Live Bottom (Low-Relief) Stipulation, which pertains to seagrass communities and low-relief hard bottom reefs within the Eastern Gulf of Mexico Planning Area blocks in water depths of 100 m (328 ft) or less and portions of Pensacola and Destin Dome Area blocks in the Central Gulf of Mexico Planning Area. The nearest block covered by the Live Bottom Stipulation, as defined by NTL 2009-G39, is located approximately 234 miles (377 km) northeast of the lease area. There are no IPFs associated with routine operations that could cause impacts to eastern Gulf live bottom areas due to the distance from the lease area.

Because of the distance from the lease area, it is unlikely that Eastern Gulf live bottom areas would be affected by accidental spills. A small diesel fuel spill would float and dissipate on the surface and would not reach these seafloor features. In the event of an oil spill from a well blowout, a surface slick would not contact these seafloor features. If a subsurface plume were to occur, impacts on these features would be unlikely due to the distance and the difference in water depth. Near-bottom currents in the region are predicted to flow along the isobaths (Nowlin et al., 2001) and typically would not be expected to carry a plume up onto the continental shelf. 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 (BOEM, 2012b).

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

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

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

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

Species	Scientific Name	Status	Potential Presence		Critical Habitat Designated in Gulf of Mexico
			Lease Area	Coastal	
Marine Mammals					
Sperm whale	*Physeter macrocephalus*	E	X	--	None
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)
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).

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

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

The sperm whale and five species of sea turtles are the only endangered or threatened species likely to occur in or near the lease area. The listed sea turtles include the leatherback turtle, Kemp's ridley turtle, hawksbill turtle, loggerhead turtle, and green turtle (Pritchard, 1997). Effective 11 August 2014, NMFS has designated certain marine areas as critical habitat for the northwest Atlantic distinct population segment (DPS) of the loggerhead sea turtle (see **Section C.3.4**). No critical habitat has been designated in the Gulf of Mexico for the leatherback turtle, Kemp's ridley turtle, hawksbill turtle, green turtle, or the sperm whale. Five endangered mysticetes (blue whale, fin whale, humpback whale, North Atlantic right whale, and sei whale) have been reported in the Gulf of Mexico, but are considered rare or extralimital (Würsig et al., 2000). These species are not included in the most recent NMFS stock assessment report (Waring et al., 2015) nor in recent BOEM EISs (BOEM, 2012b, 2015, 2016); therefore, they are not considered further in this EIA.

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

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

C.3.1 Sperm Whale (Endangered)

The only endangered marine mammal likely to be present in or near the project area is the sperm whale (*Physeter macrocephalus*). Resident populations of sperm whales occur within the Gulf of Mexico. A species description is presented in the recovery plan for this species (NMFS, 2010a). Gulf of Mexico sperm whales are classified as an endangered species and a "strategic stock" by NMFS (Waring et al., 2015). 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, 2012b).

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

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

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

Impacts of MODU Presence, Noise, and Lights

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

Sperm whales appear to have good low-frequency hearing, with variable responses to anthropogenic noise (Jochens et al., 2008). The sperm whale may possess better low-frequency hearing than some of the other odontocetes, although not as low as many baleen whale species that produce sounds within a bandwidth between 30 Hz and >5 kHz (Wartzok and Ketten, 1999). Southall et al. (2007) lists sperm whales in the same hearing group (i.e., mid-frequency cetaceans) as dolphins, toothed whales, beaked whales, and bottlenose whales (estimated hearing range from 150 Hz to 160 kHz). Generally, most of the acoustic energy from sperm whales is present at frequencies below 4 kHz, although diffuse energy up to and past 20 kHz has been reported, with source levels up to 236 dB re 1 µPa at 1 m. Other studies indicate sperm whales' wideband clicks contain energy between 0.1 and 20 kHz (Weilgart and Whitehead, 1993, Goold and Jones, 1995). Most observations of behavioral responses of marine mammals to anthropogenic sounds, in general, have been limited to short-term behavioral responses, which included the cessation of feeding, resting, or social interactions (NMFS, 2009a).

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

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

In addition, there are other OCS facilities and activities near the lease area, and the region as a whole has a large number of similar noise sources. Noise associated with this project will contribute to an increase in the ambient noise environment of the Gulf of Mexico, but it is not expected in amplitudes sufficient to cause either hearing or behavioral effects to sperm whales.

MODU vessel lighting and presence are not identified as IPFs for sperm whales (NMFS, 2007, BOEM, 2012b, 2016).

Impacts of Support Vessel and Helicopter Traffic

Support vessel traffic has the potential to disturb sperm whales, and there is a risk of vessel strikes, which are identified as a threat in the recovery plan for this species (NMFS, 2010a). Data concerning the frequency of vessel strikes are presented by BOEM (2012b). To reduce the potential for vessel strikes, BSEE and BOEM issued NTL 2012-JOINT-G01, which recommends protected species identification training and that vessel operators and crews maintain a vigilant watch for marine mammals and slow down or stop their vessel to avoid striking protected species, and requires operators to report sightings of any injured or dead protected species. When whales are sighted, vessel operators and crews are required to attempt to maintain a distance of 91 m (300 ft) or greater whenever possible. Vessel operators are required to reduce vessel speed to 10 knots or less, when safety permits, when mother/calf pairs, pods, or large assemblages of cetaceans are observed near an underway vessel. Compliance with this NTL will minimize the likelihood of vessel strikes as well as reduce the chance of disturbing sperm whales.

NMFS (2007) analyzed the potential for vessel strikes and harassment of sperm whales. With implementation of the mitigation measures in NTL 2012-JOINT-G01, NMFS concluded that the likelihood of collisions between vessels and sperm whales would be reduced to insignificant levels. NMFS concluded that the observed avoidance of passing vessels by sperm whales is an advantageous response to avoid a potential threat and is not expected to result in any significant effect on migration, breathing, nursing, breeding, feeding, or sheltering to individuals, or have any consequences at the population level. With implementation of the vessel strike avoidance measures requirement to maintain a distance of 91 m (300 ft) from sperm whales, NMFS concluded that the potential for harassment of sperm whales would be reduced to discountable levels.

Dependent on flight altitude, helicopter traffic also has the potential to disturb sperm whales. Smultea et al. (2008) documented responses of sperm whales offshore Hawaii to a fixed-wing aircraft flying at an altitude of 245 m (800 ft). 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 360 m (1,180 ft) 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 probably of no long-term biological significance.

Helicopters used in support operations maintain a minimum altitude of 213 m (700 ft) while in transit offshore, 305 m (1,000 ft) over unpopulated areas or across coastlines, and 610 m (2,000 ft) over populated areas and sensitive habitats such as wildlife refuges and park properties. In addition, guidelines and regulations specify that helicopters maintain an altitude of 305 m (1,000 ft) within 91 m (300 ft) of marine mammals (BOEM, 2012a, b). 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), NMFS (2007), and BOEM (2012b) concluded that this altitude would minimize the potential for disturbing sperm whales. Therefore, no significant impacts are expected.

Impacts of a Small Diesel Fuel Spill

Potential spill impacts on marine mammals, including sperm whales, are discussed by NMFS (2007) and BOEM (2012b, 2015, 2016). 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 SEP, 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 lease area, the duration of a small spill and opportunity for impacts to occur would be very brief.

A small diesel fuel spill in offshore waters would produce a slick on the water surface and increase the concentrations of petroleum hydrocarbons and their degradation products. The extent and persistence of impacts would depend on the meteorological and oceanographic conditions at the time and the effectiveness of spill response measures. **Section A.9.2** discusses the likely fate of a small diesel fuel spill and indicates that more than 90% would evaporate or disperse naturally within 24 hours. Results of an ADIOS2 model run (see **Section A.9.2**) indicate that the area of the sea surface with diesel fuel on it would range from 0.5 to 5 ha (1.2 to 12 ac), depending on sea state and weather conditions.

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

Impacts of a Large Oil Spill

Potential spill impacts on marine mammals, including sperm whales, are discussed by NMFS (2007) and BOEM (2012b, 2015, 2016). Oil impacts on marine mammals are discussed by Geraci and St. Aubin (1990) and by the MMC (2011). For the SEP, there are no unique site-specific issues with respect to spill impacts on these animals.

Impacts of oil spills on sperm whales can include direct impacts from oil exposure as well as indirect impacts due to response activities and materials (e.g., vessel traffic, noise, and dispersants) (MMC, 2011). Direct physical and physiological effects can include skin irritation, inflammation, or necrosis; chemical burns of skin, eyes, and mucous membranes; inhalation of toxic fumes; ingestion of oil (and dispersants) directly or via contaminated prey; and stress from the activities and noise of response vessels and aircraft. The level of impact of oil exposure depends on the amount, frequency, and duration of exposure; route of exposure; and type or condition of petroleum compounds or chemical dispersants (Waring et al., 2015). Complications from the previously listed exposures may lead to dysfunction of immune and reproductive systems, physiological stress, declining physical condition, and death. Behavioral responses can include displacement of animals from prime habitat, disruption of social structure, changing prey availability and foraging distribution or patterns, changing reproductive behavior/productivity, and changing movement patterns or migration (MMC, 2011). Ackleh et al. (2012) hypothesized that sperm whales may have temporarily relocated away from areas near the Macondo spill in 2010.

In the event of a large spill, the increased level of vessel and aircraft activity associated with spill response operations could disturb sperm whales and potentially result in vessel strikes, entanglement, or other injury or stress. Response vessels would operate in accordance with NTL 2012-JOINT-G01 (see **Table 1**) to reduce the potential for striking or disturbing these animals.

C.3.2 West Indian Manatee (Endangered)

Most of the Gulf of Mexico manatee population is located in peninsular Florida (USFWS, 2001). Critical habitat has been designated in southwest Florida in Manatee, Sarasota, Charlotte, Lee, Collier, and Monroe Counties. Manatee sightings in Louisiana have increased as the species extends its presence farther west of Florida in the warmer months (Wilson, 2003). A species description is presented by BOEM (2012b) and in the recovery plan for this species (USFWS, 2001).

IPFs that could affect manatees include support vessel and helicopter traffic and a large oil spill. A small diesel fuel spill in the lease area would be unlikely to affect manatees due to the distance from the nearest shoreline. As explained in **Section A.9.2**, a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to natural dispersion. Compliance with NTL BSEE-2015-G03 (see **Table 1**) will minimize the potential for marine debris-related impacts on manatees.

Impacts of Support Vessel and Helicopter Traffic

Support vessel traffic has the potential to disturb manatees, and there is a risk of vessel strikes, which are identified as a threat in the recovery plan for this species (USFWS, 2001). To reduce the potential for vessel strikes, BSEE and BOEM issued NTL 2012-JOINT-G01, which recommends protected species identification training and that vessel operators and crews maintain a vigilant watch for marine mammals and slow down or stop their vessel to avoid striking protected species, and requires operators to report sightings of any injured or dead protected species. Compliance with this NTL will minimize the likelihood of vessel strikes, and no significant impacts on manatees are expected.

Dependent on flight altitude, helicopter traffic also has the potential to disturb manatees. Rathbun (1988) reported that manatees were disturbed more by helicopters than by fixed-wing aircraft; however, the helicopter was flown at relatively low altitudes of 20 to 160 m (66 to 525 ft). Helicopters used in support operations maintain a minimum altitude of 213 m (700 ft) while in transit offshore, 305 m (1,000 ft) over unpopulated areas or across coastlines, and 610 m (2,000 ft) over populated areas and sensitive habitats such as wildlife refuges and park properties. In addition, guidelines and regulations specify that helicopters maintain an altitude of 305 m (1,000 ft) within 91 m (300 ft) of marine mammals (BOEM, 2012a, b). This mitigation measure will minimize the potential for disturbing manatees, and no significant impacts are expected.

Impacts of a Large Oil Spill

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

In the event that manatees are exposed to oil, effects could include direct impacts from oil exposure as well as indirect impacts due to response activities and materials (e.g., vessel traffic, noise, and dispersants) (MMC, 2011). Direct physical and physiological effects can include asphyxiation, acute poisoning, lowering of tolerance to other stress, nutritional stress, and inflammation of infection (BOEM, 2012b). Indirect impacts include stress from the activities and noise of response vessels and aircraft. Complications from oil exposure may lead to dysfunction of immune and reproductive systems, physiological stress, declining physical condition, and death. Behavioral responses can include displacement of animals from prime habitat, disruption of social structure, change in prey availability and foraging distribution or patterns, change in reproductive behavior/productivity, and change in movement patterns or migration (MMC, 2011).

In the event that a large spill reaches coastal waters where manatees are present, the increased level of vessel and aircraft activity associated with spill response could disturb manatees and potentially result in vessel strikes, entanglement, or other injury or stress. Response vessels would operate in accordance with NTL 2012-JOINT-G01 (see **Table 1**) to reduce the potential for striking or disturbing these animals, and therefore no significant impacts are expected.

C.3.3 Non-Endangered Marine Mammals (Protected)

Excluding the two endangered marine mammal species that were discussed in **Sections C.3.1** and **C.3.2**, there are 21 additional species of marine mammals that may be found in the Gulf of Mexico: 1 species of mysticete, the dwarf and pygmy sperm whales, 4 species of beaked whales, and 14 species of delphinids. The minke whale (*Balaenoptera acutorostrata*) is considered rare in the Gulf of Mexico, and is therefore not considered further in this EIA (BOEM, 2012b). All marine mammals are protected species under the MMPA. The most common non-endangered cetaceans in the deepwater environment are odontocetes such as the pantropical spotted dolphin, spinner dolphin, and Clymene dolphin. A brief summary is presented in the following subsections, and additional information on these groups is presented by (BOEM, 2012b, 2015, 2016).

Bryde's Whale. The Bryde's whale (*Balaenoptera edeni*) is a non-endangered mysticete known from the Gulf of Mexico and sighted most frequently along the 100 m (328 ft) isobath (Davis and Fargion, 1996, Davis et al., 2000a). Most sightings have been made in the DeSoto Canyon region and off western Florida, although there have been some in the west-central portion of the northeastern Gulf. Based on the available data, it is possible that Bryde's whales could occur in the lease area.

Dwarf and Pygmy Sperm Whales. At sea, it is difficult to differentiate dwarf sperm whales (*Kogia sima*) from pygmy sperm whales (*Kogia breviceps*), and sightings are often grouped together as *Kogia* spp. Both species have a worldwide distribution in temperate to tropical waters. In the Gulf of Mexico, both species occur primarily along the continental shelf edge and in deeper waters off the continental shelf (Mullin et al., 1991, Mullin, 2007, Waring et al., 2015). Either species could occur in the lease area.

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

Due to the difficulties of at-sea identification, beaked whales in the Gulf of Mexico are identified either as Cuvier's beaked whales or are grouped into an undifferentiated complex (*Mesoplodon* spp. and *Ziphius* spp.). In the northern Gulf of Mexico, they are broadly distributed in water depths greater than 1,000 m (3,281 ft) over lower slope and abyssal landscapes (Davis et al., 2000a). Any of these species could occur in the lease area (Waring et al., 2015).

Delphinids. Fourteen species of delphinids are known to occur in the Gulf of Mexico: Atlantic spotted dolphin (*Stenella frontalis*), Clymene dolphin (*Stenella clymene*), pantropical spotted dolphin (*Stenella attenuata*), spinner dolphin (*Stenella longirostris*), striped dolphin (*Stenella coeruleoalba*), bottlenose dolphin (*Tursiops truncatus*), false killer whale (*Pseudorca crassidens*), killer whale (*Orcinus orca*), pygmy killer whale (*Feresa attenuata*), melon-headed whale (*Peponocephala electra*), short-finned pilot whale (*Globicephala macrorhynchus*), Risso's dolphin (*Grampus griseus*), Fraser's dolphin (*Lagenodelphis hosei*), and rough-toothed dolphin (*Steno bredanensis*). Any of these species could occur in the lease area (Waring et al., 2015). The most common non-endangered cetaceans in the deepwater environment are the pantropical spotted dolphin, spinner dolphin, and Clymene dolphin.

The bottlenose dolphin (*Tursiops truncatus*) is a common inhabitant of the northern Gulf of Mexico, particularly within continental shelf waters. There are two ecotypes of bottlenose dolphins, a coastal form and an offshore form, which are genetically isolated from each other (Waring et al., 2015). The offshore form of the bottlenose dolphin may occur within the lease area. Inshore populations of coastal bottlenose dolphins in the northern Gulf of Mexico are separated into 37 geographically distinct population units, or stocks, for management purposes by NMFS (Waring et al., 2015). NMFS has proposed to classify the Gulf of Mexico Northern Coastal Stock, Western Coastal Stock, and all 32 of the Bay, Sound, and Estuarine Stocks as strategic stocks (Waring et al., 2015).

The strategic stock designation in this case was based primarily on the occurrence of an "unusual mortality event" (UME) of unprecedented size and duration that has affected these stock areas. The UME began in February 2010 and ended in July 2014 (NOAA, 2016c). Carmichael et al. (2012) hypothesized that the unusual number of bottlenose dolphin strandings in the northern Gulf of Mexico in 2010 and 2011 may have been associated with environmental perturbations including sustained cold weather and the Macondo spill in 2010 as well as large volumes of cold freshwater discharge in the early months of 2011. Schwacke et al. (2014) reported that 1 year after the Macondo spill, many dolphins in Barataria Bay, Louisiana, showed evidence of disease conditions associated with petroleum exposure and toxicity. (Venn-Watson et al., 2015) performed histological studies to examine contributing factors and causes of deaths for stranded common bottlenose dolphins from Louisiana, Mississippi, and Alabama and found that the dead dolphins from the UME were more likely than those from other areas to have primary bacterial pneumonia and thin adrenal cortices. The adrenal gland and lung diseases were consistent with exposure to petroleum compounds, and the exposure to petroleum compounds during and after the Macondo spill are proposed as a cause.

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

Impacts of MODU Presence, Noise, and Lights

Noise from routine drilling and well completion operations has the potential to disturb marine mammals. Most odontocetes (toothed whales and dolphins) use higher frequency sounds than those produced by OCS activities (Richardson et al., 1995). Noise intensity associated with drilling and well completion operations is relatively weak, and the noise exposure to an individual animal would be temporary. Thruster noise impacts would be expected at greater distances than vessel and drilling noise alone (LGL Ecological Research Associates, 2006), but are dependent on variables relating to thruster type and usage. It is expected that marine mammals within or near the lease area would be able to detect the presence of the MODU and avoid exposure to higher energy sounds, particularly within an open ocean environment.

Some odontocetes have shown increased feeding activity around lighted platforms at night (Todd et al., 2009). Even temporary support vessels present an attraction to pelagic food sources that may attract cetaceans. 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. There are other OCS facilities and activities near the lease area, and the region as a whole has a large number of similar sources. Marine mammal species in the northern Gulf of Mexico have been exposed to noise from anthropogenic sources for a long period of time and over large geographic areas and likely do not represent a naïve population with regard to sound (National Research Council, 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 impacts are not expected to be biologically significant to marine mammal populations.

MODU and support vessel presence, noise and lighting are not identified as IPFs for marine mammals (BOEM, 2012b, 2015, 2016).

Impacts of Support Vessel and Helicopter Traffic

Support vessel traffic has the potential to disturb marine mammals, and there is a risk of vessel strikes. Data concerning the frequency of vessel strikes are presented by BOEM (2012b). To reduce the potential for vessel strikes, BSEE and BOEM issued NTL 2012-JOINT-G01, which recommends protected species identification training and that vessel operators and crews maintain a vigilant watch for marine mammals and slow down or stop their vessel to avoid striking protected species, and requires operators to report sightings of any injured or dead protected species. Vessel operators and crews are required to attempt to maintain a distance of 91 m (300 ft) or greater when whales are sighted and 45 m (150 ft) when small (non-whale) cetaceans are sighted. When cetaceans are sighted while a vessel is underway, vessels must attempt to remain parallel to the animal's course and avoid excessive speed or abrupt changes in direction until the cetacean has left the area. Vessel operators are required to reduce vessel speed to 10 knots or less when mother/calf pairs, pods, or large assemblages of cetaceans are observed near an underway vessel, when safety permits. Compliance with NTL 2012-JOINT-G01 (see **Table 1**) will minimize the likelihood of vessel strikes as well as reduce the chance for disturbing marine mammals; therefore, no significant impacts are expected.

Aircraft traffic also has the potential to disturb marine mammals (Würsig et al., 1998). However, while flying offshore, helicopters maintain altitudes above 213 m (700 ft) during transit to and from the working area. In addition, guidelines and regulations specify that helicopters maintain an altitude of 305 m (1,000 ft) within 91 m (300 ft) of marine mammals (BOEM, 2012a, b). Maintaining this altitude will minimize the potential for disturbing marine mammals, and no significant impacts are expected (BOEM, 2012a, b).

Impacts of a Small Diesel Fuel Spill

Potential spill impacts on marine mammals are discussed by BOEM (2012b, 2015, 2016). Oil impacts on marine mammals in general are discussed by Geraci and St. Aubin (1990). For the SEP, there are no unique site-specific issues with respect to spill impacts on these animals.

The probability of a fuel spill will be minimized by 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 is expected to lessen the potential for impacts on marine mammals. **SEP Section H** provides detail on spill response measures. Given the open ocean location of the lease area, the limited duration of a small spill and response efforts, it is expected that any impacts on marine mammals would be brief and minimal.

A small diesel fuel spill in offshore waters would produce a slick on the water surface and increase the concentrations of petroleum hydrocarbons and their degradation products. Direct physical and physiological effects of exposure to diesel fuel could include skin irritation, inflammation, or necrosis; chemical burns of skin, eyes, and mucous membranes; inhalation of toxic fumes; ingestion of oil directly or via contaminated prey; and stress from the activities and noise of response vessels and aircraft (MMC, 2011). The extent and persistence of impacts would depend on the meteorological and oceanographic conditions at the time and the effectiveness of spill response measures. As **Section A.9.2** discusses, a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to breaking up. Therefore, due to the limited areal extent and short duration of water quality impacts from a small diesel fuel spill as well as the mobility of marine mammals, no significant impacts are expected.

Impacts of a Large Oil Spill

Potential spill impacts on marine mammals are discussed by (BOEM, 2012b, 2015, 2016). For the SEP, there are no unique site-specific issues.

Impacts of oil spills on marine mammals can include direct impacts from oil exposure as well as indirect impacts due to response activities and materials (e.g., vessel traffic, noise, and dispersants) (MMC, 2011). Direct physical and physiological effects can include skin irritation, inflammation, or necrosis; chemical burns of skin, eyes, and mucous membranes; inhalation of toxic fumes; ingestion of oil (and dispersants) directly or via contaminated prey. Complications of the above may lead to dysfunction of immune and reproductive systems, physiological stress, declining physical condition, and death. Indirect impacts can include stress from the activities and noise of response vessels and aircraft. Behavioral responses can include displacement of animals from prime habitat, disruption of social structure, change in prey availability and foraging distribution or patterns, change in reproductive behavior/productivity, and change in movement patterns or migration (MMC, 2011).

Data from the Macondo spill, as analyzed and summarized by NOAA (2016b) indicate the scope of potential impacts from a large spill. Tens of thousands of marine mammals were exposed to the slick, where they likely inhaled, aspirated, ingested, physically contacted, and absorbed oil components (NOAA, 2016b). Nearly all of the marine mammal stocks in the northern Gulf of Mexico were affected. The oil's physical, chemical, and toxic effects damaged tissues and organs, leading to a constellation of adverse health effects, including reproductive failure, adrenal disease, lung disease, and poor body condition (NOAA, 2016b). According to the National Wildlife Federation (2016a), approximately 100 marine mammals were collected within the spill area during the 6 months following the Macondo spill, most of which were bottlenose dolphins. NMFS (2014a) documented 13 dolphins and whales stranded alive, and over 150 dolphins and whales were found dead during the oil spill response. Other affected species included dwarf/pygmy sperm whales, melon-headed whales, and spinner dolphins. Because of known low detection rates of carcasses (Williams et al., 2011), it is possible that the number of marine mammal deaths were significantly underestimated. Also, necropsies to confirm the cause of death could not be conducted for many of these marine mammals. Schwacke et al. (2014) reported that 1 year after the spill, many dolphins in Barataria Bay, Louisiana, had evidence of disease conditions associated with petroleum exposure and toxicity. BOEM (2012b) 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.

In the event of a large spill, response activities that may impact marine mammals include increased vessel traffic, use of dispersants, and remediation activities (e.g., controlled burns, skimmers, boom) (BOEM, 2012b). 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 or other injury, or stress. Response vessels would operate in accordance with NTL 2012-JOINT-G01 to reduce the potential for striking or disturbing these animals, and therefore no significant impacts are expected. The application of dispersants is likely to reduce the chances of harmful impacts as the dispersants would remove oil from the surface, thereby reducing the risk of contact and rendering it less likely to adhere to skin, baleen plates, or other body surfaces (BOEM, 2012b). The use of trained observers during remediation activities will reduce the likelihood of capture and/or entrainment (BOEM, 2012b). Therefore, no significant impacts from response activities are anticipated.

C.3.4 Sea Turtles (Endangered/Threatened)

Five species of endangered or threatened sea turtles may be found near the lease area. Endangered species are the leatherback (*Dermochelys coriacea*), Kemp's ridley (*Lepidochelys kempii*), and hawksbill (*Eretmochelys imbricata*) turtles. As of 6 May 2016, the entire North Atlantic DPS of the green turtle (*Chelonia mydas*) is listed as threatened (81 FR 20057). The DPS of loggerhead turtles (*Caretta caretta*) that occurs in the Gulf of Mexico is listed as threatened, although other DPSs are endangered. Species descriptions are presented by BOEM (2012b).

Critical habitat has been designated for the loggerhead turtle in the Gulf of Mexico as shown in **Figure 3**. Critical habitat in the northern Gulf of Mexico includes nesting beaches in Mississippi, Alabama, and the Florida Panhandle; nearshore reproductive habitat within 1.6 km seaward from these beaches; and a large area of *Sargassum* habitat that includes most of the Western and Central Planning Areas of and parts of the southern portion of the Eastern Planning Area (NMFS, 2014b).

Loggerhead turtles in the Gulf of Mexico are part of the Northwest Atlantic Ocean DPS (76 FR 58868). In July 2014, NMFS and the USFWS designated critical habitat for this DPS. The USFWS designation (79 FR 39756) includes nesting beaches in Jackson County, Mississippi; Baldwin County, Alabama; and Bay, Gulf, and Franklin Counties in the Florida Panhandle as well as several counties in southwest Florida and the Florida Keys (and other areas along the Atlantic coast). The NMFS designation (79 FR 39856) includes nearshore reproductive habitat within 1.6 km seaward of the mean high water line at these same nesting beaches. NMFS also designated a large area of *Sargassum* habitat in the Gulf of Mexico (and Atlantic Ocean) as critical habitat; *Sargassum* serves as important foraging and developmental habitat for young loggerhead turtles. NMFS designated three other categories of critical habitat as well; of these, two (migratory habitat and overwintering habitat) are along the Atlantic coast and the third (breeding habitat) is found in the Florida Keys and along the Florida east coast (NMFS, 2014b). The closest designated nearshore reproductive critical habitat for loggerhead sea turtles is approximately 237 miles (381 km) north-northeast of the lease area. The lease area is located inside the designated *Sargassum* critical habitat for loggerhead sea turtles (**Figure 3**).

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

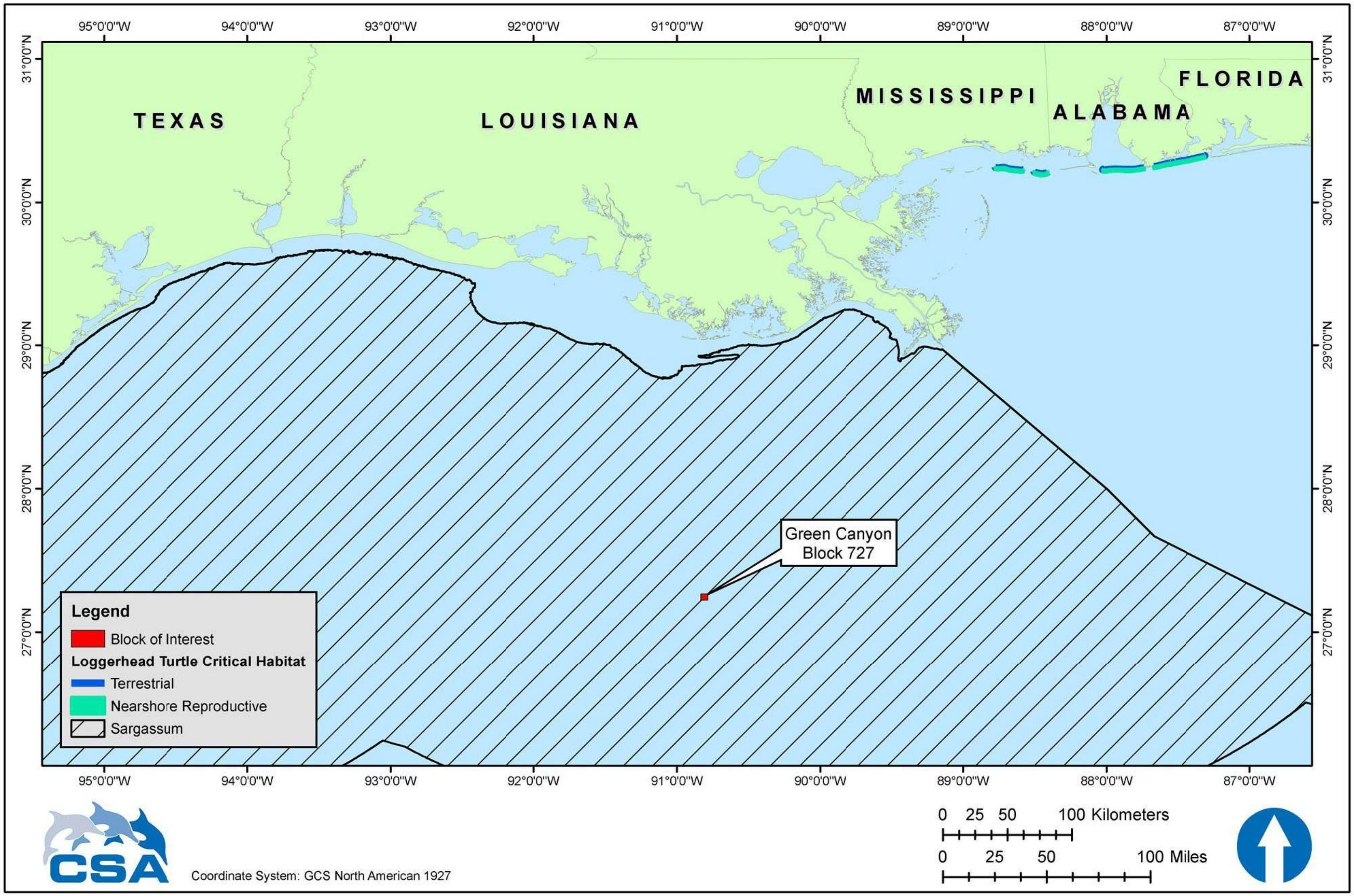


Figure 3. Location of loggerhead turtle designated critical habitat in relation to the lease area.

All five sea turtle species in the Gulf of Mexico are migratory and use different marine habitats according to their life stage. These habitats include high-energy beaches for nesting females and emerging hatchlings and pelagic convergence zones for hatchling and juvenile turtles. As adults, green, hawksbill, and loggerhead turtles forage primarily in shallow, benthic habitats. Leatherback turtles are the most pelagic of the sea turtles, feeding primarily on jellyfish.

Sea turtle nesting on the northern Gulf of Mexico coast can be summarized by species as follows:

- Loggerhead turtles – Loggerhead turtles nest in significant numbers along the Florida Panhandle (Florida Fish and Wildlife Conservation Commission, 2016a) and, to a lesser extent, from Texas through Alabama (NMFS and USFWS, 2008).
- Green and leatherback turtles – Green and leatherback turtles infrequently nest on Florida Panhandle beaches (Florida Fish and Wildlife Conservation Commission, 2016b, c).
- Kemp's ridley turtles – The critically endangered Kemp's ridley turtle nests almost exclusively on a 16-mile (26-km) stretch of coastline near Rancho Nuevo in the Mexican state of Tamaulipas (NMFS et al., 2011). A much smaller but growing population nests in Padre Island National Seashore, Texas, mostly as a result of reintroduction efforts (NMFS et al., 2011). A total of 159 Kemp's ridley turtle nests were counted on Texas beaches in 2015, an increase from the 118 counted in 2014 (Turtle Island Restoration Network, 2015). Padre Island National Seashore along the coast of Willacy, Kenedy, and Kleberg Counties in southern Texas, is the most important nesting location for this species in the United States, although there have been occasional reports of Kemp's ridleys nesting in Alabama (Share the Beach, 2015).
- Hawksbill turtles – Hawksbill turtles typically do not nest anywhere near the project area, with most nesting in the region located in the Caribbean Sea and on the beaches of the Yucatán Peninsula (USFWS, 2015a).

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

Impacts of MODU Presence, Noise, and Lights

MODU activities produce a broad array of sounds at frequencies and intensities that may be detected by sea turtles (Geraci and St. Aubin, 1987, Samuel et al., 2005). Potential impacts may include behavioral disruption and temporary or permanent displacement from the area near the sound source. Certain sea turtles, especially loggerheads, may be attracted to offshore structures (Lohoefener et al., 1990, Gitschlag et al., 1997) and, thus, may be more susceptible to impacts from sounds produced during routine operations. The most likely impacts would be short-term behavioral changes such as diving and evasive swimming, disruption of activities, or departure from the area. Due to the limited scope and short duration of activities, these short-term impacts are not expected to be biologically significant to sea turtle populations.

Artificial lighting can disrupt the nocturnal orientation of sea turtle hatchlings (Witherington, 1997, Tuxbury and Salmon, 2005). However, hatchlings may rely less on light cues when they are offshore than when they are emerging on the beach (Salmon and Wyneken, 1990). NMFS (2007) concluded that the effects of lighting from offshore structures on sea turtles are insignificant.

Impacts of Support Vessel and Helicopter Traffic

Noise generated from support vessel traffic has the potential to disturb sea turtles, and there is a risk of vessel strikes. Data show that vessel strike is one cause of sea turtle mortality in the Gulf of Mexico (Lutcavage et al., 1997). While adult sea turtles are visible at the surface during the day and in clear weather, they can be difficult to spot from a moving vessel when resting below the water surface, during nighttime, or during periods of inclement weather. To reduce the potential for vessel strikes, BSEE and BOEM issued NTL 2012-JOINT-G01, which recommends protected species identification training and that vessel operators and crews maintain a vigilant watch for sea turtles and slow down or stop their vessel to avoid striking protected species, and requires operators to report sightings of any injured or dead protected species. When sea turtles are sighted, vessel operators and crews are required to attempt to maintain a distance of 45 m (150 ft) or greater whenever possible. Compliance with this NTL (see **Table 1**) will minimize the likelihood of vessel strikes as well as reduce the chance for disturbing sea turtles (NMFS, 2007).

Noise generated from support helicopter traffic also has the potential to disturb sea turtles. However, while flying offshore, helicopters maintain altitudes above 213 m (700 ft) 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, 2012b).

Impacts of a Small Diesel Fuel Spill

Potential spill impacts on sea turtles are discussed by NMFS (2007) and (BOEM, 2012b, 2015, 2016). For this SEP, there are no unique site-specific issues with respect to spill impacts on sea turtles.

The probability of a fuel spill will be minimized by 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 is expected to minimize potential impacts on sea turtles. **SEP Section H** provides detail on spill response measures. Given the open ocean location of the lease area, the duration of a small spill and opportunity for impacts on turtles to occur would be brief.

A small diesel fuel spill in offshore waters would produce a slick on the water surface and increase the concentrations of petroleum hydrocarbons and their degradation products. Direct physical and physiological effects of exposure to diesel fuel could include skin irritation, inflammation, or necrosis; chemical burns of skin, eyes, and mucous membranes; inhalation of toxic fumes; ingestion of oil directly or via contaminated prey; and stress from the activities and noise of response vessels and aircraft (BOEM, 2012b, NMFS, 2014a). The extent and persistence of impacts would depend on the meteorological and oceanographic conditions at the time of the spill as well as the effectiveness of spill response measures. **Section A.9.2** discusses the likely fate of a small diesel fuel spill and indicates that more than 90% would evaporate or disperse naturally within 24 hours. The sea surface area covered with diesel fuel would range from 0.5 to 5 ha (1.2 to 12 ac), depending on sea state and weather conditions. Therefore, due to the limited areal extent and short duration of water quality impacts from a small diesel fuel spill, no significant impacts to sea turtles from direct or indirect exposure are expected.

Loggerhead Critical Habitat – Nesting Beaches. A small diesel fuel spill in the lease area would be unlikely to affect sea turtle nesting beaches due to the distance from 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 237 miles (381 km) from the lease area. As explained in **Section A.9.2**, a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to natural dispersion.

Loggerhead Critical Habitat – *Sargassum*. The lease area is within the *Sargassum* habitat portion of the loggerhead turtle critical habitat (**Figure 3**). A small diesel fuel spill could affect *Sargassum* and juvenile turtles by contaminating this habitat. Juvenile sea turtles could come into contact with or ingest oil, resulting in death, injury, or other sublethal effects. Effects of a small spill on *Sargassum* critical habitat for loggerhead turtles would be limited to the small area (0.5 to 5 ha [1.2 to 12 ac]) likely to be impacted by a small spill. An impact area of 5 ha (12 ac) would represent a negligible portion of the approximately 40,662,810 ha (100,480,000 ac) designated *Sargassum* critical habitat for loggerhead turtles in the northern Gulf of Mexico.

Impacts of a Large Oil Spill

Impacts of oil spills on sea turtles can include direct impacts from oil exposure as well as indirect impacts due to response activities and materials (e.g., vessel traffic, noise, and dispersants). Direct physical and physiological effects can include skin irritation, inflammation, or necrosis; chemical burns of skin, eyes, and mucous membranes; inhalation of toxic fumes and smoke (e.g., from *in situ* burning of oil); ingestion of oil (and dispersants) directly or via contaminated food; and stress from the activities and noise of response vessels and aircraft. Complications of the above may lead to dysfunction of immune and reproductive systems, physiological stress, declining physical condition, and death. Behavioral responses can include displacement of animals from prime habitat, disruption of social structure, change in food availability and foraging distribution or patterns, change in reproductive behavior/productivity, and change in movement patterns or migration (NOAA, 2010, NMFS, 2014a). In the unlikely event of a spill, implementation of Anadarko's OSRP is expected to minimize the potential for these types of impacts on sea turtles. **SEP Section H** provides detail on spill response measures.

Studies of oil effects on loggerhead turtles in a controlled setting (Lutcavage et al., 1995, NOAA, 2010) suggest that sea turtles show no avoidance behavior when they encounter an oil slick, and any sea turtle in an affected area would be expected to be exposed. Sea turtles' diving behaviors also put them at risk. Sea turtles rapidly inhale a large volume of air before diving and continually resurface over time, which may result in repeated exposure to volatile vapors and oiling (NMFS, 2007).

Results of the Macondo spill provide an indication of potential effects of a large oil spill on sea turtles. NOAA (2016b) estimates that between 4,900 and up to 7,600 large juvenile and adult sea turtles (Kemp's ridleys, loggerheads, and hardshelled sea turtles not identified to species), and between 56,000 and 166,000 small juvenile sea turtles (Kemp's ridleys, green turtles, loggerheads, hawksbills, and hardshelled sea turtles not identified to species) were killed by the Macondo spill. Nearly 35,000 hatchling sea turtles (loggerheads, Kemp's ridleys, and green turtles) were also injured by response activities (NOAA, 2016b).

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 in 2010 (NOAA, 2016b).

The 30-day OSRA results summarized in **Table 3** estimate that Louisiana and Texas shorelines that support limited sea turtle nesting could be contacted within 30 days (1% to 3% conditional probability). The 60-day OSRA modeling (**Table 4**) predicts the conditional probability of contacting Mississippi, Alabama, and Florida Panhandle shorelines that support significant loggerhead sea turtle nesting is 1% or less. The nearest nearshore reproductive critical habitat for the loggerhead turtle is 237 miles (381 km) from the lease area and is predicted by the 60-day OSRA model to have a 1% or less conditional probability of contact within 60 days of a spill.

Loggerhead Critical Habitat – Nesting Beaches. If spilled oil reaches sea turtle nesting beaches, nesting sea turtles and egg development could be affected (NMFS, 2007). An oiled beach could affect nest site selection or result in no nesting at all (e.g., false crawls). Upon hatching and successfully reaching the water, hatchlings are subject to the same types of oil spill exposure hazards as adults. Hatchlings that contact oil residues while crossing a beach can exhibit a range of effects, from acute toxicity to impaired movement and normal bodily functions (NMFS, 2007).

Loggerhead Critical Habitat – *Sargassum*. The lease area is within the loggerhead turtle critical habitat designated as *Sargassum* habitat, which includes most of the Western and Central Planning Areas in the Gulf of Mexico and parts of the southern portion of the Eastern Planning Area (**Figure 3**) (NMFS, 2014b). Because of the large area covered by the designated *Sargassum* habitat for loggerhead turtles, a large spill could result in a substantial part of the *Sargassum* habitat in the northern Gulf of Mexico being oiled. However, the catastrophic 2010 Macondo spill affected approximately one-third of the *Sargassum* habitat in the northern Gulf of Mexico (BOEM, 2014). It is extremely unlikely that the entire *Sargassum* critical habitat would be affected by a large spill. Because *Sargassum* is a floating and pelagic species, it would only be affected by impacts that occur near the surface.

The effects of oiling on *Sargassum* vary with severity, but moderate to heavy oiling that could occur during a large spill could cause complete mortality to *Sargassum* and its associated communities (BOEM, 2016). *Sargassum* also has the potential to sink during a large spill, thus temporarily removing the habitat and possibly being an additional pathway of exposure to the benthic environment (Powers et al., 2013). Lower levels of oiling may cause sub-lethal affects, including reduced growth, productivity, and recruitment of organisms associated with *Sargassum*. The *Sargassum* algae itself could be less impacted by light to moderate oiling than associated organisms because of a waxy outer layer that might help protect it from oiling (BOEM, 2016) *Sargassum* has a yearly seasonal cycle of growth and a yearly cycle of migration from the Gulf of Mexico to the western Atlantic. A large spill could affect a large portion of the annual crop of the algae; however, because of its ubiquitous distribution and seasonal cycle, recovery of the *Sargassum* community would be expected to occur within 1 to 2 years (BOEM, 2016).

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 2012-JOINT-G01 (see **Table 1**) to reduce the potential for striking or disturbing these animals, and therefore no significant impacts are expected from increased vessel and aircraft activity.

C.3.5 Piping Plover (Threatened)

The Piping Plover (*Charadrius melodus*) is a migratory shorebird that overwinters along the southeastern U.S. and Gulf of Mexico coasts. This threatened species is in decline as a result of hunting, habitat loss and modification, predation, and disease (USFWS, 2003). Critical overwintering habitat has been designated, including beaches in Texas, Louisiana, Mississippi, Alabama, and Florida (**Figure 4**). Piping Plovers inhabit coastal sandy beaches and mudflats, feeding by probing for invertebrates at or just below the surface. They use beaches adjacent to foraging areas for roosting and preening (USFWS, nd). A species description is presented by BOEM (2012b).

A large oil spill is the only IPF potentially affecting Piping Plovers. There are no IPFs associated with routine project activities that could affect these birds. A small diesel fuel spill in the lease area would be unlikely to affect Piping Plovers because a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to natural dispersion (see **Section A.9.2**).

Impacts of a Large Oil Spill

The lease area is 122 miles (196 km) the nearest shoreline that is designed as critical habitat for Piping Plovers in Terrebonne Parish, Louisiana (**Figure 4**). The 60-day OSRA modeling (**Table 4**) predicts that during the spring, there is a 13% conditional probability that an oil spill from the lease area would reach a shoreline designated as critical habitat for the Piping Plover within 60 days of a spill. Piping Plovers could become physically oiled while foraging on oiled shores or secondarily contaminated through ingestion of oiled intertidal sediments and prey (BOEM, 2012b). Piping 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 plovers are most common along the coastal Gulf or if spills contacted critical habitat. Impacts also could occur from vehicular traffic on beaches and other activities associated with spill cleanup. 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.

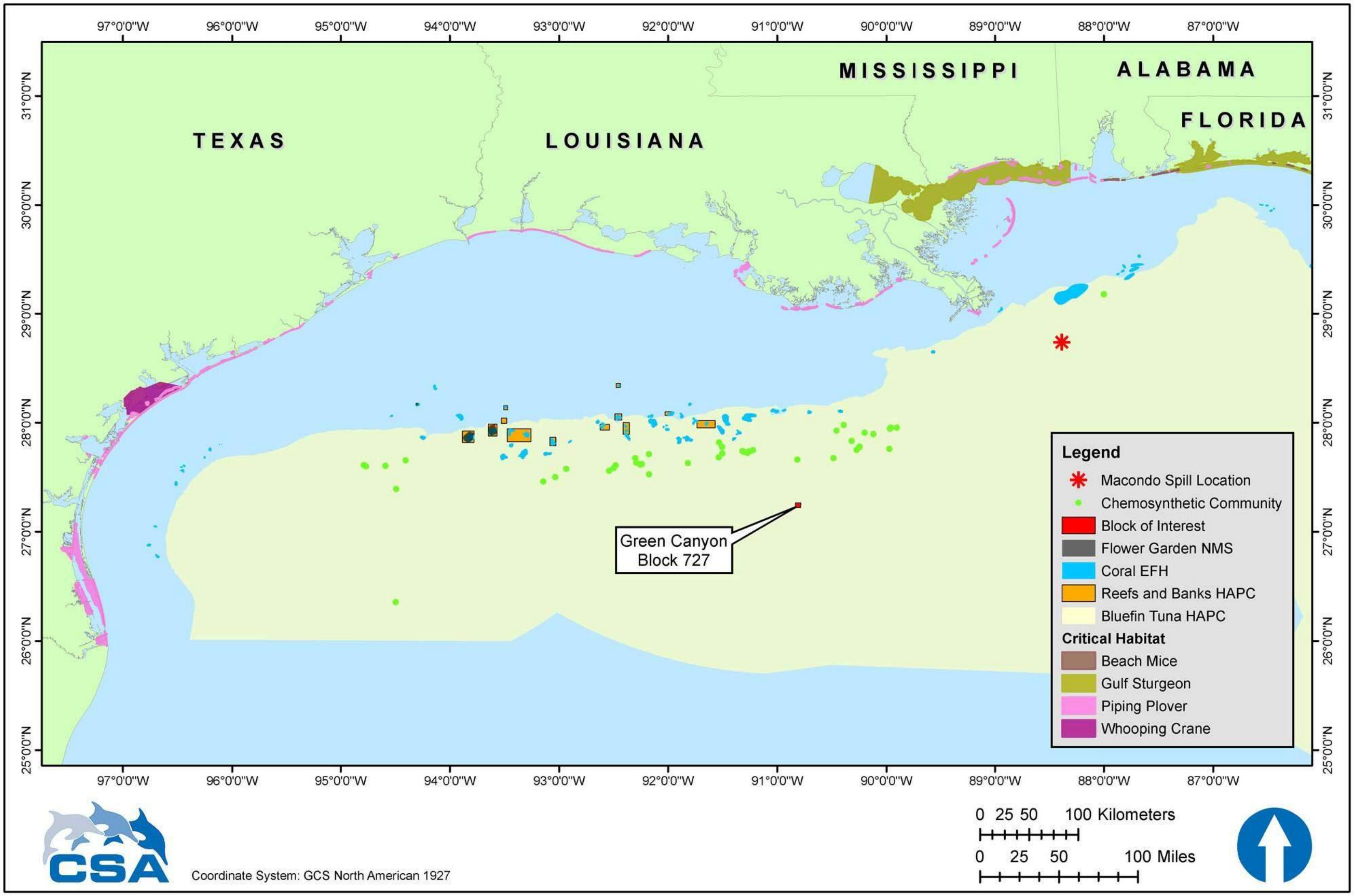


Figure 4. Location of selected environmental features in relation to the lease area. EFH = Essential Fish Habitat; HAPC = Habitat Area of Particular Concern; NMS= National Marine Sanctuary.

C.3.6 Whooping Crane (Endangered)

The Whooping Crane (*Grus americana*) is an omnivorous wading bird and an endangered species. Three wild populations live in North America (National Wildlife Federation, 2016b). One population winters along the Texas coast at Aransas NWR and summers at Wood Buffalo National Park in Canada. This population represents the majority of the world's population of free-ranging Whooping Cranes, reaching a record estimated population of 329 during the 2015-2016 winter (USFWS, 2016b). A non-migrating population has been reintroduced in central Florida, and another reintroduced population summers in Wisconsin and migrates to the southeastern U.S. for the winter. Whooping Cranes breed, migrate, winter, and forage in a variety of habitats, including coastal marshes and estuaries, inland marshes, lakes, ponds, wet meadows and rivers, and agricultural fields (USFWS, 2007). Approximately 9,000 ha (22,240 ac) of salt flats on Aransas NWR and adjacent islands make up the principal wintering grounds of the Whooping Crane. Aransas NWR is designated as critical habitat for the species. A species description is presented by BOEM (2012b).

A large oil spill is the only IPF potentially affecting Whooping Cranes. A small diesel fuel spill in the lease area would be unlikely to affect Whooping Cranes due to the distance from Aransas NWR. As explained in **Section A.9.2**, a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to natural dispersion.

Impacts of a Large Oil Spill

The lease area is 352 miles (566 km) from the Aransas NWR in Aransas and Calhoun Counties, Texas, the nearest shoreline that is designed as critical habitat for Whooping Cranes. The 60-day OSRA modeling (**Table 4**) predicts that during the winter, there is a 4% conditional probability that an oil spill from the lease area would reach a shoreline designated as critical habitat for the Whooping Crane within 60 days of a spill. Whooping Cranes could physically oil themselves while foraging in oiled areas or secondarily contaminate themselves through ingestion of contaminated shellfish, frogs, and fishes. It is possible that some deaths of Whooping Cranes could occur, especially if spills occur during winter months when Whooping Cranes are most common along the Texas coast if the spill contacts their critical habitat in Aransas NWR. Impacts could also occur from vehicular traffic on beaches and other activities associated with spill cleanup. Anadarko has extensive resources available to protect and rehabilitate wildlife in the event of a spill reaching the shoreline, as detailed in their OSRP.

C.3.7 Gulf Sturgeon (Threatened)

The Gulf sturgeon (*Acipenser oxyrinchus desotoi*) is a threatened fish species that inhabits major rivers and inner shelf waters from the Mississippi River to the Suwannee River, Florida (Barkuloo, 1988, Wakeford, 2001). An anadromous fish that migrates from the sea upstream into coastal rivers to spawn in freshwater, it historically ranged from the Mississippi River to Charlotte Harbor, Florida (Wakeford, 2001). This range has contracted to encompass major rivers and inner shelf waters from the Mississippi River to the Suwannee River, Florida. Populations have been depleted or even extirpated throughout this range by fishing, shoreline development, dam construction, water quality changes, and other factors (Barkuloo, 1988, Wakeford, 2001). These declines prompted the listing of the Gulf sturgeon as a threatened species in 1991. The best known populations occur in the Apalachicola and Suwannee Rivers in Florida (Carr, 1996, Sulak and Clugston, 1998), the Choctawhatchee River in Alabama (Fox et al., 2000), and the Pearl River in Mississippi/Louisiana (Morrow et al., 1998). Rudd et al. (2014) reconfirmed the spatial distribution and movement patterns of Gulf Sturgeon by surgically implanting acoustic telemetry tags. Critical habitat in the Gulf extends from Lake Borgne, Louisiana (St. Bernard Parish), to Suwannee Sound, Florida (Levy County) (NMFS, 2014c) (**Figure 4**). A species description is presented by BOEM (2012b) and in the recovery plan for this species (USFWS et al., 1995).

A large oil spill is the only IPF that could affect Gulf sturgeon. There are no IPFs associated with routine project activities that could affect these fish. A small diesel fuel spill in the lease area would be unlikely to affect Gulf sturgeon because a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to natural dispersion (see explanation in **Section A.9.2**).

Impacts of a Large Oil Spill

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

The lease area is approximately 226 miles (364 km) from the nearest Gulf sturgeon critical habitat in St Bernard Parish, Louisiana, and Harrison County, Mississippi. The 30-day (**Table 3**) and 60-day OSRA modeling (**Table 4**) predict that a spill in the lease area has 1% or less conditional probability of contacting any coastal areas containing Gulf sturgeon critical habitat within 60 days of a spill.

In the event of oil reaching Gulf sturgeon habitat, the fish could be affected by direct ingestion, ingestion of oiled prey, or the absorption of dissolved petroleum products through the gills. Based on the life history of this species, sub-adult and adult Gulf sturgeon would be most vulnerable to an estuarine or marine oil spill, and likely would be vulnerable only from 1 September through 30 April when the species is typically foraging in estuarine and shallow marine habitats (NMFS, 2007).

NOAA (2016b) estimated that 1,100 to 3,600 Gulf sturgeon were exposed to oil from the Macondo spill. Overall, 63% of the Gulf sturgeon from six river populations were potentially exposed to the spill. Although the number of dead or injured Gulf sturgeon was not estimated, laboratory and field tests indicated that Gulf sturgeon exposed to oil displayed both genotoxicity and immunosuppression, which can lead to malignancies, cell death, susceptibility to disease, infections, and a decreased ability to heal (NOAA, 2016b).

C.3.8 Beach Mice (Endangered)

Four subspecies of endangered beach mice (*Peromyscus polionotus*) occur on the barrier islands of Alabama and the Florida Panhandle: Alabama, Choctawhatchee, Perdido Key, and St. Andrew beach mice. Critical habitat has been designated for all four subspecies. **Figure 4** shows the combined critical habitat for all four subspecies. Species descriptions are provided by BOEM (2012b).

A large oil spill is the only IPF that could affect beach mice. There are no IPFs associated with routine project activities that could affect these animals due to the distance from shore and the lack of any onshore support activities near their habitat. A small diesel fuel spill in the lease area would not affect beach mice because a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to natural dispersion (see **Section A.9.2**).

Impacts of a Large Oil Spill

Potential spill impacts on beach mice are discussed by BOEM (2012b, 2015, 2016). For the SEP, there are no unique site-specific issues with respect to these species that were not analyzed in these documents.

Beach mouse critical habitat in Baldwin County, Alabama, is approximately 263 miles (423 km) from the lease area. The 30-day OSRA results (**Table 3**) predict less than 0.5% conditional probability of oil contact with beach mouse critical habitat within 30 days of a spill. The 60-day OSRA modeling (**Table 4**) predicts that a spill in the lease area has a 1% or less conditional probability of reaching either the Alabama or Florida shorelines inhabited by beach mice within 60 days of a spill.

In the event of oil contacting these beaches, beach mice could experience several types of direct and indirect impacts. Contact with spilled oil could cause skin and eye irritation and subsequent infection; matting of fur; irritation of sweat glands, ear tissues, and throat tissues; disruption of sight and hearing; asphyxiation from inhalation of fumes; and toxicity from ingestion of oil and contaminated food. Indirect impacts could include reduction of food supply, destruction of habitat, and fouling of nests. Impacts could also occur from vehicular traffic and other activities associated with spill cleanup (BOEM, 2012b). However, any such impacts are unlikely due to the distance from shore and response actions that would occur in the event of a spill.

C.3.9 Threatened Coral Species

Four threatened coral species are known from the northern Gulf of Mexico: elkhorn coral (*Acropora palmata*), lobed star coral (*Orbicella annularis*), mountainous star coral (*Orbicella faveolata*), and boulder star coral (*Orbicella franksi*). These species have been reported from the coral cap region of the Flower Garden Banks (NOAA, 2014) but are unlikely to be present as regular residents anywhere else in the northern Gulf of Mexico because they typically inhabit coral reefs in shallow, clear tropical, or subtropical waters. Other Caribbean coral species evaluated by NMFS in 2014 (79 FR 53852) either do not meet the criteria for ESA listing or are not known from the Flower Garden Banks. Critical habitat has been designated for elkhorn corals in the Florida Keys, but none has been designated for the other threatened coral species included above.

There are no IPFs associated with routine project activities that could affect threatened corals in the northern Gulf of Mexico. A small diesel fuel spill would not affect threatened coral species because the oil would float and dissipate on the sea surface. A large oil spill is the only relevant IPF.

Impacts of a Large Oil Spill

A large oil spill would be unlikely to reach coral reefs at the Flower Garden Banks or elkhorn coral critical habitat in the Florida Keys (Monroe County, Florida). The 60-day OSRA modeling (**Table 4**) predicts the conditional probability of oil contacting the Florida Keys is 0.5% or less. A surface slick would not contact corals on the seafloor. If a subsurface plume were to occur, impacts on the Flower Garden Banks would be unlikely due to the distance and the difference in water depth. Near-bottom currents in the region are predicted to flow along the isobaths

(Nowlin et al., 2001) and typically would not carry a plume up onto the continental shelf edge. Valentine et al. (2014) observed the spatial distribution of excess hopane, a crude oil tracer from Macondo spill sediment core samples, to be in the deeper waters and not transported up the shelf, thus confirming that near-bottom currents flow along the isobaths.

In the unlikely event that an oil slick reached reefs at the Flower Garden Banks or other Gulf of Mexico reefs, oil droplets or oiled sediment particles could come into contact with reef organisms or corals. As discussed by BOEM (2012b, 2015, 2016), 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, 2012b, 2015, 2016).

Due to the distance from the lease area and the low chance of oil contacting threatened coral habitat in the event of a spill, no significant impacts on threatened coral species are expected.

C.4 Coastal and Marine Birds

C.4.1 Marine Birds

Marine birds include seabirds and other species that may occur in the pelagic environment of the project area (Clapp et al., 1982a, Clapp et al., 1982b, 1983, Peake, 1996, Hess and Ribic, 2000). Seabirds spend much of their lives offshore over the open ocean, except during breeding season when they nest along the coast. In addition, other birds 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 due to the distance from shore. For a discussion of shorebirds and coastal nesting birds, see **Section C.4.2**.

Seabirds of the northern Gulf of Mexico were surveyed from ships during the GulfCet II program (Davis et al., 2000b). Hess and Ribic (2000) reported that terns, storm-petrels, shearwaters, and jaegers were the most frequently sighted seabirds in the deepwater area. From these surveys, four ecological categories of seabirds were documented in the deepwater areas of the Gulf: summer migrants (shearwaters, storm-petrels, boobies); summer residents that breed in the Gulf (Sooty Tern, Least Tern, Sandwich Tern, Magnificent Frigatebird); winter residents (gannets, gulls, jaegers); and permanent resident species (Laughing Gulls, Royal Terns, Bridled Terns) (Hess and Ribic, 2000). The GulfCet II study did not estimate bird densities; however, Powers (1987) indicated that seabird densities over the open ocean typically are less than 10 birds km^{-2}.

The distributions and relative densities of seabirds within the deepwater areas of the Gulf of Mexico, including the project area, vary temporally (i.e., seasonally) and spatially. In GulfCet II studies (Davis et al., 2000b), species diversity and density varied by hydrographic environment and by the presence and relative location of mesoscale features such as Loop Current eddies that may enhance nutrient levels and productivity of surface waters where these seabird species forage (Hess and Ribic, 2000).

Trans-Gulf migrant birds including shorebirds, wading birds, and terrestrial birds may also be present in the lease area. Migrant birds may use offshore structures and rigs for resting, feeding, or as temporary shelter from inclement weather. Some birds may be attracted to offshore structures because of the lights and the fish populations that aggregate around these structures (Russell, 2005).

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

Impacts of MODU Presence, Noise, and Lights

Birds migrating over water have been known to strike offshore structures, resulting in death or injury (Wiese et al., 2001, Russell, 2005). Mortality of migrant birds at tall towers and other land-based structures has been reviewed extensively, and the mechanisms involved in rig collisions appear to be similar. In some cases, migrants simply do not see a part of the rig until it is too late to avoid it. In other cases, navigation may be disrupted by noise (Russell, 2005). However, offshore structures are suitable stopover habitats for most trans-Gulf migrant species, and most of the migrants that stop over on rigs probably benefit from their stay, particularly in spring (Russell, 2005).

Due to the limited scope and duration of MODU activities at each wellsite location as described in the SEP, any impacts on populations of either seabirds or trans-Gulf migrant birds from activities described in the SEP are not expected to be significant.

Impacts of Support Vessel and Helicopter Traffic

Support vessels and helicopters are unlikely to significantly disturb pelagic birds in areas of open offshore waters. It is likely that individual birds would experience, at most, only short-term behavioral disruption resulting from support vessel and helicopter traffic, and the impact would not be significant.

Impacts of a Small Diesel Fuel Spill

Potential spill impacts on marine birds are discussed by BOEM (2012b, 2015, 2016). For this SEP, there are no unique site-specific issues with respect to spill impacts on these animals.

The probability of a fuel spill will be minimized by 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 reduce the potential for impacts on marine and pelagic birds. **SEP Section H** provides detail on spill response measures. Given the open ocean location of the lease area, the duration of a small spill and opportunity for impacts to occur would be very brief.

A small diesel fuel spill in offshore waters would produce a slick on the water surface and increase the concentrations of petroleum hydrocarbons and their degradation products. The extent and persistence of impacts would depend on the meteorological and oceanographic conditions at the time and the effectiveness of spill response measures. **Section A.9.2** discusses the likely fate of a small diesel fuel spill and indicates that more than 90% would evaporate or disperse naturally within 24 hours. The sea surface area covered with diesel fuel would range from 0.5 to 5 ha (1.2 to 12 ac), depending on sea state and weather conditions.

Birds exposed to oil on the sea surface could experience direct physical and physiological effects including skin irritation; chemical burns of skin, eyes, and mucous membranes; and inhalation of toxic fumes. Due to the limited areal extent and short duration of water quality impacts from a small diesel fuel spill, secondary impacts due to ingestion of oil via contaminated prey or reductions in prey abundance are unlikely. Due to the low densities of birds in open ocean areas, the small area affected, and the brief duration of the surface slick, no significant impacts on pelagic birds are expected.

Impacts of a Large Oil Spill

Potential spill impacts on marine and pelagic birds are discussed by BOEM (2012b, 2015, 2016). For this SEP, there are no unique site-specific issues with respect to spill impacts on marine birds.

Pelagic seabirds could be exposed to oil from a spill at the project area. Hess and Ribic (2000) reported that terns, storm-petrels, shearwaters, and jaegers were the most frequently sighted seabirds in the deepwater Gulf of Mexico (>200 m [>656 ft]). Powers (1987) indicated that seabird densities over the open ocean typically are less than 10 birds km^{-2}. The number of pelagic birds that could be affected in open offshore waters would depend on the extent and persistence of the oil slick.

Data following the Macondo spill provide relevant information about the species of pelagic birds that may be affected in the event of a large oil spill. Birds that have been treated for oiling include several pelagic species such as the Northern Gannet, Magnificent Frigatebird, and Masked Booby (USFWS, 2011). The Northern Gannet is among the species with the largest numbers of birds affected by the spill. NOAA reported that at least 93 resident and migratory bird species across all five Gulf Coast states were exposed to oil from the Macondo spill in multiple habitats, including offshore/open waters, island waterbird colonies, barrier islands, beaches, bays, and marshes (NOAA, 2016b). Exposure of marine birds to oil can result in adverse health with severity, depending on the level of oiling. Effects can range from plumage damage and loss of buoyancy from external oiling to more severe effects, such as organ damage, immune suppression, endocrine imbalance, reduced aerobic capacity, and death as a result of oil inhalation or ingestion (NOAA, 2016b).

C.4.2 Shorebirds and Coastal Nesting Birds

Threatened and endangered bird species (Piping Plover and Whooping Crane) were discussed in **Sections C.3.6** and **C.3.7**. The Brown Pelican (*Pelecanus occidentalis*) was delisted from federal endangered status in 2009 (USFWS, 2016a). However, this species remains listed as endangered by both Louisiana (State of Louisiana Department of Wildlife and Fisheries, 2005) and Mississippi (Mississippi Natural Heritage Program, 2015) and is designated as a species of special concern by the State of Florida (Florida Fish and Wildlife Conservation Commission, 2016d). Brown Pelicans inhabit coastal habitats and forage within both coastal waters and waters of the inner continental shelf. Aerial and shipboard surveys, including GulfCet and GulfCet II (Davis et al., 2000b), indicate that Brown Pelicans do not occur in deep offshore waters (Fritts and Reynolds, 1981, Peake, 1996, Hess and Ribic, 2000). Nearly half the southeastern population of Brown Pelicans lives in the northern Gulf Coast, generally nesting on protected islands (USFWS, 2010a).

The Bald Eagle (*Haliaeetus leucocephalus*) was delisted from its threatened status in the lower 48 states on 28 June 2007. The Bald Eagle still receives protection under the Migratory Bird

Treaty Act of 1918 and the Bald and Golden Eagle Protection Act of 1940 (USFWS, 2015b). The Bald Eagle is a terrestrial raptor widely distributed across the southern U.S., including coastal habitats along the Gulf of Mexico. The Gulf Coast is inhabited by both wintering migrant and resident Bald Eagles (Johnsgard, 1990, Ehrlich et al., 1992).

Various species of non-endangered birds are also found along the northern Gulf Coast, including diving birds, shorebirds, marsh birds, wading birds, and waterfowl. Gulf Coast marshes and beaches also provide important feeding grounds and nesting habitats. Species that breed on beaches, flats, dunes, bars, barrier islands, and similar habitats include the Sandwich Tern, Wilson's Plover, Black Skimmer, Forster's Tern, Gull-Billed Tern, Laughing Gull, Least Tern, and Royal Tern (USFWS, 2010a). Additional information is presented by BOEM (2012b).

IPFs that could affect shorebirds and coastal nesting birds include support vessel and helicopter traffic and a large oil spill. A small diesel fuel spill in the lease area would be unlikely to affect shorebirds or coastal nesting birds, due to the lease area's distance from the nearest shoreline. As explained in **Section A.9.2**, a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to natural dispersion. Compliance with NTL BSEE-2015-G03 (see **Table 1**) will minimize the potential for marine debris-related impacts on shorebirds.

Impacts of Support Vessel and Helicopter Traffic

Support vessels and helicopters will transit coastal areas near Port Fourchon and Houma, Louisiana, where shorebirds and coastal nesting birds may be found. These activities could periodically disturb individuals or groups of birds within sensitive coastal habitats (e.g., wetlands that may support feeding, resting, or breeding birds).

Vessel traffic may disturb foraging and resting birds. Flushing distances vary among species and individuals (Rodgers and Schwikert, 2002). The disturbances will be limited to flushing birds away from vessel pathways; known distances are from 20 to 49 m (65 to 160 ft) for personal watercraft and 23 to 58 m (75 to 190 ft) for outboard-powered boats (Rodgers and Schwikert, 2002). Flushing distances may be similar or less for the support vessels to be used for Anadarko's project, and some species such as gulls are attracted to boats. Support vessels will not approach nesting or breeding areas on the shoreline, so disturbances to nesting birds, eggs, and chicks are not expected. Vessel operators will use designated navigation channels and comply with posted speed and wake restrictions while transiting sensitive inland waterways. Due to the limited scope and short duration of support vessel activities, any short-term impacts are not expected to be biologically significant to coastal bird populations.

Aircraft traffic can cause some disturbance to birds onshore and offshore. Responses are highly dependent on the type of aircraft, bird species, activities that animals were previously engaged in, and previous exposures to overflights (Efroymson et al., 2000). Helicopters seem to cause the most intense responses when compared with other anthropogenic disturbances for some species (Bélanger and Bédard, 1989). Federal Aviation Administration (FAA) Advisory Circular No. 91-36D recommends that pilots maintain a minimum altitude of 610 m (2,000 ft) when flying over noise sensitive areas such as wildlife refuges, parks, and areas with wilderness characteristics. This is greater than the distance (slant range) at which aircraft overflights have been reported to cause behavioral effects on most species of birds studied (Efroymson et al., 2000). With the FAA guidelines in effect, it is likely that individual birds would experience, at most, only short-term behavioral disruption.

Impacts of Large Oil Spill

The OSRA results summarized in **Table 3** estimate that shorelines of Texas and Louisiana which include habitat for shorebirds and coastal nesting birds could be affected within 30 days. The 60-day OSRA modeling (**Table 4**) predicts that shorelines between Cameron County, Texas (at the Texas/Mexico border), and Miami-Dade County, Florida, have up to a 13% probability of contact within 60 days of a spill.

Coastal birds can be exposed to oil as they float on the water surface, dive during foraging, or wade in oiled coastal waters. Oiled birds can lose the ability to fly, dive for food, or float on the water, which could lead to drowning (USFWS, 2010b) Oil interferes with the water repellency of feathers and can cause hypothermia in the right conditions. As birds groom themselves, they can ingest and inhale the oil on their bodies. Scavengers such as Bald Eagles and gulls can be exposed to oil by feeding on carcasses of contaminated fish and wildlife. While ingestion can kill animals immediately, more often it results in lung, liver, and kidney damage, which can lead to death (BOEM, 2014). Bird eggs may be damaged if an oiled adult sits on the nest.

Data from the Macondo spill provide an indication of the potential impacts of a large spill on coastal bird populations. According to NOAA (2016b), an estimated 51,600 to 84,500 birds were killed by the spill, and the reproductive output lost as a result of breeding adult bird mortality was estimated to range from 4,600 to 17,900 fledglings that would have been produced in the absence of premature deaths of adult birds (NOAA, 2016b). Species with the largest numbers of estimated mortalities were American White Pelican, Black Skimmer, Black Tern, Brown Pelican, Laughing Gull, Least Tern, Northern Gannet, and Royal Tern (NOAA, 2016b).

Brown Pelicans are especially at risk from direct and indirect impacts from spilled oil within inner shelf and inshore waters, such as embayments. The range of this species is generally limited to these waters and surrounding coastal habitats. Brown Pelicans feed on mid-size fish that they capture by diving from above ("plunge diving") and then scooping the fish into their expandable gular pouch. This behavior makes them susceptible to plumage oiling if they feed in areas with surface oil or an oil sheen. They may also capture prey that has been physically contaminated with oil or has ingested oil. Issues for Brown Pelicans include direct contact with oil, disturbance from cleanup activities, and long-term habitat contamination (BOEM, 2012b).

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, 2012b).

C.5 Fisheries Resources

C.5.1 Pelagic Communities and Ichthyoplankton

Biggs and Ressler (2000) reviewed the biology of pelagic communities in the deepwater environment of the northern Gulf of Mexico. The biological oceanography of the region is dominated by the influence of the Loop Current, the surface waters of which are among the most oligotrophic in the world's oceans. Superimposed on this low-productivity condition are productive "hot spots" associated with entrainment of nutrient-rich Mississippi River water and mesoscale oceanographic features. Anticyclonic and cyclonic hydrographic features play an important role in determining biogeographic patterns and controlling primary productivity in the northern Gulf of Mexico (Biggs and Ressler, 2000).

Most fishes inhabiting shelf or oceanic waters of the Gulf of Mexico have planktonic eggs and larvae (Ditty, 1986, Ditty et al., 1988, Richards et al., 1989, Richards et al., 1993). Pelagic eggs and larvae become part of the planktonic community for various lengths of time (10 to 100 days, depending on the species) (MMS, 2007). A study by Ross et al. (2012) on midwater fauna to characterize vertical distribution of mesopelagic fishes in selected deepwater areas in the Gulf of Mexico substantiated high species richness but general numerical domination by relatively few families and species.

IPFs potentially affecting pelagic communities and ichthyoplankton include MODU presence, noise, and lights; effluent discharges; water intakes; and two types of accidents (a small diesel fuel spill and a large oil spill).

Impacts of MODU Presence, Noise, and Lights

The MODU, as floating structures in the deepwater environment, will act as a fish aggregating device (FAD). In oceanic waters, the FAD effect would be most pronounced for epipelagic fishes such as tunas, dolphin, billfishes, and jacks, which are commonly attracted to fixed and drifting surface structures (Holland, 1990, Higashi, 1994, Relini et al., 1994, MMS, 2007, 2008). Positive fish associations with offshore rigs and platforms in the Gulf of Mexico are well documented (Gallaway and Lewbel, 1982, Wilson et al., 2003, Peabody and Wilson, 2006). The FAD effect could possibly enhance the feeding of epipelagic predators by attracting and concentrating smaller fish species. MODU noise could potentially cause masking in fishes, thereby reducing their ability to hear biologically relevant sounds (Radford et al., 2014). 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). 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.

Impacts of Effluent Discharges

Discharges of treated WBM- and SBM-associated cuttings will produce temporary, localized increases in suspended solids in the water column around the MODU. In general, turbid water can be expected to extend between a few hundred meters and several kilometers down current from the discharge point (National Research Council, 1983, Neff, 1987). NPDES permit limits and requirements will be met. Neff et al. (2005) reported that benthic communities in the Gulf of Mexico within 250 m of SBM discharge locations had reduced benthic faunal abundance and diversity.

Water-based drilling muds and cuttings will also be released at the seafloor during the initial well intervals before the marine riser is set, which allows their return to the surface vessel. Excess cement slurry and BOP fluid will also be released at the seafloor. These discharges could smother or cover benthic communities in the vicinity of the discharge location. Impacts will be limited to the immediate area of the discharge, with little to no impact to fisheries resources.

Treated sanitary and domestic wastes may have a slight effect on the pelagic environment in the immediate vicinity of these discharges. These wastes may have elevated levels of nutrients, organic matter, and chlorine, but should dilute rapidly to undetectable levels within tens to hundreds of meters from the source. As a result of quick dilution, minimal impacts on water quality, plankton, and nekton are anticipated.

Deck drainage may have a slight effect on the pelagic environment in the immediate vicinity of these discharges. Deck drainage from contaminated areas will be passed through an oil-and-water separator prior to release, and discharges will be monitored for visible sheen. The discharges may have slightly elevated levels of hydrocarbons but should dilute rapidly to undetectable levels within tens to hundreds of meters from the source. Minimal impacts on water quality, plankton, and nekton are anticipated.

Other discharges in accordance with the NPDES permit, such as non-pollutant completion fluids, wash water, desalination unit brine and uncontaminated cooling water, fire water, bilge, and ballast water, are expected to dilute rapidly and have little or no impact on water column biota.

Impacts of Water Intakes

Seawater will be drawn from the ocean for once-through, non-contact cooling of machinery on the MODU. The MODU ultimately chosen for this project will be in compliance with all cooling water intake requirements of the NPDES permit to comply with Section 316(b) of the Clean Water Act.

The intake of seawater for cooling water will entrain plankton. The low intake velocity should allow most strong-swimming juvenile fishes and smaller adults to escape entrainment or impingement. However, drifting plankton would not be able to escape entrainment with the exception of a few fast-swimming larvae of certain taxonomic groups. The entrained organisms may be stressed or killed, primarily through changes in water temperature during the route from cooling intake structure to discharge structure and through mechanical damage (turbulence in pumps and condensers). Due to the limited scope and duration of proposed activities, any short-term impacts of entrainment are not expected to be significant on a population level for plankton or ichthyoplankton (BOEM, 2012b).

Impacts of a Small Diesel Fuel Spill

Potential spill impacts on fisheries resources are discussed by BOEM (2012b, 2015, 2016). For this SEP, there are no unique site-specific issues with respect to spill impacts.

The probability of a fuel spill will be minimized by Anadarko's preventative measures that will be implemented during routine operations, including fuel transfers between the supply vessel and MODU. In the unlikely event of a spill, implementation of Anadarko's OSRP could mitigate the potential for impacts on pelagic communities, including ichthyoplankton. **SEP Section H** provides detail on spill response measures. Given the open ocean location of the lease area, the duration of a small spill and opportunity for impacts to occur would be very brief.

A small diesel fuel spill in offshore waters would produce a slick on the water surface and increase the concentrations of petroleum hydrocarbons and their degradation products. The extent and persistence of impacts would depend on the meteorological and oceanographic conditions at the time and the effectiveness of spill response measures. **Section A.9.2** discusses the likely fate of a small diesel fuel spill and indicates that more than 90% would evaporate or disperse naturally within 24 hours. The sea surface area covered with diesel fuel would range from 0.5 to 5 ha (1.2 to 12 ac), depending on sea state and weather conditions.

A small diesel fuel spill could have localized impacts (i.e., hydrocarbon contamination) on phytoplankton, zooplankton, and nekton. Due to the limited areal extent and short duration of water quality impacts, a small diesel fuel spill would be unlikely to produce detectable impacts on pelagic communities.

Impacts of a Large Oil Spill

Potential spill impacts on pelagic communities and ichthyoplankton are discussed by BOEM (2012b). BOEM (2016) analyzed information that has become available since the Macondo spill and determined that no new significant information would alter the impact conclusions presented in the multisale EIS (BOEM, 2012b). For this SEP, there are no unique site-specific issues.

A large oil spill could affect water column biota including phytoplankton, zooplankton, ichthyoplankton, and nekton. A large spill that persisted for weeks or months would be more likely to affect these communities. While adult and juvenile fishes may actively avoid a large spill, planktonic eggs and larvae would be unable to avoid contact. Fish eggs and larvae are especially vulnerable to oiling because they inhabit the upper layers of the water column, and they will die if exposed to certain toxic fractions of spilled oil. Impacts could be greater if local-scale currents retained planktonic larval assemblages (and the floating oil slick) within the same water mass. Impacts to ichthyoplankton from a large spill would be greatest during spring and summer when shelf concentrations peak (BOEM, 2016).

C.5.2 Essential Fish Habitat

Essential Fish Habitat (EFH) is defined as the waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Under the Magnuson-Stevens Fishery Conservation and Management Act, as amended, federal agencies are required to consult on activities that may adversely affect EFH designated in Fishery Management Plans developed by the regional Fishery Management Councils.

The Gulf of Mexico Fishery Management Council (GMFMC) has prepared Fishery Management Plans for corals and coral reefs, shrimps, spiny lobster, reef fishes, coastal migratory pelagic fishes, and red drum. In 2005, the EFH for these managed species was redefined in Generic Amendment No. 3 to the various Fishery Management Plans (Gulf of Mexico Fishery Management Council, 2005). The EFH for most of these GMFMC-managed species is on the continental shelf in waters shallower than 183 m (600 ft). 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 52 miles (84 km) northwest of the lease area.

Highly migratory pelagic fishes, which occur as transients in the lease area, are the only remaining group for which EFH has been identified in the deepwater Gulf of Mexico. Species in this group, including tunas, swordfishes, billfishes, and sharks are managed by NMFS. Highly migratory species with EFH in or near the lease area include the following species and life stages (NMFS, 2009b):

- Bigeye thresher shark (all)
- Bigeye tuna (juveniles, adults)
- Blue marlin (juveniles, adults)
- Sailfish (adults)
- Silky shark (all)
- Skipjack tuna (spawning, adults)

- Bluefin tuna (spawning, eggs, larvae, adults)
- Longbill spearfish (juveniles, adults)
- Longfin mako shark (all)
- Oceanic whitetip shark (all)
- Swordfish (larvae, juveniles, adults)
- Whale shark (all)
- White marlin (juveniles, adults)
- Yellowfin tuna (spawning, juveniles, adults)

Research indicates the central and western Gulf of Mexico may be important spawning habitat for Atlantic bluefin tuna (*Thunnus thynnus*), and (NMFS, 2009b) has designated a Habitat Area of Particular Concern (HAPC) for this species. The HAPC covers much of the deepwater Gulf of Mexico, including the lease area (**Figure 4**). The areal extent of the HAPC is approximately 300,000 km^2 (115,830 mi^2). The prevailing assumption is that Atlantic bluefin tuna follow an annual cycle of foraging in June through March off the eastern U.S. and Canadian coasts, followed by migration to the Gulf of Mexico to spawn in April, May, and June (NMFS, 2009b). The Atlantic bluefin tuna has also been designated as a species of concern (NMFS, 2011).

An amendment to the original EFH Generic Amendment was finalized in 2005 (Gulf of Mexico Fishery Management Council, 2005). One of the most significant proposed changes in this amendment reduced the extent of EFH relative to the 1998 Generic Amendment by removing the EFH description and identification from waters between 100 fathoms and the seaward limit of the Exclusive Economic Zone (EEZ). The Highly Migratory Species Fisheries Management Plan was amended in 2009 to update EFH and HAPC to include the bluefin tuna spawning area (NMFS, 2009b).

NTLs 2009-G39 and 2009-G40 provide guidance and clarification of regulations for biologically sensitive underwater features and areas and benthic communities that are considered EFH. As part of an agreement between BOEM and NMFS to complete a new programmatic EFH consultation for each new Five-Year Program, an EFH consultation was initiated between BOEM's Gulf of Mexico Region and NOAA's Southeastern Region during the preparation, distribution, and review of BOEM's 2012-2017 WPA/CPA Multisale EIS (BOEM, 2012b). The necessary components of the EFH consultation were completed and there is ongoing coordination among NMFS, BOEM, and BSEE, including discussions of mitigation (BOEM, 2016).

Other HAPCs have been identified by the Gulf of Mexico Fishery Management Council (2005). These include the Florida Middle Grounds, Madison-Swanson Marine Reserve, Tortugas North and South Ecological Reserves, Pulley Ridge, and several individual reefs and banks of the northwestern Gulf of Mexico. (**Figure 4**). The nearest HAPC is Jakkula Bank, located approximately 65 miles (105 km) northwest of the project area.

IPFs that could affect EFH include MODU presence, noise, and lights; effluent discharges; water intakes; and two types of accidents (a small diesel fuel spill and a large oil spill).

Impacts of MODU Presence, Noise, and Lights

The MODU, as a floating structure in the deepwater environment, will act as an FAD. In oceanic waters, the FAD effect would be most pronounced for epipelagic fishes such as tunas, dolphin, billfishes, and jacks, which are commonly attracted to fixed and drifting surface structures (Holland, 1990, Higashi, 1994, Relini et al., 1994). The FAD effect would possibly enhance feeding of epipelagic predators by attracting and concentrating smaller fish species. MODU noise could potentially cause masking in 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). Because the MODU is a temporary structure, any impacts on EFH for highly migratory pelagic fishes are considered minor.

Impacts of Effluent Discharges

Effluent discharges affecting EFH by diminishing ambient water quality include drilling muds and cuttings, treated sanitary and domestic wastes, deck drainage, completion fluids, BOP fluid, and miscellaneous discharges such as desalination unit brine, wash water,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 if discharged according to NPDES permit conditions.

Impacts of Water Intakes

As noted previously, cooling water intake will cause entrainment and impingement of plankton, including fish eggs and larvae (ichthyoplankton). Due to the limited scope and relatively short duration of drilling activities, any short-term impacts on EFH for highly migratory pelagic fishes due to water intake are not expected to be biologically significant if operated in compliance with USEPA requirements.

Impacts of a Small Diesel Fuel Spill

Potential spill impacts on EFH are discussed by BOEM (2012b, 2015, 2016). For this SEP, there are no unique site-specific issues with respect to spill impacts.

The probability of a fuel spill will be minimized by Anadarko's preventative measures that will be implemented during routine operations, including fuel transfer between the supply vessel and MODU. In the unlikely event of a spill, implementation of Anadarko's OSRP could help diminish the potential for impacts on EFH. **SEP Section H** provides detail on spill response measures. Given the open ocean location of the lease area, the duration of a small spill and opportunity for impacts to occur would be very brief.

A small diesel fuel spill in offshore waters would produce a slick on the water surface and increase the concentrations of petroleum hydrocarbons and their degradation products. The extent and persistence of impacts would depend on the meteorological and oceanographic conditions at the time and the effectiveness of spill response measures. **Section A.9.2** discusses the likely fate of a small diesel fuel spill and indicates that more than 90% would evaporate or disperse naturally within 24 hours. The sea surface area covered with diesel fuel would range from 0.5 to 5 ha (1.2 to 12 ac), depending on sea state and weather conditions.

A small diesel fuel spill could have localized impacts on EFH for highly migratory pelagic fishes, including tunas, swordfishes, billfishes, and sharks. These species occur as transients in the lease area. A spill would also produce short-term impact on water quality in the HAPC for spawning bluefin tuna, which covers much of the deepwater Gulf of Mexico. The affected area would represent a negligible portion of the HAPC, which covers approximately 300,000 km^2 (115,830 mi^2) of the Gulf of Mexico.

A small diesel fuel spill would likely not affect EFH for corals and coral reefs, the nearest of which is located approximately 52 miles (84 km) northwest from the project area. A small diesel fuel spill would float and dissipate on the sea surface and would not contact these features.

Impacts of a Large Oil Spill

Potential spill impacts on EFH are discussed by BOEM (2012b, 2015, 2016). For this SEP, there are no unique site-specific issues with respect to EFH.

An oil spill in offshore waters would temporarily increase hydrocarbon concentrations on the water surface and potentially in the subsurface as well. Given the extent of EFH designations in the Gulf of Mexico (Gulf of Mexico Fishery Management Council, 2005, NMFS, 2009b), some impact on EFH would be unavoidable.

A large spill could affect the EFH for many managed species including shrimp, spiny lobster, reef fishes, coastal migratory pelagic fishes, and red drum. It would result in adverse impacts on water quality and water column biota including phytoplankton, zooplankton, and nekton. In coastal waters, sediments could be contaminated and result in persistent degradation of the seafloor habitat for managed demersal fish and shellfish species.

The lease area is within the HAPC for spawning Atlantic bluefin tuna (NMFS, 2009b). A large spill could temporarily degrade the HAPC due to increased hydrocarbon concentrations in the water column, with the potential for lethal or sublethal impacts on spawning tuna. Potential impacts would depend in part on the timing of a spill, as the species migrates to the Gulf of Mexico to spawn in April, May, and June (NMFS, 2009b).

The nearest feature designated as EFH for corals is located 52 miles (84 km) northwest from the lease area. An accidental spill could reach or affect this feature, although near-bottom currents in the region are expected to flow along the isobaths (Nowlin et al., 2001, Valentine et al., 2014) and typically would not carry a plume up onto the continental shelf edge.

C.6 Archaeological Resources

C.6.1 Shipwreck Sites

Based on NTL 2011-JOINT-G01, the lease area is not on BOEM's list of archaeology survey blocks (BOEM, 2011). An archaeological resources survey report was submitted with Anadarko's previously approved Exploration Plans for GC 727. One sonar contact was identified approximately 1,700 ft (518 m) west of proposed wellsite GC 727-H, approximately 1,630 ft (497 m) west of wellsite GC 727-HH, and approximately 1,910 ft (582 m) northwest of wellsites GC 727-K and GC 727-KK. The sonar contact was not determined to be a shipwreck (Oceaneering International Inc, 2016).

Anadarko will abide by the applicable requirements of NTL 2005-G07, which stipulate that work be stopped at the project site if any previously undetected archaeological resource is discovered after work has begun until appropriate surveys and evaluations have been completed.

Because there are no known shipwreck sites in the lease area, there are no routine IPFs that are likely to affect shipwrecks. Impacts of a large oil spill are the only IPFs considered. A small diesel fuel spill would not affect shipwrecks because the oil would float and dissipate on the sea surface.

Impacts of a Large Oil Spill

BOEM (2012b) estimated that a severe subsurface blowout could resuspend and disperse sediments within a 300-m (984-ft) radius. Because there are no historic shipwrecks in the lease area, this impact would not be relevant.

Beyond this radius, there is the potential for impacts from oil, dispersants, and depleted oxygen levels (BOEM, 2012b). These impacts could include chemical contamination as well as alteration of the rates of microbial activity (BOEM, 2012b). During the Macondo spill, subsurface plumes were reported at a water depth of approximately 1,100 m (3,609 ft), extending at least 22 miles (35 km) from the wellsite and persisting for more than a month (Camilli et al., 2010). The subsurface plumes apparently resulted from the use of subsea dispersants at the wellhead (NOAA, 2011c). While the behavior and impacts of subsurface plumes are not well known, a subsurface plume could have the potential to contact shipwreck sites beyond the 300-m (984-ft) radius estimated by BOEM (2012b), 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 in any way, and contact the BOEM Regional Supervisor, Leasing and Environment, within 48 hours of its discovery. Anadarko would cease all operations within 305 m (1,000 ft) of the site until the Regional Supervisor provides instructions on steps to take to assess the site's potential historic significance and protect it.

A spill entering shallow coastal waters could conceivably contaminate an undiscovered shipwreck site. The OSRA modeling summarized in **Table 3** predicts that Texas and Louisiana shorelines could be contacted by a spill within 30 days of a spill. In addition, 60-day OSRA modeling (**Table 4**) predicts that shorelines between Cameron County, Texas (at the Texas/Mexico border), and Miami-Dade County, Florida, have up to a 13% conditional probability of oil contact within 60 days of a spill. If an oil spill contacted a coastal historic site, such as a fort or a lighthouse, the major impact would be a visual impact from oil contact and contamination of the site and its environment (BOEM, 2012b).

C.6.2 Prehistoric Archaeological Sites

With a water depth at the proposed wellsites ranging from approximately 4,522 to 4,675 ft (1,378 to 1,425 m) the project area is well beyond the 60-m (197 ft) depth contour used by BOEM as the seaward extent for prehistoric archaeological site potential in the Gulf of Mexico. An archaeological resources survey report prepared was included with Anadarko's previously approved Exploration Plan for GC 727. Because prehistoric archaeological sites are not expected in the lease area, the only relevant IPF is a large oil spill. A small diesel fuel spill would not affect prehistoric archaeological resources because the oil would float and dissipate on the sea surface.

Impacts of a Large Oil Spill

Because of the water depth and the lack of prehistoric archaeological sites found in the lease area, they would not be impacted by the physical effects of a subsea blowout. BOEM (2012b) estimated that a severe subsurface blowout could resuspend and disperse sediments within a 300-m (984-ft) radius.

Along the northern Gulf Coast, prehistoric sites occur frequently along the barrier islands and mainland coast and along the margins of bays and bayous (BOEM, 2012b). The OSRA modeling summarized in **Table 3** estimates that Texas and Louisiana shorelines could be contacted by a spill within 30 days (≤3% conditional probability). In addition, the 60-day OSRA modeling (**Table 4**) predicts that shorelines between Cameron County, Texas (at the Texas/Mexico border), and Miami-Dade County, Florida, have up to a13% conditional probability of oil contact within 60 days of a spill. If a spill did reach a prehistoric site along these shorelines, it could coat fragile artifacts or site features and compromise the potential for radiocarbon dating organic materials in a site (although other dating methods are available, and it is possible to decontaminate an oiled sample for radiocarbon dating). 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 (2012b) 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 (2012b, 2015, 2016), and are tabulated in the OSRP. Coastal habitats inshore of the project area include barrier beaches and dunes, wetlands, and submerged seagrass beds. Most of the northeastern Gulf of Mexico is fringed by barrier beaches, with wetlands and submerged seagrass beds occurring in sheltered areas behind the barrier islands and in estuaries.

Due to the distance from shore, the only IPF associated with routine activities in the lease area that could affect beaches and dunes, wetlands, seagrass beds, coastal wildlife refuges, wilderness areas, or any other managed or protected coastal area is support vessel traffic. The support bases at Port Fourchon and Houma, Louisiana, are not in wildlife refuges or wilderness areas. Potential impacts of support vessel traffic are briefly addressed below.

A large oil spill is the only accidental IPF that could affect coastal habitats and protected areas. analyzed. A small diesel fuel spill in the lease area would be unlikely to affect coastal habitats due to the lease area's distance from the nearest shoreline. As explained in **Section A.9.2**, a small diesel fuel spill would not be expected to make landfall or reach coastal waters prior to natural dispersion.

Impacts of Support Vessel Traffic

Support operations, including crew boats and supply boats as detailed in **SEP Section K**, may have a minor incremental impact on barrier beaches and dunes, wetlands, and protected areas. Over time with a large number of vessel trips, vessel wakes can erode shorelines along inlets, channels, and harbors, resulting in localized land loss. Impacts to barrier beaches and dunes, wetlands, and protected areas will be minimized by following the speed and wake restrictions in harbors and channels.

Support operations, including crew boats and supply boats are not anticipated to have a significant impact on submerged seagrass beds. While submerged seagrass beds have the potential to be uprooted, scarred, or lost due to direct contact from vessels, use of navigation channels and adherence to local requirements and implemented programs will decrease the likelihood of impacts to submerged seagrass beds (BOEM, 2016).

Impacts of a Large Oil Spill

Potential spill impacts on coastal habitats are discussed by BOEM (2012b, 2015, 2016). Coastal habitats inshore of the project area include barrier beaches and dunes, wetlands, and submerged seagrass beds. For this SEP, there are no unique site-specific issues with respect to coastal habitats.

The 30-day OSRA modeling (**Table 3**) indicates that Cameron and Plaquemines Parishes in Louisiana have a 3% conditional probability of contact within 30 days in the event of a spill in the lease area. Other shorelines between Matagorda County, Texas, and Lafourche Parish, Louisiana, had a 1 to 2% conditional probability of shoreline contact within 30 days of a spill. The 60-day OSRA modeling (**Table 4**) predicts that shorelines between Cameron County, Texas (at the Texas/Mexico border), and Miami-Dade County, Florida, have up to a 13% conditional probability of oil contact within 60 days of a spill, with the highest probability occuring in Terrebonne Parish, Louisiana, in the spring (13% conditional probability).

The shorelines within the geographic range predicted by the 60-day OSRA modeling (**Table 4**) include extensive barrier beaches and wetlands, with submerged seagrass beds occurring in sheltered areas behind the barrier islands and in estuaries. NWRs and other protected areas along the coast are discussed by BOEM (2012b) 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 within the geographic range of the potential shoreline contacts after 30 days based on OSRA modeling.

County or Parish, State	Wildlife Refuge, Wilderness Area, or State/National Park
Matagorda, Texas	Big Boggy National Wildlife Refuge
	Matagorda Bay Nature Park
	San Bernard National Wildlife Refuge
	West Moring Dock Park
Brazoria, Texas	Brazoria National Wildlife Refuge
	Christmas Bay Coastal Preserve
	Justin Hurst Wildlife Management Area
	San Bernard National Wildlife Refuge
Galveston, Texas	Anahuac National Wildlife Refuge
	Bolivar Flats Shorebird Sanctuary
	Fort Travis Seashore Park
	Galveston Island State Park
	Horseshoe Marsh Bird Sanctuary
	Mundy Marsh Bird Sanctuary
	R.A. Apffel Park
	Seawolf Park
Jefferson, Texas	McFaddin National Wildlife Refuge
	Sea Rim State Park
	Texas Point National Wildlife Refuge
Cameron, Louisiana	Sabine National Wildlife Refuge
	Rockefeller State Wildlife Refuge and Game Preserve
	Peveto Woods Sanctuary
Vermilion, Louisiana	Paul J. Rainey Wildlife Refuge and Game Preserve

Table 7. (Continued).

County or Parish, State	Wildlife Refuge, Wilderness Area, or State/National Park
	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

The level of impacts from oil spills on coastal habitats depends on many factors, including the oil characteristics, the geographic location of the landfall, and the weather and oceanographic conditions at the time (BOEM, 2012b). Oil that makes it to beaches may be either liquid weathered oil, an oil-and-water mousse, or tarballs (BOEM, 2012b). 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, 2012b).

Coastal wetlands are highly sensitive to oiling and can be significantly affected because of the inherent toxicity of hydrocarbon and non-hydrocarbon components of the spilled substances (Beazley et al., 2012, Lin and Mendelssohn, 2012, Mendelssohn et al., 2012). Numerous variables such as oil concentration and chemical composition, vegetation type and density, season or weather, preexisting stress levels, soil types, and water levels may influence the impacts of oil exposure on wetlands. Light oiling could cause plant die-back, followed by recovery in a fairly short time. Vegetation exposed to oil that persists in wetlands could take years to recover (BOEM, 2012b). However, in a study in Barataria Bay, Louisiana, after the Macondo spill, Silliman et al. (2012) reported that vegetation in previously healthy marshes largely recovered to a pre-oiling state within 18 months. Oiled marshes that had prior accelerated rates of erosion experienced a bio-geomorphological feedback that further increased marsh loss to erosion and did not experience regrowth (Silliman et al., 2012). In addition to the direct impacts of oil, cleanup activities in marshes may accelerate rates of erosion and retard recovery rates (BOEM, 2012b). Impacts associated with an extensive oiling of coastal wetland habitat from a large oil spill are expected to be significant.

C.8 Socioeconomic and Other Resources

C.8.1 Recreational and Commercial Fishing

Potential impacts to recreational and commercial fishing are analyzed by BOEM (2012b, 2015, 2016).

The main commercial fishing activity in deep waters of the northern Gulf of Mexico is pelagic longlining for tunas, swordfishes, and other billfishes (Continental Shelf Associates, 2002). Pelagic longlining has occurred historically in the project area, primarily during spring and summer.

Longline gear consists of monofilament line deployed from a moving vessel and generally allowed to drift for 4 to 5 hours. As the mainline is put out, baited leaders and buoys are clipped in place at regular intervals. It takes 8 to 10 hours to deploy a longline and approximately the same time to retrieve it. Longlines are often set near oceanographic features such as fronts or downwellings, with the aid of sophisticated onboard temperature sensors, depth finders, and positioning equipment. Vessels typically are 10 to 30 m (33 to 98 ft) long, and their trips last from 1 to 3 weeks. The main Gulf of Mexico homeports for longlining vessels are in Louisiana (Dulac and Venice) and Florida (Destin, Madeira Beach, and Panama City) (Continental Shelf Associates, 2002).

It is unlikely that any commercial fishing activity other than longlining will occur in or near the project area due to the water depth at the project area. Benthic species targeted by commercial fishers occur on the upper continental slope, well inshore of the project area. Royal red shrimp (*Pleoticus robustus*) are caught by trawlers in water depths of approximately 250 to 550 m (820 to 1,804 ft). Tilefishes (primarily *Lophalotilus chamaeleonticeps*) are caught by bottom longlining in water depths from approximately 165 to 450 m (540 to 1,476 ft) (Continental Shelf Associates, 2002).

Most recreational fishing activity in the region occurs in water depths less than 200 m (656 ft) (Continental Shelf Associates, 1997, 2002). In deeper water, the main attraction to recreational fishers would be petroleum rigs offshore Texas and Louisiana. Due to the distance from shore, it is unlikely that recreational fishing activity is occurring in the lease area.

The only routine IPF potentially affecting fisheries and, therefore, commercial and recreational fishing, is MODU presence (including noise and lights). Potential accidents IFPs affecting fisheries are also addressed below – a small diesel fuel spill and a large oil spill.

Impacts of MODU Presence, Noise, and Lights

There is a slight possibility of pelagic longlines becoming entangled in the MODU. For example, in January 1999 a portion of a pelagic longline snagged on the acoustic Doppler current profiler of a drillship working in the Gulf of Mexico (Continental Shelf Associates, 2002). The line was removed without incident. Generally, longline fishers use radar and are aware of offshore structures and ships when placing their sets. Therefore, little or no impact on pelagic longlining is expected.

Because it is unlikely that any recreational fishing activity is occurring in the project area, no adverse impacts are anticipated.

Other factors such as effluent discharges are likely to have negligible impacts on commercial or recreational fisheries due to rapid dispersion, the small area of ocean affected, and the intermittent nature of the discharges.

Impacts of a Small Diesel Fuel Spill

Pelagic longlining activities in the lease area, if any, could be interrupted in the event of a small diesel fuel spill. The sea surface area covered with diesel fuel would range from 0.5 to 5 ha (1.2 to 12 ac), depending on sea state and weather conditions (see **Section A.9.2**). Fishing activities could be interrupted due to the activities of response vessels operating in the lease area. A small diesel fuel spill would not affect coastal water quality because the spill would not be expected to make landfall or reach coastal waters prior to natural dispersion (see **Section A.9.2**).

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 potentially mitigate and reduce the potential for impacts. **SEP Section H** provides detail on spill response measures. Given the open ocean location of the lease area, the duration of a small spill and opportunity for impacts to occur would be very brief.

Impacts of a Large Oil Spill

Potential spill impacts on fishing activities are discussed by BOEM (2012b, 2015, 2016). For this SEP, there are no unique site-specific issues with respect to this activity.

Pelagic longlining activities in the lease area and other fishing activities in the northern Gulf of Mexico could be interrupted in the event of a large oil spill. A spill may or may not result in fishery closures, depending on the duration of the spill, the oceanographic and meteorological conditions at the time, and the effectiveness of spill response measures. Data following the Macondo spill provide information about the maximum potential extent of fishery closures in the event of a large oil spill in the Gulf of Mexico (NMFS, 2010b). At its peak on 12 July 2010, closures encompassed 84,101 mi^2 (217,821 km^2), or 34.8% of the U.S. Gulf of Mexico EEZ. BOEM (2012b) notes that fisheries closures from a large spill event could have a negative effect on short-term fisheries catch and marketability.

According to BOEM (2012b), the potential impacts on commercial and recreational fishing activities from an accidental oil spill are anticipated to be minimal because the potential for oil spills is very low, the most typical events are small and of short duration, and the effects are so localized that fishes are typically able to avoid the affected area. Fish populations may be affected by an oil spill event should it occur, but they would be primarily affected if the oil reaches the productive shelf and estuarine areas where many fishes spend a portion of their life cycle. The probability of an offshore spill affecting these nearshore environments is also low. Should a large oil spill occur, economic impacts on commercial and recreational fishing activities would likely occur, but are difficult to predict because impacts would differ by fishery and season (BOEM, 2016).

C.8.2 Public Health and Safety

There are no IPFs associated with routine operations that are expected to affect public health and safety. A small diesel fuel spill would not have any impacts on public health and safety because it would affect only a small area of the open ocean 122 miles (196 km) from the nearest shoreline, and nearly all of the diesel fuel would evaporate or disperse naturally within 24 hours (see **Section A.9.2**). Impacts of a large oil spill are addressed below.

Impacts of a Large Oil Spill

In the event of a large spill from a blowout, the main safety and health concerns are those of the offshore personnel involved in the incident and those responding to the spill. The proposed activities will be covered by Anadarko's Regional OSRP and the MODU's emergency response plans.

Depending on the spill rate and duration, the physical/chemical characteristics of the oil, meteorological and oceanographic conditions at the time, and the effectiveness of spill response measures, the public could be exposed to oil on the water and along the shoreline, including skin contact or breathing VOCs. Oil is a highly flammable material, and any smoke or vapors from an oil fire can cause irritation, and in large quantities may pose a health hazard.

Studies conducted after the Macondo spill provide relevant information about the types of health issues that may occur in the event of a large oil spill. Wildlife cleaning and rehabilitation workers have reported concerns including scrapes and cuts, itchy or red skin or rash, and symptoms of headache or feeling faint, dizzy, or fatigued (King and Gibbins, 2011). Hand, shoulder, or back pain was reported by some wildlife-cleaning workers as well. Awkward postures, repetitive motions, and heavy lifting tasks were noted by investigators as contributing to musculoskeletal symptoms. Personnel working on offshore vessels or providing direct oversight to offshore vessels, including USCG personnel, civilian contractors, and other responders who were exposed to oil and dispersants, had a 7 to 12 times higher prevalence of upper respiratory symptoms and cough than those not exposed (Centers for Disease Control and Prevention, 2010). Another potential occupational hazard for spill response workers in general was heat stress from work in a hot and humid environment (King and Gibbins, 2011). Initial symptoms from cleanup workers who sought medical care in Louisiana were typical of acute exposure to hydrocarbons or H_2S (e.g., headaches, dizziness, nausea, vomiting, cough, respiratory distress, and chest pain) (Solomon and Janssen, 2010).

C.8.3 Employment and Infrastructure

There are no IPFs associated with routine operations that are expected to affect employment and infrastructure. The project involves support from drilling contractor and associated third-party services, and existing shorebase facilities in Louisiana. No new or expanded facilities will be constructed, and no new employees are expected to move permanently into the area. The project will have a negligible impact on socioeconomic conditions such as local employment and existing offshore and coastal infrastructure. A small diesel fuel spill that is dissipated within a few days would have little or no economic impact, as the spill response would use existing facilities, resources, and personnel. Impacts of a large oil spill on employment and infrastrucre are addressed below.

Impacts of a Large Oil Spill

Potential socioeconomic impacts of an oil spill are discussed by BOEM (2012a, 2015, 2016). For this SEP, there are no unique site-specific issues with respect to employment and coastal infrastructure. A large spill could cause economic impacts in several ways: it could result in extensive fishery closures that put fishermen out of work; it could result in temporary employment as part of the response effort; it could result in adverse publicity that affects employment in coastal recreation and tourism industries; and it could result in another suspension of OCS drilling activities, including service and support operations that are an important part of local economies.

In addition to the analyses presented by BOEM (2012b), a study explored the economic impacts of the Macondo spill on oil and gas industry employment due to suspension of deepwater drilling (U.S. Department of Commerce, 2010). The study indicates that during the moratorium, the number of oil industry workers in the Gulf of Mexico fell by approximately 2,000 and may have indirectly caused a temporary loss of 8,000 to 12,000 jobs along the Gulf Coast. Total spending by drilling operators is estimated to have declined by $1.8 billion over a 6-month period; this direct reduction in spending affected employment in the industries that supply the Gulf drilling industry and in all other industries affected by declines in consumer and business spending (U.S. Department of Commerce, 2010).

As noted by BOEM (2012b), the short-term social and economic consequences for the Gulf Coast region should a large spill occur include the opportunity cost of employment and expenditures that could have gone to production or consumption rather the spill cleanup efforts. Nonmarket effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations could also occur in the short term. These negative, short-term social and economic consequences of a spill are expected to be modest in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities (BOEM, 2012b). Net employment impacts from a spill would not be expected to exceed 1% of baseline employment in any given year (BOEM, 2012b).

C.8.4 Recreation and Tourism

BOEM (2016) has reexamined the analyses for recreation and tourism previously presented by BOEM (2012b). No new information was found that would alter the potential impacts on recreation and tourism (BOEM, 2016). For this SEP, there are no unique site-specific issues with respect to this activity.

There are no known recreational uses of the lease area. Recreational resources and tourism in coastal areas would not be affected by any routine activities due to the distance from shore. Compliance with NTL BSEE-2015-G03 (see **Table 1**) will minimize the chance of trash or debris being lost overboard from the MODU and subsequently washing up on beaches. A small diesel fuel spill in the lease area would be unlikely to affect recreation and tourism because, as explained in **Section A.9.2**, it would not be expected to make landfall or reach coastal waters prior to breaking up. Impacts of a large oil spill on recreation and tourism are discussed below.

Impacts of a Large Oil Spill

Potential impacts of an oil spill on recreation and tourism are discussed by BOEM (2012b, 2015, 2016). For this SEP, there are no unique site-specific issues with respect to these impacts.

Impacts on recreation and tourism would vary depending on the duration of the spill and its fate including the effectiveness of response measures. A large spill that reached coastal waters and shorelines could adversely affect recreation and tourism by contaminating beaches and wetlands, resulting in negative publicity that encourages people to stay away. The 30-day OSRA modeling (**Table 3**) indicates that Cameron and Plaquemines Parishes, Louisiana, with 3% conditional probabilities, are the areas most likely to be contacted within 30 days in the event of a spill in the lease area. However, the 60-day OSRA modeling (**Table 4**) predicts that shorelines between Cameron County, Texas (at the Texas/Mexico border), and Miami-Dade County, Florida, have up to a 13% conditional probability of oil contact within 60 days of a spill.

According to BOEM (2012b), should an oil spill occur and contact a beach area or other recreational resource, it would cause some disruption during the impact and cleanup phases of the spill. However, these effects are also likely to be small in scale and of short duration, in part because the probability of an offshore spill contacting most beaches is small. In the unlikely event that a spill occurs that is sufficiently large to affect large areas of the coast and, through public perception, have effects that reach beyond the damaged area, effects to recreation and tourism could be significant (BOEM, 2012b).

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 (2012b, 2015, 2016). There are no routine IPFs that could affect land use. The project will use existing onshore support facilities in Louisiana. The land use at the existing shorebase sites is industrial. The project will not involve any new construction or changes to existing land use and therefore will not have any impacts. Levels of boat and helicopter traffic as well as demand for goods and services including scarce coastal resources will represent a small fraction of the level of activity occurring at the shorebases.

A large oil spill is the only relevant IPF on land use. A small diesel fuel spill would not have any impacts on land use, as the response would be staged out of existing shorebases and facilities.

Impacts of a Large Oil Spill

The initial response for a large oil spill would be staged out of existing facilities with no effect on land use. A large spill could have limited temporary impacts on land use along the coast if additional staging areas were needed. For example, during the Macondo spill, temporary staging areas were established in Louisiana, Mississippi, Alabama, and Florida for spill response and cleanup efforts. In the event of a large spill in the lease area, similar temporary staging areas could be needed. These areas would eventually return to their original use as the response is demobilized.

An accidental oil spill is not likely to significantly affect land use and coastal infrastructure in the region, in part because an offshore spill would have a small probability of contacting onshore resources. BOEM (2016) 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, 2016b).

C.8.6 Other Marine Uses

The lease area is not located within any USCG-designated fairway or shipping lane, but is located within Military Warning Area W-92. Anadarko will comply with BOEM requirements and lease stipulations to avoid impacts on uses of the area by military vessels and aircraft.

Based on the site clearance letters for the proposed wellsites (Oceaneering International Inc, 2016) the S-18711 DIscovery 20' pipeline is located approxaimtely 977 ft (298 m) west of proposed wellsite GC 727-I and approxaimtely 1,455 ft west of proposed wellsite GC 727-J. No other existing infrastrcuture is known to exist within 610 m (2,000 ft) of the proposed wellsites. There are no IPFs from routine project activities that are likely to affect other marine uses of the lease area. A large oil spill is the only relevant accident-related IPF on other marine uses. A small diesel fuel spill would not have any impacts on other marine uses because spill response activities would be mainly within the lease area and the duration would be brief.

Impacts of a Large Oil Spill

In the event of a large spill requiring numerous response vessels, coordination would be required to manage the vessel traffic for safe operations and to ensure that no anchoring or seafloor-disturbing activities occur near the existing wells. Other OCS activities located nearby the location of a large spill may be temporarily interrupted, which could include evacuation of non-essential personnel. Anadarko will comply with BOEM requirements and lease stipulations to avoid impacts on uses of the area by military vessels and aircraft.

C.9 Cumulative Impacts

For purposes of the National Environmental Policy Act, cumulative impact is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Any single activity or action may have a negligible impact(s) by itself, but when combined with impacts from other activities in the same area or time period, substantial impacts may result.

<u>Prior Studies:</u>

BOEM (2012b) prepared a multisale EIS in which it analyzed the environmental impact of activities that might occur in the multisale area. The level and types of activities planned in Anadarko's SEP are within the range of activities described and evaluated by BOEM in the 2012 Final EIS for Gulf of Mexico OCS Oil and Gas Lease Sales 2012-2017 (BOEM, 2012b), the Final Supplemental EIS for Gulf of Mexico Lease Sale OCS Oil and Gas Sale: 2012 (BOEM, 2012c), the Final Supplemental EIS for Gulf of Mexico OCS Oil and Gas Lease Sales 2015-2017 (BOEM, 2014), the Final EIS for Gulf of Mexico OCS Oil and Gas Lease Sales: 2016 and 2017 (BOEM, 2015), and the Final Supplemental EIS for Gulf of Mexico OCS Oil and Gas Lease Sale: 2016 (BOEM, 2016). Past, present, and reasonably foreseeable activities were identified in the cumulative effects scenario of these documents, which are incorporated by reference. The proposed activities should not result in any additional impacts beyond those evaluated in the multisale and Final EISs.

<u>Description of Activities Reasonably Expected to Occur in the Vicinity of Project Area:</u>

Other exploration and development activities are ongoing in the vicinity of the proposed project area. Anadarko does not anticipate other projects in the vicinity of the proposed project location beyond the types of projects analyzed in the lease sale and Supplemental EISs (BOEM, 2012b, c, 2013, 2014, 2015, 2016)

Cumulative Impacts of Activities in the SEP:

The BOEM (2012b) Final EIS included a lengthy discussion of cumulative impacts, which analyzed the environmental and socioeconomic impacts from the incremental impacts of the 11 proposed lease sales, in addition to all activities (including non-OCS activities) projected to occur from past, proposed, and future lease sales during the 40-year period of 2007 to 2046. The following activities were considered in development of the EISs: exploration, delineation, and development of wells; platform installation; service-vessel trips; and oil spills. The EISs examined the potential cumulative effects on each specific resource for the entire Gulf of Mexico.

The level and type of activity proposed in Anadarko's SEP for GC 727 drilling program are within the range of activities described and evaluated in the recent lease sale EISs. This EIA incorporates and builds on these analyses by examining the potential impacts on physical, biological, and socioeconomic resources from the work planned in the SEP along with other reasonably foreseeable activities expected to occur in the Gulf of Mexico. Thus, for all impacts, the incremental contribution of Anadarko's proposed actions to the cumulative impacts in these prior analyses should not be significant.

D. Environmental Hazards

D.1 Geologic Hazards

Based on the site clearance letters for the proposed wellsites (Oceaneering International Inc, 2016), the locations of the proposed activities are clear of constraining geologic conditions within 610 m (2,000 ft). The seafloor in the area is relatively smooth, with some areas exhibiting slightly irregular and undulating surface sediments. Some seafloor faulting is present nearby the proposed wellsites due to salt diapiric uplift (Oceaneering International Inc, 2016). See **SEP Section C** for supporting geological and geophysical information.

D.2 Severe Weather

Under most circumstances, weather is not expected to have any effect on the proposed activities. Extreme weather, including high winds, strong currents, and large waves, was considered in the design criteria for the MODU under consideration for this project. High winds and limited visibility during a severe storm could disrupt support activities (vessel and helicopter traffic) and make it necessary to suspend some activities and potentially evacuate the MODU for safety reasons until the storm or weather event passes. In the event of a hurricane, procedures as outlined in the Hurricane Evacuation Plan would be adhered to. Evacuation in the event of a hurricane or other severe weather would increase the number and frequency of support vessel and helicopter trips to and from the project area.

D.3 Currents and Waves

Metocean conditions such as sea states, wind speed, and ocean currents will be continuously monitored. Under most circumstances, physical oceanographic conditions are not expected to have any effect on the proposed activities. Strong currents (e.g., caused by Loop Current eddies and intrusions) and large waves were considered in the design criteria for the MODU under consideration for this project. High waves during a severe storm could disrupt support activities (i.e., vessel and helicopter traffic) and make it necessary to suspend some activities on the MODU for safety reasons until the storm or weather event passes.

E. Alternatives

No formal alternatives were evaluated in this EIA for the SEP. However, various technical and operational options, including the location of the wellsites and the selection of the MODU, 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 **SEP Section H**.

G. Consultation

No persons or agencies beyond those cited as Preparers (**Section H**) were consulted during the preparation of this EIA.

H. Preparers

This EIA was prepared by CSA Ocean Sciences Inc. Contributors included:

- John M. Tiggelaar II (Project Scientist);
- Sarah Watson (Senior Scientist);
- Brent Gore (Geospatial Analyst);
- Kristen L. Metzger (Library and Information Services Director); and
- LeslieAnn Weekes (Technical Editor).

I. References

Ackleh, A.S., G.E. Ioup, J.W. Ioup, B. Ma, J.J. Newcomb, N. Pal, N.A. Sidorovskaia, and C. Tiemann. 2012. Assessing the Deepwater Horizon oil spill impact on marine mammal population through acoustics: endangered sperm whales. J. Acoust. Soc. Am. 131(3): 2306-2314.

Anderson, C.M., M. Mayes, and R. LaBelle. 2012. Update of Occurence Rates for Offshore Oil Spills. U.S. Department of the Interior, Bureau of Ocean Energy Management and Bureau of Safety and Environmental Enforcement. OCS Report BOEM 2012-069, BSEE 2012-069. http://www.boem.gov/uploadedFiles/BOEM/Environmental_Stewardship/Environmental_Assessment/Oil_Spill_Modeling/AndersonMayesLabelle2012.pdf

Baguley, J.G., P.A. Montagna, C. Cooksey, J.L. Hyland, H.W. Bang, C.L. Morrison, A. Kamikawa, P. Bennetts, G. Saiyo, E. Parsons, M. Herdener, and M. Ricci. 2015. Community Response of Deep-sea Soft sediment Metazoan Meiofauna to the Deepwater Horizon Blowout and Oil Spill. Mar. Ecol. Prog. Ser. 528: 127-140.

Barkaszi, M.J., M. Butler, R. Compton, A. Unietis, and B. Bennett. 2012. Seismic survey mitigation measures and marine mammal observer reports. New Orleans, LA. OCS Study BOEM 2012-015.

Barkuloo, J.M. 1988. Report on the Conservation Status of the Gulf of Mexico sturgeon, *Acipenser oxyrinchus desotoi*. U.S. Department of the Interior, U.S. Fish and Wildlife Service. Panama City, FL.

Beazley, M.J., R.J. Martinez, S. Rajan, J. Powell, Y.M. Piceno, L.M. Tom, G.L. Andersen, T.C. Hazen, J.D. Van Nostrand, J. Zhou, B. Mortazavi, and P.A. Sobecky. 2012. Microbial community analysis of a coastal salt marsh affected by the Deepwater Horizon oil spill. PLoS One 7(7): e41305.

Biggs, D.C., and P.H. Ressler. 2000. Water column biology. In: Deepwater Program: Gulf of Mexico Deepwater Information Resources Data Search and Literature Synthesis. Volume I: Narrative Report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2000-049.

Blackwell, S.B., and C.R. Greene Jr. 2003. Acoustic measurements in Cook Inlet, Alaska, during August 2001. Greeneridge Sciences, Inc., for NMFS, Anchorage, AK. 43 pp.

Boehm, P., D. Turton, A. Raval, D. Caudle, D. French, N. Rabalais, R. Spies, and J. Johnson. 2001. Deepwater program: Literature review, environmental risks of chemical products used in Gulf of Mexico deepwater oil and gas operations. Volume I: Technical report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2001-011.

Bureau of Ocean Energy Management. 2011. Archaeology Survey Blocks. http://www.boem.gov/Environmental-Stewardship/Archaeology/surveyblocks-pdf.aspx

Bureau of Ocean Energy Management. 2012a. Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017. Final Programmatic Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. OCS EIS/EIA BOEM 2012-030.

Bureau of Ocean Energy Management. 2012b. Gulf of Mexico OCS Oil and Gas Lease Sales: 2012-2017. Western Planning Area Lease Sales 229, 233, 238, 246, and 248. Central Planning Area Lease Sales 227, 231, 235, 241, and 247. Final Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA BOEM 2012-019.

Bureau of Ocean Energy Management. 2012c. Gulf of Mexico OCS Oil and Gas Lease Sale: 2012. Central Planning Area Lease Sale 216/222. Final Supplemental Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA BOEM 2012-058.

Bureau of Ocean Energy Management. 2013. Gulf of Mexico OCS Oil and Gas Lease Sales: 2013-2014. Western Planning Are Lease Sale 233. Central Planning Area 231. Final Supplemental Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA BOEM 2013-0118.

Bureau of Ocean Energy Management. 2014. Gulf of Mexico OCS Oil and Gas Lease Sales: 2015-2017. Central Planning Area Lease Sales 235, 241, and 247. Final Supplemental Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA BOEM 2014-655.

Bureau of Ocean Energy Management. 2015. Gulf of Mexico OCS Oil and Gas Lease Sales: 2016 and 2017. Central Planning Area Lease Sales 241 and 247; Eastern Planning Area Lease Sale 226. Final Supplemental Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA BOEM 2015-033.

Bureau of Ocean Energy Management. 2016. Gulf of Mexico OCS Oil and Gas Lease Sale: 2016. Western Planning Area Lease Sale 248. Final Supplemental Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA BOEM 2016-005.

Bureau of Ocean Energy Management. nd. Chemosynthetic Community Locations in the Gulf of Mexico. http://www.boem.gov/Chemo-Community-Locations-in-the-GOM/

Bureau of Ocean Energy Management, Regulation, and Enforcement. 2010. Federal & Academic Scientists Return from Deep-sea Research Cruise in Gulf of Mexico: Scientists Observe Damage to Deep-sea Corals. U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement. http://www.noaanews.noaa.gov/stories2010/20101104_coralcruise.html

Bonde, R.K., and T.J. O'Shea. 1989. Sowerby's beaked whale (Mesoplodon bidens) in the Gulf of Mexico. J. Mammal. 70: 447-449.

Brooke, S., and W.W. Schroeder. 2007. State of deep coral ecosystems in teh Gulf of Mexico region: Texas to the Florida Straits, pp 271-306. In: S.E. Lumdsen, T.F. Hourigan, A.W. Bruckner and G. Dorr, The State of Deep Coral Ecosystems of the United STates. NOAA Technical Memo CRCP-3, Silver Spring, MD.

Brooks, J.M., C. Fisher, H. Roberts, E. Cordes, I. Baums, B. Bernard, R. Church, P. Etnoyer, C. German, E. Goehring, I. McDonald, H. Roberts, T. Shank, D. Warren, S. Welsh, and G. Wolff. 2012. Exploration and research of northern Gulf of Mexico deepwater natural and artificial hard-bottom habitats with emphasis on coral communities: Reefs, rigs, and wrecks — "Lophelia II" Interim report. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. PCS Study BOEM 2012-106.

Bruintjes, R., and A.N. Radford. 2013. Context-dependent impacts of anthropogenic noise on individual and social behaviour in a cooperatively breeding fish. Animal Behaviour 85(6): 1343-1349.

Camilli, R., C.M. Reddy, D.R. Yoerger, B.A. Van Mooy, M.V. Jakuba, J.C. Kinsey, C.P. McIntyre, S.P. Sylva, and J.V. Maloney. 2010. Tracking hydrocarbon plume transport and biodegradation at Deepwater Horizon. Science 330(6001): 201-204.

Carmichael, R.H., W.M. Graham, A. Aven, G. Worthy, and S. Howden. 2012. Were multiple stressors a 'perfect storm' for northern Gulf of Mexico bottlenose dolphins (*Tursiops truncatus*) in 2011? PLoS One 7(7): e41155.

Carr, A. 1996. Suwanee River sturgeon, pp 73-83. In: M.H. Carr, A Naturalist in Florida. Yale University Press, New Haven, CT.

Carvalho, R., C.-L. Wei, G.T. Rowe, and A. Schulze. 2013. Complex depth-related patterns in taxonomic and functional diversity of Polychaetes in the Gulf of Mexico. Deep Sea Research I 80: 66-77.

Centers for Disease Control and Prevention. 2010. Health Hazard Evaluation of Deepwater Horizon Response Workers. HETA 2010-0115. http://www.cdc.gov/niosh/hhe/pdfs/interim_report_6.pdf.

Clapp, R.B., R.C. Banks, D. Morgan-Jacobs, and W.A. Hoffman. 1982a. Marine birds of the southeastern United States and Gulf of Mexico. Part I. Gaviiformes through Pelicaniformes. U.S. Fish and Wildlife Service, Office of Biological Services. Washington, DC FWS/OBS-82/01.

Clapp, R.B., D. Morgan-Jacobs, and R.C. Banks. 1982b. Marine birds of the southeastern United States and Gulf of Mexico. Part II. Anseriformes. U.S. Fish and Wildlife Service, Office of Biological Services. Washington DC. FWS/OBS 82/20.

Clapp, R.B., D. Morgan-Jacobs, and R.C. Banks. 1983. Marine birds of the southeastern United States and Gulf of Mexico. Part III. Charadriiformes. U.S. Fish and Wildlife Service, Office of Biological Services. Washington, DC. FWS/OBS-83/30.

Continental Shelf Associates, Inc. 1997. Characterization and trends of recreational and commercial fishing from the Florida Panhandle. U.S. Department of Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. USGS/BRD/CR 1997 0001 and OCS Study MMS 97 0020.

Continental Shelf Associates, Inc. 2002. Deepwater Program: Bluewater fishing and OCS activity, interactions between the fishing and petroleum industries in deepwaters of the Gulf of Mexico. U.S. Department of

the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2002-078.
Continental Shelf Associates, Inc. 2004. Final Report: Gulf of Mexico Comprehensive Synthetic Based Muds Monitoring Program.
Continental Shelf Associates, Inc. 2006. Effects of oil and gas exploration and development at selected continental slope sites in the Gulf of Mexico. Volume II: Technical report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2006 045.
Cruz-Kaegi, M.E. 1998. Latitudinal variations in biomass and metabolism of benthic infaunal communities. Ph.D. Dissertation, Texas A&M University, College Station, TX
CSA International, Inc. 2007. Characterization of northern Gulf of Mexico deepwater hard-bottom communities with emphasis on Lophelia coral. M.M.S. U.S. Department of the Interior, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2007 044.
Davis, R.W., and G.S. Fargion, (eds.). 1996. Distribution and abundance of cetaceans in the north-central and western Gulf of Mexico: Technical report. M.M.S. U.S. Department of the Interior, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 96-0026.
Davis, R.W., J.G. Ortega-Ortiz, C.A. Ribic, W.E. Evans, D.C. Biggs, P.H. Ressler, J.H. Wormuth, R.R. Leben, K.D. Mullin, and W. B. 2000a. Cetacean habitat in the northern Gulf of Mexico, pp 217-253. In: Cetaceans, sea turtles, and seabirds in the northern Gulf of Mexico: Distribution, abundance and habitat associations. Volume II: Technical report. U.S. Geological Survey, Biological Resources Division, USGS/BRD/CR 1999 0006 and U.S. Department of the Interior,, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2000-003.
Davis, R.W., W.E. Evans, and B. Würsig. 2000b. Cetaceans, sea turtles, and seabirds in the northern Gulf of Mexico: Distribution, abundance and habitat associations. Volume II: Technical Report. U.S. Geological Survey, Biological Resources Division, USGS/BRD/CR 1999 0006 and U.S. Department of the Interior,, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2000 003.
Ditty, J.G. 1986. Ichthyoplankton in neritic waters of the northern Gulf of Mexico off Louisiana: Composition, relative abundance, and seasonality. Fish. Bull. 84(4): 935-946.
Ditty, J.G., G.G. Zieske, and R.F. Shaw. 1988. Seasonality and depth distribution of larval fishes in the northern Gulf of Mexico above 26°00'N. Fish. Bull. 86(4): 811-823.
Eastern Research Group, Inc. 2014. Assessing the impacts of the Deepwater Horizon oil spill on tourism in the Gulf of Mexico region. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study BOEM 2014-661.
Efroymson, R.A., W.H. Rose, S. Nemeth, and G.W. Sutter II. 2000. Ecological risk assessment framework for low altitude overflights by fixed-wing and rotary-wing military aircraft.
Ehrlich, P.R., D.S. Dobkin, and D. Wheye. 1992. Birds in Jeopardy: The Imperiled and Extinct Birds of the United States and Canada, including Hawaii and Puerto Rico. Palo Alto, CA, Stanford University Press.
Felder, C.R., B. Thoma, W.E. Schmidt, T. Sauvage, S.L. Self-Krayesky, and A. Christoserdov. 2014. Seaweeds and Decapod Crustaceans on Gulf Deep Banks after the Macondo Spill. BioScience 64(9): 808-819.
Fisher, C.R., A.W.J. Demopoulos, E.E. Cordes, I.B. Baums, H.K. White, and J.R. Borque. 2014a. Coral communities as indicators of ecosystem-level impacts of the Deepwater Horizon spill. BioScience 64: 796-807.
Fisher, C.R., P.Y. Hsing, C.L. Kaiser, D.R. Yoerger, H.H. Roberts, W.W. Shedd, E.E. Cordes, T.M. Shank, S.P. Berlet, M.G. Saunders, E.A. Larcom, and J.M. Brooks. 2014b. Footprint of Deepwater Horizon blowout impact to deep-water coral communities. Proc. Natl. Acad. Sci. USA 111(32): 11744-11749.
Florida Fish and Wildlife Conservation Commission. 2016a. Loggerhead nesting in Florida. Website accessed 18 April 2016. http://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead/
Florida Fish and Wildlife Conservation Commission. 2016b. Green turtle nesting in Florida. Website accessed 18 April 2016. http://myfwc.com/research/wildlife/sea-turtles/nesting/green-turtle/
Florida Fish and Wildlife Conservation Commission. 2016c. Leatherback nesting in Florida. Website accessed 18 April 2016. http://myfwc.com/research/wildlife/sea-turtles/nesting/leatherback/
Florida Fish and Wildlife Conservation Commission. 2016d. Florida's endangered and threatened species. http://myfwc.com/media/1515251/Threatened_Endangered_Species.pdf
Fox, D.A., J.E. Hightower, and F.M. Parauka. 2000. Gulf Sturgeon Spawning Migration and Habitat in the Choctawhatchee River System, Alabama–Florida. Trans. Am. Fish. Soc. 129(3): 811-826.

Fritts, T.H., and R.P. Reynolds. 1981. Pilot study of the marine mammals, birds, and turtles in OCS areas of the Gulf of Mexico. U.S. Department of the Interior, Fish and Wildlife Service, Biological Services Program. FWS/OBS 81/36.

Gallaway, B.J., and G.S. Lewbel. 1982. The ecology of petroleum platforms in the northwestern Gulf of Mexico: a community profile. U.S. Fish and Wildlife Service, Biological Services Program and U.S. Department of the Interior, Bureau of Land Management. Washington, D.C. FWS/OBS-82/27 and Open File Report 82-03. http://www.nwrc.usgs.gov/techrpt/82-27text.pdf

Gallaway, B.J., J.G. Cole, and R.G. Fechhelm. 2003. Selected Aspects of the Ecology of the Continental Slope Fauna of the Gulf of Mexico: A Synopsis of the Northern Gulf of Mexico Continental Slope Study, 1983-1988. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2003 072.

Gallaway, B.J., (ed.). 1988. Northern Gulf of Mexico Continental Slope Study, Final report: Year 4. Volume II: Synthesis report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 88-0053.

Geraci, J.R., and D.J. St. Aubin. 1987. Effects of offshore oil and gas development on marine mammals and turtles, pp In: D.F. Boesch and N.N. Rabalais, Long Term Environmental Effects of Offshore Oil and Gas Development. Elsevier Applied Science Publ. Ltd., London and New York.

Geraci, J.R., and D.J. St. Aubin. 1990. Sea Mammals and Oil: Confronting the Risks. San Diego, CA, Academic Press.

Gitschlag, G., B. Herczeg, and T. Barcack. 1997. Observations of sea turtles and other marine life at the explosive removal of offshore oil and gas structures in the Gulf of Mexico. Gulf Research Reports 9(4): 247-262.

Goold, J.C., and S.E. Jones. 1995. Time and frequency domain characteristics of sperm whale clicks. J. Acoust. Soc. Am. 98: 1,279-271,291.

Gulf of Mexico Fishery Management Council. 2005. Generic Amendment Number 3 for addressing Essential Fish Habitat Requirements, Habitat Areas of Particular Concern, and adverse effects of fishing in the following Fishery Management Plans of the Gulf of Mexico: Shrimp fishery of the Gulf of Mexico, United States waters red drum fishery of the Gulf of Mexico, reef fish fishery of the Gulf of Mexico coastal migratory pelagic resources (mackerels) in the Gulf of Mexico and South Atlantic, stone crab fishery of the Gulf of Mexico, spiny lobster in the Gulf of Mexico and South Atlantic, coral and coral reefs of the Gulf of Mexico. Tampa, FL.

Hazen, T.C., E.A. Dubinsky, T.Z. DeSantis, G.L. Andersen, Y.M. Piceno, N. Singh, J.K. Jansson, A. Probst, S.E. Borglin, J.L. Fortney, W.T. Stringfellow, M. Bill, M.E. Conrad, L.M. Tom, K.L. Chavarria, T.R. Alusi, R. Lamendella, D.C. Joyner, C. Spier, J. Baelum, M. Auer, M.L. Zemla, R. Chakraborty, E.L. Sonnenthal, P. D'Haeseleer, H.Y. Holman, S. Osman, Z. Lu, J.D. Van Nostrand, Y. Deng, J. Zhou, and O.U. Mason. 2010. Deep-sea oil plume enriches indigenous oil-degrading bacteria. Science 330(6001): 204-208.

Hess, N.A., and C.A. Ribic. 2000. Seabird ecology, pp 275-315. In: R.W. Davis, W.E. Evans and B. Würsig, Cetaceans, sea turtles, and seabirds in the northern Gulf of Mexico: Distribution, abundance and habitat associations. Volume II: Technical report. U.S. Geological Survey, Biological Resources Division, USGS/BRD/CR 1999 0006 and U.S. Department of the Interior, Minerals Management Service, New Orleans, LA.

Higashi, G.R. 1994. Ten years of fish aggregating device (FAD) design development in Hawaii. Bull. Mar. Sci. 55(2-3): 651-666.

Hildebrand, J.A. 2005. Impacts of anthropogenic sound, pp 101-124. In: J.E. Reynolds III, W.F. Perrin, R.R. Reeves, S. Montgomery and T.J. Ragen, Marine mammal research: conservation beyond crisis. Johns Hopkins University Press, Baltimore, MD.

Hildebrand, J.A. 2009. Anthropogenic and natural sources of ambient noise in the ocean. Mar. Ecol. Prog. Ser. 395: 5-20.

Hildebrand, J.A., S. Baumann-Pickering, K.E. Frasier, J.S. Trickey, K.P. Merkens, S.M. Wiggins, M.A. McDonald, L.P. Garrison, D. Harris, T.A. Marques, and L. Thomas. 2015. Passive acoustic monitoring of beaked whale densities in the Gulf of Mexico. Scientific Reports 5(16343).

Holand, P. 1997. Offshore Blowouts: Causes and Control. Houston, TX, Gulf Publishing Co.

Holland, K.N. 1990. Horizontal and vertical movements of yellowfin and bigeye tuna associated with fish aggregating devices. Fish. Bull. 88: 493-507.

Holt, M.M., D.P. Noren, V. Veirs, C.K. Emmons, and S. Veirs. 2009. Speaking up: Killer whales (Orcinus orca) increase their call amplitude in response to vessel noise. J. Acoust. Soc. Am. 125(1): 27-32.

Hsing, P.-Y., B. Fu, E.A. Larcom, S.P. Berlet, T.M. Shank, A.F. Govindarajan, A.J. Lukasiewicz, P.M. Dixon, and C.R. Fisher. 2013. Evidence of lasting impact of the Deepwater Horizon oil spill on a deep Gulf of Mexico coral community. Elementa: Science of the Anthropocene 1(1): 000012.

Intergovernmental Panel on Climate Change. 2014. Climate Change 2014: Impacts, Adaptation and Vulnerability. http://www.ipcc.ch/report/ar5/wg2/.

International Association of Oil & Gas Producers. 2010. Risk assessment data directory: Blowout frequencies. OGP Report No. 434 2. http://www.ogp.org.uk/pubs/434-02.pdf.

Ji, Z.-G., W.R. Johnson, C.F. Marshall, and E.M. Lear. 2004. Oil-Spill Risk Analysis: Contingency Planning Statistics for Gulf of Mexico OCS Activities. M.M.S. U.S. Department of the Interior, Gulf of Mexico OCS Region. New Orleans, LA. OCS Report MMS 2004 026.

Jochens, A., D.C. Biggs, D. Benoit-Bird, D. Engelhaupt, J. Gordon, C. Hu, N. Jaquet, M. Johnson, R.R. Leben, B. Mate, P. Miller, J.G. Ortega-Ortiz, A. Thode, P. Tyack, and B. Würsig. 2008. Sperm whale seismic study in the Gulf of Mexico: Synthesis report. M.M.S. U.S. Department of the Interior, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2008-006.

Johnsgard, P.A. 1990. Hawks, Eagles, and Falcons of North America; Biology and Natural History. Washington, D.C., Smithsonian Institute Press.

Kennicutt, M.C. 2000. Chemical Oceanography, pp. 123 139. In: Continental Shelf Associates, Inc. Deepwater Program: Gulf of Mexico deepwater information resources data search and literature synthesis. Volume I: Narrative report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2000 049.

King, B.S., and J.D. Gibbins. 2011. Health hazard evaluation of Deepwater Horizon response workers. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. Health Hazard Evaluation Report HETA 2010-0115 & 2010-0129-3138.

Kujawinski, E.B., M.C. Kido Soule, D.L. Valentine, A.K. Boysen, K. Longnecker, and M.C. Redmond. 2011. Fate of dispersants associated with the deepwater horizon oil spill. Environ. Sci. Technol. 45(4): 1298-1306.

Kyhn, L.A., J. Tougaard, and S. Sveegaard. 2011. Underwater noise from the drillship *Stena Forth* in Disko West, Baffin Bay, Greenland. http://www.dmu.dk/Pub/FR838.pdf 30 pp.

LGL Ecological Research Associates, Ltd. 2006. Assessment of the effects of underwater noise from the proposed Neptune LNG Project - Supplementary Biological Effects Report to Ecology and Environment, Inc. LGL Report No. 4200-2a. 11 pp.

Lin, Q., and I.A. Mendelssohn. 2012. Impacts and recovery of the Deepwater Horizon oil spill on vegetation structure and function of coastal salt marshes in the northern Gulf of Mexico. Environ. Sci. Technol. 46(7): 3737-3743.

Lohoefener, R., W. Hoggard, K.D. Mullin, C. Roden, and C. Rogers. 1990. Association of sea turtles with petroleum platforms in the north central Gulf of Mexico. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 90-0025.

Lutcavage, M.E., P.L. Lutz, G.D. Bossart, and D.M. Hudson. 1995. Physiologic and clinicopathologic effects of crude oil on loggerhead sea turtles. Arch. Environ. Contam. Toxicol. 28(4): 417-422.

Lutcavage, M.E., P. Plotkin, B. Witherington, and P.L. Lutz. 1997. Human impacts on sea turtle survival, pp pp. 387-409. In: P.L. Lutz and J.A. Musick, The Biology of Sea Turtles. CRC Press, Boca Raton, FL.

MacDonald, I.R., W.W. Schroeder, and J.M. Brooks. 1995. Northern Gulf of Mexico Chemosynthetic Ecosystems Study. Final Report. Volume II: Technical Report. OCS Study MMS 95-0022. 335 pp.

MacDonald, I.R.e. 2002. Stability and Change in Gulf of Mexico Chemosynthetic Communities. Volume II: Technical Report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2002-036.

Main, C.E., H.A. Ruhl, D.O.B. Jones, A. Yool, B. Thornton, and D.J. Mayor. 2015. Hydrocarbon contamination affects Deep-sea benthic oxygen uptake and microbial community composition. Deep Sea Research I 100: 79-87.

McCauley, R. 1998. Radiated underwater noise measured from the drilling rig Ocean General, rig tenders Pacific Ariki and Pacific Frontier, fishing vessel Reef Venture and natural sources in the Timor sea, northern Australia. Prepared for Shell Australia, Melbourne. 52pp. http://cmst.curtin.edu.au/local/docs/pubs/1998-19.pdf

McKenna, M.F., D. Ross, S.M. Wiggins, and J.A. Hildebrand. 2012. Underwater radiated noise from modern commercial ships. J. Acoust. Soc. Am. 131: 92-103.

McLaughlin, K.E., and H.P. Kunc. 2015. Changes in the acoustic environment alter the foraging and sheltering behaviour of the cichlid *Amititlania nigrofasciata*. Behavioural processes 116: 75-79.

Mendelssohn, I.A., G.L. Andersen, D.M. Baltx, R.H. Caffey, K.R. Carman, J.W. Fleeger, S.B. Joyce, Q. Lin, E. Maltby, E.B. Overton, and L.P. Rozas. 2012. Oil impacts on coastal wetlands: Implications for the Mississippi River delta ecosystem after the Deepwater Horizon oil spill. BioScience 62(6): 562-574.

Mississippi Natural Heritage Program. 2015. Listed species of Mississippi. Museum of Natural Science, Mississippi Deptartment of Wildlife, Fisheries, and Parks. Jackson, MS. http://www.mdwfp.com/media/246709/t_e_2015.pdf

Marine Mammal Commission. 2011. Assessing the long-term effects of the BP Deepwater Horizon oil spill on marine mammals in the Gulf of Mexico: A statement of research needs. http://www.mmc.gov/wp-content/uploads/longterm_effects_bp_oilspil.pdf

Minerals Management Service. 2000. Gulf of Mexico Deepwater Operations and Activities: Environmental Assessment. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA MMS 2000 001.

Minerals Management Service. 2007. Outer Continental Shelf Oil & Gas Leasing Program: 2007- 2012 Final Environmental Impact Statement. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. Herndon, VA. OCS EIS/EA MMS 2007-003.

Minerals Management Service. 2008. Outer Continental Shelf Oil & Gas Leasing Program: 2007 2012 Final Environmental Impact Statement. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS EIS/EA MMS 2008-041.

Montagna, P.A., J.G. Baguley, C. Cooksey, I. Hartwell, L.J. Hyde, J.L. Hyland, R.D. Kalke, L.M. Kracker, M. Reuscher, and A.C. Rhodes. 2013. Deep-sea benthic footprint of the *Deepwater Horizon* blowout. PLoS One 8(8): e70540.

Morrow, J.V.J., J.P. Kirk, K.J. Killgore, H. Rugillio, and C. Knight. 1998. Status and recovery of Gulf sturgeon in the Pearl River system, Louisiana-Mississippi. N. Am. J. Fish Manage. 18: 798-808.

Mullin, K.D., W. Hoggard, C. Roden, R. Lohoefener, C. Rogers, and B. Taggart. 1991. Cetaceans on the upper continental slope in the north-central Gulf of Mexico. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 91-0027.

Mullin, K.D. 2007. Abundance of cetaceans in the oceanic Gulf of Mexico based on 2003-2004 ship surveys. Available from: NMFS, Southeast Fisheries Science Center. Pascagoula, MS.

National Marine Fisheries Service. 2007. Endangered Species Act, Section 7 Consultation – Biological Opinion. Gulf of Mexico Oil and Gas Activities: Five Year Leasing Plan for Western and Central Planning Areas 2007-2012. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. St. Petersburg, FL. http://www.nmfs.noaa.gov/ocs/mafac/meetings/2010_06/docs/mms_02611_leases_2007_2012.pdf

National Marine Fisheries Service. 2009a. Sperm Whale (*Physeter macrocephalus*) 5-Year Review: Summary and Evaluation. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division. Silver Spring, MD.

National Marine Fisheries Service. 2009b. Final Amendment 1 to the Consolidated Atlantic Highly Migratory Species Fishery Management Plan Essential Fish Habitat. Highly Migratory Species Management Division, Office of Sustainable Fisheries. Silver Spring, MD. http://pbadupws.nrc.gov/docs/ML1219/ML12195A241.pdf

National Marine Fisheries Service. 2010a. Final recovery plan for the sperm whale (*Physeter macrocephalus*). Silver Spring, MD. http://www.nmfs.noaa.gov/pr/pdfs/health/oil_impacts.pdf

National Marine Fisheries Service. 2010b. Deepwater Horizon/BP oil spill: size and percent coverage of fishing area closures due to BP oil spill. http://sero.nmfs.noaa.gov/deepwater_horizon/size_percent_closure/index.html

National Marine Fisheries Service. 2011. Species of concern: Atlantic bluefin tuna, *Thunnus thynnus*. http://www.nmfs.noaa.gov/pr/pdfs/species/bluefintuna_detailed.pdf

National Marine Fisheries Service, U.S. Fish and Wildlife Service and Secretaría de Medio Ambiente y Recursos Naturales. 2011. Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*), Second Revision. http://www.nmfs.noaa.gov/pr/pdfs/recovery/kempsridley_revision2.pdf

National Marine Fisheries Service. 2014a. Sea turtles, dolphins, and whales and the Gulf of Mexico oil spill. http://www.nmfs.noaa.gov/pr/health/oilspill/gulf2010.htm

National Marine Fisheries Service. 2014b. Loggerhead Sea Turtle Critical Habitat in the Northwest Atlantic Ocean. http://www.nmfs.noaa.gov/pr/species/turtles/criticalhabitat_loggerhead.htm
National Marine Fisheries Service. 2014c. Gulf sturgeon (*Acipenser oxyrinchus desotoi*). http://www.nmfs.noaa.gov/pr/species/fish/gulfsturgeon.htm
National Marine Fisheries Service and U.S. Fish and Wildlife Service. 2008. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (*Caretta caretta*), Second Revision. http://www.nmfs.noaa.gov/pr/pdfs/recovery/turtle_loggerhead_atlantic.pdf
National Oceanic and Atmospheric Administration. 2006. Fact Sheet: Small Diesel Spills (500-5,000 gallons). NOAA Scientific Support Team, Hazardous Materials Response and Assessment Division. Seattle, WA.
National Oceanic and Atmospheric Administration. 2010. Oil and Sea Turtles. Biology, Planning, and Response. http://response.restoration.noaa.gov/sites/default/files/Oil_Sea_Turtles.pdf
National Oceanic and Atmospheric Administration. 2011a. Joint Analysis Group. Deepwater Horizon oil spill: Review of preliminary data to examine subsurface oil in the vicinity of MC252#1, May 19 to June 19, 2010. U.S. Department of Commerce, National Ocean Service. Silver Spring, MD. NOAA Technical Report NOS OR&R 25. http://service.ncddc.noaa.gov/rdn/www/media/documents/activities/jag-reports/NTR-NOS-ORR-25-082011.pdf
National Oceanic and Atmospheric Administration. 2011b. Joint Analysis Group, Deepwater Horizon oil spill: Review of R/V Brooks McCall data to examine subsurface oil. U.S. Department of Commerce, National Ocean Service. Silver Spring, MD. NOAA Technical Report NOS OR&R 24. http://service.ncddc.noaa.gov/rdn/www/media/documents/activities/jag-reports/NTR-NOS-ORR-24-062011.pdf
National Oceanic and Atmospheric Administration. 2011c. Joint Analysis Group, Deepwater Horizon oil spill: Review of preliminary data to examine oxygen levels in the vicinity of MC252#1 May 8 to August 9, 2010. U.S. Department of Commerce, National Ocean Service. Silver Spring, MD. NOAA Technical Report NOS OR&R 26. http://service.ncddc.noaa.gov/rdn/www/media/documents/activities/jag-reports/NTR-NOS-ORR-26-082011.pdf
National Oceanic and Atmospheric Administration. 2014. Flower Garden Banks National Marine Sanctuary. http://flowergarden.noaa.gov/education/oilspill.html
National Oceanic and Atmospheric Administration. 2016a. ADIOS 2 (Automated Data Inquiry for Oil Spills). http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/response-tools/downloading-installing-and-running-adios.html
National Oceanic and Atmospheric Administration. 2016b. Deepwater Horizon Oil Spill: Final Programmatic Damage Assessment and Restoration Plan and Final Programmatic Environmental Impact Statement. http://www.gulfspillrestoration.noaa.gov/restoration-planning/gulf-plan/
National Oceanic and Atmospheric Administration. 2016c. Cetacean Unusual Mortality Event in Northern Gulf of Mexico (2010-2014). http://www.nmfs.noaa.gov/pr/health/mmume/cetacean_gulfofmexico.htm
National Park Service. 2010. Breton Wilderness 300 km Radius. http://www2.nature.nps.gov/air/Permits/ARIS/docs/bretMap300.pdf
National Research Council. 1983. Drilling Discharges in the Marine Environment. Washington, DC.
National Research Council. 2003a. Oil in the Sea III: Inputs, Fates, and Effects. Washington, DC. 182 pp. + app.
National Research Council. 2003b. Ocean Noise and Marine Mammals. Washington, DC. 204 pp.
National Wildlife Federation. 2016a. Oil Spill Impacts on Marine Mammals. Website accessed 15 April 2016. http://www.nwf.org/What-We-Do/Protect-Habitat/Gulf-Restoration/Oil-Spill/Effects-on-Wildlife/Mammals.aspx
National Wildlife Federation. 2016b. Wildlife Library: Whooping Crane. Website accessed 4 April 2016. http://www.nwf.org/wildlife/wildlife-library/birds/whooping-crane.aspx
Nedwell, J.R., K. Needham, and B. Edwards. 2001. Report on measurements of underwater noise from the Jack Bates Drill Rig. Report No. 462 R 0202. Subacoustech Ltd., Southhampton, UK. 49 pp.
Nedwell, J.R., and D. Howell. 2004. A review of offshore windfarm related underwater noise sources. Report No. 544 R 0308, 0308. Subacoustech Ltd., Southampton, UK. 63 pp.
Nedwell, J.R., and B. Edwards. 2004. A review of measurements of underwater man-made noise carried out by Subacoustech Ltd, 1993 - 2003. Prepared by Subacoustech Report Reference: 565R00109, September 2004; prepared for ChevronTexaco Ltd, Total Final Elf Exploration UK PLC, DSTL, DTI, Shell UK.

Neff, J.M. 1987. Biological effects of drilling fluids, drill cuttings and produced waters, pp 469-538. In: D.F. Boesch and N.N. Rabalais, Long Term Effects of Offshore Oil and Gas Development. Elsevier Applied Science Publishers, London, UK.

Neff, J.M., S. McKelvie, and R.C. Ayers. 2000. Environmental impacts of synthetic based drilling fluids. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2000-064.

Neff, J.M., A.D. Hart, J.P. Ray, J.M. Limia, and T.W. Purcell (2005). An assessment of seabed impacts of synthetic based drilling-mud cuttings in the Gulf of Mexico. 2005 SPE/EPA/DOE Exploration and Production Environmental Conference, 7-9 March 2005, Galveston, TX. SPE 94086.

Nowlin, W.D.J., A.E. Jochens, S.F. DiMarco, R.O. Reid, and M.K. Howard. 2001. Deepwater Physical Oceanography Reanalysis and Synthesis of Historical Data: Synthesis Report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2001-064.

Oceaneering International, Inc. 2016. Site Clearance Letter, Proposed Wellsites H, HH, I, J, K, and KK, Block 727 (OCS-G-16783), Green Canyon Area. Project No. 172082.

Operational Science Advisory Team. 2010. Summary report for sub-surface and sub sea oil and dispersant detection: Sampling and monitoring. Prepared for Paul F. Zukunft, U.S. Coast Guard Federal On Scene Coordinator, Deepwater Horizon MC252. http://www.restorethegulf.gov/sites/default/files/documents/pdf/OSAT_Report_FINAL_17DEC.pdf.

Oxford Economics. 2010. Potential impact of the Gulf oil spill on tourism. Report prepared for the U.S. Travel Association. http://www.mississippiriverdelta.org/blog/files/2010/10/Gulf_Oil_Spill_Analysis_Oxford_Economics_710.pdf

Peabody, M.B., and C.A. Wilson. 2006. Fidelity of red snapper (*Lutjanus campechanus*) to petroleum platforms and artificial reefs in the northern Gulf of Mexico. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2006-005.

Peake, D.E. 1996. Bird surveys, pp. 271 304. In: R.W. Davis and G.S. Fargion (eds.), Distribution and abundance of cetaceans in the north central and western Gulf of Mexico, Final report. Volume II: Technical report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region New Orleans, LA. OCS Study MMS 96-0027.

Picciulin, M., L. Sebastianutto, A. Codarin, A. Farina, and E.A. Ferrero. 2010. In situ behavioural responses to boat noise exposure of Gobius cruentatus (Gmelin, 1789; fam. Gobiidae) and Chromis chromis (Linnaeus, 1758; fam. Pomacentridae) living in a Marine Protected Area. J. Exp. Mar. Biol. Ecol. 386(1): 125-132.

Powers, K. 1987. Seabirds, pp 194-201. In: J.D. Milliman and W.R. Wright, The Marine Environment of the U.S. Atlantic Continental Slope and Rise. Jones and Bartlett Publishers, Inc, Boston/Woods Hole, MA.

Powers, S.P., F.J. Hernandez, R.H. Condon, J.M. Drymon, and C.M. Free. 2013. Novel pathways for injury from offshore oil spills: Direct, sublethal and indirect effects of the Deepwater Horizon oil spill on pelagic *Sargassum* communities. PLoS One 8(9): e74802.

Pritchard, P.C.H. 1997. Evolution, phylogeny, and current status, pp In: P.L. Lutz and J.A. Musick, The Biology of Sea Turtles. CFC Press, Boca Raton, FL.

Radford, A.N., E. Kerridge, and S.D. Simpson. 2014. Acoustic communication in a noisy world: Can fish compete with anthropogenic noise? Behavioral Ecology 25: 1,022-021,030.

Rathbun, G.B. 1988. Fixed-wing airplane versus helicopter surveys of manatees. Mar. Mamm. Sci. 4(1): 71-75.

Relini, M., L.R. Orsi, and G. Relini. 1994. An offshore buoy as a FAD in the Mediterranean. Bull. Mar. Sci. 55(2-3): 1099-1105.

Richards, W.J., T. Leming, M.F. McGowan, J.T. Lamkin, and S. Kelley-Farga. 1989. Distribution of fish larvae in relation to hydrographic features of the Loop Current boundary in the Gulf of Mexico. ICES Mar. Sci. Symp. 191: 169-176.

Richards, W.J., M.F. McGowan, T. Leming, J.T. Lamkin, and S. Kelley-Farga. 1993. Larval fish assemblages at the Loop Current boundary in the Gulf of Mexico. Bull. Mar. Sci. 53(2): 475-537.

Richardson, W.J., C.R. Greene Jr., C.I. Malme, and D.H. Thomson. 1995. Marine Mammals and Noise. San Diego, CA, Acdemic Press.

Rodgers, J.A., and S.T. Schwikert. 2002. Buffer-Zone Distances to Protect Foraging and Loafing Waterbirds from Disturbance by Personal Watercraft and Outboard-Powered Boats. Conserv. Biol. 16(1): 216-224.

Ross, S.W., A.W.J. Demopoulos, C.A. Kellogg, C.L. Morrison, M.S. Nizinski, C.L. Ames, T.L. Casazza, D. Gualtieri, K. Kovacs, J.P. McClain, A.M. Quattrini, A.Y. Roa-Varón, and A.D. Thaler. 2012. Deepwater Program: Studies of Gulf of Mexico lower continental slope communities related to chemosynthetic and hard substrate habitats. U.S. Department of the Interior, U.S. Geological Survey. U.S. Geological Survey Open-File Report 2012-1032.

Rowe, G.T., and M.C. Kennicutt. 2009. Northern Gulf of Mexico Continental Slope Habitats and Benthic Ecology Study. Final Report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2009-039.

Rudd, M.B., R.N.M. Ahrens, W.E. Pine III, and S.K. Bolden. 2014. Empirical spatially explicit natural mortality and movement rate estimates for the threatened Gulf Sturgeon (*Acipenser oxyrinchus desotoi*). Can. J. Fish. Aquat. Sci. 71: 1407-1417.

Russell, R.W. 2005. Interactions between migrating birds and offshore oil and gas platforms in the northern Gulf of Mexico: Final Report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2005-009.

Salmon, M., and J. Wyneken. 1990. Do swimming loggerhead sea turtles (*Caretta caretta L.*) use light cues for offshore orientation? Mar. Fresh. Behav. Phy. 17(4): 233-246.

Samuel, Y., S.J. Morreale, C.W. Clark, C.H. Greene, and M.E. Richmond. 2005. Underwater, low-frequency noise in a coastal sea turtle habitat. J. Acoust. Soc. Am. 117(3): 1465-1472.

Schwacke, L.H., C.R. Smith, F.I. Townsend, R.S. Wells, L.B. Hart, B.C. Balmer, T.K. Collier, S. De Guise, M.M. Fry, L.J. Guillette, Jr., S.V. Lamb, S.M. Lane, W.E. McFee, N.J. Place, M.C. Tumlin, G.M. Ylitalo, E.S. Zolman, and T.K. Rowles. 2014. Response to comment on health of common bottlenose dolphins (Tursiops truncatus) in Barataria Bay, Louisiana following the deepwater horizon oil spill. Environ. Sci. Technol. 48(7): 4,209-204,211.

Share the Beach. 2015. Nesting season statistics. Website accessed 19 April 2016. http://www.alabamaseaturtles.com/nesting-season-statistics/

Silliman, B.R., J. van de Koppel, M.W. McCoy, J. Diller, G.N. Kasozi, K. Earl, P.N. Adams, and A.R. Zimmerman. 2012. Degradation and resilience in Louisiana salt marshes after the BP-Deepwater Horizon oil spill. Proc. Nat. Acad. Sci. USA 109(28): 11234-11239.

Smultea, M.A., J.R. Mobley Jr., D. Fertl, and G.L. Fulling. 2008. An unusual reaction and other observations of sperm whales near fixed wing aircraft. Gulf. Carib. Res. 20: 75-80.

Solomon, G.M., and S. Janssen. 2010. Health effects of the Gulf oil spill. JAMA 304(10): 1118-1119.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: initial scientific recommendation. Aquat. Mamm. 33: 411-521.

Spier, C., W.T. Stringfellow, T.C. Hazen, and M. Conrad. 2013. Distribution of hydrocarbons released during the 2010 MC252 oil spill in deep offshore waters. Environ. Pollut. 173: 224-230.

State of Louisiana Department of Wildlife and Fisheries. 2005. Chapter 4 - Conservation habits and species assessments. http://www.wlf.louisiana.gov/sites/default/files/pdf/document/32857-chapter-4-conservation-habitats-and-species-assessments/13_chapter_4_conservation_habitats___species_assessmen.pdf

Sulak, K.J., and J.P. Clugston. 1998. Early life history stages of Gulf sturgeon in the Suwanee River, Florida. Trans. Am. Fish. Soc. 127: 758-771.

Todd, V.L.G., W.D. Pearse, N.C. Tegenza, P.A. Lepper, and I.B. Todd. 2009. Diel echolocation activity of harbour porpoises (Phocoena phocoena) around North Sea offshore gas installations. ICES J. Mar. Sci. 66: 734-745.

Turtle Island Restoration Network. 2015. Kemp's Ridley Sea Turtle Count on the Texas Coast. Website accessed 2 March 2016. https://seaturtles.org/turtle-count-texas-coast/

Tuxbury, S.M., and M. Salmon. 2005. Competitive interactions between artificial lighting and natural cues during seafinding by hatchling marine turtles. Biol. Conserv. 121: 311-316.

U.S. Department of Commerce, Economics and Statistics Administration. 2010. Estimating the effects of the deepwater drilling moratorium on the Gulf coast economy. Inter-agency economic report. http://www.esa.doc.gov/Reports/estimating-economic-effects-deepwater-drilling-moratorium-gulf-coast-econom

U.S. Environmental Protection Agency. 2016a. The green book nonattainment areas for criteria pollutants. http://www3.epa.gov/airquality/greenbook/

U.S. Environmental Protection Agency. 2016b. Questions and answers about the BP oil spill in the Gulf Coast. http://archive.epa.gov/bpspill/web/html/qanda.html

U.S. Fish and Wildlife Service. 2001. Florida manatee recovery plan (*Trichechus manatus latirostris*), Third Revision. U.S. Department of the Interior, Southeast Region. Atlanta, GA.

U.S. Fish and Wildlife Service. 2003. Recovery plan for the Great Lakes Piping Plover (*Charadrius melodus*). U.S. Department of the Interior. Fort Snelling, MN.

U.S. Fish and Wildlife Service. 2007. International Recovery Plan: Whooping Crane (*Grus americana*), Third Revision. U.S. Department of the Interior. Albequerque, NM.

U.S. Fish and Wildlife Service. 2010a. Bech-nesting birds of the Gulf. http://www.fws.gov/home/dhoilspill/pdfs/DHBirdsOfTheGulf.pdf

U.S. Fish and Wildlife Service. 2010b. Effects of oil on wildlife and habitat. http://www.fws.gov/home/dhoilspill/pdfs/DHJICFWSOilImpactsWildlifeFactSheet.pdf

U.S. Fish and Wildlife Service. 2011. FWS Deepwater Horizon Oil Spill Response. Bird Impact Data and Consolidated Wildlife Reports. Deepwater Horizon Bird Impact Data from the DOI-ERDC NRDA Database 12 May 2011. http://www.fws.gov/home/dhoilspill/pdfs/Bird%20Data%20Species%20Spreadsheet%2005122011.pdf

U.S. Fish and Wildlife Service. 2015a. Hawksbill sea turtle (*Eretmochelys imbricata*). http://www.fws.gov/northflorida/SeaTurtles/Turtle%20Factsheets/hawksbill-sea-turtle.htm

U.S. Fish and Wildlife Service. 2015b. Bald and Golden Eage Information. http://www.fws.gov/birds/management/managed-species/bald-and-golden-eagle-information.php

U.S. Fish and Wildlife Service. 2016a. Find Endangered Species. http://www.fws.gov/endangered/

U.S. Fish and Wildlife Service. 2016b. Whooping Crane Survey Results: Winter 2015-2016. http://www.fws.gov/uploadedFiles/Region_2/NWRS/Zone_1/Aransas-Matagorda_Island_Complex/Aransas/Sections/What_We_Do/Science/Whooping_Crane_Updates_2013/WHCR%20Update%20Winter%202015-2016.pdf

U.S. Fish and Wildlife Service. nd. All About Piping Plovers. http://www.fws.gov/plover/facts.html

U.S. Fish and Wildlife Service, Gulf States Marine Fisheries Commission and National Marine Fisheries Service. 1995. Gulf Sturgeon Recovery/Management Plan. U.S. Department of Interior, U.S. Fish and Wildlife Service, Southeast Region. Atlanta, GA. http://www.nmfs.noaa.gov/pr/pdfs/recovery/sturgeon_gulf.pdf

U.S. Geological Survey. 2011. Cold-water coral ecosystem studies: U.S. Gulf of Mexico. Website accessed 14 April 2016. http://fl.biology.usgs.gov/pdf/20100504Gulf_corals_v1.pdf

Valentine, D.L., G.B. Fisher, S.C. Bagby, R.K. Nelson, C.M. Reddy, S.P. Sylva, and M.A. Woo. 2014. Fallout plume of submerged oil from Deepwater Horizon. Proc. Nat. Acad. Sci. USA 111(45): 906-915.

Venn-Watson, S., K.M. Colegrove, J. Litz, M. Kinsel, K. Terio, J. Saliki, S. Fire, R.H. Carmichael, C. Chevis, W. Hatchett, J. Pitchford, M.C. Tumlin, C. Field, S. Smith, R. Ewing, D. Fauquier, G. Lovewell, H. Whitehead, D. Rotstein, W.E. McFee, and E. Fougeres. 2015. Adrenal Gland and Lung Lesions in Gulf of Mexico Common Bottlenose Dolphins (Tursiops truncates) Found Dead following the Deepwater Horizon Oil Spill. PLoS One 10(5): e0126538.

Wakeford, A. 2001. State of Florida conservation plan for Gulf sturgeon (*Acipencer oxyrinchus desotoi*).

Waring, G.T., E. Josephson, K. Maze0Foley, and P.E.e. Rosel. 2015. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2014. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. NOAA Tech. Memo. NMFS NE 231.

Wartzok, D., and D.R. Ketten. 1999. Marine mammal sensory systems, pp 117-175. In: J.E. Reynolds III and S. Rommel, Biology of Marine Mammals. Smithsonian Institution Press, Washington, DC.

Wei, C.-L. 2006. The bathymetric zonation and community structure of deep-sea macrobenthos in the northern Gulf of Mexico. M.S. Thesis, Texas A&M University. http://repository.tamu.edu/handle/1969.1/4927

Wei, C.-L., G.T. Rowe, G.F. Hubbard, A.H. Scheltema, G.D.F. Wilson, I. Petrescu, J.M. Foster, M.K. Wickstein, M. Chen, R. Davenport, Y. Soliman, and Y. Wang. 2010. Bathymetric zonation of deep-sea macrofauna in relation to export of surface phytoplankton production. Mar. Ecol. Prog. Ser. 39: 1-14.

Weilgart, L., and H. Whitehead. 1993. Coda communication by sperm whales (*Physeter macrocephalus*) off the Galapagos Islands. Can. J. Zool. 71: 744-752.

White, H.K., P.Y. Hsing, W. Cho, T.M. Shank, E.E. Cordes, A.M. Quattrini, R.K. Nelson, R. Camilli, A.W.J. Demopoulos, C. German, J.M. Brooks, H. Roberts, W.W. Shedd, C.M. Reddy, and C. Fisher. 2012. Impact of the Deepwater Horizon oil spill on a deep-water coral community in the Gulf of Mexico. Proc. Nat. Acad. Sci. USA 109(50): 20303-20308.

Wiese, F.K., W.A. Montevecchi, G.K. Davoren, F. Huettmann, A.W. Diamond, and J. Linke. 2001. Seabirds at risk around offshore oil platforms in the north-west Atlantic. Mar. Poll. Bull. 42(12): 1285-1290.

Williams, R., E. Ashe, and P.D. O'Hara. 2011. Marine mammals and debris in coastal waters of British Columbia, Canada. Mar. Poll. Bull. 62(6): 1303-1316.

Wilson, C.A., A. Pierce, and M.W. Miller. 2003. Rigs and reefs: A comparison of the fish communities at two artificial reefs, a production platform, and a natural reef in the northern Gulf of Mexico. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, LA. OCS Study MMS 2003-009.

Wilson, J. 2003. Manatees in Louisiana. Louisiana Conservationist July/August 2003: 7 pp.

Witherington, B. 1997. The problem of photopollution for sea turtles and other nocturnal animals, pp 303-328. In: J.R. Clemmons and R. Buchholz, Behavioral Approaches to Conservation in the Wild. Cambridge University Presws, Cambridge, England.

Würsig, B., S.K. Lynn, T.A. Jefferson, and K.D. Mullin. 1998. Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft. Aquat. Mamm. 24(1): 41-50.

Würsig, B., T.A. Jefferson, and D.J. Schmidly. 2000. The Marine Mammals of the Gulf of Mexico. College Station, TX, Texas A&M University Press.

O
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
Initial Exploration Plan Control No. N-7577.
Supplemental EP Control No. S-7509 (GC 727)
Supplemental EP Control No. S-7791 (GC 726 & 727)
Final Sale Package for Central Gulf of Mexico Sale Number 157.