OCS EIS/EA
MMS 2002-081

Programmatic Environmental Assessment for Grid 16

Site-Specific Evaluation of BP Exploration and Production, Inc.'s Initial Development Operations Coordination Document, N-7469

Thunder Horse Project
Mississippi Canyon Block 777 Unit
(Blocks 775, 776, 777, 778, 819, 820, 821, and 822)

U.S. Department of the Interior
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Prepared by

Minerals Management Service
Gulf of Mexico OCS Region

Published by

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Gulf of Mexico OCS Region

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PROGRAMMATIC ENVIRONMENTAL ASSESSMENT FOR GRID 16 AND SITE-SPECIFIC EVALUATION FOR BP'S THUNDER HORSE PROJECT

Finding of No Significant Impact

BP Exploration and Production, Inc.'s (BP) Initial Unit Development Operations Coordination Document (DOCD) and its amendments propose to drill and complete a total of 27 wells (17 production and 10 water injection wells) initially. In addition, approximately 16 recompletions and 16 sidetracks are planned in the mid-to-late life of the fields. The wells will be drilled from eight drill centers and production will be tied back to a semisubmersible production, drilling, and quarters facility in Mississippi Canyon, Block 778. BP's Mississippi Canyon Block 777 Unit is composed of the following leases: Blocks 775 (OCS-G 19997), 776 (OCS-G 9866), 777 (OCS-G 9867), 778 (OCS-G 9868), 819 (OCS-G 12168), 820 (OCS-G 14656), 821 (OCS-G 14657), and 822 (OCS-G 14658). Our programmatic environmental assessment (PEA) and site-specific evaluation of the proposed action (N-7469) is complete and results in a Finding of No Significant Impact (FONSI). Based on this PEA, we have concluded that the proposed action will not significantly (40 CFR 1508.27) affect the quality of the marine and human environments. Preparation of an environmental impact statement is not required. The MMS identified mitigative measures during the preparation of this PEA that will be transmitted to BP for their implementation. These measures are included on the next page of this document.

J. Hammond Eve
Regional Supervisor, Leasing and Environment
GOM OCS Region

12/19/02
Date

Pasquale F. Roscigno
Chief, Environmental Sciences Section
Leasing and Environment, GOM OCS Region

12/19/02
Date

Dennis Chew
Supervisor, NEPA/CZM Coordination Unit
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12/19/02
Date

for Elizabeth Peuler
Supervisor, Physical Sciences Unit
Leasing and Environment, GOM OCS Region

Dec. 19, 02
Date

MITIGATION FOR N-7469

Mitigation 2.02 (Advisory) – Potential to exceed exemption level, DOCD

A deviation from your DOCD (such as additional drilling time, changes in the drilling schedule, and/or the use of higher horsepower equipment, especially for the drilling rig and construction barges) could potentially cause the annual emissions exemption level for NO_x to be exceeded. Therefore, if such a deviation occurs, please be advised that you will immediately prepare a revised DOCD pursuant to 30 CFR 250.204(q)(2) to include the recalculated emission amounts and the air quality modeling required by 30 CFR 250.303(e). You will not proceed with the actions that could cause the potential exceedance until the revised DOCD has been submitted to and approved by this office.

Mitigation 2.05 (Advisory) – Fuel usage or run time documentation

The projected NO_x emissions amounts in your plan were calculated using historic fuel consumption rates. Therefore, please be advised that you will maintain records of the total monthly fuel consumption for the drilling rig and provide the information to this office upon request.

Mitigation 2.06 (Reminder) – Flaring beyond 48 hours

Your plan indicates well test flaring for more than 48 continuous hours. Please be reminded that 30 CFR 250.1105(a)(3) requires you to obtain approval from the Regional Supervisor for Production and Development prior to conducting the proposed flaring activities.

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ABBREVIATIONS AND ACRONYMS

AHTS	anchor-handling tug/supply (vessel)
BAST	best available and safest technology
bbl	barrel(s)
BOD	biochemical oxygen demand
B.P.	before present
BP	BP Exploration and Production, Inc.
bpd	barrels per day
Btu	British thermal unit
CEI	Coastal Environments, Inc.
CER	categorical exclusion review
CFR	Code of Federal Regulations
cm	centimeter
CO	carbon monoxide
COD	chemical oxygen demand
CPA	Central Planning Area
CSA	Continental Shelf Associates
CZM	Coastal Zone Management
DC	Drill Center
DDT	Dichlorodiphenyltrichloroethane
DHPTG	downhole pressure and temperature gauge
DM	Departmental Manual
DOCD	Development Operations Coordination Document
DO	dissolved oxygen
DOI	Department of the Interior (U.S.) (also: USDOI)
DTS	distributed temperature sensor
DWOP	Deepwater Operations Plan
EA	environmental assessment
EEZ	Exclusive Economic Zone
EFH	essential fish habitat
EIA	Energy Information Administration
EIS	environmental impact statement
E&P	exploration and production
EP	Exploration Plan
EPA	Eastern Planning Area
ESA	Endangered Species Act
ESS	expandable sand screen
et al.	and others
et seq.	and the following
EWTA	Eglin Water Test Area
FAA	Federal Aviation Administration
FSL	from the south line of the lease
FWL	from the west line of the lease
FMC	Fishery Management Council
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impact
FR	*Federal Register*
ft	foot
FWS	Fish and Wildlife Service
gal	gallon
GMFMC	Gulf of Mexico Fishery Management Council
GOM	Gulf of Mexico
GulfCet	Gulf Cetaceans (MMS-funded study)
H_2S	hydrogen sulfide
hp	horsepower
HPHT	high pressure, high temperature
in	inch
kg	kilogram
km	kilometer
LATEX	Texas-Louisiana Shelf Circulation and Transport Process Program (MMS-funded study)
lb	pound
LDHI	low-dosage hydrate inhibitor
LOOP	Louisiana Offshore Oil Port
LTL	Letter to Lessees and Operators
MARPOL	International Convention for the Prevention of Pollution from Ships
mi	mile
mph	miles per hour
mm	millimeter
MMS	Minerals Management Service
MODU	mobile offshore drilling unit
MSA	Metropolitan Statistical Area
MWA	military warning area
NAAQS	National Ambient Air Quality Standards
NBS	National Biological Service
NEPA	National Environmental Policy Act, as amended
NGMCS	Northern Gulf of Mexico Continental Slope Study
NMFS	National Marine Fisheries Service
NO_X	nitrogen oxide
NOAA	National Oceanic and Atmospheric Administration
NORM	naturally occurring radioactive material
NPDES	National Pollutant and Discharge Elimination System
NRC	National Response Corporation
NTL	Notice to Lessees and Operators
OBM	oil-based mud
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act, as amended
OPEC	Organization for Petroleum Exporting Countries
OSRA	Oil Spill Risk Analysis
P	production

PAH	polynuclear aromatic hydrocarbons
PM	particulate matter
PEA	programmatic environmental assessment
PDQ	production, drilling, and quarters facility
P.L.	Public Law
PCB	polychlorinated biphenyl
PLET	pipeline end termination
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
PSD	Prevention of Significant Deterioration
RCRA	Resource Conservation and Recovery Act
ROC	retention on cuttings
ROW	right-of-way
SBF	synthetic-based fluid
SBM	synthetic-based mud
SCR	steel catenary riser
SEA	site-specific environmental assessment
SIC	Standard Industrial Classification
SO_X	sulphur oxide
SOP	suspension of production
SOV	spill occurrence variable
TLP	tension leg platform
TV	transport variable
USCG	U.S. Coast Guard
USDOC	U.S. Department of Commerce
USDOI	U.S. Department of the Interior (also: DOI)
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compounds
VRU	vapor recovery unit
WBM	water-based mud
WI	well injection
WPA	Western Planning Area

INTRODUCTION

The Minerals Management Service (MMS) developed a comprehensive strategy for postlease National Environmental Policy Act (NEPA) compliance in deepwater areas (water depths greater than 1,312 ft or 400 m) of the Central and Western Planning Areas of the Gulf of Mexico (GOM). You can find an in-depth discussion of this strategy on our Internet site at the following address:

www.gomr.mms.gov/homepg/regulate/environ/strategy/strategy.html.

The MMS's strategy led to the development of a biologically-based grid system to ensure broad and systematic analysis of the GOM's deepwater region. The grid system divided the Gulf into 17 areas or "grids" of biological similarity. Under this strategy, the MMS will prepare a programmatic environmental assessment (PEA) to address proposed development activities within each of the 17 grids. The PEA will also address categorical exclusion criterion C.(10)(1) (from 516 DM 6 Appendix 10). This criterion requires the MMS to prepare an environmental assessment for "… areas of ... relatively untested deep water or remote areas." A Grid PEA will be comprehensive in terms of the impact-producing factors and environmental and socioeconomic resources described and analyzed. The PEA will also include a site-specific evaluation on a development proposal within the grid's boundaries.

Once a PEA for a grid has been completed, it will serve as a reference document to implement the "tiering" (40 CFR 1502.20) concept detailed in NEPA's implementing regulations. Future environmental evaluations may reference appropriate sections from the PEA to reduce reiteration of issues and effects previously addressed in the "grid" document. This will allow the subsequent environmental analyses for individual plans within the grid to focus on specific issues and effects related to the proposals.

This PEA characterizes the environment of Grid 16 and also examines the effects that may result from the site-specific activities proposed in BP's Initial Unit Development Operations Coordination Document (DOCD) for the Thunder Horse project (N-7469). To the extent possible, the PEA will also evaluate other potential activities proposed or known within Grid 16.

Figure 1 shows the relationship of Grid 16 to the Gulf's coastline and to the other 16 grids. The Mississippi Canyon Block 777 Unit is highlighted.

Figure 2 depicts the protraction diagrams and blocks that are contained in Grid 16. The highlighted blocks are the proposed location for the Thunder Horse project activities.

Current Status of Grid 16

The purpose of this section is to provide the reader with a "state of the grid." Information in this section is based on current MMS data and publicly announced prospects that are projected for Grid 16. Figure 1 shows the relationship of Grid 16 to the coastline and to the other grids in the GOM. Figure 2 depicts the portions of the protraction diagrams and the blocks that constitute Grid 16.

Grid 16 includes portions of the Viosca Knoll, Mississippi Canyon, and Atwater Valley Outer Continental Shelf (OCS) protraction diagrams. Table 1 provides information on the protraction diagrams, blocks, leases, and acreage in Grid 16.

Table 1

Protraction Diagram, Blocks, Leases, and Acreage in Grid 16

Protraction Diagram	No. of Grid Blocks	Approximate Acreage in Grid	No. of Grid Blocks Leased	Percentage of Grid Blocks Leased
Viosca Knoll	26	149,760	23	88%
Mississippi Canyon	280	1,612,800	228	81%
Atwater Valley	86	495,360	54	63%
Grid Totals	392	2,257,920	305	78%

Mississippi Canyon constitutes approximately 71 percent of the total number of blocks in the grid. It also contains about 75 percent of the total number of leases in the grid. Atwater Valley is the second largest component of the grid. It contains approximately 22 percent of the total number of blocks in the

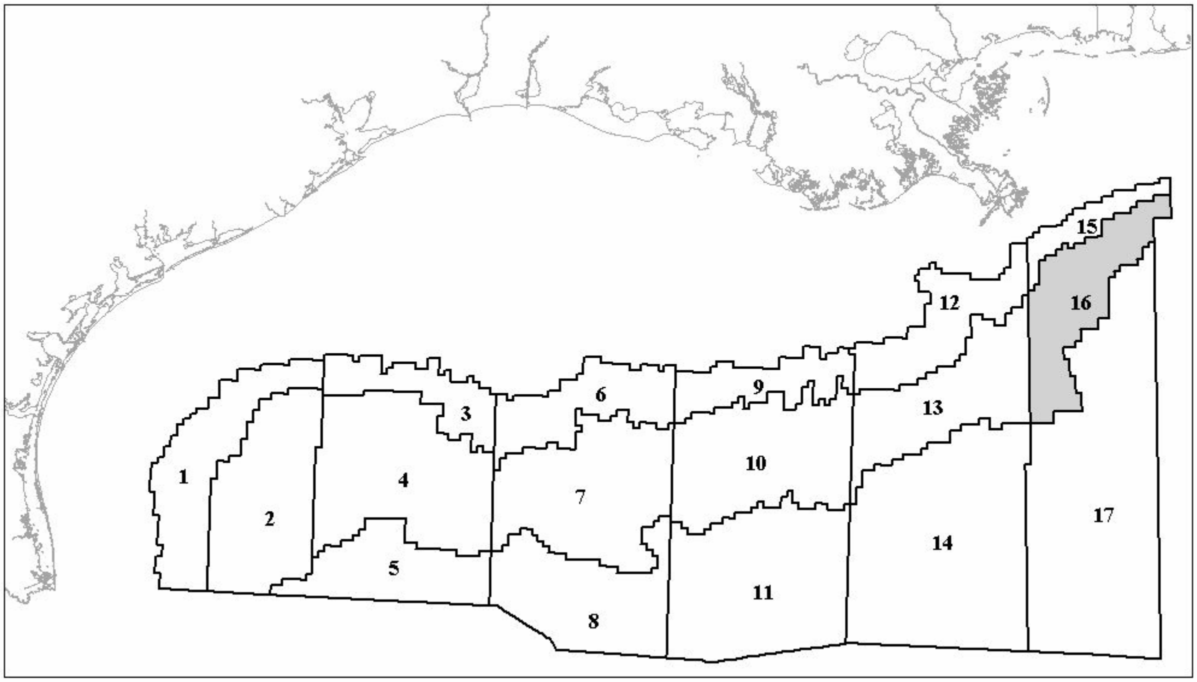

Figure 1. Grid 16 in Relationship to the Gulf Coastline and to Other Grids.

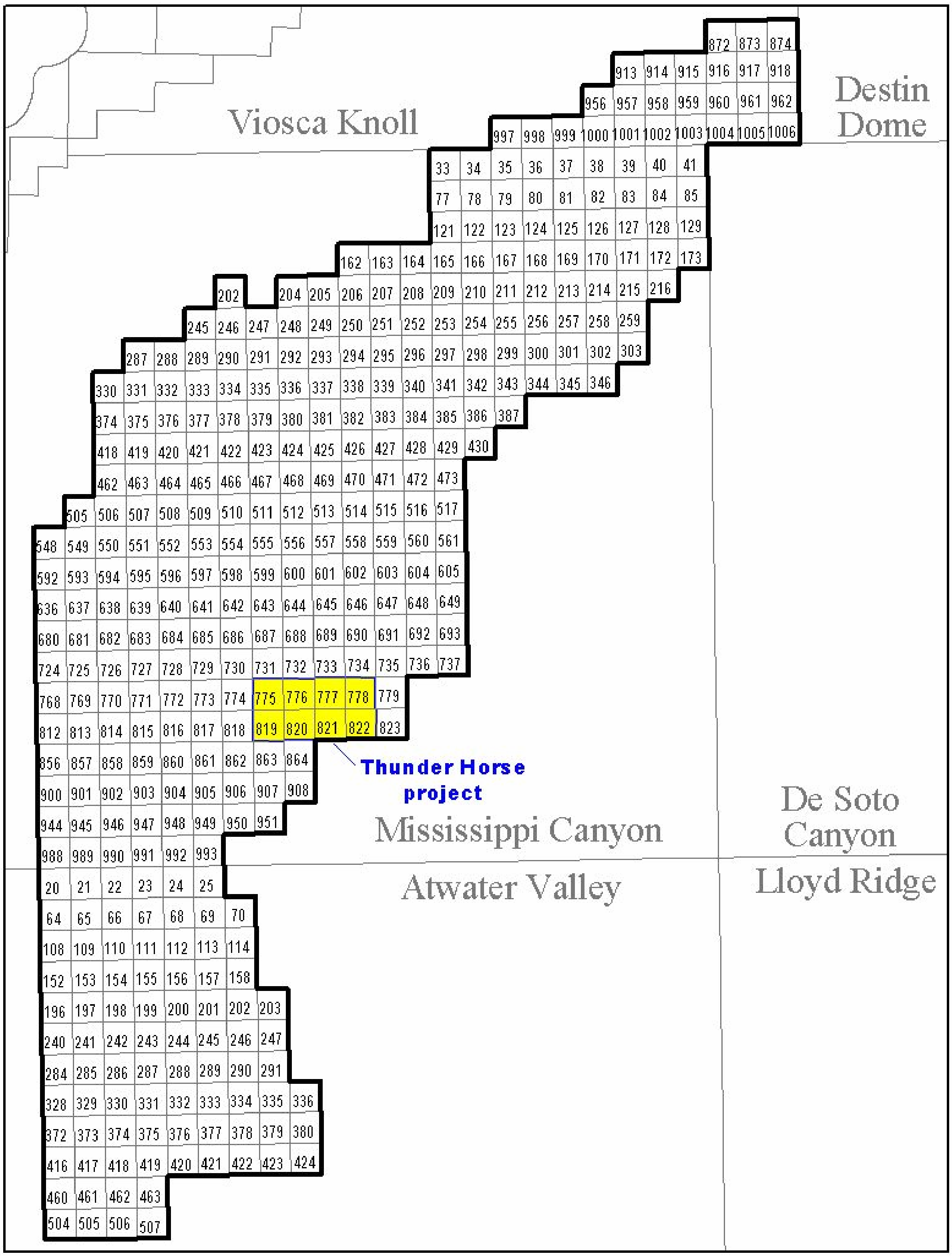

Figure 2. Protraction Diagrams and Blocks in Grid 16 with Highlighted Thunder Horse Project Blocks.

grid and has about 18 percent of the total leases. Viosca Knoll has about 7 percent of the total number of blocks and over 7 percent of the leases. Overall, about 78 percent of all the blocks in the grid are leased.

Figure 3 depicts the bathymetry of Grid 16 in 500-m contour intervals.

Three Military Warning Areas (MWA's) impinge on the northeast portion of Gird 16. See Figure 4 for the boundaries of these MWA's (W-155B, W-155C, and EWTA-1). All blocks that are contained within the MWA's will have stipulations included within their leases regarding specific Department of Defense mitigative measures, i.e., hold and save harmless, electromagnetic emissions, and operational considerations. For additional information regarding these stipulations, see the Central and Western Planning Area Multisale Final EIS 2002-2007. Figure 4 also shows that an ordnance disposal area is located on the west flank of Grid 16. Though this disposal area is inactive, it may contain unexploded munitions and other ordnance. Operators must exercise special precautions and care when conducting ground-founding or seafloor disturbing activities within the disposal area.

One block (Mississippi Canyon, Block 900) within the grid is known to contain concentrations of hydrogen sulfide (H_2S), which requires special precautions and plans from the operator. See the MMS's Operating Regulations (30 CFR 250, Subparts D, E, F, and H) for specific H_2S requirements based on operational considerations. For additional information regarding H_2S and operational activities, see the Multisale EIS 2002-2007.

Approximately 90 percent of the blocks in Grid 16 are located within 200 km of the Breton National Wilderness Area. Operators may be required to mitigate their air emissions if their rates exceed established thresholds.

At present, there are 25 operators and/or leaseholders in Grid 16. These operators include

- Amerada Hess Corporation
- Amoco Production Company
- Anadarko Petroleum Corporation
- BHP Petroleum (GOM) Inc.
- BP Exploration & Production Inc.
- Burlington Resources Offshore Inc.
- Chevron U.S.A. Inc.
- Conoco Inc.
- Dominion Exploration & Production, Inc.
- EEX Corporation
- Enterprise Oil Gulf of Mexico Inc.
- Exxon Mobil Corporation
- Kerr-McGee Oil & Gas Corporation
- LLOG Exploration Offshore, Inc.
- Marathon Oil Company
- Mariner Energy, Inc.
- Mobil Oil Exploration & Producing Southeast Inc.
- Murphy Exploration & Production Company
- Phillips Petroleum Company
- Samedan Oil Corporation
- Shell Offshore Inc.
- Spinnaker Exploration Company, L.L.C.
- Texaco Exploration and Production Inc.
- TotalFinaElf E & P USA, Inc.
- Vastar Resources, Inc.

Figure 5 depicts the leasehold position of these operators within Grid 16.

The grid's active lease status and plans submitted data are portrayed in Figure 6. A total of 74 (19%) of the leased blocks have Exploration Plans (EP's) approved by the MMS. There are 15 (4% of the leased blocks) DOCD's filed within the grid. Twenty-eight blocks are in units. One lease has a suspension of production (SOP). A total of five leases are currently producing within the grid.

There are 14 publicly announced prospects contained within Grid 16. Figure 7 shows the location of these prospects, as well as the locations of wells drilled within the grid.

At this time, there are four existing and two more proposed surface structures within Grid 16. There are numerous proposed and existing pipelines within the grid. The pipeline locations and wellbore status are depicted on Figure 8.

Figure 9 depicts the status of wells drilled within Grid 16.

There are numerous onshore support bases that are available along the Gulf Coast and that could serve as logistical infrastructure for Grid 16. In the current proposal, BP chose their C-Port Shore Base at Pass Fourchon, Louisiana, as its primary onshore base to support the proposed operations. Figure 10 shows the relationship of Grid 16 to the shore base. The distance in miles from the Grid to the shore base is also depicted on Figure 10.

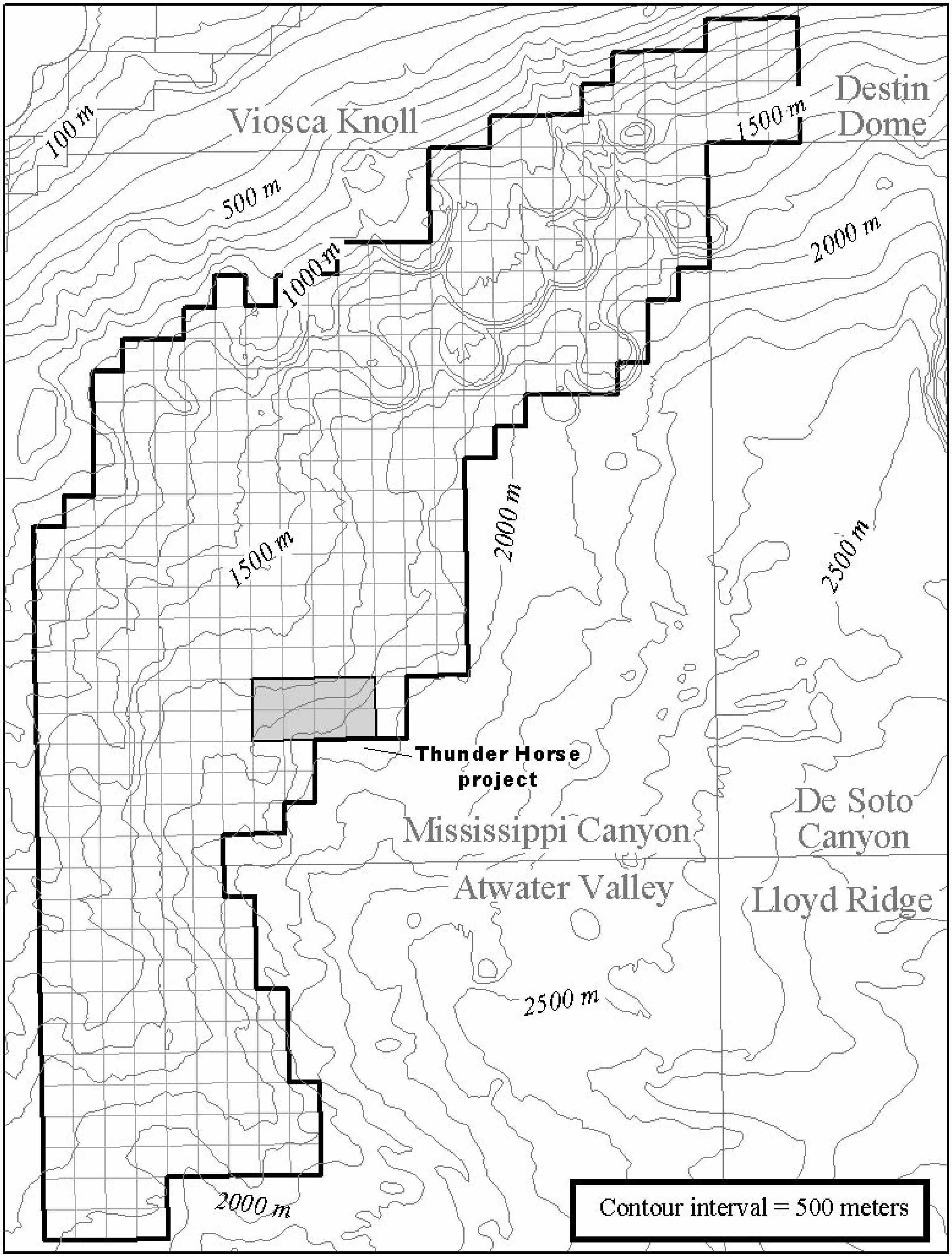

Figure 3. Bathymetry of Grid 16.

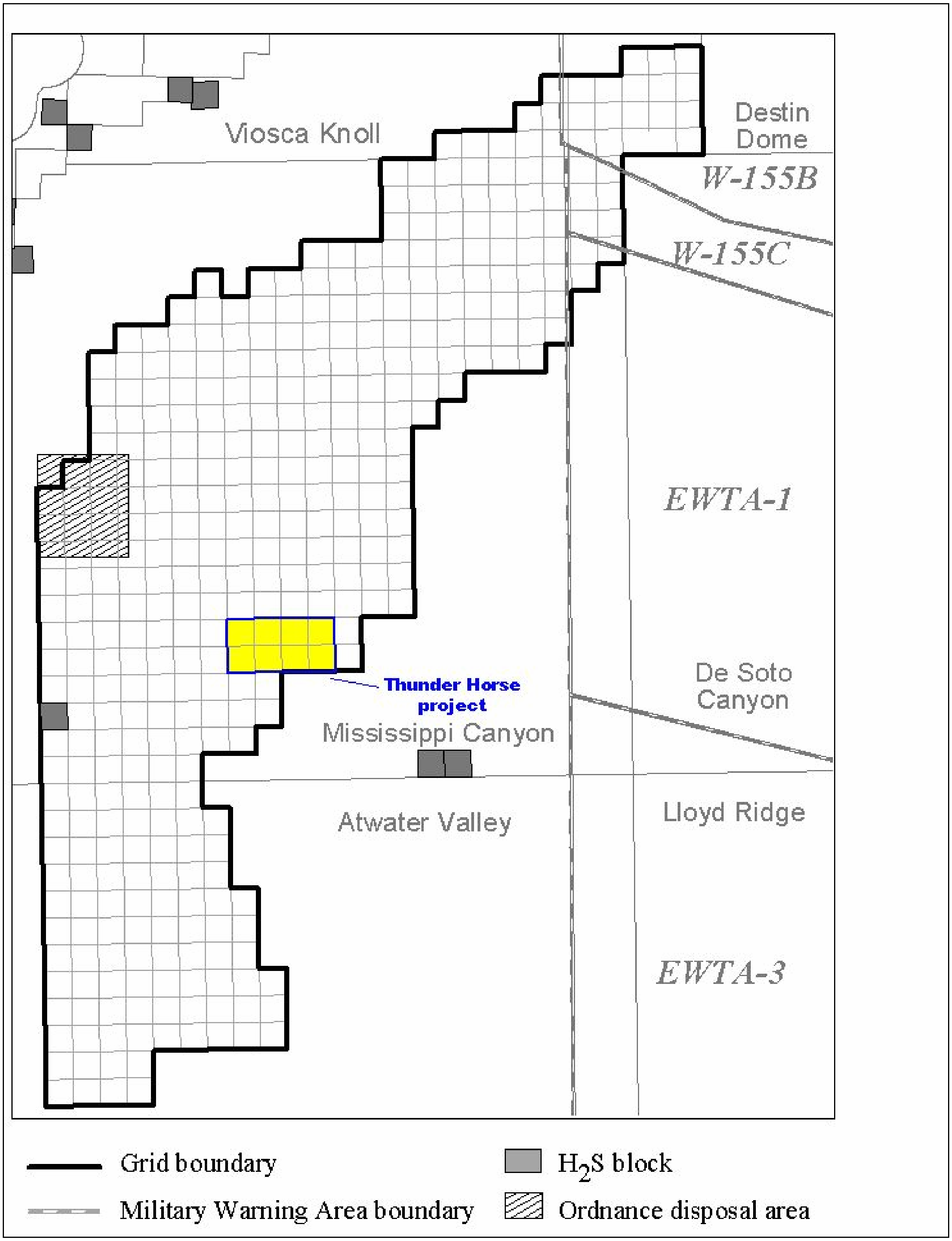

Figure 4. Military Warning Areas, H_2S Blocks, and Ordnance Disposal Area.

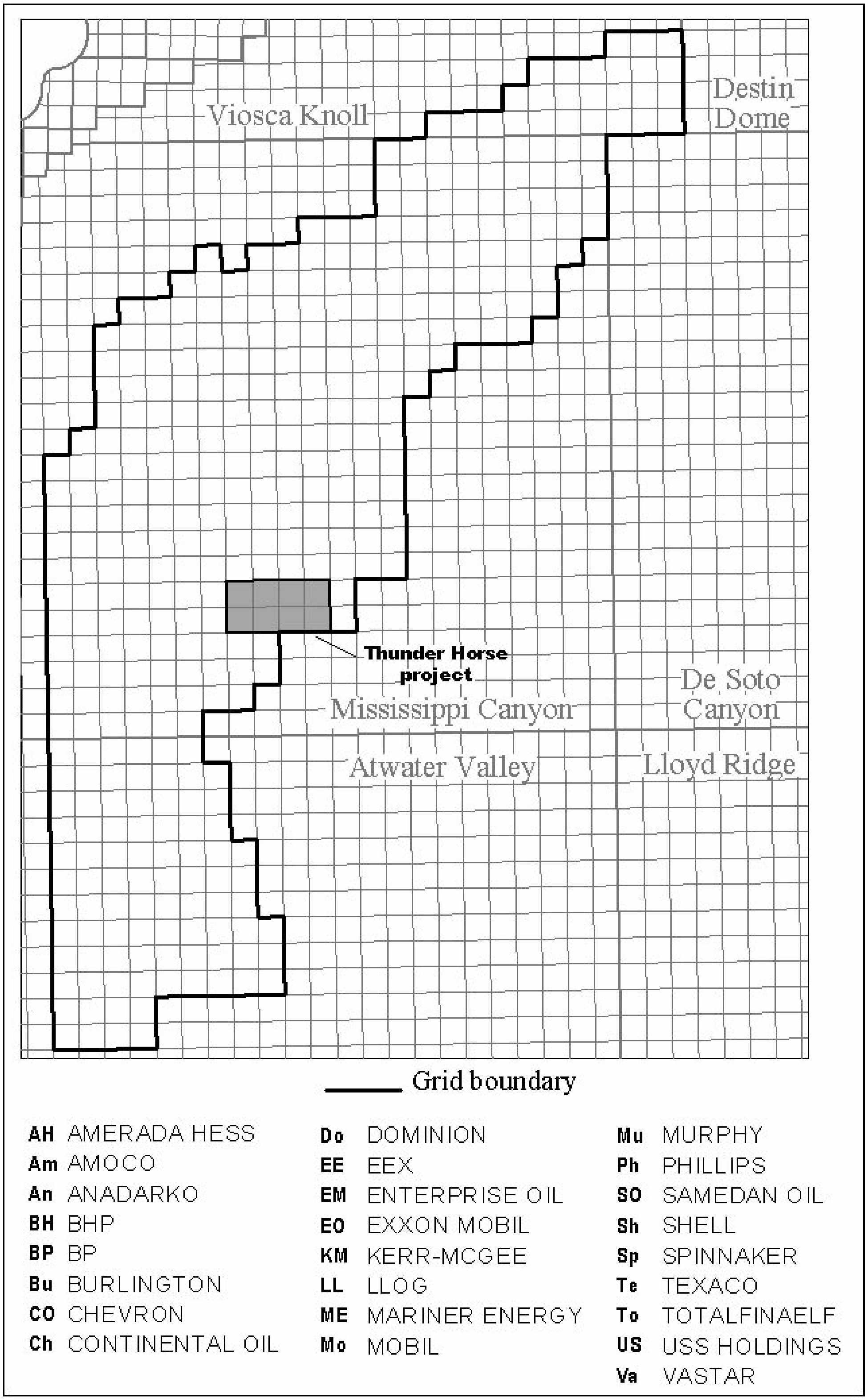

Figure 5. Leasehold Positions within Grid 16.

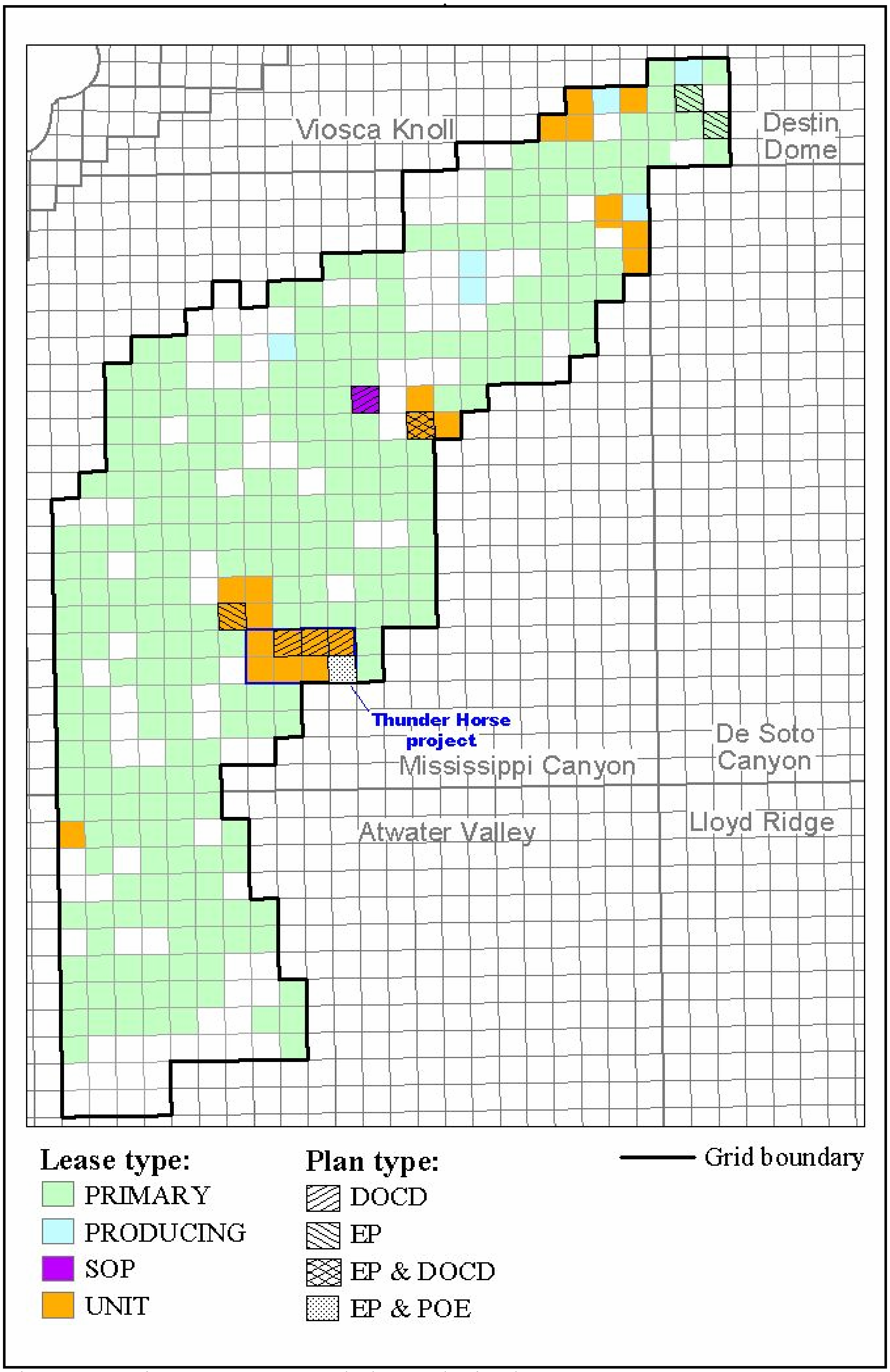

Figure 6. Active Lease Status and Plans Submitted.

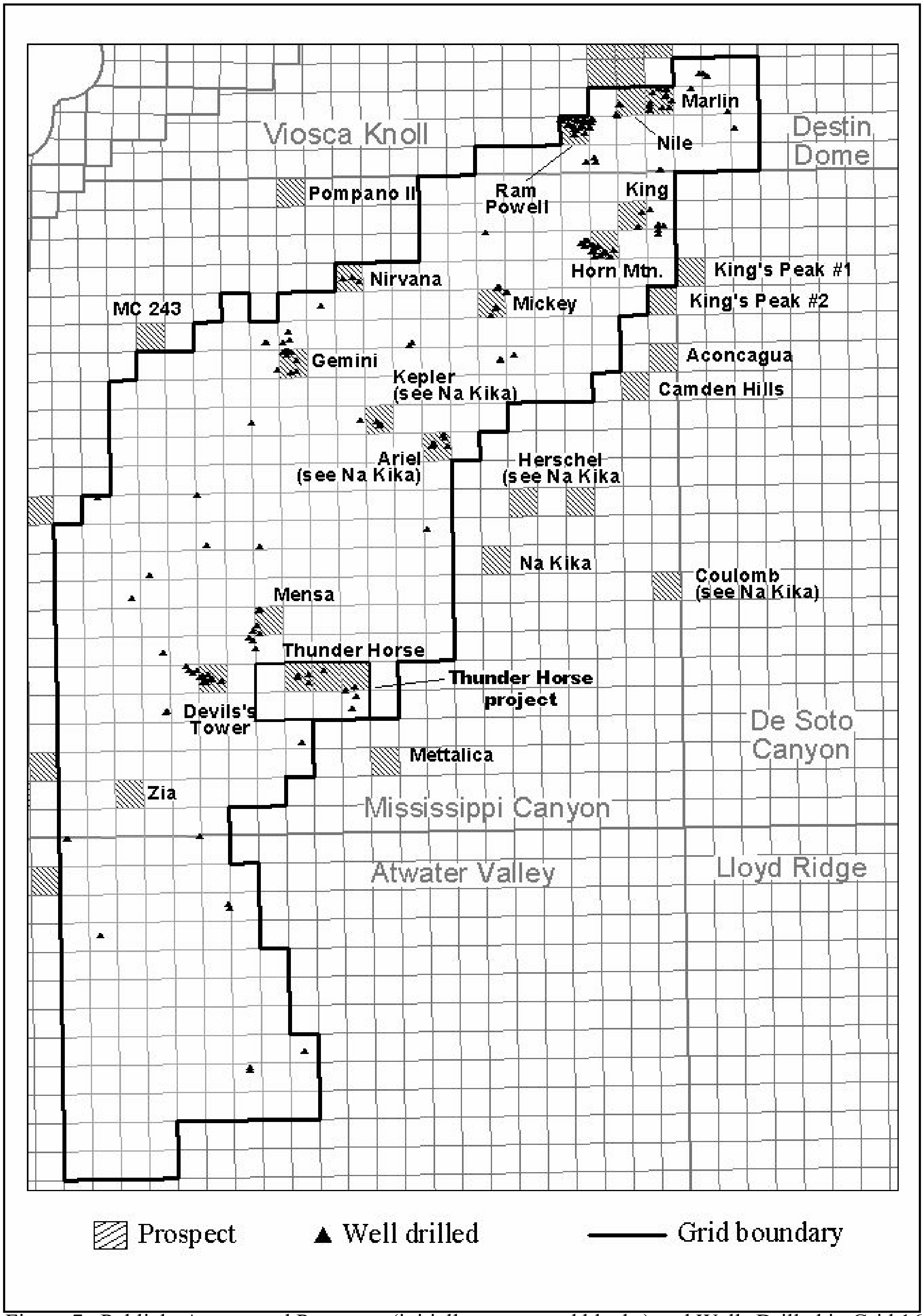

Figure 7. Publicly Announced Prospects (initially announced blocks) and Wells Drilled in Grid 16.

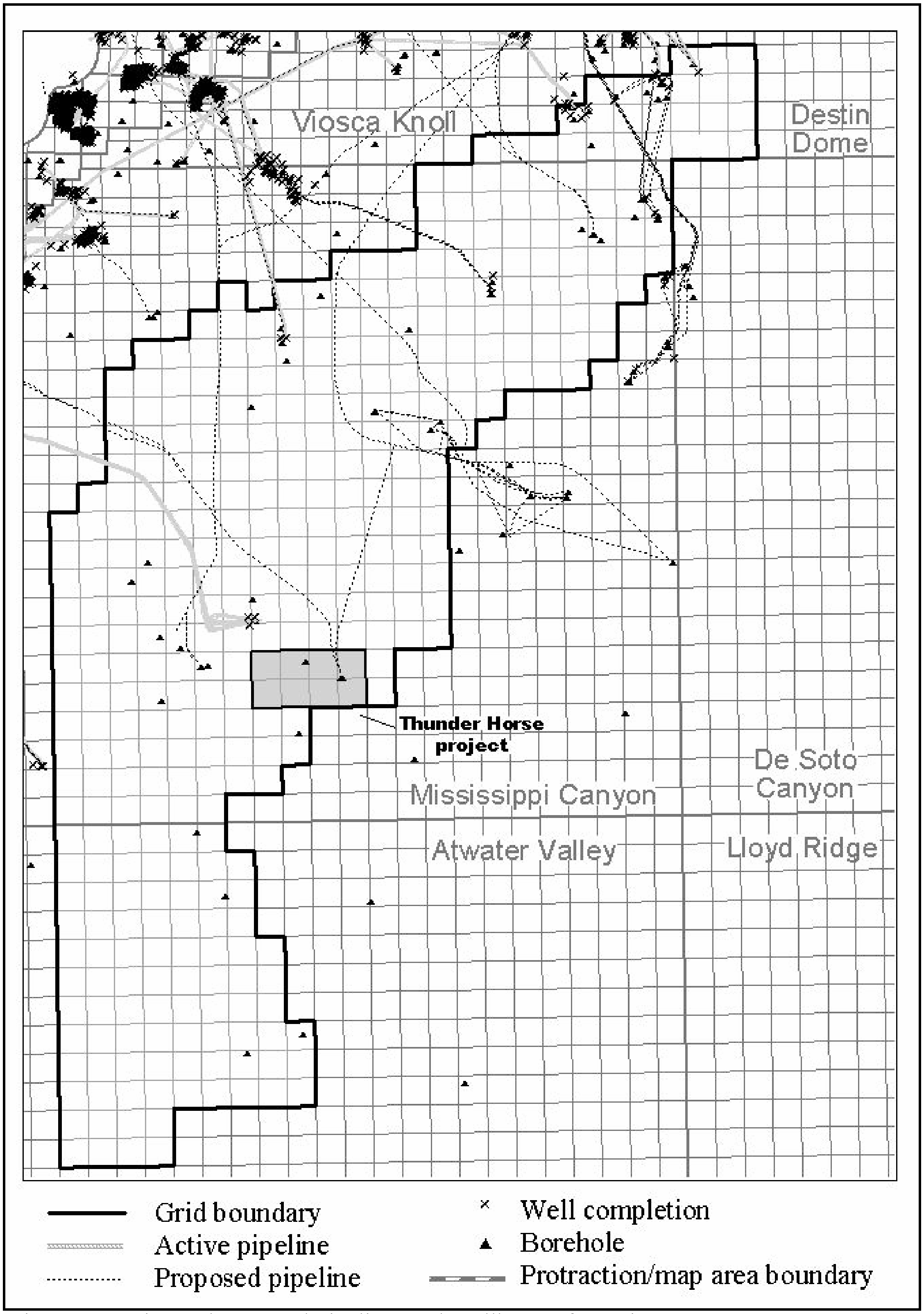

Figure 8. Active and Proposed Pipelines and Wellbore Information.

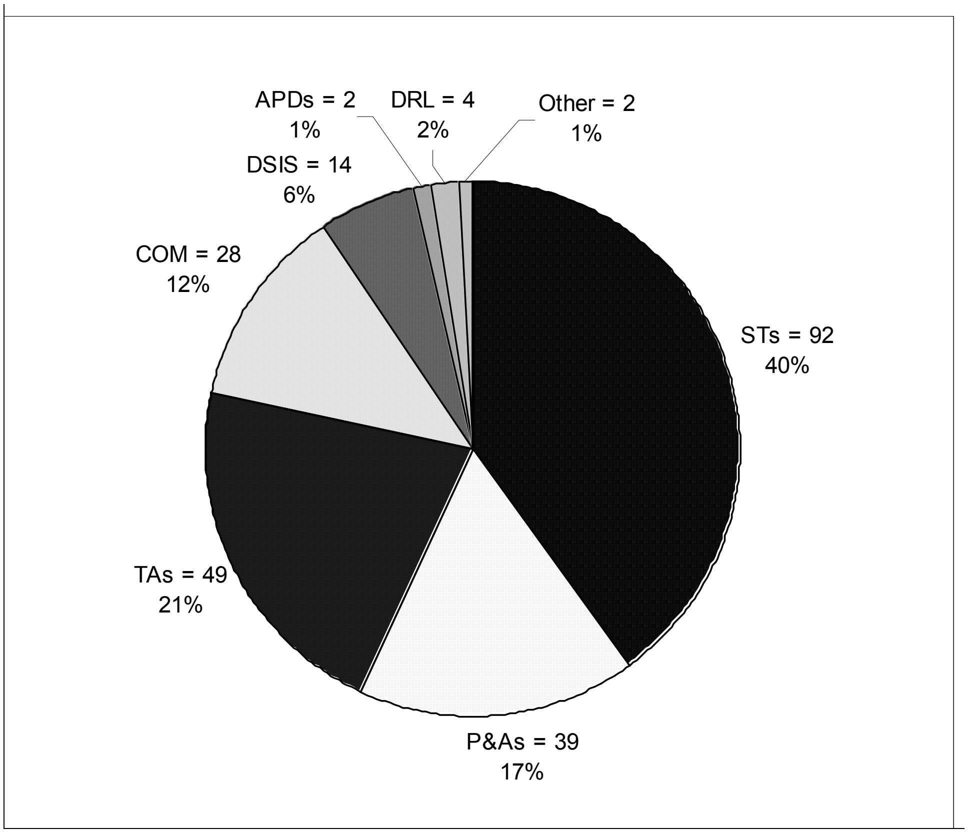

Figure 9. Status of Existing Wells Drilled in Grid 16.

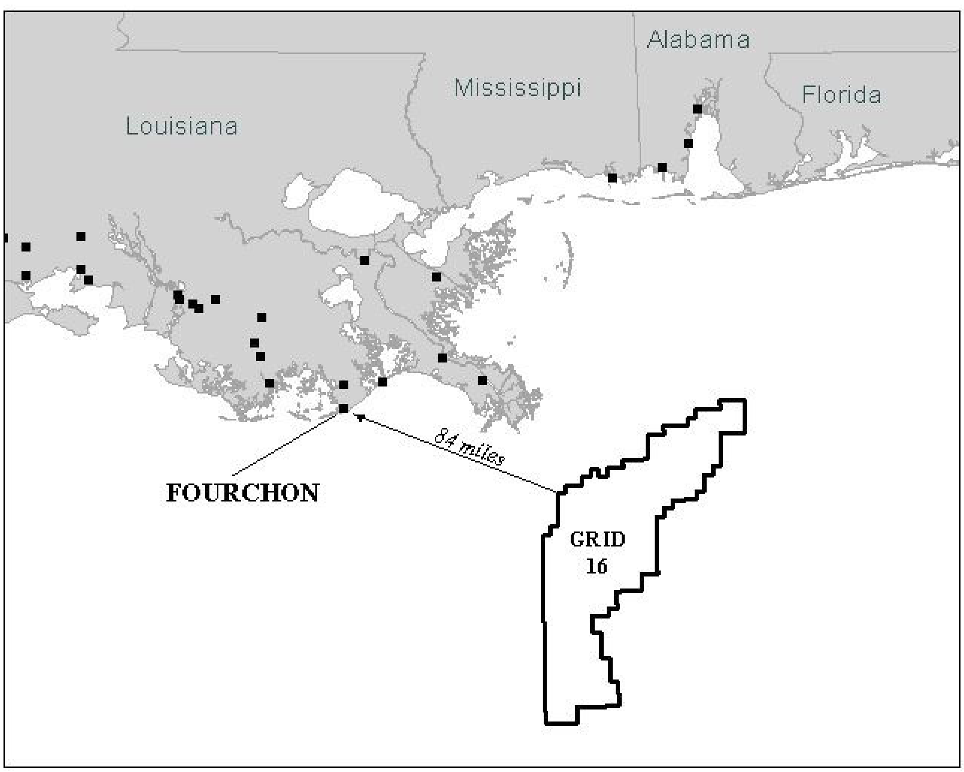

Figure 10. Distance from Grid 16 to BP's Primary Shore Base.

1. THE PROPOSED ACTION

1.1. PURPOSE AND NEED FOR THE PROPOSED ACTION

Under the Outer Continental Shelf Lands Act (OCSLA), as amended, the U.S. Department of the Interior (USDOI or DOI) is required to manage the leasing, exploration, development, and production of oil and gas resources on the Federal OCS. The Secretary of the Interior oversees the OCS oil and gas program and is required to balance orderly resource development with protection of the human, marine, and coastal environments while simultaneously ensuring that the public receives an equitable return for these resources and that free-market competition is maintained.

The purpose of this programmatic environmental assessment (PEA) is two-fold. It assesses the specific and cumulative impacts associated with the proposed action and also provides information on the deepwater area within Grid 16. The document can be used as a basis to allow most subsequent activities proposed in the grid to be processed as categorical exclusion reviews (CER's). However, if it is determined that a subsequent proposal will require preparation of a site-specific environmental assessment (SEA), the PEA provides sufficient information so it can be referenced (tiered) in the SEA. The SEA will be focused on a few key issues. The grid area was determined by the MMS's implementing regulations for the National Environmental Policy Act (NEPA) to be an area of “relatively untested deep water” [516 DM Chapter 6, Appendix 10, C.(10)(1)]. To properly characterize the grid, the PEA captures all of the available environmental and operational information for the area. Chapter 3 describes the environment at the specific site of the proposed activities and in the broader grid area. Analyses within Chapter 4 examine the potential effects of the proposed action and other reasonably foreseeable activities within the grid on the environment in the vicinity of the proposal and on the broader grid area.

BP Exploration and Production, Inc.'s (BP) Initial Unit Development Operations Coordination Document (DOCD) represents an action that cannot be categorically excluded because it represents activities in relatively untested deep water [516 DM Chapter 6, Appendix 10, C.(10)(1)].

This PEA of the Grid implements the "tiering" process outlined in 40 CFR 1502.20, which encourages agencies to tier environmental documents, eliminating repetitive discussions of the same issue. By use of tiering from the most recent Central and Western Planning Area Multisale Final EIS 2002-2007 (USDOI, MMS, 2002) and by summarizing and referencing related environmental documents, this PEA concentrates on environmental effects and issues specific to the proposed action and proposed activities within the Grid.

1.2. DESCRIPTION OF THE PROPOSED ACTION

The Thunder Horse project area is located approximately 251 km (156 mi) southeast of New Orleans and approximately 106-109 km (66-68 mi) from the Louisiana coastline. The project area encompasses the Mississippi Canyon Block 777 Unit, Agreement No. 754398003, and is composed of eight contiguous blocks: Mississippi Canyon, Blocks 775, 776, 777, 778, 819, 820, 821, and 822 (OCS-G 19997, 9866, 9867, 9868, 12168, 14656, 14657, and 14658, respectively). BP holds 75 percent of the working interest in the unit and ExxonMobil owns the remaining 25 percent interest. BP is the designated operator.

A number of Exploration Plans (EP's) have been approved for the unit. These include N-6604, R-3409, R-3652, S-5817, S-5899, and S-5995. These EP's proposed drilling operations for Mississippi Canyon, Blocks 776, 777, 778, and 822.

BP's initial unit DOCD proposes to develop two separate but closely related discoveries in their eight-block unit. Four blocks, Mississippi Canyon, Blocks 777, 778, 821, and 822, hold the first discovery known as "Thunder Horse South." The initial Thunder Horse discovery well, Mississippi Canyon, Block 778, Well No. 1, was temporarily abandoned on June 29, 1999. This well is located in approximately 1,829 m (6,000 ft) of water.

The remaining four blocks in the unit, Mississippi Canyon, Blocks 775, 776, 819, and 820, hold the second discovery known as "Thunder Horse North." Its discovery well, Mississippi Canyon, Block 776, Well No 1, was temporarily abandoned on November 22, 2000. This well is located in approximately 1,646 m (5,400 ft) of water.

Wells for the Thunder Horse project will be located in five major subsea well clusters, with additional satellite subsea production (P) and water injection (WI) wells (Figure 1-1). The well cluster concept will allow one drilling rig located directly above the cluster to reach all wells without relocating the rig. Initial drilling projections include 27 wells (17 P and 10 WI), with the addition of approximately 16 recompletions and 16 sidetracks planned in mid-to-late life of the project.

Of the 27 wells included in the DOCD, 18 are new locations that will be drilled, as well as completed and produced. The remaining nine wells are predrill locations and have been permitted through approved EP's. These wells have either been drilled or will be drilled in 2002 prior to the MMS's final decision on this DOCD.

There are a total of 16 wells proposed for the Thunder Horse South development — 10 production and 6 injection wells. Of these 16 wells, 10 are under the production, drilling, and quarters facility (PDQ) (2 WI, 8 P). The PDQ will be moored directly over the major Thunder Horse South Drill Center (DC) — DC 41, in Mississippi Canyon Block 778. The other DC's of Thunder Horse South are as follows:

- DC 42—satellite WI well
- DC 43—satellite P well (Mississippi Canyon 822#1, Discovery Well)
- DC 44—water injection drill center with three WI wells
- DC 45—satellite P well (Mississippi Canyon 822 #3)

In addition, there are three drill centers proposed for the Thunder Horse North development that will be tied-back to the PDQ. These drill centers contain a total of 11 wells (7 production and 4 injection wells):

- DC 31—drill center with three P and two WI wells
- DC 32—single production well (Mississippi Canyon 776 #1, Discovery Well)
- DC 33—drill center with three P and two WI wells

Many of the 16 recompletions and 16 sidetracks proposed in the DOCD are still notional at this time. For the purposes of evaluating future air emissions, BP included 20 sidetracks/deepening of wells within the DOCD. BP also estimated the timing of these activities in the plan.

Two mobile drilling units (MODU's) are planned for the drilling program prior to initiating hydrocarbon production from the unit. The first is Diamond Offshore's self-propelled, semisubmersible, *Ocean Confidence*. This rig can be either dynamically-positioned or moored. For the 2002 predrill program, this rig will be dynamically positioned. BP's air emission calculations for this DOCD address this fact. For subsequent years, the DOCD assumes that the rig will continue to be dynamically positioned. If BP decides to moor the rig at a later date, they will be required to submit data regarding the areas disturbed by the rig's anchors and that portion of the mooring lines that would lie on the sea bottom. An environmental evaluation of these areas will be required prior to installing the mooring system.

The second MODU is the Transocean Sedco Forex, *Discoverer Enterprise*, a dynamically-positioned drillship. After installation of the PDQ and commencement of production operations, the planned drilling schedule assumes the use of two MODU's and the PDQ's drilling rig (simultaneous drilling and production operations).

BP proposes to install a floating semisubmersible PDQ structure in Mississippi Canyon, Block 778, as the primary development and production facility for its initial field activities. The PDQ facility will be manned and will be permanently anchored on location by a 16-line (4 by 4 spread), semitaut or catenary mooring system composed of conventional 152-mm (6-in) steel spiral strand wire, chain, and suction pile anchors. The mooring lines will be unequally spaced between adjacent groups in order to allow a large subsea corridor for riser connection at the aft end of the PDQ. The lines in each group radiate away from the hull at an angle of about five degrees from one another. The water depth at the PDQ's location is approximately 1,840 m (6,037 ft). Table 1-1 depicts the proposed location for the PDQ semisubmersible.

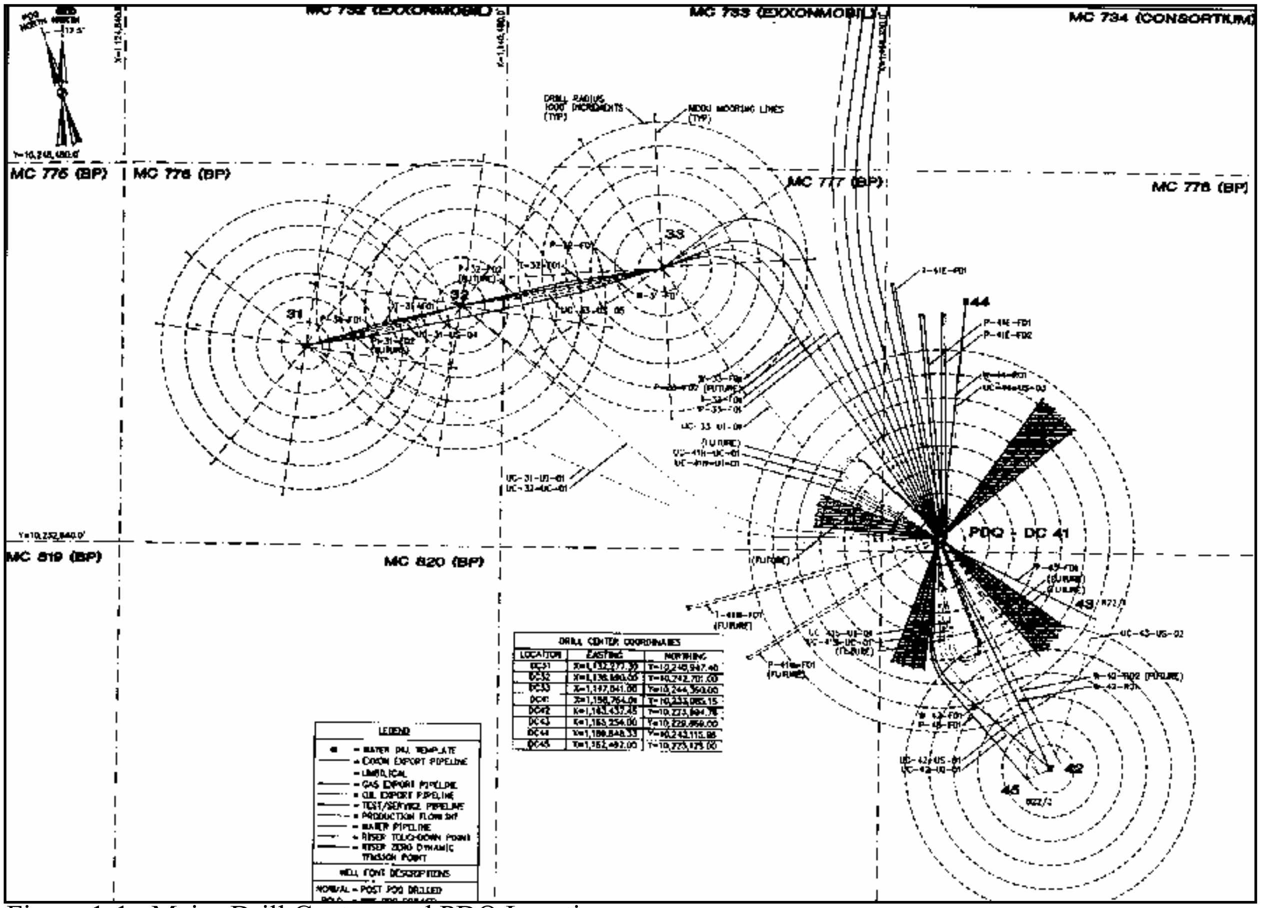

Figure 1-1. Major Drill Centers and PDQ Locations.

Table 1-1

Proposed Location of the Thunder Horse Semisubmersible Production, Drilling, and Quarters Facility in Mississippi Canyon Block 778

Surface Location	Distance from Lease Lines	Lambert X-Y Coordinates	Latitude/Longitude
Semisubmersible Drilling and Production Facility	FWL 2,444 ft FSL 445 ft	X = 1,158,764.01 Y = 10,233,085.15	Lat. 28° 11′ 26.205" N. Long. 88° 29′ 44.318" W.

Note: FWL is from the west line of the lease.
FSL is from the south line of the lease.

The hull of the PDQ will be comprised of four columns, a ring pontoon, and an integrated deck box. The PDQ's deck measures approximately 139 m (455 ft) by approximately 101 m (330 ft). The hull will have a load carrying capacity of approximately 68,000 short tons of combined lightship and variable deck load above the column tops. The hull has been designed to support up to 16 steel catenary risers that will be supported on the forward, starboard, and aft pontoons. Subsea flowlines and pipelines are attached to the aft, starboard, and forward pontoons; umbilicals are connected at the deck box level and hung through guide tubes that extend to the keel level. The upper hull supports the mooring line chain jacks at the structure's columns and four fairleads are located on each column. The PDQ has designed accommodations for up to 188 personnel. The PDQ and associated equipment have a 25-year design life. The PDQ scheduled to be installed with a dynamically positioned derrick barge.

Production from the subsea wells in the drill centers is commingled at a manifold and directed to flowlines that tie back to the PDQ using steel catenary risers. Subsea wells remote to the drill centers are tied back to the PDQ through available slots on the drill center manifold.

Thunder Horse North and Thunder Horse South produce back to the PDQ through separate dual flowlines, which are arranged for round trip pigging from the PDQ. At Thunder Horse North, one of the flowlines is used for well testing and servicing, in addition to production. In Thunder Horse South, a separate test line is run parallel to the production lines and forms a piggable loop with one of the production lines.

The Thunder Horse South base case production system will consists of eight production wells located directly beneath the PDQ at DC 41 and two satellite wells located to the south. The wells at DC 41 are each tied into a 20-slot manifold arrangement, consisting of two, 10-slot manifolds, (DC 41 West, DC 41 East), using a rigid well jumper. The two satellite wells are tied back with single non-piggable flowlines to production slots on the DC 41 manifolds. The manifolds are lined up in series and each has two production headers and a test header. Interconnecting jumpers are used to connect the manifold headers. The production and test flowlines are connected to the manifolds with rigid jumpers.

The Thunder Horse North production system consists of three wells at DC 33, one well at DC 32, and three wells at DC 31. The manifold at each of the Thunder Horse North drill centers has a production header, a test header, and a spare header for possible future production. The dual flowlines from the PDQ manifold connect to the DC 33 manifold headers and run through to pick up the DC 32 manifold in series and then the DC 31 manifold where the lines terminate and are joined with a jumper to enable round trip pigging from the PDQ. The clustered wells are connected to the manifolds with rigid well jumpers.

Valves in the subsea manifolds and trees will be controlled by a redundant multiplexed electro-hydraulic control system connected by an umbilical between the manifold and the PDQ. In addition, dedicated steel tubes will also be used to deliver the following chemicals to injection points on the subsea equipment: corrosion inhibitor, methanol, low-dosage hydrate inhibitor (LDHI), scale inhibitor, and asphaltene inhibitor.

Reservoir management includes pressure maintenance, which is achieved by a water injection system. BP also plans to inject its produced water as a part of these operations.

The Thunder Horse North water injection system consists of a single pipeline supplying water to two water injection wells in the vicinity of DC 33 and two water injection wells in the vicinity of DC 31. Connections are made to the wells by utilizing pipeline end termination sleds (PLET's) with vertical hubs and rigid well jumpers. The Thunder Horse South water injection system consists of two water injection wells directly beneath the PDQ at DC 41, one well at DC 42, and three wells at a dedicated water injection drill center, DC 44, located to the northeast of the PDQ. A single pipeline originating on the PDQ supplies water to the well at DC 42 and the wells at DC 41. The pipeline terminates in a PLET with multiple hubs at DC 42 to feed the DC 42 well with a rigid well jumper and to feed the DC 41 wells through a subsea pipeline from DC 42 to DC 41. The water injection header at DC 41 extends across both of the DC 41 manifolds by means of an interconnecting jumper. The three wells at DC 44 will be supplied water by a single pipeline originating on the PDQ and terminating in a PLET with vertical hubs for rigid well jumper connections.

BP plans to file lease-term pipeline applications for the Thunder Horse flowlines and related subsea architecture around October 2003.

The deepwater development is located approximately 108 km (67 mi) from the nearest Louisiana shoreline. The project will use existing onshore support bases in Fourchon (BP's C-Port Shore Base, primary base) and Venice (back up base), Louisiana, to support the proposed activities [about 195 km and

146 km (121 mi and 91 mi), respectively, to the proposed PDQ location]. Table 1-2 depicts the types of support vessels expected to be used displayed with the corresponding type of operations, and the frequency of trips.

Table 1-2

Type of Support Vessel for Each Type of Operation and Frequency of Trips

Type of Support Vessel	Type of Operations and Frequency of Trips			
	Drilling/ Completion	Facility Installation	Hook-Up/ Commissioning	Production
Workboat	4 weekly			3 weekly
Crew Boat	6 weekly			4 weekly
Manifold Installation		2		
Flowline Installation		1		
Jumper Installation		2		
Installation Support Vessel		1		
Umbilical Installation Support		4		
Large Supply Vessel		13		
Tug Boat		14		
Large Freight Boat		11		
Infield Riser Installation		1		
Dive Support (spool pieces)		2		
Pre-lay PDQ Moorings			2	
PDQ Mooring Hookup			1	

Liquid hydrocarbon production from the Thunder Horse project will depart the PDQ facility in a proposed right-of-way pipeline (ROW G-23429; Segment Number 13633) to be owned and operated by Proteus Oil Pipeline Company, LLC (MMS Qualification Number 2530). The proposed Proteus oil pipeline is a 61-71 cm (24-28 in), bi-directional pipeline that will carry liquid hydrocarbons approximately 111 km (69 mi) from the PDQ facility in Mississippi Canyon, Block 778, to a proposed Platform E in South Pass Area, South Addition, Block 89. The new four-pile, Platform E is proposed to be set as an accessory structure for the Proteus pipeline. The water depth at the platform's location is approximately 120 m (393 ft). The platform will be unmanned. No processing or pumping equipment is currently proposed for the platform.

From Platform E, liquid hydrocarbon production will depart in a proposed right-of-way pipeline (ROW G-23068; Segment Number 13534) to be owned and operated by Endymion Oil Pipeline Company, LLC (MMS Qualification Number 2529). The proposed Endymion Oil Pipeline is a 76-cm (30-in), bi-directional pipeline. It will carry the liquid hydrocarbons approximately 87 km (54 mi) from Platform E to a landfall at the existing BP facilities on Grand Isle, Louisiana, and ultimately terminate at the Louisiana Offshore Oil Port (LOOP) storage facilities near the Clovelly Oil and Gas Field.

Produced natural gas from the Thunder Horse project will depart the PDQ facility in a proposed right-of-way pipeline (ROW G-23428; Segment Number 13632) to be owned and operated by Okeanos Gas Gathering Company, LLC (MMS Qualification Number 2545). The proposed Thunder Horse lateral to the Okeanos Gas Pipeline System will be a 51-cm (20-in), bi-directional pipeline to carry the processed natural gas approximately 40 km (25 mi) from the PDQ facility in Mississippi Canyon, Block 778, through a PLET and jumper located in Mississippi Canyon, Block 428, to the proposed Na Kika gas lateral of the Okeanos Gas Pipeline System.

Earlier in 2002, ExxonMobil was pursuing options for separate oil and gas pipelines to transport its share of the Thunder Horse project's production to existing facilities in the South Pass Area. Recently, ExxonMobil Pipeline Company joined the Mardi Gras Transportation System as an owner in the Proteus and Endymion oil pipelines that will extend from the Thunder Horse facilities to Clovelly, Louisiana. As a result, the Thunder Horse project is currently planning one export oil pipeline (Proteus/Endymion) but continues to consider two gas export pipelines, one for BP's share of natural gas production (to be shipped in the Okeanos pipeline), and the other for ExxonMobil's share of the project's production. The ExxonMobil gas export pipeline is described in the next paragraph.

A 51-cm (20-in) natural gas export pipeline is currently proposed to transport ExxonMobil's "take-in-kind" gas production approximately 161 km (100 mi) from the PDQ facility to a new riser platform near ExxonMobil's existing facilities in West Delta Area, Block 73. Water depth at West Delta Area, Block 73, is approximately 53 m (175 ft). The export natural gas pipeline riser from the PDQ will be a 46-cm (18-in) steel catenary riser (SCR). The route is planned to begin at Mississippi Canyon, Block 778, and proceed northwest to Mississippi Canyon, Block 325, then continue west to West Delta Area, South Addition, Block 144, and finally northwest to West Delta Area, Block 73.

Proposed Activity Schedule

BP's proposed activity schedule for their Thunder Horse project is contained in Appendix A. Exploration and delineation activities are continuing on this project. Predrilling operations using two MODU's began in 2002. The Mississippi Canyon, Block 776, Well No. 2 and the Mississippi Canyon, Block 777, Well No. 1 will be drilled by the *Ocean Confidence* in the Thunder Horse North area. The Mississippi Canyon, Block 778, Well No. 2, batch setting of the Mississippi Canyon, Block 778, Well No. 3 and Mississippi Canyon, Block 778, Well No. 4, as well as the deepening of Mississippi Canyon Block 778, Well No. 3, are also part of the 2002 predrill program. These activities were permitted under existing approved EP's. Some subsea component installation activities (tree installation) are expected to begin in early 2003. It is currently anticipated that the PDQ's moorings will be prelaid in May 2004, immediately followed by installation of manifolds, flowlines, and jumper measurement in June to October 2004. The full PDQ mooring and umbilical installation is expected between November 2004 and March 2005.

New or Unusual Technology

BP has proposed the use of several new or unusual technologies in its DOCD. They are discussed briefly below. See the Environmental Report submitted with BP's DOCD for a full discussion of these technologies (BP, 2001). Each proposed technology was individually evaluated for any potential environmental effects. Engineering review of the new or unusual technologies was also conducted by the MMS in its review of BP's conceptual deepwater operations plan (DWOP).

High-Pressure Water Injection Pumps

The individual pump process conditions for water injection on the Thunder Horse project are 50,000 barrels per day (bpd) at 8,500 psig and 75,000 bpd at 6,500 psig. (Note: Four or more of these pumps will be required, depending on sparing.) These conditions will require the use of a multistage, centrifugal pump design that has not been previously manufactured in this configuration. The development plan includes a plan for design, manufacture, and testing. A one-year period exists in the schedule to design, manufacture, test, and incorporate lessons learned from this prototype into the delivery plan. These pumps will be electrically powered.

Environmental review of the multistage centrifugal pump system determined that it will not interact with the environment any differently than the traditional water flood pumping system. Air emissions were included and considered in the environmental evaluation.

High-Pressure, High-Temperature (HPHT) Flowline and Riser Design

The wells for the Thunder Horse project will be drilled from a number of discrete locations or drilling centers, where production will be commingled at a manifold and then connected by a flowline and steel catenary riser system to the PDQ platform. Key components of this system, from a technology standpoint, will include the flowline connectors, the flowline and coating, flowline insulation, and finally, the steel catenary riser configuration. Flow assurance studies and PDQ size/weight considerations have indicated that the peak fluid flowrate can be met by a combination of 305-mm (12-in) and 254-mm (10-in) diameter flowlines, and 203-mm (8-in) diameter service and test lines. Using high strength steel, the wall thicknesses for the design pressures will be between 30 and 40 mm. These sizes are at or beyond the current industry production experience for high strength, steel. However, BP has successfully made test joints of pipe with one supplier. Manufacturing capacity and technology issues for both the riser and flowline pipe are still under review. Operating temperatures in the pipelines may be as high as 270^o F, but insulation will be required on the lines to allow operator intervention time to depressurize and stabilize the system before the contents cool to the hydrate formation temperature of 80^o F. The coating system will be selected to give thermal performance and withstand installation, pressure and thermal cycling, and hydrostatic loads. A development program is ongoing to prove the chosen insulation system.

Thermal Cycling

Flowlines are being designed to withstand the number of heating and cooling cycles anticipated over the project's design life of 25 years, including an adequate margin of safety on the number of cycles. Designing properly for good fatigue performance eliminates any spill risk associated with thermal cycling.

End Expansion

Flowlines are designed to expand at the ends. This expansion is to be accommodated by PLET's that slide and steel flowline jumpers and connectors designed to absorb the flowline expansions and reaction loads, respectively. Jumpers and connectors are being designed to accommodate cyclic fatigue and high reaction loads to eliminate leakage potential.

Lateral Deflections

Some longer flowlines will build up significant mid-line compressive loads that may lead to lateral deflections. These lateral deflections will relieve local axial compressive loads (e.g., the flowline wants to expand, and the only way this can happen in the middle of a flowline is via lateral deflections). Although these lateral deflections are difficult to predict, BP has conducted extensive soil test results to better understand the soil resistance to axial and lateral flowline movement. These data are entered into finite-element computer models, and other analytical models, to better predict flowline deflection behavior and resulting stresses. There is no buckling of the cross-section, thus no issues with leakage from this type of buckle.

Flowline Creep

This is more commonly known as "flowline walking" and is associated with transients in the thermal cycling process. BP is currently investigating this phenomenon and will apply corrective measures if it is shown to be a problem.

HPHT Riser Connections

Due to water depth, large riser size, and HPHT (see section above) characteristics of the anticipated production, hard pipe steel catenary risers will be required to terminate subsea flowlines onboard the PDQ semisubmersible floating unit. The attachment of these steel risers to the semisubmersible requires an accommodation of dynamic angular motion and/or steady trim/list of the unit. This is conventionally done onboard tension leg (TLP) platforms and spars in the Gulf of Mexico via elastomeric and steel (laminated) flex-joints. However, the proposed application requires an extension of both angular capability and HPHT conditions versus previous TLP and spar experience. An experienced supplier has been selected to develop the Thunder Horse flex joints. Testing of a full-scale prototype to confirm the design is planned before manufacturing the production units.

Environmental reviews of the above HPHT flowline and riser design, its operational implications, and riser connection proposals determined that use of these technologies will not constitute additional risks to the environment compared to available "conventional" technologies.

Intelligent Wells Interface

Different fiber optic measurement systems may be deployed down-hole at some of the proposed production wells. The systems may include pressure and temperature, replacing the conventional electronic downhole pressure and temperature gauges (DHPTG) and distributed temperature sensor (DTS). Water injection wells will have DTS sensors only. The proposed development project will be the first application utilizing fiber optic, downhole instrumentation sensors within subsea wells tied back to the host facility via the subsea control system. Novel technologies include the fiber optic tubing hanger connector, the connection system through the subsea tree and the fiber optic subsea distribution system. The regulations of 30 CFR 250.122 require the use of Best Available and Safest technologies (BAST). The fiber optic downhole technology is passive and inherently more reliable in the high temperature environment than conventional electronics and, therefore, exceeds BAST standards. The sensors are required to operate for the life of field. The project has already initiated a development and qualification program. The program will deliver a fiber optic connection system between the downhole cables through the tubing hanger to a tree-mounted connector.

The use of fiber optic systems may actually improve downhole measurements considering the HPHT conditions expected in the production wells. Intelligent well interface technology is not expected to interface with the environment any differently than conventional technology and may prove to be more reliable.

Expandable Sand Screens (ESS) and Solid Expandable Pipe

ESS has been chosen as the primary method of downhole sand control for the Thunder Horse North wells. The ability to effectively shutoff water in a sand control environment, achieve the well potentials, and simplify the completion operations has driven the choice of ESS over conventional sand control methods. This is a new technology which has so far had limited application in the GOM but has been run in other areas of the world. BP is committed to the development of this technology along with solid expandable pipe and has set up a centrally funded project that is working with the Thunder Horse team to develop these products within our development timeframe. It is BP's intention to ensure that ESS is qualified for Thunder Horse conditions and extensively field tried prior to installation at the project. Solid expandable pipe is being evaluated as an option to run in conjunction with ESS to assist water shutoff and also as a contingency casing and replacement for liner hangers during drilling operations.

An environmental evaluation of the EES and solid expandable pipe technologies determined that these new technologies should not interface with the environment any differently than the corresponding conventional technologies. In fact, enhanced sand control would minimize sand disposal onshore (overboard disposal of sand is not allowed by the USEPA).

2. ALTERNATIVES TO THE PROPOSED ACTION

2.1. NONAPPROVAL OF THE PROPOSAL

BP would not be allowed to drill, complete, and produce the 27 wells proposed in its Initial Unit DOCD. This alternative would result in no impact from the proposed action but could discourage the development of much needed hydrocarbon resources, and thereby result in a loss of royalty income for the United States and energy for America. Considering these aspects and the fact that we anticipate minor environmental and human effects resulting from the proposed action, this alternative was not selected for further analysis.

2.2. APPROVAL OF THE PROPOSAL WITH EXISTING AND/OR ADDED MITIGATION

Measures that BP proposes to implement to limit potential environmental effects are discussed in their Initial Unit DOCD and throughout this PEA. The MMS's lease stipulations, Outer Continental Shelf Operating Regulations, Notices to Lessees and Operators, and other regulations and laws were identified throughout this environmental assessment as existing mitigation to minimize potential environmental effects associated with the proposed action. Additional information on these measures can be found in the Final Multisale EIS (USDOI, MMS, 2002). This alternative was selected for evaluation in this PEA.

2.2.1. Mitigative Measures Identified in the PEA

Mitigation 2.02 (Advisory) – Potential to exceed exemption level, DOCD

A deviation from your DOCD (such as additional drilling time, changes in the drilling schedule, and/or the use of higher horsepower equipment, especially for the drilling rig and construction barges) could potentially cause the annual emissions exemption level for NO_X to be exceeded. Therefore, if such a deviation occurs, please be advised that you will immediately prepare a revised DOCD pursuant to 30 CFR 250.204(q)(2) to include the recalculated emission amounts and the air quality modeling required by 30 CFR 250.303(e). You will not proceed with the actions that could cause the potential exceedance until the revised DOCD has been submitted to and approved by this office.

Mitigation 2.05 (Advisory) – Fuel usage or run time documentation

The projected NO_X emissions amounts in your plan were calculated using historic fuel consumption rates. Therefore, please be advised that you will maintain records of the total monthly fuel consumption for the drilling rig and provide the information to this office upon request.

Mitigation 2.06 (Reminder) – Flaring beyond 48 hours

Your plan indicates well test flaring for more than 48 continuous hours. Please be reminded that 30 CFR 250.1105(a)(3) requires you to obtain approval from the Regional Supervisor for Production and Development prior to conducting the proposed flaring activities.

2.2.2. Mitigation Proposed by the Operator

BP will comply with the military stipulations on its leases by contacting the headquarters of Eglin Air Force Base to enter into an agreement concerning the control of electromagnetic emissions and the use of boats and aircraft in the warning areas (BP, 2002).

BP's corporate headquarters mandates that their new projects will use the best available technology for handling operational discharges. In addition, BP operates it facilities under an environmental management system and they are ISO 14001 certified.

In order to meet the power requirements and minimize potential emissions, the Thunder Horse project has optimized energy efficiency in equipment design and selection. BP has conducted an extensive energy efficiency study to ensure that the facilities at the Thunder Horse project have the least emissions considering cost, weight, and space.

BP conducted a "driver study" to select the optimum combination of engine driven equipment versus electric motor driven equipment. The scope of this study included life cycle costs, including capital cost, fuel cost, operating cost, and maintenance cost, in addition to total emissions for life of the project. BP selected the "all electric" option in the study. Under this option, the larger loads, such as compressors and water injection pumps, are driven by electric motors. While mechanical drive turbines have historically driven these large loads in the Gulf of Mexico, the "all electric" option minimizes NO_X, as well as CO_2 emissions (which is a BP internal goal tied to Greenhouse Gas Reductions) and still provides needed operational flexibility and equipment efficiency. The "all electric" option created the least emissions in the appropriate load profile cases.

BP also intends to minimize the environmental effects from their Thunder Horse project by:

- eliminating all routine flaring through engineering design or through operational controls;
- eliminating venting through the use of vapor recovery units (VRU's);
- capturing emissions from the glycol de-hydrator by VRU's;

- reducing fugitive emissions by engineering design and incorporating BP's "no leaks" initiative;
- minimizing waste for land disposal; and
- using low sulfur diesel for the drilling rig and separate diesel powered engines (cranes) or for emergency and essential generators.

At this time, BP proposes to discharge its drill cuttings overboard if the retention on cuttings (ROC) concentrations of SBM is less than 6.9 percent. BP intents to reduce or eliminate these discharges as technology improves.

The Thunder Horse project will co-mingle and re-inject produced water to support pressure maintenance for the reservoir. The option of overboard discharge of produced water per NPDES general permit requirements will be retained as a contingency.

BP engineers have selected five LM 2500 gas turbines to deliver the 93 mw power load requirements of the Thunder Horse project. These turbines will supply electric power for the "all electric" option for compression, water injection pumps, and export pipeline pumps that will all use VFD's to enhance performance and efficiency.

Process heating will utilize waste heat recovery to eliminate the need for fired heaters on the facility.

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1. Physical Elements of the Environment

3.1.1. Water Quality

3.1.1.1. Coastal Waters

Coastal water quality along the north-central Gulf is addressed here because Grid 16 and the Thunder Horse project are located off the mouth of the Mississippi River and because accidental spills could make landfall in this region. The service bases for development of Grid 16 are located on or near the coast, and marine transportation to and from the grid would traverse coastal waters.

The bays, estuaries, and nearshore coastal waters of the north-central Gulf are highly important in that they provide important feeding, breeding, and/or nursery habitat for many commercially important invertebrates and fishes, as well as sea turtles, birds, and mammals. Water quality governs the suitability of these waters for animal as well as human use. Furthermore, the egg, larval, and juvenile stages of marine biota dependent upon these coastal areas are typically more sensitive to water quality degradation than adult stages. The quality of coastal waters is, therefore, an important issue. A comprehensive assessment of water quality in the coastal areas of the GOM is contained in the USEPA's estuarine report (1999b).

More than 30 percent of the estuaries along the north-central Gulf have impaired water quality to the point that they cannot support beneficial uses such as aquatic life support or recreational and commercial fisheries (USEPA, 1999b). Some of the industries and activities contributing to water quality degradation include petrochemical, agricultural, power production, pulp and paper, fish processing, municipal waste, shipping, and dredging operations. There are over 3,700 known point sources of contamination that flow into the Gulf (Weber et al., 1992 in USDOI, MMS, 1997a; USDOI, MMS, 2000) with municipalities, refineries, and petrochemical plants accounting for the majority of these point sources. Vessels from the shipping and fishing industries, as well as recreational boaters, add contaminants to coastal water in the form of bilge water, waste, spills, and leaching from antifouling paints. Many millions of cubic feet of sediments are moved each year in coastal areas due to channelization, dredging, dredged material disposal, and shoreline modification in support of shipping, oil and gas operations, and other coastal activities. Water quality may be affected by these activities as they can facilitate saltwater intrusion, increased turbidity, and release of contaminants. Point-source discharges are regulated by governmental entities and water quality is expected to improve.

Nonpoint sources of contamination from forestry, agriculture, and urban runoff are difficult to regulate and probably have the greatest impact on coastal water quality. Inland cities, farms, ranches, and various industries drain into waterways that empty into the Gulf. About 80 percent of U.S. croplands are upstream of the northern Gulf coastal waters. The Gulf coastal area alone used 10 million pounds of pesticides in 1987 (USDOC, NOAA, 1992 cited in USDOI, MMS, 1997a). Nutrient enrichment from nitrogen and phosphorus compounds, mostly from river runoff, is another major contributing factor to the water quality problem. It can lead to noxious algal blooms, reduced seagrasses, fish kills, and oxygen depletion. It is estimated that the Mississippi River alone contributes more than 341,000 pounds of phosphorus and 1.68 million pounds of nitrogen to the Gulf per day (USDOI, MMS, 1997a; USDOI, MMS, 2000).

Water quality in coastal waters of the northern GOM is highly influenced by season. For example, salinity in open water near the coast may vary between 29 and 32 ppt during fall and winter but decline to 20 ppt during spring and summer due to increased runoff (USDOI, MMS, 2000). Oxygen and nutrient concentrations also vary seasonally.

Biological indicators of poor coastal water quality are evident in that 50 percent of the largest U.S. fish kills between 1980 and 1989 occurred in Texas and 50 percent of shellfish beds in Louisiana are closed annually because of contamination (USDOC, NOAA, 1992 cited in USDOI, MMS, 1997a; USDOI, MMS 2000). Despite the fact that the Gulf States had a number of "hot spots" for certain locations and contaminants, the area did not fare that badly when compared to other U.S. coastal waters as characterized in NOAA's National Status and Trends Mussel Watch Program (USDOI, MMS, 2001b).

Sediment contamination in U.S. coastal waters is highly related to proximity to large industrialized cities. High levels for certain contaminants have been reported for all Gulf States waters (O'Connor and Beliaeff, 1995). At least some contaminants are bioavailable, as evidenced by the 1986-1999 Mussel Watch Program (USDOI, MMS, 2001b). Cadmium, copper, and zinc increases have been noted in mollusks at eight sites between Pascagoula Bay, Mississippi, and the Mississippi River. Since these sites are in or west of the mouth of the Mississippi River, the trend is attributed to increased discharges of those metals from the river (USDOC, NOAA, 1998).

3.1.1.2. Offshore Waters

Offshore marine waters in the GOM are characterized by higher salinity (36.0-36.5 ppt) than nearshore coastal waters (USDOI, MMS, 1997a; USDOI, MMS, 2000). The five watermasses identified in Appendix G (Physical Oceanography) can be recognized by their chemical characteristics such as salinity, dissolved oxygen (DO), nitrate, phosphate, and silicate. The Mississippi River exerts considerable influence on the Gulf, including the offshore.

The depth distribution of nutrients and DO in the deep water of the Gulf is similar to that of the Atlantic Ocean. The DO is highest at the surface due to photosynthesis and exchange with the atmosphere, and it generally decreases with depth due to respiration by various organisms (including bacteria), although higher oxygen concentrations may be encountered in cold watermasses. Nutrient concentrations are lowest in the upper water layers where they become depleted by photosynthetic activity and are highest in deep water. Usually nutrient and oxygen concentrations in the open water of the deep Gulf are not measurably affected by anthropogenic inputs.

Two water quality phenomena occur in the Gulf: (1) development of a nepheloid layer and (2) development of a hypoxic or oxygen-depleted zone. Portions of the Gulf experience a nepheloid layer; a thin, near-bottom, highly turbid zone that may play a role in transporting material, including contaminants, from nearshore to offshore waters. Hypoxic bottom waters may be present in the northern Gulf off the mouth of the Mississippi River. This hypoxic area may be very large (16,500 km^2), ranging from the river delta to Freeport, Texas, and is probably exacerbated by human inputs (USDOI, MMS, 1997a; USDOI, MMS, 2002). Near-hypoxic conditions, unrelated to the river plume, may also be observed in the oceanic oxygen minimum at depths between 200-400 m (656-1312 ft); these conditions are low enough (2.5-3.0 mg/l) to affect the biota (USDOI, MMS, 2000).

Generally, the water quality in the offshore areas of the Gulf, particularly over deep water, could be considered significantly better than that of the coastal waters (USDOI, MMS, 1997a and USDOI, MMS, 2002). However, petroleum-related volatile organic carbons have been detected at offshore locations. Offshore Texas, Louisiana, and Alabama show detectable levels of petroleum hydrocarbons, likely from natural seeps (USDOI, MMS, 1997a and USDOI, MMS, 2000). Similarly, trace metal concentrations are low relative compared to coastal waters (Boyle et al., 1984 in USDOI, MMS, 1997a; USDOI, MMS, 2000).

Recent research found that the concentration of hydrocarbons in slope sediments (except in seep areas) was lower than previous reports for shelf and coastal sediments. No consistent decrease with increasing water depth was apparent below 300 m (984 ft) (Gallaway et al., 2002). In general, the Central Gulf had higher levels of hydrocarbons, particularly those from terrestrial sources, than the Western and Eastern Gulf (Gallaway and Kennicutt, 1988). Total organic carbon was also highest in the Central Gulf. Hydrocarbons in sediments have been determined to influence biological communities of the Gulf slope, even when present in trace amount (Gallaway and Kennicutt, 1988).

Deepwater sediments, with the exception of barium concentrations in the vicinity of previous drilling activity, do not appear to contain elevated levels of metal contaminants (USDOI, MMS, 1997a; USDOI, MMS, 2000). Reported total hydrocarbons, including biogenic (e.g., from plankton and other biological sources) hydrocarbons, in sediments collected from the Gulf slope range from 5 to 86 ng/g (Kennicutt et al., 1987 in USDOI, MMS, 1997a; USDOI, MMS, 2000). Petroleum hydrocarbons, including aromatic hydrocarbons (<5 ppb), were present at all sites sampled, apparently varying more by distance along an isopleth than by depth (one transect from 300 to 3,000 m, 984 to 9,843 ft) (Gallaway et al., 2002; USDOI, MMS, 1997a). Land-derived material is widespread in the Gulf due to large riverine inputs and transport across the shelf to the slope by slumping, slope failure (Gallaway et al., 2002), and other processes. Natural seepage is considered to be a major source of petroleum hydrocarbons in the Gulf slope area (Kennicutt et al., 1987; Gallaway et al., 2002; USDOI, MMS, 1997a; USDOI, MMS, 2000).

3.1.2. Air Quality

Grid 16 is located west of 87.5° W. longitude and hence falls under the MMS's jurisdiction for enforcement of the Clean Air Act. The air over the OCS water is not classified, but it is presumed to be better than the National Ambient Air Quality Standards (NAAQS) for all criteria pollutants. The blocks involved with the Thunder Horse project in OCS waters are located southeast of Plaquemines Parish, Louisiana. Plaquemines Parish is an area that is in attainment of all of the NAAQS and for PSD purposes is classified as a Class II area.

The influence to onshore air quality is dependent upon meteorological conditions and air pollution emitted from operational activities. The pertinent meteorological conditions regarding air quality are the wind speed and direction, the atmospheric stability, and the mixing height (which govern the dispersion and transport of emissions). The typical synoptic wind flow for the Grid 16 area is driven by the clockwise circulation around the Bermuda High, resulting in a prevailing southeasterly to southerly flow, which is conducive to transporting emissions toward shore. However, superimposed upon this synoptic circulation are smaller meso-scale wind flow patterns, such as the land/sea breeze phenomenon. In addition, there are other synoptic scale patterns that occur periodically, namely tropical cyclones, and mid-latitude frontal systems. Because of the routine occurrence of these various conditions, the winds blow from all directions in the area of concern (USDOI, MMS, 1988).

Atmospheric stability is typically expressed by using Pasquill-Gifford stability classes. Not all of the Pasquill-Gifford stability classes are routinely found in the offshore GOM. Specifically, the “F” stability class is rare. The “F” stability class is characterized by the extremely Hcondition (i.e., a strong radiative inversion) that usually develops at night, over land, with rapid radiative cooling of the ground surface and the air directly above it. This type of atmospheric stability strongly limits the vertical dispersion of emitted air pollutants. The large heat capacity of the GOM is simply incapable of loosing enough heat overnight to set up a strong radiative inversion. Likewise, the “A” stability class is also rare. This stability class is characterized by the extremely unstable condition that develops over land with very rapid warming of the ground surface and the air directly above it and the occurrence of colder air aloft. This type of atmospheric stability strongly enhances the vertical dispersion of air pollutants. Once again, the large heat capacity of the GOM does not allow for the ocean surface warming rapidly. Therefore, the most common stability classes over the GOM are slightly unstable to neutral, which are conducive to only a moderate amount of buoyant vertical dispersion.

The mixing height is a measure of the upward extent for the vertical dispersion of emitted air pollutants. Offshore mixing heights are rather shallow, generally less than 1,000 m (3,281 ft), as compared to onshore mixing heights, which are typically greater than 2,000 m (6,362 ft) during the day. Close to shore, the mixing height over the water increases notably from the typical offshore level, due to the water being shallower and the influence of the land, which penetrates out over the water for a short distance. Thus, with a typical southeasterly to southerly wind flow, which is conducive to transporting emissions toward shore, the extent of the vertical dispersion will increase as the shoreline is approached. This has the effect of lowering the resultant air pollutant concentration arising from emissions. The composite of these meteorological conditions that influence the dispersion and transport of emissions is represented by an exemption level, which can be compared to the projected air pollutant emissions for a proposed action.

Appendix I contains air emissions data for the proposed action. Please refer to this appendix for Tables depicting each drill center's projected emissions and the MMS's corresponding exemption levels.

3.2 Biological Resources

3.2.1. Sensitive Coastal Environments

3.2.1.1. Coastal Barrier Beaches and Associated Dunes

General information on the types and status of coastal landforms in the Central and Western Gulf is contained in USDOI, MMS (2001b). The brief description below is a summary of the coastal barrier beaches and associated dunes information contained in that document.

Barrier landforms include islands, spits, dunes, and beaches. The landforms are usually long and narrow in shape, having been formed by sediment transported by rivers, waves, currents, storm surges, and winds. Barrier landforms are in a state of constant change and they can be classified into two main types:

(1) Transgressive—where the shoreline is moving inland and marine deposits overlay terrestrial ones. This type is usually rapidly eroding, low profile, sparsely vegetated, with numerous washover channels, or

(2) Regressive—where the shoreline is moving seaward and terrestrial sediments are becoming overlain over the marine ones. This type is higher profile, well-vegetated dunes, with few if any washover channels (USDOI, MMS, 2001a).

Both types are important ecologically. Barrier islands, particularly vegetated ones with fresh- and/or saltwater pools, may serve as habitat for a variety of fairly specialized species, including birds. The islands and spits protect the bays, lagoons, estuaries, salt marshes, seagrass beds, and other wetlands, some of which may contain threatened or endangered species.

3.2.1.2. Wetlands

Wetlands are common along the Gulf Coast, especially along coastal Louisiana. They include seagrass meadows, mudflats, mangroves, marshes (fresh, brackish, salt), and hardwood and cypress-tupelogum swamps. These areas may occur in isolated pockets, narrow bands, or cover large areas of the coast (USDOI, MMS, 2001a).

High productivity, high detritus input, and extensive nutrient recycling characterize coastal wetlands. They are important habitats for a large number of invertebrate, fish, reptile, bird, and mammal species, including rare, endangered, or threatened species, and high value commercial and recreational species for at least part of their life cycles. Since the 1980's, wetland areas have declined significantly (USDOI, MMS, 2001a). For these reasons, wetlands are an important issue when assessing impacts of coastal developments and/or accidental spills (in situations where spills may impinge on the coast).

The GOM coastal wetlands represent about half of the Nation's total wetland area. These wetlands help support the exceptionally productive coastal fisheries (e.g., Gulf ports account for four of the top five ports in the U.S. in terms of landed weight) and about 75 percent of the migratory waterfowl traversing the country (Johnston et al., 1995). NOAA data (1991) and Johnston et al. (1995) estimated that, although wetlands have decreased substantially over the last 30 years, about 1.3 million ha of marshes, estuarine shrub-scrub, and freshwater forested/shrub-scrub remain on the Gulf Coast. Of these three categories, 80 percent is marsh, 19 percent is estuarine scrub-shrub, and 1 percent is forested wetland. Louisiana has the greatest area with 55 percent of the total (representing 69% of total marsh) followed by Florida (18%) (including 97% of total scrub-shrub, mostly mangrove), Texas (14%), and Mississippi (2%) (Johnston et al., 1995).

The National Biological Service (NBS) provides more recent calculations of wetland losses than the NOAA data, with updates every three years based on satellite imagery. The NBS suggests that wetland losses are greater than previously thought, although the rate of loss appears to be declining (Johnston et al., 1995).

3.2.1.3. Seagrasses

Seagrass communities are extremely productive, providing essential habitat for wintering waterfowl, as well as spawning and feeding habitat for several commercial and recreational species of fish and shellfish, and endangered or threatened species of manatee and sea turtles. Seagrass habitat loss in the Gulf has been extensive over the last 50 years. Although found in isolated patches and narrow bands along the entire Gulf Coast in shallow, clear, estuarine areas, seagrass meadows occur extensively along the eastern coast between Mobile Bay and Florida Bay. Florida contains about 693,000 ha of the 1.02 million ha estimated for all the Gulf States (Handley, 1995). Louisiana has a large amount of submerged vegetation but only a small area of seagrass habitat (about 5,657 ha in 1988) (Handley, 1995).

3.2.2. Deepwater Benthic Communities/Organisms

Marine benthic communities consist of a wide variety of single-celled organisms, plants, invertebrates, and fish. Their lifestyles are extremely varied as well and can include absorption of dissolved organic material, symbiosis (e.g., chemosynthetic communities), collection of food through filtering, mucous webs, seizing, or other mechanisms.

3.2.2.1. Chemosynthetic Communities

Chemosynthetic communities are defined as persistent, largely sessile assemblages of marine organisms dependent upon symbiotic chemosynthetic bacteria as their primary food source (MacDonald, 1992). Chemosynthetic clams, mussels, and tube worms are similar to (but not identical with) the hydrothermal vent communities of the eastern Pacific (Corliss et al., 1979). Chemosynthetic communities were discovered in association with hydrocarbon seeps in the northern GOM. Bacteria live within specialized cells in these invertebrate organisms and are supplied with oxygen and chemosynthetic compounds by the host via specialized blood chemistry (Fisher, 1990). The host, in turn, lives off the organic products subsequently released by the chemosynthetic bacteria and may even feed on the bacteria themselves. Free-living chemosynthetic bacteria may also live in the substrate within the invertebrate communities and may compete with their symbionts for sulfide and methane energy sources.

Initial discoveries of cold-water seep communities indicated that they are primarily associated with hydrocarbon and H_2S seep areas (Kennicutt et al., 1985; Brooks et al., 1986a). Since the initial discovery in 1984 of chemosynthetic communities dependent on hydrocarbon seepage in the GOM off the west coast of Florida, their geographic range has been found to include the Texas, Louisiana, and Alabama continental slope with a depth range varying from less than 500 m to 2,200 m (1,640 to 7,218 ft) (Rosman et al., 1987; MacDonald, 1992). Four general community types have been described by MacDonald et al. (1990). These are communities dominated by vestimentiferan tube worms, mytilid mussels, vesicomyid, and infaunal lucinid or thyasirid clams. These faunal groups tend to display distinctive characteristics in terms of how they aggregate, the size of aggregations, the geological and chemical properties of the habitats in which they occur and, to some degree, the heterotrophic fauna that occur with them.

The reliance of deep-sea chemosynthetic communities on nonphotosynthetic carbon sources limits their distribution in the Gulf to areas where hydrocarbon sources are available. Within the northern Gulf, chemosynthetic communities are generally associated with slow oil and gas seeps, rapid expulsion mud volcanoes, and mineral seeps (Roberts and Carney, 1997). The most common energy source for the Gulf communities is a hydrocarbon seep. Hydrocarbon reservoirs beneath the Gulf may include faults within source rock that have allowed oil and gas to migrate upward to the seafloor over the past several million years (Sassen et al., 1993). Hydrocarbons seeping to the surface diffuse through overlying sediments where bacterial degradation creates the chemosynthetic substrate taken up by symbiotic invertebrates. Vestimentiferan tube worms and lucinid and vesicomyid clams rely on hydrogen sulfide (H_2S), whereas mytilid mussels used dissolved methane (CH_4). Mud volcanoes and mineral seeps provide similar chemosynthetic source material, but their occurrence in the Gulf is far less extensive than oil and gas seeps.

Hydrocarbon seep communities in the Central Gulf have been reported to occur at water depths between 290 and 2,200 m (951 and 7,218 ft) (Roberts et al., 1990; MacDonald, 1992). The total number of chemosynthetic communities in the Gulf is now known to exceed 50 (MacDonald, 1992; Boland, personal observations, 2000; Gallaway et al., 2000).

A review for the potential occurrence of chemosynthetic communities associated with Grid 16 and the the Thunder Horse project was performed for this EA. The conclusion of this analysis determined that there are no known chemosynthetic communities located within Grid 16. The nearest known chemosynthetic community is located in Viosca Knoll, Block 826, approximately 143 km (77 nmi) from the Thunder Horse development (Figure 3-1).

3.2.2.2. Coral Reefs

Coral reefs are particularly sensitive to human disturbance from increased sediments (e.g., from dredging), nutrient inputs (e.g., from sewage effluents), and physical damage (e.g., from anchoring). In the GOM, shallow-water coral reefs are associated with topographic highs such as the well-known East and West Flower Gardens and a number of others in the Central Planning Area (CPA). None of these are located in the deepwater areas of Grid 16.

Currently, there is little information regarding deepwater coral reefs and their abundance in the Gulf (USDOI, MMS, 2000). Moore and Bullis (1960) collected more than 136 kg (300 lb) of scleractinian coral, *Lophelia prolifera*, from a depth of 421-512 m (1,381-1,680 ft), about 20 nmi from Viosca Knoll, Block 907 (USDOI, MMS, 2000). Recently, there have been observed reports of large amounts of *L. prolifera* video recorded in Viosca Knoll, Block 826 (Roberts, personal communication, 2002), as well as video recordings of *Madrapora oculata*, another deepwater scleractinian coral, found in Green Canyon, Block 238 (Childs, personal observation, 2002). Known hard bottoms supporting potential unknown coral reef habitat are avoided as a consequence of the MMS's Chemosynthetic Community NTL (NTL No. 2000-G20).

3.2.2.3. Deepwater Benthos

Marine benthic communities consist of a wide variety of organisms. It is convention in the Gulf region to classify benthic animals according to size as megafauna (large, usually mobile animals on the surface), macrofauna (retained on 0.25- to 0.50-mm mesh size sieve), meiofauna (0.063-mm screen; mostly nematode worms), and microfauna (protists and bacteria). The four types are discussed briefly below.

3.2.2.3.1. Megafauna

Animals of a size typically caught in trawls and large enough to be easily visible (e.g., crabs, shrimp, benthic fish, etc.) are called megafauna. In the Gulf, most are crustaceans, echinoderms, or benthic fish. Benthic megafaunal communities in the Central Gulf appear to be typical of most temperate continental slope assemblages found at depths from 300 to 3,000 m (984 to 9,843 ft) (USDOI, MMS, 2001a). Exceptions include the chemosynthetic communities discussed previously.

Megafaunal invertebrate and benthic fish densities appear to decline with depth between the upper slope and the abyssal plain (Pequegnat 1983; Pequegnat et al., 1990). This phenomenon is generally believed to be related to the low productivity in deep, offshore Gulf waters (USDOI, MMS, 2001a). Megafaunal communities in the offshore Gulf have historically been zoned by depth strata, which are typified by certain species assemblages (Menzies et al., 1973; Pequegnat, 1983; Gallaway et al., 1988; Gallaway, 1988a-c; Pequegnat et al., 1990; USDOI, MMS, 2001a). These zones include the following:

- Shelf/Slope Transition Zone (100-500 m or 328-1,640 ft) — Echinoderms, crustaceans, and several species of abundant fish.

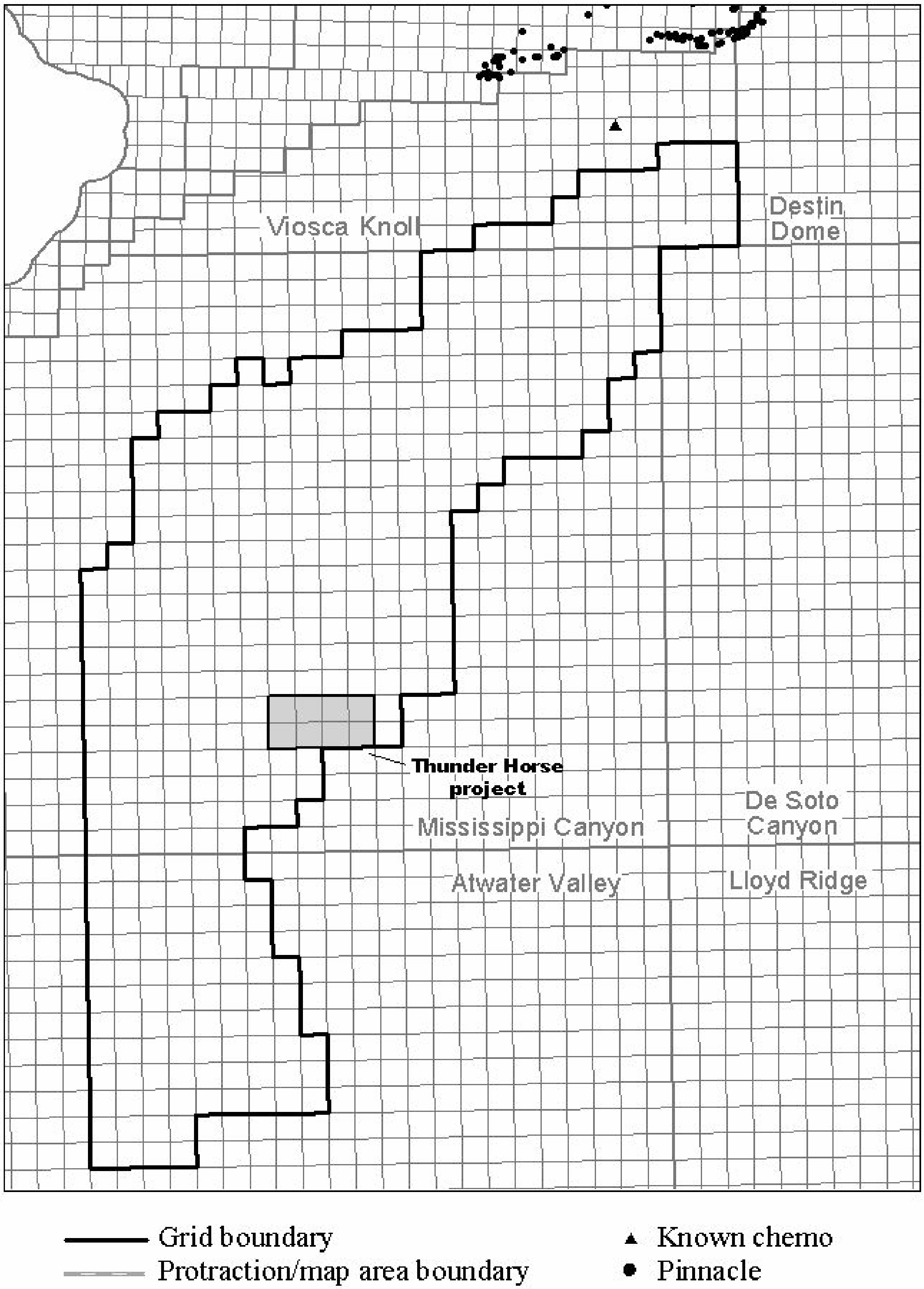

Figure 3-1. Known Chemosynthetic Communities and Pinnacles.

- Archibenthal Zone (Horizon A) (500-775 m or 1,640-2,543 ft) — Galatheid crabs, rat tail fishes, large sea cucumbers, and sea stars are abundant.
- Archibenthal Zone (Horizon B) (800-1,000 m or 2,625 to 3,281 ft) — Galatheid crabs and rat tail fishes are abundant; fishes, echinoderms, and crustaceans decline; characterized by the red crab, *Chaceon quinquedens*.
- Upper Abyssal Zone (1,000-2,000 m or 3,281-6,562 ft) — Number of fish species decline while the number of invertebrate species appear to increase; sea cucumbers, *Mesothuria lactea* and *Benthodytes sanguinolenta* are common; galatheid crabs include 12 species of the deep-sea genera Munida and Munidopsis, while the shallow brachyuran crabs decline.
- Mesoabyssal Zone (2,300-3,000 m or 7,546-9,843 ft) — Fish species are few and echinoderms continue to dominate the megafauna.
- Lower Abyssal Zone (3,200-3,800 m or 10,499 to 12,468 ft) — Large asteroid, *Dytaster insignis*, is the most common megafaunal species.

Carney et al. (1983) postulated a simpler system of zonation having three zones: (1) a distinct shelf assemblage in the upper 1,000 m (3,281 ft); (2) indistinct fauna between 1,000 and 2,000 m (3,281-6,562 ft); and (3) a distinct slope fauna between 2,000 and 3,000 m (6,562-9,843 ft).

The baseline Northern Gulf of Mexico Continental Slope Study (NGMCS) conducted in the mid- to late 1980's trawled 5,751 individual fish and 33,695 invertebrates, representing 153 and 538 taxa, respectively. That study also collected 56,052 photographic observations, which included 76 fish taxa and 193 non-fish taxa. Interestingly, the photographic observations were dominated by holothurians, bivalves, and sea pens, groups that were not sampled effectively (if at all) by trawling. Decapod crustaceans dominated the trawls and were fourth in the photos from an abundance perspective. Decapod density generally declined with depth but with peaks at 500 m (1,640 ft) and between 1,100 and 1,200 m (3,609 and 3,937 ft), after which depth abundance was quite low. Fish density, while variable, was generally high at depths between 300 and 1,200 m (984 and 3,937 ft); it then declined substantially.

Gallaway et al. (2002) concluded that megafaunal composition changes continually with depth such that a distinct upper slope fauna penetrates to about 1,200 m (3,937 ft) depths and a distinct deep-slope fauna is present below 2,500 m (8,202 ft). A broad transition zone characterized by low abundance and diversity occurs between depths of 1,200 and 2,500 m (3,937 and 8,203 ft). The proposed Thunder Horse development, at a depth of approximately 1,829 m (6,001 ft), lies within this broad transition zone.

3.2.2.3.2. Macrofauna

The benthic macrofaunal component of the NGMCS Study (Gallaway et. al., 2002) included sampling in nearby areas at similar depths, both east and west of the Thunder Horse project. A transect (the central transect) of 11 baseline stations through Grids 12, 13, and 14 from 305 m (1,000 ft) to nearly the 3,000-m (9,843-ft) contour was sampled in this study. All of these data are relevant to the proposed Thunder Horse development because they were taken from the same geographic area and encompass the same depths and substrates.

The NGMCS Study examined 69,933 individual macrofauna from over 1,548 taxa; 1,107 species from 46 major groups were identified (Gallaway et al., 2002). Polychaetes (407 species), mostly deposit-feeding forms (196 taxa), dominated in terms of numbers. Carnivorous polychaetes were more diverse, but less numerous than deposit-feeders, omnivores, or scavengers (Pequegnat et al., 1990; Gallaway et al., 2001). Polychaetes were followed in abundance by nematodes, ostracods, harpacticoid copepods, bivalves, tanaidacids, bryozoans, isopods, amphipods, and others. Overall abundance of macrofauna ranged from 518 to 5,369 individuals/m^2 (Gallaway et al., 1988). The central transect (4,938 individuals/m^2) had higher macrofaunal abundance than either the Eastern or Western Gulf transects (4,869 and 3,389 individuals/m^2, respectively) (Gallaway et al., 2002).

In the GOM, macrofaunal density and biomass declines with depth from approximately 5,000 individuals/m^2 on the lower shelf-upper slope to several hundred individuals/m^2 on the abyssal plain

(USDOI, MMS, 2001a). This decline in benthos has been attributed to the relatively low productivity of the Gulf offshore open waters (USDOI, MMS, 2001a). However, Pequegnat et al. (1990) reported mid-depth maxima of macrofauna in the upper slope at some locations of high organic particulate matter, and Gallaway et al. (2002) noted that the decline with depth is not clear cut and is somewhat obscured by sampling artifacts.

There is some suggestion that sizes of individual macrofauna decrease with depth (Gallaway et al., 2002) and that size of individuals are generally small. Macrofaunal abundance appears to be higher in spring than in fall (Gallaway et al., 2002).

Macrofauna in the Gulf appears to have lower densities but higher diversities than the Atlantic, especially above 1,000 m (3,281 ft), whereas at deep depths the fauna are less dissimilar in densities and very similar in diversities (Gallaway et al., 2002).

3.2.2.3.3 Meiofauna

Meiofauna (primarily composed of small nematode worms), as with megafauna and macrofauna, also decline in abundance with depth (Pequegnat et al., 1990; Gallaway et al., 2002; USDOI, MMS, 2001a). The overall density (mean of 707,000/m^2) of meiofauna is approximately two orders of magnitude greater than the macrofauna throughout the depth range of the slope (Gallaway et al., 1988). These authors reported 43 major groups of meiofauna with nematodes, harpacticoid copepods (adults and larvae), polychaetes, ostracods, and Kinorhyncha accounting for 98 percent of the total numbers. Nematodes and harpacticoids were dominant in terms of numbers, but polychaetes and ostracods were dominant in terms of biomass, a feature that was remarkably consistent across all stations, regions, seasons, and years (Gallaway et al., 2002). Meiofaunal densities appeared to be somewhat higher in the spring than in the fall. Meiofaunal densities reported in the NGMCS Study are among the highest recorded worldwide (Gallaway et al., 2002). There is also evidence that the presence of chemosynthetic communities may enrich the density and diversity of meiofauna in the immediate surrounding area (Gallaway et al., 2002).

The above conclusions were partially based on the collections from the NGMCS Study stations in adjacent Grid areas (the Central Gulf transect) (see also “Macrofauna” above). The Central Gulf transect appeared to contain a higher abundance of meiofauna than transects in the Eastern or Western Gulf, and, in general, there was a trend of decreasing meiofauna numbers with depth (Gallaway et al., 2002).

3.2.2.3.4 Microbiota

Less is known about the microbiota than the other groups in the GOM, especially in deep water (USDOI, MMS, 2000). A recent MMS publication (USDOI, MMS, 2001b) provides information on this subject. An overview is provided below.

As reported by Rowe (CSA, 2000), the microbiota of the deep Gulf sediments is not well characterized. While direct counts have been coupled with some *in situ* and repressurized metabolic studies performed in other deep ocean sediments (Deming and Baross, 1993), none have been made in the deep GOM. Cruz-Kaegi (1998) made direct counts using a fluorescing nuclear stain at several depths down the slope, allowing bacterial biomass to be estimated from their densities and sizes. Mean biomass was estimated to be 2.37 g $C \cdot m^{-2}$ for the shelf and slope combined, and 0.37 g $C \cdot m^{-2}$ for the abyssal plain. In terms of biomass, data indicate that bacteria are the most important component of the functional infaunal biota. Cruz-Kaegi (1998) developed a carbon cycling budget based on estimates of biomass and metabolic rates in the literature. She discovered that, on the deep slope of the Gulf, the energy from organic carbon in the benthos is cycled through bacteria.

3.2.3. Marine Mammals

Twenty-nine species of marine mammals are known to occur in the GOM (Davis et al., 2000). The Gulf’s marine mammals are represented by members of the taxonomic order Cetacea, which is divided into the suborders Mysticeti (i.e., baleen whales) and Odontoceti (i.e., toothed whales, dolphins, and their allies), as well as the order Sirenia, which include the manatee and dugong. Within the GOM, there are 28 species of cetaceans (7 mysticete and 21 odontocete species) and 1 sirenian species, the manatee (Jefferson et al., 1992).

3.2.3.1. Nonendangered and Nonthreatened Species

Cetaceans – Mysticetes

Bryde's Whale (Balaenoptera edeni)

The Bryde's whale (*Balaenoptera edeni*) is the second smallest of the balaenopterid whales; it is generally confined to tropical and subtropical waters (i.e., between lat. 40º N. and lat. 40º S.) (Cummings, 1985). Unlike some baleen whales, it does not have a well-defined breeding season in most areas; thus, calving may occur throughout the year. The Bryde's whale feeds on small pelagic fishes and invertebrates (Leatherwood and Reeves, 1983; Cummings, 1985; Jefferson et al., 1993).

There are more records of Bryde's whale than of any other baleen whale species in the northern GOM. It is likely that the Gulf represents at least a portion of the range of a dispersed, resident population of Bryde's whale (Jefferson and Schiro, 1997). Bryde's whale in the northern Gulf, with few exceptions, have been sighted along a narrow corridor near the 100-m (328-ft) isobath (Davis and Fargion, 1996; Davis et al., 2000). Most sightings have been made in the DeSoto Canyon region and off western Florida, though there have been some in the west-central portion of the northeastern Gulf. Group sizes range from one to seven animals.

Minke Whale (Balaenoptera acutorostrata)

The minke whale *(Balaenoptera acutorostrata*) is a small rorqual that is widely distributed in tropical, temperate, and polar waters. Minke whales may be found offshore but appear to prefer coastal waters. Their diet consists of invertebrates and fishes (Leatherwood and Reeves, 1983; Stewart and Leatherwood, 1985; Jefferson et al., 1993; Würsig et al., 2000).

The North Atlantic population migrates southward during winter months to the Florida Keys and the Caribbean Sea. There are 10 reliable records of minke whales in the GOM and all are the result of strandings (Jefferson and Schiro, 1997). Most records from the Gulf have come from the Florida Keys, although strandings in western and northern Florida, Louisiana, and Texas have been reported (Jefferson and Schiro, 1997). Sightings data suggest that minke whales either migrate into Gulf waters in small numbers during the winter or, more likely, that sighted individuals represent strays from low-latitude breeding grounds in the western North Atlantic (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000).

Cetaceans — Odontocetes

Pygmy and Dwarf Sperm Whales (Family Kogiidae)

The pygmy sperm whale *(Kogia breviceps*) and its congener, the dwarf sperm whale *(K. sima*), are medium-sized toothed whales that feed on cephalopods and, less often, on deep-sea fishes and shrimps (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Caldwell and Caldwell, 1989). Hence, they inhabit oceanic waters in tropical to warm temperate zones (Jefferson and Schiro, 1997). They appear to be most common in waters over the continental slope and along the shelf edge. Little is known of their natural history, although a recent study of *Kogia* in South Africa has determined that these two species attain sexual maturity much earlier and live fewer years than other similarly sized toothed whales (Plön and Bernard, 1999).

Kogia have been sighted throughout the Gulf in waters that vary broadly in depth and seafloor topographies (Mullin et al., 1991; Davis et al., 1998 and 2000). The GulfCet I study reported these animals in waters with a mean bottom depth of 929 m (3,048 ft) (Davis et al., 1998). *Kogia* have been sighted over the continental shelf, but there is insufficient evidence that they regularly inhabit continental shelf waters. *Kogia* sightings were made during GulfCet aerial surveys (1992-97) in all waters between the 100-m and 2,000-m (328-ft and 6,562-ft) isobaths. Data also indicate that *Kogia* may associate with frontal regions along the shelf break and upper continental slope, areas with high epipelagic zooplankton biomass (Baumgartner, 1995). During the GulfCet II study, *Kogia* were widely distributed in the oceanic northern Gulf, including slope waters of the Eastern Gulf. *Kogia* frequently strand on the coastline of the northern Gulf, more often in the Eastern Gulf (Jefferson and Schiro, 1997). Between 1984 and 1990, 22 pygmy sperm whales and 10 dwarf sperm whales stranded in the GOM.

Beaked Whales (Family Ziphiidae)

Two genera and four species of beaked whales occur in the GOM. These encompass (1) three species of the genus *Mesoplodon* (Sowerby's beaked whale [*M. biden*s], Blainville's beaked whale [*M. densirostri*s], and Gervais' beaked whale [*M. europaeu*s]) and (2) one species of the genus *Ziphiu*s (Cuvier's beaked whale *[Ziphius cavirostri*s]). Morphological similarities among species in the genus *Mesoplodon* make identification of free-ranging animals difficult. Generally, beaked whales appear to prefer oceanic waters, although little is known of their respective life histories. Stomach content analyses suggest that these whales feed primarily on deepwater cephalopods, although they also consume some mesopelagic fishes and deepwater benthic invertebrates (Leatherwood and Reeves, 1983; Heyning, 1989; Mead, 1989; Jefferson et al., 1993).

In the northern Gulf, beaked whales are broadly distributed in waters greater than 1,000 m (3,281 ft) over lower slope and abyssal landscapes (Davis et al., 1998 and 2000). Group sizes of beaked whales observed in the northern Gulf comprise 1-4 individuals per group (Mullin et al., 1991; Davis and Fargion, 1996; Davis et al., 2000). Sightings data indicate that Cuvier's beaked whale is probably the most common beaked whale in the Gulf (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000). Wursig et al., (2000) indicate there are 18 documented strandings of Cuvier's beaked whales in the GOM. The Gervais' beaked whale is probably the most common mesoplodont in the northern Gulf, as suggested by stranding records (Jefferson and Schiro, 1997). Wursig et al. (2000) states that there are four verified stranding records of Blainville's beaked whales from the GOM. Additionally, one beaked whale sighted during GulfCet II was determined to be a Blainville's beaked whale (Davis et al., 2000). Sowerby's beaked whale is represented in the Gulf by only a single record, a stranding in Florida; this record is considered extralimital since this species normally occurs much farther north in the North Atlantic (Jefferson and Schiro, 1997).

Dolphins (Family Delphinidae)

Atlantic Spotted Dolphin (Stenella frontalis)

The Atlantic spotted dolphin (*Stenella frontalis*) is endemic to the Atlantic Ocean within tropical to temperate zones. Surveys in the northern Gulf documented the Atlantic spotted dolphin primarily over the continental shelf and shelf edge in waters that were less than 250 m (820 ft) in depth, although some individuals were sighted along the slope in waters of up to approximately 600 m (1,969 ft) (Davis et al., 1998). Mills and Rademacher (1996) found the principal depth range of the Atlantic spotted dolphin to be much shallower at 15-100 m (49-328 ft) water depth. Griffin and Griffin (1999) found Atlantic spotted dolphins on the eastern Gulf continental shelf in waters greater than 20 m (65 ft) [30 km (19 mi) from the coast]. A satellite-tagged Atlantic spotted dolphin was found to prefer shallow water habitat and make short dives (Davis et al., 1996). Atlantic spotted dolphins are sighted more frequently in areas east of the Mississippi River (Mills and Rademacher, 1996). Perrin et al. (1994a) relate accounts of brief aggregations of smaller groups of Atlantic spotted dolphins (forming a larger group) off the coast of northern Florida. While not well substantiated, these dolphins may demonstrate seasonal nearshore-offshore movements that appear to be influenced by prey availability and water temperature (Wursig et al., 2000). They are known to feed on a wide variety of fishes, cephalopods, and benthic invertebrates (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Perrin et al., 1994a).

Bottlenose Dolphin (Tursiops truncatus)

The bottlenose dolphin *(Tursiops truncatu*s) is a common inhabitant of the continental shelf and upper slope waters of the northern Gulf. It is the most widespread and common cetacean observed in the northern GOM. Sightings of this species in the northern Gulf are rare beyond approximately the 1,200-m (3,937-ft) isobath (Mullin et al., 1994b; Jefferson and Schiro, 1997; Davis et al., 2000). There appears to be two ecotypes of bottlenose dolphins, a coastal form and an offshore form (Hersh and Duffield, 1990; Mead and Potter, 1990). The coastal or inshore stock(s) is genetically isolated from the offshore stock (Curry and Smith, 1997). Genetic data also support the concept of relatively discrete bay, sound, and estuary stocks (Waring et al., 1999). In the northern GOM, bottlenose dolphins appear to have an almost bimodal distribution: a shallow water (16-67 m or 52-220 ft) and a shelf break (about 250 m or 820 ft) region. These regions may represent the individual depth preferences of the coastal and offshore forms (Baumgartner, 1995). Little is known of the behavior or ranging patterns of offshore bottlenose dolphins. Bottlenose dolphins are opportunistic feeders, taking a wide variety of fishes, cephalopods, and shrimp (Davis and Fargion, 1996; Jefferson and Schiro, 1997; Wells and Scott, 1999). Mating and calving occurs primarily from February through May.

Clymene Dolphin (Stenella clymene)

The Clymene dolphin *(Stenella clymen*e) is endemic to the Atlantic Ocean and found only in tropical and subtropical waters (Perrin and Mead, 1994). Data suggest that Clymene dolphins are widespread within deeper Gulf waters (i.e., shelf edge and slope) (Davis et al., 2000; Würsig et al., 2000). The Clymene dolphin represents a significant component of the northern GOM cetacean assemblage (Mullin et al., 1994c). However, the few records of the Clymene dolphin in the northern Gulf in the past were probably a result of this species' recently clarified taxonomic status and the tendency for observers to confuse it with other species (Jefferson and Schiro, 1997). Sightings made during GulfCet surveys indicate the Clymene dolphin to be widely distributed in the western oceanic Gulf during spring and in the northeastern Gulf during summer and winter. Also, most sightings tended to occur in the central portion of the GOM, west of the Mississippi Delta and east of Galveston Bay. Clymene dolphins have been sighted in water depths of 612-1,979 m (2,008-6,493 ft) (Davis et al., 1998). This species appears to feed on fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Mullin et al., 1994a).

False Killer Whale (Pseudorca crassidens)

The false killer whale (*Pseudorca crassidens*) occurs in oceanic waters of tropical and warm temperate zones (Odell and McClune, 1999). Most sightings have been made in waters exceeding 200 m (656 ft), although there have been sightings over the continental shelf (Davis and Fargion, 1996). Although sample sizes are small, most false killer whale sightings have been east of the Mississippi River (Mullin and Hansen, 1999). False killer whales primarily eat fish and cephalopods, but they have been known to attack other toothed whales (Leatherwood and Reeves, 1983; Jefferson et al., 1993).

Fraser's Dolphin (Lagenodelphis hosei)

The Fraser's dolphin (*Lagenodelphis hosei*) has a pantropical distribution (Perrin et al., 1994c) in oceanic waters and in areas where deep water approaches the coast. Fraser's dolphins feed on fishes, cephalopods, and crustaceans (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Jefferson and Schiro, 1997). This species was previously known to occur in the northern Gulf based on a mass stranding in the Florida Keys in 1981 (Hersh and Odell, 1986). From 1992 to 1996, there were at least three strandings in Florida and Texas (Würsig et al., 2000). GulfCet ship-based surveys led to sightings of two large herds (greater than 100 individuals) and first-time recordings of sounds produced by these animals (Leatherwood et al., 1993). Fraser's dolphins have been sighted in the western and eastern Gulf at depths of around 1,000 m (3,281 ft) (Leatherwood et al., 1993; Davis and Fargion, 1996; Jefferson and Schiro, 1997; Davis et al., 2000).

Killer Whale (Orcinus orca)

The killer whale (*Orcinus orca*) is a cosmopolitan species that occurs in all oceans and seas (Dahlheim and Heyning, 1999). Generally, they appear to inhabit coastal, cold temperate and subpolar zones. Most killer whale sightings in the northern Gulf have been in waters greater than 200 m (656 ft) deep, although there are sightings made over the continental shelf (Davis and Fargion, 1996). Killer whales are found almost exclusively in a broad area of the north-central Gulf (Jefferson and Schiro, 1997; O'Sullivan and Mullin, 1997; Mullin and Hansen, 1999). There was a sighting in May 1998 of killer whales in DeSoto Canyon (Ortega, personal communication, 1998). Worldwide, killer whales feed on marine mammals, marine birds, sea turtles, cartilaginous and bony fishes, and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). An attack by killer whales on a group of pantropical spotted dolphins was observed during one of the GulfCet surveys (O'Sullivan and Mullin, 1997).

Melon-headed Whale (Peponocephala electra)

The melon-headed whale *(Peponocephala electra*) is a deepwater, pantropical species (Perryman et al., 1994) that feeds on cephalopods and fishes (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Mullin et al., 1994c; Jefferson and Schiro, 1997). Sightings of this species in the northern Gulf have been primarily in continental slope waters west of the Mississippi River (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000; Mullin and Hansen, 1999). The first two records of this species' occurrence in the Gulf are from strandings, one in Texas in 1990 and the other in Louisiana in 1991 (Barron and Jefferson, 1993). GulfCet surveys resulted in many sightings of melon-headed whales, suggesting that this species is a regular inhabitant of the GOM (e.g., Mullin et al., 1994b).

Pantropical Spotted Dolphin (Stenella attenuata)

The pantropical spotted dolphin *(Stenella attenuat*a) is distributed in tropical and subtropical marine waters of the world (Perrin and Hohn, 1994). It is the most common cetacean in the oceanic northern Gulf (Mullin et al., 1994a; Davis and Fargion, 1996; Davis et al., 2000). Pantropical spotted dolphins are typically found in waters deeper than 1,200 m (3,937 ft) deep (Mullin et al., 1994a; Davis et al., 1998 and 2000) but have been sighted over the continental shelf (Mullin et al., 1994a). It feeds on epipelagic fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993).

Pygmy Killer Whale (Feresa attenuata)

The pygmy killer whale (*Feresa attenuata*) occurs in tropical and subtropical waters throughout the world (Ross and Leatherwood, 1994), although little is known of its biology or ecology. Its diet includes cephalopods and fishes, though reports of attacks on other dolphins have been reported (Leatherwood and Reeves, 1983; Jefferson et al., 1993). The pygmy killer whale does not appear to be common in the Gulf; most records are of strandings (Jefferson and Schiro, 1997). Fourteen strandings have been documented from southern Florida to south Texas. Four ship sightings occurred during the GulfCet surveys, once off the south Texas coast in November and three in the spring in the west-central portion of the GulfCet study area. Sightings of this species have been at depths of 500-1,000 m (1,640-3,281 ft) (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000).

Risso's Dolphin (Grampus griseus)

The Risso's dolphin (*Grampus griseus*) is a pantropical species that inhabits deep oceanic and continental slope waters of tropical and warm temperate zones (Kruse et al., 1999). Risso's dolphins in the northern Gulf have been frequently sighted along the shelf edge, along the upper slope, and most commonly, over or near the 200-m (656-ft) water isobath just south of the Mississippi River in recent years (Würsig et al., 2000). A strong correlation between Risso's dolphin distribution and the steeper portions of the upper continental slope is most likely the result of cephalopod distribution along the continental slope (Baumgartner, 1997; Davis et al., 2000). Risso's dolphins have been sighted over the continental shelf at water depths less than 200 m (656 ft) (Mullin et al., 1994a; Davis et al., 1998). Strandings and GulfCet sightings have occurred in all seasons in the GOM and it is likely that Risso's dolphins occur year round in the GOM. Risso's dolphins feed primarily on squid and secondarily on fishes and crustaceans (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Baumgartner, 1997; Würsig et al., 2000).

Rough-toothed Dolphin (Steno bredanensis)

The rough-toothed dolphin (*Steno bredanensis*) occurs in tropical to warm temperate marine waters globally (Miyazaki and Perrin, 1994). Sightings in the northern Gulf occur primarily over the deeper waters (950-1,100 m or 3,117-3,609 ft) off the continental shelf (Mullin et al., 1994a; Davis et al., 1998). Most sightings of the rough-toothed dolphin have been west of the Mississippi River (Mullin and Hansen, 1999); however, a mass stranding of 62 rough-toothed dolphins occurred near Cape San Blas, Florida, on December 14, 1997. Four of the stranded dolphins were rehabilitated and released; three carried satellite-linked transmitters (Wells et al., 1999b). Water depth at tracking locations of these individuals averaged

195 m (640 ft). Data from the tracked individuals, in addition to sightings at Santa Rosa Beach on December 28-29, 1998 (Rhinehart et al., 1999), suggest a regular occurrence of this species in the northern Gulf. This species feeds on cephalopods and fishes (Leatherwood and Reeves, 1983; Jefferson et al., 1993).

Short-finned Pilot Whale (Globicephala macrorhynchus)

The short-finned pilot whale (*Globicephala macrorhynchus*) is found in warm temperate to tropical marine waters of the world, generally in deep offshore areas (Bernard and Reilly, 1999). In the northern Gulf, it is most commonly sighted along the continental slope at depths of 250-2,000 m (820-6,562 ft) (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000). Short-finned pilot whales have been sighted almost exclusively west of the Mississippi River (Mullin and Hansen, 1999). There was one sighting of short-finned pilot whales in the slope in the eastern Gulf during GulfCet II, in the extreme western part of the study area (Davis et al., 2000). Stranding records have declined dramatically over the past decade, which contributes to the evidence (though not conclusively) that this population may be declining in the GOM. Squid are the predominant prey, with fishes being consumed occasionally.

Spinner Dolphin (Stenella longirostris)

The spinner dolphin *(Stenella longirostris*) occurs worldwide in tropical oceanic waters (Perrin and Gilpatrick, 1994; Jefferson and Schiro, 1997). In the northern Gulf, most sightings of spinner dolphins have been east of the Mississippi River at depths of 500-1,800 m (1,640-5,906 ft) (Jefferson and Schiro, 1997; Mullin and Hansen, 1999; Davis et al., 2000). Spinner dolphins have mass stranded on two occasions in the GOM, each time on the Florida coast. Spinner dolphins appear to feed on fishes and cephalopods (Würsig et al., 2000).

Striped Dolphin (Stenella coeruleoalba)

The striped dolphin *(Stenella coeruleoalba*) occurs in tropical and subtropical oceanic waters (Perrin et al., 1994a). Sightings in the northern Gulf occur primarily over the deeper waters beyond the continental shelf (Jefferson and Schiro, 1997; Davis et al., 2000; Würsig et al., 2000). Striped dolphins feed primarily on small, mid-water squid and fishes (especially lanternfish).

3.2.3.2. Endangered and Threatened Species

Cetaceans — Mysticetes

Blue Whale (Balaenoptera musculus)

The blue whale (*Balaenoptera musculus*) is the largest animal known. It feeds almost exclusively on concentrations of zooplankton (Yochem and Leatherwood, 1985; Jefferson et al., 1993). The blue whale occurs in all major oceans of the world; some blue whales are resident, some are migratory (Jefferson et al., 1993; USDOC, NMFS, 1998). Those that migrate move to feeding grounds in polar waters during spring and summer, after wintering in subtropical and tropical waters (Yochem and Leatherwood, 1985). Records of the blue whale in the northern Gulf consist of two strandings on the Texas coast (Lowery, 1974). There appears to be little justification for considering the blue whale to be a regular inhabitant of the GOM (Jefferson and Schiro, 1997).

Fin Whale (Balaenoptera physalus)

The fin whale (*Balaenoptera physalus*) is an oceanic species that occurs worldwide in marine waters and is most commonly sighted where deep water approaches the coast (Jefferson et al., 1993). Fin whales feed on concentrations of zooplankton, fishes, and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). The fin whale makes seasonal migrations between temperate waters, where it mates and calves, and polar feeding grounds that are occupied during summer months. Their presence in the northern Gulf is considered rare (Würsig et al., 2000). Sightings in the northern Gulf have typically been made in oceanic waters, chiefly in the north-central region of the Gulf (Mullin et al., 1991). There are seven reliable reports of fin whales in the northern Gulf, indicating that fin whales are not abundant in the GOM (Jefferson and Schiro, 1997). Sparse sighting data on this species suggest that individuals in the northern Gulf may be extralimital strays from their western Atlantic population (Jefferson and Schiro, 1997; Würsig et al., 2000).

Humpback Whale (Megaptera novaeangliae)

The humpback whale (*Megaptera novaeangliae*) occurs in all oceans, feeding in higher latitudes during spring, summer, and autumn, and migrating to a winter range over shallow tropical banks, where they calve and presumably conceive (Jefferson et al., 1993). Humpback whales feed on concentrations of zooplankton and fishes using a variety of techniques that concentrate prey for easier feeding (Winn and Reichley, 1985; Jefferson et al., 1993). There have been occasional reports of humpback whales in the northern Gulf off Florida: a confirmed sighting of a humpback whale in 1980 in the coastal waters off Pensacola (Weller et al., 1996); two questionable records of humpback whale sightings from 1952 and 1957 off the coast of Alabama (Weller et al., 1996); a stranding east of Destin, Florida, in mid-April 1998 (Mullin, personal communication, 1998); and a confirmed sighting of six humpback whales in May 1998 in DeSoto Canyon (Ortega, personal communication, 1998). Most recently, a lone humpback whale was photographed at Main Pass, Block 281, in December 2001. Humpback whales sighted in the GOM may be extralimital strays during their breeding season or during their migrations (Würsig et al., 2000). The time of the year (winter and spring) and the small size of the animals involved in many sightings suggest the likelihood that these records are of inexperienced juveniles on their first return migration northward (Weller et al., 1996).

Northern Right Whale (Eubalaena glacialis)

The northern right whale (*Eubalaena glacialis*) inhabits primarily temperate and subpolar waters. Northern right whales range from wintering and calving grounds in coastal waters of the southeastern United States to summer feeding, nursery, and mating grounds in New England waters and northward to the Bay of Fundy and the Scotian Shelf. During the winter, a portion of the population moves from the summer foraging grounds to the calving/breeding grounds off Florida, Georgia, and South Carolina. Right whales forage primarily on subsurface concentrations of zooplankton such as calanoid copepods by skim feeding with their mouths agape (Watkins and Schevill, 1976; Leatherwood and Reeves, 1983; Jefferson et al., 1993).

Confirmed historical records of northern right whales in the GOM consist of a single stranding in Texas (Schmidly et al., 1972) and a sighting off Sarasota County, Florida (Moore and Clark, 1963; Schmidly, 1981). The northern right whale is not considered a resident (year-round or seasonal) of the GOM; existing records probably represent extralimital strays from the wintering grounds of this species off the southeastern United States from Georgia to northeastern Florida (Jefferson and Schiro, 1997).

Sei Whale (Balaenoptera borealis)

The sei whale (*Balaenoptera borealis*) is an oceanic species that is not often seen close to shore (Jefferson et al., 1993). They occur in marine waters from the tropics to polar regions but are more common in mid-latitude temperate zones (Jefferson et al., 1993). Sei whales feed on concentrations of zooplankton, small fishes, and cephalopods (Gambell, 1985; Jefferson et al., 1993). The sei whale is represented in the northern Gulf by only four reliable records (Jefferson and Schiro, 1997). One stranding was reported for the Florida Panhandle and three strandings were in eastern Louisiana (Jefferson and Schiro, 1997). This species' occurrence in the northern Gulf is considered most likely to be accidental.

Cetaceans — Odontocetes

Sperm Whale (Physeter macrocephalus)

The sperm whale (*Physeter macrocephalus*) inhabits marine waters from the tropics to the pack-ice edges of both hemispheres, although generally only large males venture to the extreme northern and southern portions of their range (Jefferson et al., 1993). In general, sperm whales seem to prefer certain areas within each major ocean basin, which historically have been termed "grounds" (Rice, 1989). As deep divers, sperm whales generally inhabit oceanic waters, but they do come close to shore where submarine canyons or other geophysical features bring deep water near the coast (Jefferson et al., 1993). Sperm whales prey on cephalopods, demersal fishes, and benthic invertebrates (Rice, 1989; Jefferson et al., 1993).

The sperm whale is the only great whale that is considered to be common in the northern Gulf (Fritts et al., 1983b; Mullin et al., 1991; Davis and Fargion, 1996; Jefferson and Schiro, 1997). Sighting data suggest a northern Gulfwide distribution over slope waters. Congregations of sperm whales are commonly found in waters over the shelf edge in the vicinity of the Mississippi River delta in waters that are 500-2,000 m (1,640-6,562 ft) in depth (Mullin et al., 1994a; Davis and Fargion, 1996; Davis et al., 2000). Sperm whale sightings in the northern Gulf chiefly occur in waters with a mean seafloor depth of 1,105 m (3,626 ft) (Davis et al., 1998). Mesoscale biological and physical patterns in the environment are important in regulating sperm whale habitat use (Griffin, 1999). The GulfCet II study found that most sperm whales were concentrated along the slope in or near cyclones (Davis et al., 2000). Low-salinity, nutrient-rich water from the Mississippi River may contribute to enhanced primary and secondary productivity in the north-central Gulf, and thus provide resources that support the year-round presence of sperm whales south of the delta.

Consistent sightings in the region indicate that there is a resident population of sperm whales in the northern Gulf consisting of adult females, calves, and immature individuals (Mullin et al., 1994b; Davis and Fargion, 1996; Sparks et al., 1996; Jefferson and Schiro, 1997; Davis et al., 2000). Also, recent sightings were made in 2000 and 2001 of solitary mature male sperm whales in the DeSoto Canyon area (Lang, personal communication, 2001). Sperm whales in the Gulf are currently considered a separate stock from those in the Atlantic and Caribbean (Waring et al., 1997).

Sirenians

West Indian Manatee (Trichechus manatus)

The West Indian manatee (*Trichechus manatus*) is the only sirenian known to occur in tropical and subtropical coastal waters of the southeastern U.S., GOM, Caribbean Sea, and the Atlantic coast of northern and northeastern South America (Reeves et al., 1992; Jefferson et al., 1993; O'Shea et al., 1995). During warmer months, manatees are common along the west coast of Florida from the Everglades National Park northward to the Suwannee River in northwestern Florida and less common farther westward. In winter, the population moves southward to warmer waters. Manatees are uncommon along the Florida Panhandle and are infrequently found (strandings and sightings) as far west as Louisiana and Texas (Powell and Rathbun, 1984; Rathbun et al., 1990; Schiro et al., 1998). One manatee that died in Louisiana waters was determined to be from Tampa Bay, Florida; this determination was based on a photoidentification rematch (Schiro et al., 1998). The manatees occasionally appearing in south Texas waters might be strays from Mexico rather than Florida (Powell and Rathbun, 1984).

Manatees are herbivores that feed opportunistically on submerged, floating, and emergent vegetation (USDOI, FWS, 1995). Distribution of the manatee is limited to low-energy, inshore habitats supporting the growth of seagrasses (Hartman, 1979). Manatees primarily use open coastal (shallow nearshore) areas and estuaries; and they are also found far up freshwater tributaries. Shallow grass beds with access to deep channels are preferred feeding areas in coastal and riverine habitats (USDOI, FWS, 1995). Notwithstanding their association with coastal areas, a manatee was documented offshore at several OCS work barges where it was grazing on algae growing on the vessel's sides and bottom. Multiple sightings of the animal were made in October 2001 and occurred in waters exceeding 1,500 m (4,922 ft) in depth south of Mobile Bay, Alabama.

3.2.4. Sea Turtles

Of the seven or eight extant species of sea turtles, five are known to inhabit the waters of the GOM (Pritchard, 1997): the green turtle, the loggerhead, the hawksbill, the Kemp's ridley, and the leatherback. As a group, sea turtles possess elongated, paddle-like forelimbs that are modified for swimming and shells that are depressed and streamlined (Márquez-M., 1990; Ernst et al., 1994; Pritchard, 1997). Sea turtles spend nearly all of their lives in the water and only depend on land (specifically sandy beaches) as nesting habitat. They mature slowly and are long-lived. Generally, their distributions are primarily circumtropical, although various species differ widely in their seasonal movements, geographical ranges, and behavior. There are also considerable differences in behavior among populations of the same species (Márquez-M., 1990). All sea turtle species inhabiting the GOM are listed as either endangered or threatened under the Endangered Species Act of 1973, as amended (Pritchard, 1997).

Hard-shell Sea Turtles (Family Cheloniidae)

Green Sea Turtle (Chelonia mydas)

The green sea turtle (*Chelonia mydas*) is the largest hard-shelled sea turtle; adults commonly reach 100 cm (39 in) in carapace length and 150 kg (331 lb) in weight (USDOC, NMFS, 1990a). The green sea turtle is commonly found in tropical and subtropical marine waters with extralimital occurrences generally between latitude 40 ^{o}N. and latitude 40 ^{o}S. (USDOC, NMFS and USDOI, FWS, 1991a; Hirth, 1997). In U.S. Atlantic waters, green sea turtles are found around the U.S. Virgin Islands, Puerto Rico, and Atlantic and Gulf Coasts of the U.S. from Texas to Massachusetts.

Green sea turtles primarily occur in coastal waters, where they forage on seagrasses, algae, and associated organisms (Carr and Caldwell, 1956; Hendrickson, 1980). Small green sea turtles are omnivorous. Adult green sea turtles in the Caribbean and GOM are herbivorous, feeding primarily on seagrasses and, to a lesser extent, on algae and sponges. The adult feeding habitats are beds of seagrasses and algae in relatively shallow, protected waters; juveniles may forage in areas such as coral reefs, emergent rocky bottom, sargassum mats, and in lagoons and bays. Green sea turtles in the Western Gulf are primarily restricted to the Texas coast where seagrass meadows and algae-laden jetties provide them developmental habitat, especially during warmer months (Landry and Costa, 1999). Movements between principal foraging areas and nesting beaches can be extensive, with some populations regularly conducting transoceanic migrations (USDOC, NMFS and USDOI, FWS, 1991a; Ernst et al., 1994; Hirth, 1997).

Hawksbill Sea Turtle (Eretmochelys imbricata)

The hawksbill (*Eretmochelys imbricata*) is a small- to medium-sized sea turtle that occurs in tropical to subtropical waters of the Atlantic, Pacific, and Indian Oceans. The species is widely distributed in the Caribbean Sea and western Atlantic Ocean. In the continental U.S., the hawksbill has been recorded in coastal waters of each of the Gulf States and along the Atlantic coast from Florida to Massachusetts (USDOC, NMFS, 1993), although sightings north of Florida are rare (Hildebrand, 1982). They are considered to be the most tropical of all sea turtle species and the least commonly reported sea turtle species occurring in the Gulf (Márquez-M., 1990; Hildebrand, 1995).

Coral reefs are generally recognized as the resident foraging habitat for both juveniles and adults. Adult hawksbills feed primarily on sponges (Carr and Stancyk, 1975; Meylan, 1988) and demonstrate a high degree of selectivity, feeding on a relatively limited number of sponge species, primarily demosponges (Ernst et al., 1994). Texas and Florida are the only states in the U.S. where hawksbills are sighted with any regularity (USDOC, NMFS, 1993). Stranded hawksbills have been reported in Texas (Hildebrand, 1982; Amos, 1989) and in Louisiana (Koike, 1996); these tend to be either hatchlings or yearlings. A hawksbill was captured accidentally in a purse seine net just offshore Louisiana (Rester and Condrey, 1996).

Kemp's Ridley Sea Turtle (Lepidochelys kempi)

The Kemp's ridley (*Lepidochelys kempi*) is the smallest sea turtle species and occurs chiefly in the GOM. It may also be found along the northwestern Atlantic coast of North America as far north as Newfoundland. It is the most imperiled of the world's sea turtles.

In the northern Gulf, Kemp's ridleys are most abundant in coastal waters from Texas to west Florida (Ogren, 1989; Márquez-M., 1990 and 1994; Rudloe et al., 1991). Kemp's ridleys display strong seasonal fidelity to tidal passes and adjacent beachfront environs of the northern Gulf (Landry and Costa, 1999).

There is little prolonged utilization of waters seaward of the 50-m (164-ft) isobath by this species (Renaud, 2001). Adult Kemp's ridley turtles usually occur only in the Gulf, but juvenile and immature individuals sometimes range between tropical and temperate coastal areas of the northwestern Atlantic and Gulf (Márquez-M., 1990). Within the Gulf, juvenile and immature Kemp's ridleys have been documented along the Texas and Louisiana coasts, at the mouth of the Mississippi River, and along the west coast of Florida, as quoted in stranding reports (Ogren, 1989; Márquez-M., 1990).

Loggerhead Sea Turtle (Caretta caretta)

The loggerhead (*Caretta caretta*) is a large sea turtle that inhabits temperate and tropical marine waters of the Atlantic, Pacific, and Indian Oceans. This species is wide-ranging throughout its range and is capable of living in varied habitat types for a relatively long time (Márquez-M., 1990; USDOC, NMFS and USDOI, FWS, 1991b; Ernst et al., 1994). Loggerheads feed primarily on benthic invertebrates but are capable of feeding on a wide range of food items (Ernst et al., 1994). Juvenile and subadult loggerheads are omnivorous, foraging on pelagic crabs, molluscs, jellyfish, and vegetation captured at or near the surface (Dodd, 1988; Plotkin et al., 1993). Adult loggerheads forage on benthic invertebrates (Dodd, 1988). The loggerhead is the most abundant species of sea turtle occurring in U.S. waters of the Atlantic, from Florida to Cape Cod, Massachusetts. The loggerhead is probably the most common sea turtle species in the northern Gulf (e.g., Fritts et al., 1983a; Fuller and Tappan, 1986; Rosman et al., 1987; Lohoefener et al., 1990) and is currently listed as a threatened species.

Aerial surveys indicate that loggerheads are largely abundant in water depths less than 100 m (328 ft) (Shoop et al., 1981; Fritts et al., 1983a). During the GulfCet aerial surveys, loggerheads were sighted throughout the northern Gulf continental shelf waters near the 100-m (328-ft) isobath (Davis et al., 2000). Loggerheads were also sighted over very deep waters (>1,000 m or 3,281 ft). Sightings indicate that loggerhead distribution is not as coastal-associated as that of Kemp's ridley and green sea turtles (Landry and Costa, 1999). Loggerheads have also been sighted seaward of the shelf break in the northeast U.S. (Shoop and Kenney, 1992). Loggerhead abundance in continental slope waters of the eastern Gulf increased appreciably during winter (Davis et al., 2000).

Leatherback Sea Turtle (Family Dermochelyidae)

Leatherback Sea Turtle (Dermochelys coriacea)

The leatherback (*Dermochelys coriacea*) is the largest and most distinctive sea turtle. This species possesses a unique skeletal morphology, most evident in its flexible, ridged carapace, and in cold water maintains a core body temperature several degrees above ambient. They also have unique deep-diving abilities (Eckert et al., 1986). This species is the most wide-ranging sea turtle, undertaking extensive migrations from the tropics to boreal (cold-temperate regions of the northern latitudes) waters (Morreale et al., 1996; Hughes et al., 1998). Though considered oceanic, leatherbacks will occasionally enter bays and estuaries (Hoffman and Fritts, 1982; Knowlton and Weigle, 1989; Shoop and Kenney, 1992). Leatherbacks feed primarily on gelatinous zooplankton such as jellyfish, siphonophores, and salps (Brongersma, 1972), although they may ingest some algae and vertebrates (Ernst et al., 1994). Leatherbacks' stomach contents have been analyzed and data suggest that they may feed at the surface, at depth within deep scattering layers, or on the benthos. Florida is the only site in the continental U.S. where leatherbacks regularly nest (USDOC, NMFS and USDOI, FWS, 1992b; Ernst et al., 1994; Meylan et al., 1995). The leatherback is currently listed as an endangered species.

Sightings of leatherbacks are common in oceanic waters of the northern GOM (Leary, 1957; Fritts et al., 1983b; Lohoefener et al., 1988, 1990; Collard, 1990; Davis et al., 2000). Based on a summary of several studies, Davis and Fargion (1996) concluded that the primary habitat of the leatherback in the northwestern Gulf is oceanic waters (>200 m or 656 ft). It has been suggested that the region from Mississippi Canyon east to DeSoto Canyon appears to be an important habitat area for leatherbacks (Davis and Fargion, 1996). Most sightings of leatherbacks made during the GulfCet surveys occurred slightly north of DeSoto Canyon (Davis and Fargion, 1996; Davis et al., 2000). The nearly disjunct summer and winter distributions of leatherback sightings over the continental slope in the Eastern Gulf during GulfCet II indicate that specific areas may be important to this species either seasonally or for short periods of time. These specific locations are most probably correlated with oceanographic conditions and resulting concentrations of prey. Other clustered sightings of leatherbacks have been reported for the northern Gulf: 8 leatherbacks were sighted one day in DeSoto Canyon (Davis and Fargion, 1996), 11 during one day just south of the Mississippi River Delta (Lohoefener et al., 1990), and 14 during another day in DeSoto Canyon (Lohoefener et al., 1990).

3.2.5. Birds

Marine Birds

Most species of marine birds that are listed as either threatened or endangered inhabit nearshore waters along the coast and the continental shelf of the GOM and rarely occur in deepwater areas (USDOI, MMS, 2001a). Forty-three species of seabird representing four ecological categories have been documented from deepwater areas of the Gulf: summer migrants (e.g., shearwaters, storm-petrels, boobies), summer residents that breed in the Gulf (e.g., sooty, least, and sandwich terns), winter residents (e.g., gannets, gulls, and jaegers), and permanent resident species (e.g., laughing gull, royal, and bridled terns) (Hess and Ribic 2000, USDOI, MMS, 2001a). The most abundant species typically found in deepwater areas include terns, storm-petrels, and gulls (Hess and Ribic, 2000).

Seabirds' presence in the Gulf changes seasonally with species diversity with overall abundance being highest in the spring and summer and lowest in fall and winter. Seabirds also tend to associate with various oceanic conditions including specific sea-surface temperatures and salinities (e.g., laughing gull, black and sooty terns), areas of high plankton productivity (e.g., laughing gulls, pomarine jaeger, Audubon's shearwater, band-rumped storm-petrel, bridled tern), and particular currents (pomarine jaeger) (Hess and Ribic, 2000). Various birds (especially passerines) that seasonally migrate over the Gulf may use offshore oil and gas platforms and merchant, cruise, and naval ships as artificial islands for rest and shelter during inclement weather.

Shorebirds

Shorebirds are those members of the order Charadriiformes that are generally restricted to coastline margins (beaches, mudflats, etc.). The GOM shorebirds comprise five taxonomic families--Jacanidae (jacanas), Haematopodidae (oystercatchers), Recurvirostridae (stilts and avocets), Charadriidae (plovers), and Scolopacidae (sandpipers, snipes, and allies) (Hayman et al., 1986). An important characteristic of almost all shorebird species is their strongly developed migratory behavior, with some shorebirds migrating from nesting places in the far north to the southern part of South America (Terres, 1991). Both spring and fall migrations take place in a series of "hops" to staging areas where birds spend time feeding heavily to store up fat for the sustained flight to the next staging area; many coastal habitats along the GOM are critical for such purposes. Along the Gulf Coast, 44 species of shorebirds have been recorded; only six species nest in the area. The remaining species are wintering residents and/or "staging" transients (Pashley, 1991). Although variations occur between species, most shorebirds begin breeding at 1-2 years of age and generally lay 3-4 eggs per year. They feed on a variety of marine and freshwater invertebrates and fish, and small amounts of plant life.

Marsh and Wading Birds

The following families of mostly wading birds have some representatives in the northern Gulf: Ardeidae (herons, egrets, and bitterns), Ciconiidae (storks), Threskiornithidae (ibises and spoonbills), and Gruidae (cranes). They have long legs that allow them to forage by wading into shallow water, while their long bills and usually long necks are used to probe under water or to make long swift strokes to seize fish, frogs, aquatic insects, crustaceans, and other prey (Terres, 1991). Seventeen species of wading birds in the Order Ciconiiformes are currently known to nest in the U.S., and all except the wood stork nest in the northern Gulf coastal region (Martin, 1991). Within the Gulf Coast region, Louisiana supports the majority of nesting wading birds. Great egrets are the most widespread nesting species in the Gulf region (Martin, 1991).

Along the GOM, most members of the family Rallidae have compact bodies; therefore, they are not labeled wading birds. They are also elusive and rarely seen within the low vegetation of fresh and saline marshes, swamps, and rice fields (Bent, 1926; National Geographic Society, 1983; Ripley and Beehler, 1985).

Waterfowl

Waterfowl belong to the taxonomic order Anseriformes and include swans, geese, and ducks. A total of 36 species are regularly reported along the north-central and western Gulf Coast. They include 1 swan, 5 geese, 11 surface-feeding (dabbling) ducks and teal, 5 diving ducks (pochards), and 14 others (including the wood duck, whistling ducks, sea ducks, the ruddy duck, and mergansers) (Clapp et al., 1982; National Geographic Society, 1983; Madge and Burn, 1988). Many species usually migrate from wintering grounds along the Gulf Coast to summer nesting grounds in the north. Waterfowl migration pathways have traditionally been divided into four parallel north-south paths, or "flyways," across the North American continent. The Gulf Coast serves as the southern terminus of the Mississippi (Louisiana, Mississippi, and Alabama) flyway. Waterfowl are highly social and possess a diverse array of feeding adaptations related to their habitat (Johnsgard, 1975).

Endangered and Threatened Species

The following coastal and marine bird species that inhabit or frequent the northern GOM coastal areas are recognized by FWS as either endangered or threatened: piping plover, southeastern snowy plover, bald eagle, and brown pelican. The southeastern snowy plover is a species of concern to the State of Florida.

Piping Plover

The piping plover (*Charadrius melodus*) is a migratory shorebird that is endemic to North America. The piping plover breeds on the northern Great Plains, in the Great Lakes, and along the Atlantic Coast (Newfoundland to North Carolina); and winters on the Atlantic and Gulf Coasts from North Carolina to Mexico and in the Bahamas and West Indies. Hypothetically, plovers may have a preferred prey base and/or the substrate coloration provides protection from aerial predators due to camouflage from chromatic matching in specific wintering habitat. Such areas include coastal sand flats and mud flats in proximity to large inlets or passes, which may attract the largest concentrations of piping plovers (Nicholls and Baldassarre, 1990). Similarly, nesting habitat in the north includes open flats along the Missouri River and the Great Lakes. This species remains in a precarious state given its low population numbers, sparse distribution, and continued threats to habitat throughout its range.

Southeastern Snowy Plover

The following account of the southeastern snowy plover (*Charadrius alexandrius tenuirostris*) is taken from Gore and Chase (1989). The species nests on coastal sand beaches and interior alkali flats. Observed nest sites in the Florida Panhandle ranged from the Florida-Alabama border eastward beyond Little St. George. At some locations more than 1.5 breeding pairs/km were counted. Most nests are near the front dune and close to vegetation. Vehicles and humans may cause nest failure. Human activity is absent near the beaches of Eglin West and Eglin East because Eglin Air Force Base has restricted areas. This may account for a high nest count in part of this area.

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) is the only species of sea eagle that regularly occurs on the North American continent (USDOI, FWS, 1984). Its range extends from central Alaska and Canada to northern Mexico. The bulk of the bald eagle's diet is fish, though it will opportunistically take birds, reptiles, and mammals (USDOI, FWS, 1984). The general tendency is for winter breeding in the south with a progressive shift toward spring breeding in northern locations. In the southeast, nesting activities generally begin in early September; egg laying begins as early as late October and peaks in late December. The historical nesting range of the bald eagle within the southeast United States included the entire coastal plain and shores of major rivers and lakes. There are certain general elements that seem to be consistent among nest site selection. These include (1) the proximity of water (usually within about 1 km or ½ mi) and a clear flight path to a close point on the water, (2) the largest living tree in a span, and (3) an open view of the surrounding area. The proximity of good perching trees may also be a factor in site selection. An otherwise suitable site may not be used if there is excessive human activity in the area. The current range is limited, with most breeding pairs occurring in peninsular Florida and Louisiana, and some in South Carolina, Alabama, and east Texas. Sporadic breeding takes place in the rest of the southeastern states and in the Florida Panhandle. One hundred twenty nests have been found in Louisiana; only three nests occurred within 8 km (5 mi) of the coast (Patrick, written communication, 1997). The bald eagle was listed as endangered in 1967 in response to its declines due to DDT and other organochlorines that affected the species' reproduction (USDOI, FWS, 1984). In July 1995, the FWS reclassified the bald eagle from endangered to threatened in the lower 48 states (*Federal Register*, 1995).

Brown Pelican

The brown pelican (*Pelicanus occidentalis*) is one of two pelican species in North America. It feeds entirely upon fish captured by plunge diving in coastal waters. Organochlorine pesticide pollution apparently contributed to the endangerment of the brown pelican. In recent years, there has been a marked increase in brown pelican populations along its entire former range. The population of brown pelicans and their habitat in Alabama, Florida, Georgia, North and South Carolina, and point's northward along the Atlantic Coast were removed from the endangered species list in 1985. Within the remainder of the range, which includes coastal areas of Louisiana and Mississippi, the brown pelican remains listed as endangered (*Federal Register*, 1985).

3.2.6. Essential Fish Habitat and Fish Resources

3.2.6.1. Essential Fish Habitat

Healthy fish resources and fishery stocks depend on essential fish habitat (EFH); waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Due to the wide variation of habitat requirements for all life history stages for managed species, EFH has been identified throughout the Gulf of Mexico, including all coastal and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone (EEZ).

There are Fishery Management Plans (FMP) in the GOM region for shrimp, red drum, reef fishes, coastal migratory pelagics, stone crabs, spiny lobsters, coral and coral reefs, billfish, and highly migratory species. The Gulf of Mexico Fishery Management Council (FMC) *Generic Amendment for Addressing Essential Fish Habitat Requirements* amends the first seven FMP's listed above, identifying estuarine/inshore and marine/offshore EFH for over 450 managed species (about 400 in the Coral FMP). Although not part of the Gulf of Mexico Fishery Management Council's FMP's, separate Fishery Management Plans have been finalized by NMFS for Atlantic tunas, swordfish and sharks, and the Atlantic billfish fishery. The Gulf of Mexico FMC *Generic Amendment* also identifies threats to EFH and makes a number of general and specific habitat preservation recommendations for pipelines and oil and gas exploration and production activities within State waters and OCS areas. These recommendations can be found in the Final EIS for Lease Sale 181 (USDOI, MMS, 2001; page III-91). Pelagic species would be the only managed fisheries in the grid area and for the Thunder Horse development.

3.2.6.2. Description of Fish Resources

The GOM supports a great diversity of fish resources. The distribution and abundance of these resources are not random and are governed by a variety of ecological factors such as temperature, salinity, primary productivity, bottom types, and many other physical and biological factors. There are considerable inshore and offshore differences in fish resources. The majority of the GOM fisheries are dependent upon wetland, estuarine, and nearshore habitats (USDOI, MMS, 2001b).

Fish can be classified as demersal (bottom-dwelling), oceanic pelagic, or mesopelagic (midwater). Demersal (or benthic) fish have been addressed above under the megafauna descriptions (Chapter 3.2.2.3.1.). There are no commercial fisheries directed at demersal species in the Grid 16 area and in the vicinity of the Thunder Horse project. Oceanic pelagic and mesopelagic fishes are discussed briefly below. Additional life history information on important commercial invertebrate fish resources of the GOM is contained in USDOI, MMS (2000 and 2001a).

Oceanic Pelagics (Including Highly Migratory Species)

Common oceanic pelagic species include the large predatory tunas, marlins, sailfish, swordfish, dolphins, wahoo, and mako sharks. Other pelagics include halfbeaks, flyingfishes, and driftfishes (Stromateidae). Lesser known oceanic pelagics include opah, snake mackerels (Gempylidae), ribbonfishes (Trachipteridae), and escolar.

Oceanic pelagic species occur throughout the GOM, especially at or beyond the shelf edge. Oceanic pelagics are reportedly associated with mesoscale hydrographic features such as fronts, eddies, and discontinuities. Fishermen contend that yellowfin tuna aggregate near sea-surface temperature boundaries or frontal zones; however, Power and May (1991) found no correlation between longline catches of yellowfin tuna and sea-surface temperature (defined from satellite imagery) in the GOM. Many of the oceanic fishes associate with drifting *Sargassum* seaweed, which provides feeding and/or nursery habitat.

Mesopelagic fish assemblages in GOM collections are numerically dominated by myctophids (lanternfishes), with gonostomatids (bristlemouths) and sternoptychids (hatchet fishes) common but less abundant. These fishes make extensive vertical migrations during the night from mesopelagic depths (200-1,000 m; 656-3,281 ft) to feed in upper, more productive layers of the water column (Hopkins and Baird, 1985). Mesopelagic fishes are important ecologically because they transfer substantial amounts of energy between mesopelagic and epipelagic zones.

The GOM appears to be a distinct zoogeographic province based upon analysis of lanternfish distribution (Bakus et al., 1977). The GOM lanternfish assemblage was characterized by species with tropical and subtropical affinities. This was particularly true for the eastern GOM where Loop Current effects on species distributions were most pronounced. Gartner et al. (1987) collected 17 genera and 49 species of lanternfish in trawls fished at discrete depths from stations in the Western, Central, and Eastern Gulf. The most abundant species in decreasing order of importance were *Ceratoscopleus warmingii*, *Notolychus valdiviae*, *Lepidophanes guentheri*, *Lampanyctus alatus*, *Daiphus dumerili*, *Benthosema suborbitale*, and *Myctophum affine*. Ichthyoplankton collections from oceanic waters yielded high numbers of mesopelagic larvae as compared with larvae of other groups (Richards et al., 1989). Lanternfishes generally spawn year-round, with peak activity in spring and summer (Gartner, 1993).

3.2.7. Gulf Sturgeon

The Gulf sturgeon (*Acipenser oxyrhynchus desotoii*) is the only listed threatened fish species in the GOM. A subspecies of the Atlantic sturgeon, Gulf sturgeon are classified as anadromous, with immature and mature fish participating in freshwater migrations. Gill netting and biotelemetry have shown that subadults and adults spend 8-9 months each year in rivers and 3-4 of the coolest months in estuaries or Gulf waters. Sturgeon less than about two years old remain in riverine habitats and estuaries throughout the year (Clugston, 1991). According to Wooley and Crateau (1985), Gulf sturgeon occurred in most major riverine and estuarine systems from the Mississippi River to the Suwannee River, Florida, and marine waters of the Central and Eastern GOM south to Florida Bay. Important waters west-to-east and north-to-south are Biloxi Bay, Pascagoula Bay, Mobile Bay, Choctawhatchee Bay, the Apalachicola River, the Ochlockounee River, and the Suwannee River. It is not possible, at present, to estimate the size of Gulf sturgeon populations throughout the range of the species, but extant occurrences in 1996 include the Mississippi River and Lake Pontchartrain, Louisiana, to Charlotte Harbor, Florida (Patrick, personal communication, 1996). Eggs have now been discovered in six locations within the Choctawhatchee River system in Florida and Alabama (Fox and Hightower, 1998). During the riverine stage, adults cease feeding, undergo gonadal maturation, and migrate upstream to spawn. Spawning occurs over coarse substrate in deep holes. The decline of the Gulf sturgeon is believed to be due to overfishing, the damming of coastal rivers, and the degradation of water quality (Barkuloo, 1988).

3.3. SOCIOECONOMIC CONDITIONS AND OTHER CONCERNS

3.3.1. Economic and Demographic Conditions

3.3.1.1. Socioeconomic Impact Area

The MMS defines the GOM impact area for population, labor, and employment as that portion of the GOM coastal zone whose social and economic well-being (population, labor, and employment) is directly or indirectly affected by the OCS oil and gas industry. For this analysis, the coastal impact area consists of 80 counties and parishes along the U.S. portion of the GOM. This area includes 24 counties in Texas, 26 parishes in Louisiana, four counties in Mississippi, two counties in Alabama, and 24 counties in the Panhandle of Florida. Inland counties and parishes are included where offshore oil and gas activities are known to exist, where offshore-related petroleum industries are established, and where one or more counties or parishes within a Metropolitan Statistical Area (MSA) are on the coast; all counties and parishes within the MSA are included.

Note that activities proposed for the Grid 16 area are expected to have economic consequences throughout all 10 of the Gulf's coastal subareas and are likely to have global effects. Most of the probable changes in population, labor, and employment resulting from the proposed activities would occur in the 24 counties in Texas and the 26 parishes in Louisiana because the oil and gas industry is best established in this region. Some of the likely changes in population, labor, and employment resulting from the proposed activities would also occur in the six Alabama and Mississippi counties due to having an established oil and gas industry and its proximity to the offshore location. Changes in economic factors (in minor service and support industries) from the proposed activities would occur, to a much lesser extent, in the 24 counties of the Florida Panhandle because of its economy only marginally includes primary and support industries for oil and gas development

For analysis purposes, MMS has divided the impact area (defined geographically in the first paragraph of this section) into the subareas listed below. This impact area is based on the results of a recent MMS socioeconomic study, "Cost Profiles and Cost Functions for Gulf of Mexico Oil and Gas Development Phases for Input-Output Modeling." One of the objectives of this study was to allocate expenditures from the offshore oil and gas industry to the representative onshore subarea where the dollars were spent. Table E-1 (Appendix E) presents these findings in percentage terms. In the table, the IMPLAN number is the code given to the industry (sector) by the input-output software (IMPLAN) used to calculate impacts in Chapter 4 of this document. It is analogous to the standardized industry code (SIC). As shown in the table, very little has been spent in the Florida subareas. This is to be expected given the lack of offshore leasing in this area and Florida's attitude towards oil and gas development off their beaches. The table also makes clear the reason for including all of the GOM subareas in the economic impact area. Expenditures in Texas to several sectors are either exclusively found there or make up a very large percentage of the total. In addition, a significant percentage of total sector expenditures is allocated to each Louisiana subarea. The following subareas (which include the counties/parishes as listed below) are considered as the economic impact area for the proposed activities (Table 3-1).

3.3.1.2. Population and Education

Table E-2 (Appendix E) depicts baseline population projections for the potential impact area. Baseline projections are for the impact area in the absence of the proposed activities. The analysis area consists of highly populated metropolitan areas (such as the Houston MSA, which predominates Subarea TX-2) and sparsely populated rural areas (as is much of Subarea TX-1). Some communities in the analysis area experienced extensive growth during the late 1970's and early 1980's when OCS activity was booming. Following the drop in oil prices, many of these same areas experienced a loss in population (Gramling, 1984; Laska et al., 1993). All subarea populations are expected to grow at a higher rate than the United States' average annual population growth rate over the life of the proposed actions, reflecting the region migration pattern of favoring the south and west over the northeast and Midwest (USDOC, Bureau of the Census, 2001). This is a continuation of historic trends. Average annual population growth projected over the life of the proposed actions range from a low of 0.45 percent for Subarea LA-3 (dominated by the Orleans MSA) to a high of 3.27 percent for Subarea FL-3 in the lower panhandle of Florida. Over the same time period, the population for the United States is expected to grow at about 1.36 percent per year.

At present, the 2000 U.S. Census data for education at the county/parish level have not been released. The last available data at this level is the 1990 Census data. Therefore, this analysis uses the 2000 U.S. Census Supplementary Survey Profile educational attainment data for the Gulf States. For people 25 years and over, 75.2 percent of the population in the U.S. has graduated from high school, while 20.3 percent has received a bachelor's degree. Texas' educational attainment percentages are higher than the national average for both categories: 76.8 and 23.5 percent, respectively. Louisiana, while higher than the national average for high school graduates, 76.7 percent, is lower for college degrees, 19.5 percent. Mississippi's educational attainments are lower than the Nation's for both categories—74.3 and 18.6 percent, respectively. Alabama, like Louisiana, has a higher than national high school graduation rate (76.0%), but a lower rate for bachelor's degree (20.2%). Florida mirrors Texas; its educational attainments are higher than the national rates—81.9 and 23.2 percent, respectively.

Table 3-1

Listing of Counties and Parishes of the Coastal Impact Area

LA-1	LA-2	LA-3	MA-1
Acadia, LA	Ascension, LA	Jefferson, LA	Baldwin, AL
Calcasieu, LA	Assumption, LA	Orleans, LA	Hancock, MS
Cameron, LA	East Baton Rouge, LA	Plaquemines, LA	Harrison, MS
Iberia, LA	Iberville, LA	St. Bernard, LA	Jackson, MS
Lafayette, LA	Lafourche, LA	St. Charles, LA	Mobile, AL
St. Landry, LA	Livingston, LA	St. James, LA	Stone, MS
St. Martin, LA	St. Mary, LA	St. John the Baptist, LA	
Vermilion, LA	Tangipahoa, LA	St. Tammany, LA	
	Terrebonne, LA		
	West Baton Rouge, LA		
TX-1	**TX-2**	**FL-1**	**FL-3**
Aransas, TX	Brazoria, TX	Bay, FL	Charlotte, FL
Calhoun, TX	Chambers, TX	Escambia, FL	Citrus, FL
Cameron, TX	Fort Bend, TX	Okaloosa, FL	Collier, FL
Jackson, TX	Galveston, TX	Santa Rosa, FL	Hernando, FL
Kenedy, TX	Hardin, TX	Walton, FL	Hillsborough, FL
Kleberg, TX	Harris, TX		Lee, FL
Nueces, TX	Jefferson, TX	**FL-2**	Manatee, FL
Refugio, TX	Liberty, TX		Pasco, FL
San Patricio, TX	Matagorda, TX	Dixie, FL	Pinellas, FL
Victoria, TX	Montgomery, TX	Franklin, FL	Sarasota, FL
Willacy, TX	Orange, TX	Gulf, FL	
	Waller, TX	Jefferson, FL	**FL-4**
	Wharton, TX	Levy, FL	
		Taylor, FL	Miami-Dade, FL
		Wakulla, FL	Monroe, FL

3.3.1.3. Infrastructure and Land Use

The Gulf of Mexico OCS Region has one of the highest concentrations of oil and gas activities in the world. The offshore oil and gas industry has experienced dramatic changes over recent years, particularly since 1981. Historically, most of the activities have been concentrated on the continental shelf off the coasts of Texas and Louisiana. Future activities are expected to extend into progressively deeper waters and into the Eastern Planning Area (EPA). To date, only exploration activities have taken place off the shores of the State of Florida. The high level of offshore oil and gas activity in the GOM is accompanied by an extensive development of onshore service and support facilities. The major types of onshore infrastructure include gas processing plants, navigation channels, oil refineries, pipelines and pipeline landfalls, pipecoating and storage yards, platform fabrication yards, separation facilities, service bases, terminals, and other industry-related installations such as landfills and disposal sites for drilling and production wastes.

Land use in the impact area varies from state to state. The coasts of Florida and Texas are a mixture of urban, industrial, recreational beaches, wetlands, forests, and agricultural areas. Alabama's coastal impact area is predominantly recreational beaches, and small residential and fishing communities. Mississippi's coast consists of barrier islands, some wetlands, recreational beaches, and urban areas. Louisiana's coast impact area is mostly vast areas of wetlands; some small communities and industrial areas extend inward from the wetlands.

3.3.1.4. Navigation and Port Usage

A service base is a community of businesses that load, store, and supply equipment, supplies, and personnel needed at offshore work sites. Although a service base may primarily serve the OCS planning area and subarea in which it is located, it may also provide significant services for the other OCS planning areas and subareas. As OCS operations have progressively moved into deeper waters, larger vessels with deeper drafts have been phased into service, mainly for their greater range of travel, greater speed of travel, and larger carrying capacity. Service bases with the greatest appeal for deepwater activity have several common characteristics: strong and reliable transportation system; adequate depth and width of navigation channels; adequate port facilities; existing petroleum industry support infrastructure; location central to OCS deepwater activities; adequate worker population within commuting distance; and insightful strong leadership. Typically, deeper draft service vessels require channels with depths of 6-8 m (20-26 ft). The proposed activities are expected to impact Port Fourchon, Louisiana, the designated service base for the proposed action and likely service base for most of the Grid 16 area. Venice, Louisiana, is named as a back-up service base for the proposed activities associated with the Thunder Horse project. Historically, Terrebonne and Lafourche Parishes have been the primary staging and support area for offshore oil and gas exploration and development. The Port of Fourchon, at the mouth of Bayou Lafourche on the Gulf of Mexico, is a major onshore staging area for OCS oil and gas activities in the CPA and WPA and the headquarters of LOOP. Chapter 3.3.3.2 in the Multisale EIS for the CPA and WPA discusses the Port Fourchon area in detail.

3.3.1.5. Employment

Table E-3 (Appendix E) depicts baseline employment projections for the potential impact area. Baseline projections are for the impact area in the absence of the proposed Thunder Horse activities. Average annual employment growth projected over the life of the proposed actions range from a low of 1.19 percent for Subarea LA-3 (predominated by the Orleans MSA) to a high of 5.43 percent for Subarea FL-3 in the lower panhandle of Florida. Over the same time period, employment for the United States is expected to grow at about 2.25 percent per year, while the GOM analysis area is expected to grow at about 2.06 percent per year. As stated above, this represents growth in general employment for the subareas. Continuation of existing trends, both in OCS activity and other industries in the area, are included in the projections.

The industrial composition for the subareas in the WPA and that in the CPA are similar. With the exception of Subareas LA-2, LA-3, and FL-4, the top four ranking sectors in terms of employment in the analysis area are the service, manufacturing, retail trade, and State and local government sectors. In Subareas LA-2 and LA-3, construction replaces manufacturing as one of the top four industries on the basis of employment. In Subarea FL-4, transportation, communication, and public utilities replaces manufacturing as one of the top four industries on the basis of employment. The service industry employs more people in all subareas. The service industry is also the fastest growing industry.

3.3.1.6. Current Economic Baseline Data

Oil and natural gas prices are used to evaluate the oil and gas industry's ability to economically develop resources. Since the beginning of 2002, oil prices have surged more than 35 percent, but drilling for oil has declined by 3 percent. Over the same period, natural gas prices also have risen by nearly 30 percent, while drilling for natural gas has dropped nearly 15 percent. The reasons behind the drilling decline are different for oil than natural gas. An overhang in the capacity to produce oil, i.e., political uncertainty and OPEC production restraints have pushed world oil prices upward, although excess capacity is about 10 percent of world oil consumption, is restraining oil drilling. However, a continued adjustment to previous declines in natural gas prices is driving down natural gas drilling. Natural gas drilling was greatly stimulated by the strong rise in natural gas prices that occurred in 1999 and 2000. Natural gas drilling is still adjusting to the sharp decline in natural gas prices that occurred in 2001 despite recent gains in natural gas prices. Also, relatively high inventory levels of natural gas in storage raise the possibility of slippage in natural gas prices.

As of August 16, 2002, Henry Hub Natural Gas closed at \$3.10 per million Btu (an increase of 5.62% or \$0.165 from a year ago) (Oilnergy, 2002). During September 2001, natural gas futures plummeted below \$2 per thousand cubic feet for the first time since April 1999 amid concerns that the U.S. economy may slip into a recession. Natural gas demand from manufacturers, which accounts for about a quarter of U.S. consumption, was down and a turnaround in the economy was not expected in the short term (Houston Chronicle On-line, 2001a). U.S. natural gas consumption varies by 40 percent of Gross Domestic Production. As the economy strengthens, drilling for oil and natural gas is likely to pick up (Federal Reserve Bank of Dallas what year).

With world oil markets on edge over rising tensions between the United States and Iraq and uncertainty over OPECS's plans for production, September 2002 crude oil futures closed at \$29.06 on August 14, 2002, on the New York Mercantile Exchange. Crude has been on the rise much of August because of concerns over Iraq. The rally in crude oil futures were spurred by unexpected high declines in U.S. crude inventories as reported by the American Petroleum Institute and Energy Information Administration (EIA). The EIA also reported that Japan's largest oil company, Nippon Oil, had increased its crude stockpiles by 2.45 million barrels since June to cushion potential cuts in supplies from the Persian Gulf.

Exploration and production (E&P) expenditures are another indicator of the energy industry's strength. Lehman Brothers mid-year update of its original E&P spending survey of 279 companies indicates that U.S. 2002 E&P expenditures are expected to fall by 20.2 percent. This compares with a 17.9 percent decline cited in the company's December 2001 survey. However, the survey did reveal that 58 percent of the companies surveyed expect to increase E&P budgets in 2003.

In addition to E&P spending, drilling rig use is employed by the industry as a barometer of economic activity. After having hovered around 90 percent or better for most of 2000 through May 2001 before declining in June 2001 to a low around 50 percent in November 2001 before rebounding from November 2001 to April 2002 to around 70 percent where it hovered throughout the summer of 2002. As of August 16, 2002, the fleet utilization rate for all marketed mobile rigs in the GOM was 65.0 percent (One Offshore, 2002). By drilling rig type, this percentage breaks down into a 66.2 percent fleet utilization rate for jackups (average day rates of \$16,200-\$75,000); 57.5 percent for semisubmersibles (average day rates of \$30,000-\$125,000); 87.5 percent for drillships (average day rates are not available); and 57.1 percent for submersibles (average day rates of \$21,000-\$22,500). Platform rigs in the Gulf recorded a 37.8 percent fleet utilization rate, while inland barges had a 48.3 percent utilization rate. Offshore drilling rig day rates continue to decline for some rig markets but have improved in the Gulf of Mexico jackup and floating rig day rates. In the GOM, 76-m to 91-m (250-ft to 300-ft) rated jackup drilling units continued their slow improvement. Utilization among this group of rigs has been boosted by the departure of some units from the region and continued strong demand for higher-specification rigs at the top-end of the fleet. Deepwater floating rig day rates spiked up in August 2002, mostly due to the strength of two contracts signed in late July. Day rates for mid-water depth semisubmersible drilling rigs continue to seesaw along with demand for rigs of this class. Since utilization of semisubmersible rigs has increased for two consecutive months, so have day rates for these rigs (One Offshore, 2002).

As rig utilization rates have fallen and the market has become much softer, drilling contractors are no longer lamenting the lack of skilled crews to run their rigs. While some contractors are recruiting vigorously, some are only recruiting for deepwater vessels, while others are not recruiting at all or only at the entry level. With some operators still "stinging" from laying off too many crews during the last downturn, it appears that many companies are more careful about laying off crews this time in response to a slowing market. If companies begin laying off personnel, when the market turns up again, drilling contractors may once again be left out in the cold when it comes to recruiting skilled personnel (One Offshore, 2001b).

The still depressed GOM rig market continues to hit offshore service vessel (OSV) operators hard, with the smaller vessel owners hit the hardest. The most significant barometer of rig activity is what the energy companies are thinking, even if commodity prices are high enough to make money. The June 2002 utilization rates for supply boats and crewboats used by the offshore oil and gas industry decreased from the June 2001 Figures and for the most part, average day rates for these vessels followed suit. However, anchor-handling tug/supply vessels (AHTS) utilization and average day rates increased over the same time period. Average day rates for AHTS vessels ranged from $12,500 for under 6,000-hp vessels (up $2,000 or 19 % from last year's rate) to $15,500 for over 6,000-hp vessels (up $3,000 or 24% from last year's rate); utilization rates were 100 percent for both. Supply boat average day rates ranged from $5,390 for boats up to 61 m (200 ft) (down $3,010 or 36% from a year ago) and $10,725 for boats 61 m and over (up $125 or 1% from a year ago); utilization was 61 percent and 96 percent, respectively. Crewboat average day rates ranged from $2,100 for boats under 38 m (125 ft) to $3,000 for boats 38 m and over (both down about 22% from last year's average rates); utilization was 71 percent and 82 percent, respectively (Greenberg, 2002).

Commencing with Central GOM Lease Sale 178 Part 1 in March 2001, new royalty relief provisions for both oil and gas production in the GOM's deep and shallow waters were enacted. These rules will govern the next three years of lease sales. Central Gulf Lease Sale 178 Part 1 resulted in 534 leases (an increase of 59.88% or 200 blocks from Central Gulf Lease Sale 175 in March 2000). Of these 534 leases, 348 were in shallow water (0-400 m). This increase of 67.30 percent from the last Central Gulf lease sale largely reflects the intensified interest in natural gas due to higher prices over the last year and the new royalty relief provisions. The 186 blocks receiving bids in deepwater (greater than 400 m) reflect an increase of 47.62 percent or 60 blocks. Again, this dramatic increase in leasing could be a result of the recently issued royalty relief provisions. Western GOM Lease Sale 180 and Central GOM Lease Sale 178 Part 2, offering the newly available United States' blocks beyond the U.S. Exclusive Economic Zone, were held on August 22, 2001. No bids were received for blocks offered in Central Gulf Lease Sale 178 Part 2. Of the 4,114 blocks offered in Western Gulf Lease Sale 180, 320 received bids. About 55 percent of blocks receiving bids (177 blocks) in Western Gulf Lease Sale 180 are in deepwater, and 175 of these deepwater blocks were leased. In Sale 181 in the Eastern GOM held on December 5, 2001, all 95 deepwater blocks receiving bids were leased. In Central GOM Sale 182, held March 20, 2002, 307 shallow-water blocks and 199 deepwater blocks received bids. In Western GOM Sale 184, held August 21, 2002, 164 shallow-water blocks and 159 deepwater blocks received bids.

3.3.1.7. Environmental Justice

On February 11, 1994, President Clinton issued an executive order to address questions of equity in the environmental and health conditions of impoverished communities. The most effective way of assuring that environmental endangerment is not concentrated in minority or low-income neighborhoods is to locate and identify these neighborhoods from the outset of a proposed project. While low incomes tend to coincide with concentrations of minority populations – African American, Hispanic, Native American, and/or Asian people – living on low incomes also include fishermen and timber harvesters. Minority populations within the Grid 16 impact area include African American and Hispanic persons, Native American tribal members, and Asians.

The web site www.NativeWeb.org lists tribes that are located in the impact area including the Chitimacha, Tunica-Biloxi, Coushatta, Houma, and Jena Band of Choctaws. In the early 1970's, only the Coushatta tribe was federally recognized. Today, four of the five tribes have Federal status, with the United Houma Nation still awaiting a finding on its petition. Since members of both the Houma Nation and the Bayou Lafourche community of the Biloxi-Chitimacha-Choctaw live principally around the bayou and close to Port Fourchon, they could be directly affected by increases in oil and gas activities from the Grid 16 area and the proposed action.

3.3.1.8. Commercial Fisheries

More than 26 percent (40% excluding Alaska) of commercial fish landings in the continental U.S. occur in the GOM. In 1999, the GOM placed second in total landed weight (almost 1 million tons) and third in value ($776 million) considering all U.S. regions (USDOC, NMFS, 2001). The most important species, such as menhaden, shrimps, oyster, crabs, and drums, are all species that depend heavily on estuarine habitats and the fisheries are restricted to the continental shelf. Menhaden was the most valuable finfish landed in 1999, accounting for $78.5 million in total value. The GOM shrimp fishery, however, is the most valuable fishery in the U.S., and the Gulf fishery accounts for 71.5 percent of total domestic production.

Commercial fishing in deeper waters, i.e., >200 m (>656 ft), of the GOM is characterized by fewer species, and lower landed weights and values than the inshore fisheries. Historically, the deepwater offshore fishery contributes less than 1 percent to the regional total weight and value (USDOI, MMS, 2001a). Target species can be classified into three groups: (1) epipelagic fishes, (2) reef fishes, and (3) invertebrates. In general, Grid 16 and the Thunder Horse development is beyond the normal depth range of commercial reef fishes and invertebrates. While it is possible that new species of demersal fish or invertebrates may be pursued in the future, if other fisheries fail, it appears unlikely at present because of the high cost and risk of fishing at extreme water depths. In addition, considerable time, effort, and finances would have to be expended to develop new markets for new species. Thus, if new fisheries develop in the deepwater Gulf, the most likely target species would be the epipelagic fishes, normally fished using surface longlines.

Epipelagic commercial fishes include dolphin, sharks (silky, and tiger; many species of shark are now protected and harvest is prohibited including mako and thresher), snake mackerels (escolar and oilfish), swordfish, tunas (bigeye, blackfin, bluefin, and yellowfin), and wahoo (USDOI, MMS, 2001a). These species are widespread in the Gulf and probably occur in Grid 16. Oceanic pelagic fishes were not landed in high quantities relative to other finfish groups. However, during 1983-1993 in the Eastern Gulf (very near the Thunder Horse development), they were very valuable, ranking second to reef fishes in average dollar value of landings. The most important species, yellowfin tuna and swordfish, were caught primarily by surface longline in oceanic waters offshore the shelf break. Since these fisheries operate in the open Gulf, catches responsible for specific State landings could have been made in waters outside the region.

Grid 16 and the Thunder Horse development are relatively near an area that is closed to longline fishing. On November 1, 2000, the NMFS put into effect a new regulation to reduce bycatch and bycatch mortality in the pelagic longline fishery. Two rectangular areas in the Gulf of Mexico (one of which lies over a portion of the DeSoto Canyon area and the area of the proposed action) are closed year-round to pelagic longline fishing. These closed areas cover 32,800 mi^2 (84,950 km^2). This region has been identified by the NMFS as a swordfish nursery area, and where there has historically been a low ratio of swordfish kept to the number of undersized swordfish discarded, which over the period of 1993-1998 has averaged less than one swordfish kept to one swordfish returned. The area closure is expected to produce approximately a 4 percent reduction in Gulf and Atlantic undersized swordfish bycatch. The DeSoto Canyon area coordinates are shown in Table 3-2.

Table 3-2

Area of Longline Fishing Ban, Eastern Planning Area

Upper Area		Lower Area	
Boundary	Location	Boundary	Location
North	30 °N. latitude	North	28 °N. latitude
South	28 °N. latitude	South	26 °N. latitude
East	86 °W. longitude	East	84 °W. longitude
West	88 °W. longitude	West	86 °W. longitude

The Thunder Horse development lies only 50 km (27 nmi) to the west of the northern closure area. This proximity to the closed longline area may restrict the activities in the immediate vicinity of the Thunder Horse project. Additional information or greater depth of discussion on commercial fisheries can be found in the Final EIS for Lease Sale 181 (USDOI, MMS, 2001). A map showing the location of the longline fishing ban areas and the EPA sale area is shown in Figure III-9 of the Final EIS for Lease Sale 181 (USDOI, MMS, 2001).

3.3.1.9. Recreational Resources

Over the past 20 years, the northern Gulf of Mexico coastal zone has become increasingly domesticated with residential and recreational land use predominating the transition. Figure 3-2 below is a satellite photograph that shows the distribution of the population throughout the United States by light intensity. The most intense light indicates population centers. One notices immediately that nearly all of the Gulf Coast is a concentrated band of light. In addition to homes, condominiums and some industry, that same coastline is one of the major recreational regions of the United States, particularly for marine fishing and beach activities, both of which are viewed as public assets, belonging to no one individual or company. There is a diversity of natural and developed landscapes and seascapes, including coastal beaches, barrier islands, estuarine bays and sounds, river deltas, and tidal marshes. Other recreational resources are publicly owned and administered, such as national and State seashores, parks, beaches, and wildlife lands, as well as designated preservation areas, such as historic and natural sites and landmarks, wilderness areas, wildlife sanctuaries, research reserves and scenic rivers. Gulf Coast residents and tourists from throughout the nation, as well as from foreign countries, use these resources extensively and intensively for recreational activity. Commercial and private recreational facilities and establishments, such as resorts, marinas, amusement parks, and ornamental gardens, also serve as primary-interest areas. Locating, identifying, and observing coastal and marine birds, is part of a growing interest in the interrelationships of any given ecosystem.

Although there is recreational use of the Central Gulf Coast year round, the primary season is the spring and summer.

More than 25 years ago, Congress set aside outstanding examples of Gulf coastal beach and barrier island ecosystems to be managed by the National Park Service for the preservation, enjoyment, and understanding of their inherent value. State and county legislation added to this preservation program so that today there is a lengthy list of reserves, refuges, and public parks.

The United States coastline potentially affected by the development of Grid 16 is from Lafourche Parish east to St. Bernard Parish in Louisiana. It includes Jefferson and Plaquemines Parishes and encompasses the confluence of the Mississippi River with the sea forming one of the largest delta systems in the United States (Alabama Seaport, 2001; page 25). This section describes some of the coastline according to topography, discrete human and other biological populations, barrier island formations, and special preservation areas. This gives the reader the chance to put in geographical context the textual descriptions. Likewise, the reader will note that these parishes host a plethora of ecological characteristics that humans use for recreation, research, conservation, and mineral extraction.

Figure 3-2. Satellite Photograph Shows the Distribution of the U.S. Population Light Intensity. Source: National Aeronautics and Space Administration, Astronomy Picture of the Day, November 27, 2000. http://antwrp.gsfc.nasa/gov/apod/image/0011/earthlights2_dmsp_big.jpg

3.3.1.9.1. Federal and State Reserves

The three parishes of Cameron, Lafourche, and Jefferson comprise the Federal reserves of the Barataria-Terrebonne National Estuary Program, the Atchafalaya National Wildlife Refuge, and the Jean Lafitte National Historic Park and Reserve. Additional acreage is in wildlife management areas that are either owned or managed by the State of Louisiana, Department of Wildlife and Fisheries. Within the impact area, these areas are Pointe-au-Chien in Terrebonne and Lafourche Parishes; Wisner Wildlife Management Area in Lafourche Parish, close to Port Fourchon; Pass a Loutre in Plaquemines Parish; and Biloxi Wildlife.

3.3.1.9.2. Marine Recreational Activities

In coastal Louisiana, marine fishing and diving are also important to the State's economy. This marine industry generates millions of dollars in sales of equipment, transportation, food, lodging, insurance, and services and accounts for thousands of jobs. Just over one-third of the marine recreational fishing trips in the Gulf of Mexico extend into offshore water under Federal jurisdiction. According to statistics from the NMFS, fishermen catch a variety of species, from barracudas and sharks to drums, snappers, and flounders (http://www.st.nmfs.gov/pls/webpls, August 28, 2002). Recreational diving trips are popular in nearshore and offshore waters near natural and artificial reefs. Indeed, in a study for the MMS, researchers found that fishing, party, and diving trips originating from Louisiana's coast numbered over 3 million in 1999, higher than any of the other three states lining the Gulf of Mexico (Hiett and Milon 2002; pages 2-4).

3.3.1.10. Archaeological Resources

Archaeological resources are any material remains of human life or activities that are at least 50 years of age and that are of archaeological interest. The archaeological resources regulation (30 CFR 250.194) provides specific authority to each MMS Regional Director to require archaeological resource surveys, analyses, and reports. Surveys are required prior to any exploration or development activities on leases within the high-probability areas (NTL 2002-G01).

3.3.1.10.1. Prehistoric

Available geologic evidence suggests that sea level in the northern GOM was at least 90 m (295 ft), and possibly as much as 130 m (427 ft), lower than present sea level, and that the low sea-stand occurred during the period 20,000-17,000 years before present (B.P.) (Nelson and Bray, 1970). Sea level in the northern Gulf reached its present stand around 3,500 years B.P. (Coastal Environments, Inc., 1986).

During periods that the continental shelf was exposed above sea level, the area was open to habitation by prehistoric peoples. The advent of early man into the GOM region is currently accepted to be around 12,000 years B.P. (Aten, 1983). According to the sea-level curve for the northern GOM proposed by Coastal Environments, Inc. (CEI), sea level at 12,000 B.P. would have been approximately 45 m (148 ft) below the present still stand (CEI, 1977 and 1982). On this basis, the continental shelf shoreward of the 45-m to 60-m (148-ft to 197-ft) bathymetric contours has potential for prehistoric sites dating after 12,000 B.P. Because of inherent uncertainties in both the depth of sea level and the entry date of prehistoric man into North America, MMS adopted the 12,000 years B.P. and the 60-m (197 ft) water depth as the seaward extant of the prehistoric archaeological high-probability area.

Based on the extreme water depth of Grid 16 and the Thunder Horse project lease blocks, oil or gas activities will not impact any prehistoric archaeological resources.

3.3.1.10.2. Historic

With the exception of the Ship Shoal Lighthouse structure, historic archaeological resources on the OCS consist of historic shipwrecks. A historic shipwreck is defined as a submerged or buried vessel, at least 50 years old, that has foundered, stranded, or wrecked and is presently lying on or embedded in the seafloor. This includes vessels (except abandoned hulks) that exist intact or as scattered components on or in the seafloor. A 1977 MMS archaeological resources baseline study for the northern GOM concluded that two-thirds of the total number of shipwrecks in the northern Gulf lie within 1.5 km (0.9 mi) of shore and most of the remainder lie between 1.5 and 10 km (0.9 and 6.2 mi) of the coast (CEI, 1977). A subsequent MMS study published in 1989 found that changes in the late 19th and early 20th century sailing routes increased the frequency of shipwrecks in the open sea in the Eastern Gulf to nearly double that of the Western and Central Gulf (Garrison et al., 1989). The highest observed frequency of shipwrecks occurred within areas of intense marine traffic, such as the approaches and entrances to seaports and the mouths of navigable rivers and straits.

Review of the Garrison et al. (1989) and Pearson et al. (2002) shipwreck database lists eight shipwrecks that fall within Grid 16 (in the Mississippi Canyon and Viosca Knoll areas). These shipwrecks are listed in Table 3-3. Five of the shipwrecks listed by the Garrison et al. (1989) and Pearson et al. (2002) studies are known only through the historical record and, to date, have not been located on the ocean floor. Three of the wrecks, the *U-166*, *Alcoa Puritan*, and the *Robert E. Lee*, have been located on the seafloor by pipeline or lease block side-scan-sonar surveys. The Garrison et al. (1989) and Pearson et al. (2002) shipwreck databases should not be considered exhaustive lists of shipwrecks. Regular reporting of shipwrecks did not occur until late in the 19th century, and losses of several classes of vessels, such as small coastal fishing boats, were largely unreported in official records.

Wrecks occurring in deeper water would have a moderate to high preservation potential, as can be seen by the copper-sheathed wreck in Mississippi Canyon, Block 74, just three lease blocks west of Grid 16. In the deep water, temperature at the seafloor is extremely cold, which slows the oxidation of ferrous metals and help to preserve wood features. The cold water would also eliminate woodeating shipworm *Terredo navalis* (Anuskiewicz, 1989).

Aside from acts of war, hurricanes cause the greatest number of wrecks in the Gulf. The wreckage of the 19th-century steamer *New York,* which was destroyed in a hurricane in 1846, lies in 16 m (52 ft) of water and has been documented by the MMS (Irion and Anuskiewicz, 1999) as scattered over the ocean floor in a swath over 457 m (1,500 ft) long. Shipwrecks occurring in shallow water nearer to shore are more likely to have been reworked and scattered by subsequent storms than those wrecks occurring at greater depths on the OCS. Historic research indicates that shipwrecks occur less frequently in Federal waters. However, these wrecks are likely to be better preserved, less disturbed, and, therefore, more likely to be eligible for nomination to the National Register of Historic Places than are wrecks in shallower State waters.

Table 3-3

Shipwrecks in Grid 16 Area

Area	Vessel Name	Date of Loss
Viosca Knoll	*Bradford C. French*	1916
Viosca Knoll	Unknown	Unknown
Mississippi Canyon	*Providence*	1982
Mississippi Canyon	*Western Empire*	1875
Mississippi Canyon	*German Submarine U-166**	1942
Mississippi Canyon	*Alcoa Puritan**	1942
Mississippi Canyon	*Robert E. Lee**	1942
Mississippi Canyon	*Heedless*	1962

*Deepwater shipwrecks located by side-scan sonar.

4. POTENTIAL ENVIRONMENTAL EFFECTS

4.1. PHYSICAL ELEMENTS OF THE ENVIRONMENT

4.1.1. Impacts on Water Quality

4.1.1.1. Coastal

The proposed Thunder Horse project is located approximately 108 km (67 mi) from the nearest Louisiana coastline (the closest shoreline is the Mississippi River's active delta area). Effects to coastal waters from the project would primarily be associated with onshore support activities. BP plans to use existing onshore support bases at Port Fourchon (primary base), Terrebonne Parish, and Venice (secondary base), Plaquemines Parish, Louisiana. No expansion of these onshore facilities is expected to result from the proposed activities. No increase in maintenance dredging of access canals is expected.

Waste waters would be discharged from the onshore bases as well as support vessels. State regulations are in place to control contaminants associated with these waste discharges. Minor, transient changes in localized water quality would be intermittent, resulting from such waste discharges.

Accidental spills could also affect coastal waters. See Appendix B for a discussion of these potential effects.

Offshore sediment disturbance described below is not likely to impact coastal water quality since the coastal area is characterized by turbid, contaminated water discharged from the Mississippi River.

Conclusion

Since the proposed action would use existing onshore support bases and these facilities are not expected to expand as a result of the project's activities, only discharges from these support bases and associated vessel traffic would result in effects to coastal waters. The level of these effects is expected to be very minor and transient, negligibly affecting coastal water quality. Offshore activities associated with the project are not expected to adversely affect coastal water quality because of the water depth and the distal location of the project.

4.1.1.2. Offshore

Localized sediment disturbance will occur from the emplacement of anchors and the mooring system associated with the PDQ facility as well as from other subsea infrastructure, e.g., drilled wells, manifolds, umbilicals, and other subsea equipment. Sediments will also be disturbed from the installation of risers and from oil and gas lease-term and right-of-way pipelines. Sediment disturbance and increased turbidity would create little effect on the offshore water quality because the inputs would be localized and limited in amount and the disturbances would be spread out over time. Light limitation, one of the effects of high turbidity, is not an issue in the deepwater area of Grid 16. Surface sediments in the deepwater GOM are relatively pristine so that any turbidity created by bottom disturbances would not decrease water quality other than for the expected increase in total suspended solids (TSS). In conclusion, any effects from elevated turbidity would be short term, localized, and reversible.

BP will not discharge its produced water from the Thunder Horse project. They plan to co-mingle and reinject the produced water to support pressure maintenance of the producing reservoirs.

Sanitary and domestic waste discharges from personnel on-site are expected to increase nutrient input and biological oxygen demand (BOD) slightly, but this is not normally a concern in open oceanic waters. Other minor discharges from development activities such as deck drainage, excess cement, other well fluids, and cooling water would affect water quality (e.g., TSS, nutrients, chlorine, and BOD) within tens of meters of the discharge.

Accidental spills are examined in Appendix B. Oil from a spill would weather dependent upon a number of factors, particularly the characteristics of the released oil and oceanographic conditions. Some of the subsurface oil may disperse within the water column, as in the case of the *Ixtoc I* seafloor blowout. Evidence from a recent experiment in the North Sea indicated that oil released during a deepwater blowout [844 m (2,769 ft) water depth] would quickly rise to the surface and form a slick (Johansen et al., 2001). Once the oil enters the ocean, a variety of physical, chemical, and biological processes act to disperse the oil slick. These include spreading, evaporation of the more volatile constituents, dissolution into the water column, emulsification of small droplets, agglomeration sinking, microbial modification, photochemical modification, and biological ingestion and excretion. Some oil from the slick would be mixed into the water and dispersed by wind and waves. The quality of marine waters would be temporarily affected by the dissolved components and small, dispersed oil droplets that do not rise to the surface are mixed down by surface turbulence. Dispersion by currents and microbial degradation remove the oil from the water column or dilute the constituents to background levels.

Decommissioning effects would presumably be similar in scope and magnitude with offshore construction and installation operations. All discharges would adhere to existing regulatory discharge criteria designed to mitigate adverse environmental effects.

Conclusion

Near-bottom water quality would be affected by sediments disturbed during the period of installation of subsea infrastructure, including the moorings and anchors and the risers and pipelines that would transport the oil and gas from the Thunder Horse field. Any effects from the elevated turbidity would be short term, localized, and reversible.

Offshore effects from an accidental spill of oil would affect water quality immediately under the slick (top few meters of the water column). Operator-initiated activities to contain and clean up an oil spill would begin as soon as possible after an event. However, the remaining portion of the discharged oil would weather, disperse, and biodegrade within a short period of time so that no significant long-term effects on offshore water quality are expected to occur.

4.1.2. Impacts on Air Quality

Air quality will be affected in the immediate vicinity of the production facilities, the drilling rigs, and the attending vessels and aircraft. The operator provided air emissions data for the next 12 years. The cumulative impact from emissions for BP's Supplemental Exploration Plan and this Development Operations Coordination Document will not exceed the MMS's exemption level. Activities associated with these plans are not expected to significantly affect onshore air quality. Impacts from NO_x emissions will be highest during the years when production and construction are taking place. Emissions of SO_x will be highest during the days when temporary flaring occurs.

Air quality would be affected in the event of a blowout or oil spill. The VOC's, which would escape, are precursors to photochemically produced ozone. A spike in VOC's could contribute to a corresponding spike in ozone, especially if the release were to occur on a hot sunny day in a NO_2-rich environment. The corresponding onshore area is in attainment for ozone. If a fire occurs, particulate and combustible emissions will be released in addition to the VOC's.

Conclusion

The air quality in the immediate vicinity of the proposed activities will be affected by the projected emissions. However, the proposed action is not expected to result in any significant impacts to air quality.

4.2. Biological Resources

4.2.1. Impacts on Sensitive Coastal Environments

4.2.1.1. Coastal Barrier Beaches and Associated Dunes

The following section describes potential impacts to coastal barrier beaches and associated dunes from oil spills that might occur as a result of activities proposed in Grid 16. Appendix B describes the probability of an oil spill and the estimated dispersal characteristics should a spill occur. Spill response and effectiveness is also discussed in Appendix B.

Contact between an oil slick and a beach primarily depends upon environmental conditions and the nature of the oil spilled. It is not very likely that severe adverse impacts would occur to dunes from a spill within the Grid 16 area. For storm tides to carry oil from a spill across and over the dunes, strong southerly or easterly winds must persist for an extended period of time, prior to or immediately after the spill. The strong winds that would be required to raise the water level sufficiently to contact dunes would also result in oil slick dispersal, thereby reducing impact severity at a landfall site. In addition, a study in Texas showed that oil on vegetated sand dunes had no deleterious effects on the existing vegetation or on the recolonization of the oiled sand by plants (Webb, 1988).

The cleanup operations associated with large oil spills can affect the stability of barrier beaches more than the spill itself. If large quantities of sand were removed during spill cleanup operations, a new beach profile and sand configuration would be established in response to the reduced sand supply and volume. The net result of these changes could be accelerated rates of shoreline erosion at the contact site and down drift of that site. This situation would be accentuated in sand-starved or eroding barrier beaches, such as those found on the Louisiana coast. State governments around the Gulf have recognized these problems and have established policies to limit sand removal by cleanup operations.

Conclusion

Actions proposed in Grid 16 are not expected to adversely alter barrier beach or dune configurations significantly as a result of a related oil spill, should one occur.

4.2.1.2. Wetlands

A description of a hypothetical oil spill associated with the proposed action is provided in Appendix B. The information below regarding potential effects of oil spills on wetlands is based on analyses in the Final Multisale EIS (USDOI, MMS, 2002).

Data in Appendix B indicate that a very low probability exists for an oil spill to occur from the Thunder Horse development. As discussed in USDOI, MMS 2002, distant offshore spills have an even further diminished probability of impacting inland wetland shorelines and seagrasses, largely due to the sheltered locations of these habitats.

An inland, fuel-oil spill may occur at a shore base or as a result of a vessel collision. The probability of an inland, fuel-oil spill occurring in association with the proposed action is very small. However, should a spill occur inshore or in nearshore waters, it presents a much greater potential for adversely impacting wetlands and seagrasses than an offshore spill, due simply to their proximity to the spill. Oil could accumulate in sheens and thick layers in the marsh and in protected pools and embayments.

The works of several investigators (Webb et al., 1981 and 1985; Alexander and Webb, 1983, 1985, and 1987; Lytle, 1975; Delaune et al., 1979; Fischel et al., 1989) were used to evaluate effects of potential spills to area wetlands. For wetlands along the central Louisiana area, the critical oil concentration is assumed to be 1.0 l/m^2 of marsh. Concentrations above this would result in longer-term effects to wetland vegetation, including some plant mortality and loss of land. Concentrations less than this may cause diebacks for one growing season or less, depending upon the concentration and the season during which contact occurs.

Conclusion

It is highly unlikely that significant adverse impacts to wetlands would result from a spill associated with the proposed Thunder Horse project. If a spill does occur offshore, oceanographic and meteorological conditions are very unlikely to move the spilled oil far enough in a short enough time to cause oil contacts with wetlands. If an unlikely, project-related fuel-oil spill occurs inshore, some wetlands in the vicinity of the spill may be adversely impacted.

4.2.1.3. Seagrasses

Seagrasses have generally experienced little or no damage from oil spills (Chan, 1977; Zieman et al., 1984). The relatively low susceptibility of seagrasses in the northern GOM to oil-spill impacts is partly the result of their location, which is subtidal, generally landward of barrier islands and in a region with a small tidal range. Furthermore, it should be noted that seagrasses are much less common in Louisiana, the most likely landfall for a spill event, than elsewhere in the Gulf.

The lack of low-tide exposure protects seagrasses from direct contact with spilled oil. The degree of impact depends on water depth, the nature of the oil, and the tidal and weather events in the affected area during the presence of the floating oil. Another reason for the low susceptibility of seagrass to oil spills is that a large percentage of their biomass is found in the buried root and rhizome, from which the leaves generate. An oil spill that moves over a seagrass area would not be expected to directly cause anything but slight damage to the vegetation. Some seagrass dieback for one growing season might occur, largely depending upon water currents and weather. No permanent loss of seagrass habitat is expected to result from such spills.

During extremely low water conditions such as wind-driven tidal events, seagrass beds might be exposed to the air and could potentially be impacted directly by an oil slick. Even then, their roots and rhizomes remain buried in the water bottom. Given the geography of the coastal area discussed, a strong wind that could lower the water that much generally would be a northerly or westerly wind, which would push water out of bays and estuaries and drive a slick away from the coast. In this situation, oil that was already in the bay or sound would be driven against the southern or eastern shores. Any seagrass beds that may be exposed there might be contacted.

The greatest oil-spill effect to seagrass communities has been to the diversity and populations of the epifaunal community found in the grass bed. Should water turbulence and turbidity increase sufficiently, some oil on the water surface may be emulsified. Suspended particles in the water column will adsorb oil from a sheen as well as from emulsified droplets, causing some particulates to clump together and decrease their suspendability. Typically, submerged vegetation reduces water velocity among the vegetation as well as for a short distance above it. Reduced flow velocity or turbulence further enhances sedimentation.

Minute oil droplets, whether emulsified or bound to suspended particulates, may adhere to vegetation or other marine life; they may be ingested by animals, particularly by filter and sedimentation feeders; or they may settle onto bottom sediments in or around a bed. In these situations, oil has a limited life because it will be degraded chemically and biologically (Zieman et al., 1984).

The potential danger to a seagrass community from an oil-spill event is a reduction for up to two years of the diversity or population of epifauna and benthic fauna found in grass beds. The degree of impact further depends on the time of year, water depth, currents, and weather in the affected area during the presence of a slick, as well as oil characteristics such as density, solubility, ability to emulsify, and toxicity.

A more damaging scenario would involve the secondary impacts of a slick that remains, for a period of time, over a submerged bed of vegetation in a protected embayment during typical fair-weather conditions. This would reduce light levels in the bed. If light reduction continues for several days, chlorophyll content in the leaves will be reduced (Wolfe et al., 1988), causing the grasses to yellow, reducing their productivity. By itself, shading from an oil slick should not last long enough to cause mortality. This depends upon the slick thickness, currents, weather, efforts to clean up the slick, and the nature of the embayment.

Also, a slick that remains over a submerged vegetation bed in an embayment will reduce or eliminate oxygen exchange between the air and the water of the embayment. Currents may not flush adequately oxygenated water from the larger waterbody to the shallow embayment. Seagrasses and related epifauna might be stressed and perhaps suffocated if the biochemical oxygen demand is high, as would be expected for a shallow waterbody that contains submerged vegetation, with its usual detritus load, and an additional burden of spilled oil (Wolfe et al., 1988).

The cleanup of slicks that come to rest in shallow or protected waters (0-1.5 m [0-5 ft] deep) may be performed using "john" boats, booms, anchors, and skimmers mounted on boats or shore vehicles. Personnel assisting in oil-spill cleanup in water shallower than about 1 m (3-4 ft) may readily wade through the water to complete their tasks. Foot traffic and cleanup equipment can easily damage the seagrass beds. Oil can also be worked more deeply into their sediments by these activities.

As described for wetlands, oil that penetrates or is buried into the water bottom is less available for dissolution, oxidation, or microbial degradation. Oil may then be detectable in the sediments for five years or more, depending upon circumstances.

Navigational vessels that vary their route from established navigation channels can directly scar shallow beds of submerged vegetation with their props, keels (or flat bottoms), and anchors (Durako et al., 1992).

Conclusion

It is highly unlikely that significant adverse impacts to seagrasses would result from a spill associated with the proposed Thunder Horse project. If a spill does occur offshore, oceanographic and meteorological conditions are very unlikely to move oil far enough in a short enough time to cause oil contacts with seagrasses. If an unlikely, project-related fuel-oil spill occurs inshore, some wetlands in the vicinity of the spill may be adversely impacted; however, seagrasses are unlikely to be impacted directly.

4.2.2. Impacts on Deepwater Benthic Communities/Organisms

4.2.2.1. Chemosynthetic Communities

A review for the potential occurrence of chemosynthetic communities was performed for the Thunder Horse project and for the Grid 16 area. This review was conducted using the most recent available information. No areas for potential chemosynthetic communities were identified in the areas, including the 457-m (1500-ft) avoidance distance from the discharging structure, required by NTL 2000-G20. No other potential chemosynthetic community areas were identified within 152 m (500 ft) of all 16 anchor locations or anchor chain/cable impacting areas for the semi-submersible drill site as well as the other drill sites that will be using dynamically positioned drilling units. The closest known chemosynthetic community is located in Viosca Knoll, Block 826, more than 72 nmi to the northeast of the Thunder Horse development. The absence of chemosynthetic communities in this review does not preclude the discovery of additional communities as new data become available from future operations within the grid.

Conclusion

The proposed Thunder Horse project would not have an impact on known chemosynthetic communities and no potential communities are located in the vicinity of the proposed activities, as indicated by geophysical characteristics.

4.2.2.2. Deepwater Benthos and Sediment Communities

The deepwater benthos in the immediate vicinity of the proposed Thunder Horse project would be impacted by the discharge of drilling mud and cuttings, placement of mooring lines and anchors, and well site locations (the dynamically positioned drill sites would not have anchor impacts). The most common adverse impact would be physical smothering by sediments. Invertebrates, many with some degree of mobility, typically dominate the megafaunal benthic communities at the project depth of about 1,840 m (6,076 ft). The macrofauna is dominated by deposit-feeding polychaete worms with varying degrees of mobility and tolerance to disturbance. The meiofauna, primarily composed of small nematode worms, is more abundant than macrofauna, and their numbers decline with depth. Little is known of the microbiota in deepwater, but it probably includes hydrocarbon-degrading forms. None of the benthic communities found around the Thunder Horse project are unique to the area and appear to be widespread throughout the Gulf, where depths, substrates, and other environmental factors are similar.

The effects of drilling muds and cuttings on the deepwater benthos would be limited for the following reasons:

- *Low Toxicity*. The synthetic-based fluids (SBF) are expensive and are recycled. Any unusable portion of the SBF is sent to approved recycling/disposal sites onshore. The SBF cuttings would be treated to conform to regulatory guidelines. The SBF's are essentially nontoxic, and the composite formulation of the discharged fluid adhering to the cuttings has a very low toxicity to aquatic organisms. Most of the SBF in current use can easily pass the USEPA's 96-hour, LC_{50} criteria of 30,000 ppm (McKelvie and Ayers, 1999). Test results with four types of SBF's on algae, mysids, copepods, mussels, and amphipods range from 277 to 1,000,000 ppm (McKelvie and Ayers, 1999). Dose response studies on fish by Payne et al. (2001a and b) demonstrated that sediments contaminated with Hibernia (Grand Banks, Newfoundland) source cuttings containing an aliphatic hydrocarbon-based synthetic drilling fluid had a very low toxicity potential. Acute toxicity was not observed in juvenile flounder exposed for up to two months to sediment containing approximately 6,000 ppm of diesel-range (aliphatic) hydrocarbons.
- *Limited Biological Effects*. The only direct biological effect reported for SBF's and associated cuttings in the field environment has been smothering of benthic animals by physical and/or anoxic conditions. Anoxia is caused by the rapid biodegradation of the SBF. Organic enrichment due to the introduction of carbon into a carbon-poor environment has also been noted (Gallaway and Beaubien, 1997).
- *Limited Affected Area*. Cuttings from wells drilled with SBF tend to clump together and are transported to the bottom relatively quickly. Thus, the affected area would be relatively small. The vast majority of historical literature [based on the more toxic oil-based mud (OBM) or water-based mud (WBM) that tend to disperse farther] indicates biological effects generally do not occur beyond 500 m (1,640 ft) from the source, although several papers have noted subtle effects beyond that range. Most relevant is the recent research in the North Sea (Jensen et al., 1999) that studied a number of platforms that used only SBF's. That study found no benthic effects (i.e., benthic effects as measured by subtle community changes) beyond 250 m (820 ft) in most cases, and 500 m (1,640 ft) in a few cases. However, one must note that the North Sea is a shallower environment than the deepwater GOM.

The anchor system for the semisubmersible PDQ and mooring lines should have minimal effects on the benthos. Installation of the suction-pile anchors and activities at the proposed well sites would physically disturb the benthos in the immediate vicinity. The benthos would also be affected in the unlikely event of a subsea blowout that caused disturbance and slumping of the surrounding seabed.

Conclusion

Structure emplacement (including anchor installations and moorings), well drilling, and completion operations would disturb benthic communities by smothering and displacing them from patches within limited distances of the well site locations and within a small area of the anchors and chains or cables that contact the bottom. Partial recovery of the community would occur within weeks or months of the disturbance probably followed by a more or less full recovery within 1-2 years. This would not result in a significant impact on the benthic communities because of the duration and area extent of the proposed activities would be limited.

Routine production activities would not significantly impact the benthos. A subsea blowout would physically disturb the benthos within a small radius of the blowout, but most of the released fluids are expected to go to the surface and not interact with deepwater benthos.

4.2.3. Impacts on Marine Mammals

Some potential effects on GOM marine mammals include disturbance (subtle changes in behavior, interruption of previous activities, or short- or long-term displacement); masking of sound (calls from conspecifics, important cues such as surf or predators, reverberations from own calls); stress (physiological); and hearing impairment (permanent or temporary) by explosions and other strong noise sources.

The major impact-producing factors affecting marine mammals as a result of routine OCS activities within Grid 16 and associated with the proposed Thunder Horse project include the noise generated by helicopters, vessels, and operating facilities; vessel traffic; underwater obstacles; explosive structure removals; jetsam and flotsam from associated support vessels and structure facilities; degradation of water quality from operational discharges; accidental chemical/waste spills or releases; and spill-response actions.

Some effluents are routinely discharged into offshore marine waters. However, BP has chosen not to discharge its produced water from the Thunder Horse development. It is expected that cetaceans may have some interaction with other routine discharges. Direct effects to cetaceans are expected to be sublethal. Since OCS discharges are diluted and dispersed in the offshore environment, impacts to cetaceans are expected to be negligible relative to the contaminants introduced into the Gulf from national and international watersheds. The proposed use of low-toxicity, synthetic-based fluids during the Thunder Horse project should further reduce the possibility of adverse impact to marine mammals or their prey.

Helicopter activity and the associated noise have the potential to disrupt marine mammals. The FAA Advisory Circular 91-36C encourages pilots to maintain higher than minimum altitudes (noted below) over noise-sensitive areas. Corporate helicopter policy states that helicopters should maintain a minimum altitude of 213 m (700 ft) while in transit offshore and 152 m (500 ft) while working between platforms. In addition, guidelines and regulations promulgated by the NMFS under the authority of the Marine Mammal Protection Act include provisions specifying that helicopter pilots maintain an altitude of 305 m (1,000 ft) within 91 m (300 ft) of marine mammals. It is unlikely that cetaceans would be affected by routine OCS helicopter traffic operating at these altitudes, provided pilots do not alter their flight patterns to more closely observe or photograph marine mammals. Temporary disturbance to cetaceans may occur on occasion as a helicopter approaches or departs an OCS facility, if animals are near the facility. Routine overflights may elicit a startle response from, and interrupt cetaceans nearby (depending on the activity of the animals) (Richardson et al., 1995). Both the noise and the shadow cast by the helicopter can elicit a response. Occasional overflights probably have no long-term consequences on cetaceans; however, frequent overflights could have long-term consequences if they repeatedly disrupt necessary activities, such as feeding and breeding. As more prospects are developed within Grid 16, the helicopter activity is expected to increase. However, such disturbance is believed negligible relative to other sources of noise (e.g., vessel traffic).

Well development activities associated with the Thunder Horse project could produce sounds at intensities and frequencies heard by cetaceans. It is expected that noise from drilling and completion activities will be somewhat constant for the next few years and continue with sporadic drilling and completion work into the year 2015. As more prospects are developed within Grid 16, the drilling, completion, and production activities and associated noise are expected to increase. Odontocetes echolocate and communicate at higher frequencies than the dominant sounds generated by drilling units. Sound levels in this range are not expected to be generated by drilling operations (Gales, 1982). Bottlenose dolphins are one of the few species in which low-frequency sound detection has been studied. Researchers have found that these dolphins have poor sensitivity at the level where most industrial noise energy is concentrated.

The Thunder Horse project's vessel traffic estimates during drilling and completion operations are four workboats and six crew boats per week, dropping to three and four, respectively, during production activities. Dozens of other support vessels will be utilized during the project's various installation operations. As with other potential sources of disturbance, vessel activity is expected to increase as more development occurs within Grid 16. Noise from support-vessel traffic may elicit a startle and/or avoidance reaction from cetaceans or mask their sound reception. There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or productivity. Long-term displacement of animals from an area is also a consideration. Toothed whales exposed to recurring vessel disturbance could be stressed or otherwise affected in a negative but inconspicuous way.

Increased vessel traffic also increases the probability of collisions between ships and marine mammals, which may result in injury or death to some animals. The MMS issued NTL 2002-G14, "Vessel Strike Avoidance and Injured/Dead Protected Species Reporting," to help mitigate vessel/marine mammal strikes. Smaller delphinids may "bow-ride" vessels that are in transit from a shorebase to an offshore location in Grid 16. Vessels may also be a threat to smaller, coastal delphinids, where the majority of OCS vessel traffic occurs. Marine mammalogists conducting surveys in the CPA during the summer of 2001 documented an adult killer whale that bore conspicuous and aged scarring across its back that were indubitably the result of a collision with a motor vessel.

Of particular concern for the Thunder Horse project and Grid 16 is the presence of sperm whales. An area of sperm whale concentration south of the mouth of the Mississippi River has been the subject of research for the last three years. Sperm whales have consistently been observed in the area and there is speculation that these whales are year round residents. Although this area is not located in Grid 16, shore-based support vessels would be transiting through the sperm whale area enroute to Grid 16. Also, smaller numbers of sperm whales have been observed in nearly all areas of the Gulf and may very likely occur, at least sporadically, in Grid 16. Deep-diving whales (including sperm whales, beaked whales, and pygmy and dwarf sperm whales, all of which occur in this area) are more vulnerable to vessel strikes because of the extended surface period required to recover from extended deep dives. These animals also periodically congregate on the surface in "social groups" and, during these times, may be distracted from, or oblivious to, vessel approaches. Support vessel activity in Grid 16 or adjacent waters would increase the risk of vessel strikes to sperm whales and other deep-diving cetaceans. Limited observations on an NMFS cruise off the mouth of the Mississippi River in the summer of 2000 indicated that sperm whales appeared to avoid passing service vessels. However, the strong preference of sperm whales for an area between Grid 16 and the onshore support bases is a source of concern.

Many types of materials, including plastics, are used during drilling and production operations. If some of this material is accidentally lost overboard, cetaceans may consume it. The result of ingesting some materials lost overboard can be lethal, and the probabilities of occurrence, ingestion, and lethal effect are unknown. The MMS issued NTL 2002-G13, "Marine Trash and Debris Awareness and Elimination" to help mitigate the potential threat to marine mammals, fish, sea turtles, and other marine animals from marine trash and debris.

The ability of marine mammals, and sperm whales in particular, to avoid underwater obstacles is unknown. Sperm whales have been entangled in deepsea cables (USDOI 2001; Heezen, 1957). The underwater mooring lines, steel catenary risers, pipelines, and other paraphernalia associated with the PDQ and numerous wells of the Thunder Horse project will support a large underwater presence. Whales would normally be expected to detect the structures through echolocation; however, if noise from drilling, vessels, etc., masks or distorts feedback to the whale, these underwater obstacles may be a source of concern.

Information on potential accidental oil spills associated with the Thunder Horse project is located in Appendix B. The worst-case scenario is a blowout that could result in a spill of up to 141,000 bbl/day. Such a spill is highly unlikely. However, if it did occur, it could result in negative effects to sperm whales and other oceanic marine mammal species. The expected impacts would involve the oiling of animals and prey and probable displacement from the impacted area. Sperm whales may use this area as foraging, nursery, and possibly mating habitat. Spill-response activities could also disrupt normal behavioral activities of marine mammals in the area.

Conclusion

The routine activities associated with the Thunder Horse project are not expected to have long-term adverse effects on the size and productivity of any marine mammal species or population stock endemic to the northern GOM. Accidental events (e.g., collisions with vessels, oil spills) are expected to be rare and the MMS has regulations and NTL's in place to greatly restrict their possibility.

However, small numbers of marine mammals could be injured or killed by collision with support vessels and by eating indigestible debris, particularly plastic items, lost from support vessels, drilling rigs, and fixed and floating platforms. The likelihood of such "takes" are greater within or enroute to this grid than many other grids within the Gulf because surveys indicate there are increased concentrations of sperm whales in waters adjacent to Grid 16. Such cases of "takes" are expected to be rare due to diligent watches for marine mammals on the support vessels as mandated by NTL 2002-G14. Conclusive evidence is lacking as to whether anthropogenic noise has or has not caused long-term displacements of, or reductions in, marine mammal populations. Obstacles posed by underwater structures and the consequences that may have on marine mammals are unknown. Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain involvement. Hydrocarbon spills in the area could impact marine mammals. The spill's magnitude and fate would determine the species and numbers of animals impacted. Spills and spill-response activities in Grid 16 may temporarily displace marine mammals, such as the endangered sperm whale, from important foraging, nursery, and/or mating habitat.

4.2.4. Impacts on Sea Turtles

As stated in the above section, multiple vessel trips per week are expected during the lifetime of the Thunder Horse project. During installation operations, dozens of other support vessels will be used. Transportation corridors will be through areas where Kemp's ridley, green, loggerhead, and leatherback sea turtles have been sighted. Multiple helicopter trips per week are also expected. Noise from support-vessel traffic and helicopter overflights may elicit a startle reaction from sea turtles and there is the possibility of short-term disruption of activity patterns. Sounds from approaching aircraft are detectable in the air far earlier than in water. There are no systematic studies published concerning the reactions of sea turtles to aircraft overflights, and anecdotal reports are scarce. It is assumed that aircraft noise could be heard by a sea turtle at or near the surface and may cause it to alter its activity (Advanced Research Projects Agency, 1995). In the wild, most sea turtles spend at least 3-6 percent of their time at the surface. Despite the brevity of their respiratory phases, sea turtles sometimes spend as much as 19-26 percent of their time at the surface engaged in surface basking, feeding, orientation, and mating (Lutcavage et al., 1997). Sea turtles located in shallower waters have shorter surface intervals, whereas turtles occurring in deeper waters have longer surface intervals. Sea turtles exposed to recurring vessel disturbance could be stressed or otherwise affected in a negative but inconspicuous way. As other blocks in Grid 16 are developed, the increased vessel traffic would elevate the probability of collisions between vessels and turtles, potentially resulting in injury or death to some animals. The MMS's NTL 2002-G14 is designed to mitigate vessel/animal collisions.

Activities associated with the Thunder Horse project could generate sounds at intensities and frequencies that could be heard by turtles. There is evidence suggesting that turtles may be receptive to low-frequency sounds, which is at the level where most industrial noise energy is concentrated. Potential effects on turtles include disturbance (subtle changes in behavior and interruption of activity), masking of other sounds (e.g., surf, predators, vessels), and stress (physiological). Such noise is expected to have sublethal effects on sea turtles.

Many types of materials, including plastics, are used during development and production operations. Some of this material could be accidentally lost overboard where sea turtles can consume it. The result of ingesting materials lost overboard could be lethal. Leatherback turtles (a species known to inhabit Grid

16) do mistake plastics for jellyfish and may be more vulnerable to gastrointestinal blockage than other sea turtle species. Sea turtles could also become entangled in debris lost by vessels or platforms associated with the Thunder Horse project. The MMS's NTL 2002-G13 will help mitigate some of these concerns. As more blocks are developed in the Grid 16 area, the probability of OCS-related flotsam in the area would increase. More flotsam increases the risks to sea turtles.

Some effluents will be discharged into offshore marine waters as a result of the Thunder Horse project and will be regulated by USEPA NPDES permit. BP has chosen to reinject its produced water from the project, thereby substantially reducing its operational discharges. Turtles may have some interaction with other discharges from the project. Very little information exists on the impact of drilling fluids on Gulf sea turtles (Tucker and Associates, Inc., 1990). Exposure to these discharges could result in sublethal effects to subadult and adult sea turtles. However, hatchling and young juveniles exposed to these discharges may be more susceptible to adverse effects. The proposed use of synthetic-based drilling fluids in the Thunder Horse project would reduce the toxicity, and subsequently the potential for injury or death, to sea turtles and/or their prey.

Little or no damage is expected to the physical integrity, species diversity, or biological productivity of live-bottom habitat utilized by sea turtles as a result of the proposed action unless a spill occurs that impacts these areas. Since sea turtle habitat in the Gulf includes inshore, neritic, and oceanic waters, as well as numerous beaches in the region, sea turtles could be impacted by accidental spills resulting from operations associated with the proposed action.

A spill of the magnitude calculated under a worst-case scenario could result in negative impacts to any of the five sea turtle species inhabiting the Gulf. The expected impacts from a large spill would involve the oiling of animals and prey, and probable displacement from the impacted area. Historically, the majority of spills are small, less than a barrel, and do not pose a significant threat to sea turtles.

A large, persistent spill in oceanic waters could have an impact on any hatchling or juvenile sea turtles that it contacts. All neonate sea turtles undertake a passive voyage via oceanic waters following nest evacuation. Depending on the species and population, their voyage in oceanic waters may last 10 or more years. Beaches of the Gulf and the Caribbean Sea are used as nesting habitat, and hatchlings evacuating these nesting beaches emigrate to oceanic waters seaward of their nesting sites. Surface drifter card data (Lugo-Fernandez et al., 2001) indicate that circulation patterns in the Caribbean Sea and southern GOM may transport neonate and young juvenile sea turtles from these areas to oceanic waters off the coasts of Texas and Louisiana. Moreover, these journeys begin as pulsed events, with many hatchlings emerging and emigrating offshore at the same times. Consequently, if an oil spill occurred in Grid 16, timing could be a significant factor. A spill that coincided with a pulsed hatchling event could impact multiple turtles, particularly neonate or young juvenile sea turtles associating with oceanic fronts or refuging in sargassum mats where oil slicks, decomposing residues, and tarballs are likely to accumulate. Oceanic waters of the GOM (including those of Grid 16) are also inhabited by subadult and adult leatherback and loggerhead sea turtles; however, adults of any endemic sea turtle species may be found offshore. Sea turtles (and most notably hatchlings and juveniles) coming into contact with the spill could suffer sublethal leading to lethal (over time) exposure. Aggregations of sea turtles may be exposed in one spill event. Prey species may be negatively impacted, thereby impacting sea turtles that would otherwise feed on them. Turtles may be temporarily displaced from the impacted areas. The magnitude of impacts to sea turtles would depend upon the oils that they are exposed to, their concentrations, and the period of exposure.

Spill-response activities could also disrupt normal behavioral activities of sea turtles in the area and cause animals to temporarily vacate the spill-response area.

Conclusion

Routine activities resulting from the Thunder Horse project have the potential to harm sea turtles or temporarily displace them from important habitat areas. These animals could be impacted by the degradation of water quality resulting from operational discharges; noise generated by helicopter and vessel traffic, platforms, and drillships; brightly-lit platforms; vessel collisions; and jetsam and flotsam generated by service vessels and OCS facilities. Collisions with OCS service vessels and ingestion of plastic materials have the potential to cause lethal effects. However, most Thunder Horse project impacts are expected to have sublethal effects. Contaminants in waste discharges and drilling fluids might indirectly affect sea turtles through food-chain effects. Routine activities associated with the Thunder Horse project are unlikely to have significant adverse effects on the size and recovery of any sea turtle species or population in the GOM.

Oil spills are accidental events. Populations of sea turtles in the northern Gulf may be exposed to residuals of oil spilled and attributed to the proposed action during their lifetimes. Chronic or acute exposure has the potential to debilitate or kill sea turtles. In most foreseeable cases, exposure to spilled hydrocarbons persisting in the sea following the dispersal of an oil slick would result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease) to sea turtles. Sea turtle hatchlings exposed to and becoming fouled by spilled oil or consuming associated tarballs persisting in the sea following the dispersal of an oil slick have the greatest risks from a spill.

4.2.5. Impacts on Coastal and Marine Birds

4.2.5.1. Nonthreatened and Nonendangered Birds

This section discusses the possible effects of the proposed action on coastal and marine birds of the GOM and its contiguous waters and wetlands. Air emissions, water quality degradation resulting from discharges, helicopter and service-vessel traffic and noise, light attraction, and discarded trash and debris from service vessels and platforms could impact coastal and marine birds. Associated spill-response activities may also impact coastal and marine birds. Any effects would be especially critical for intensively managed populations such as endangered and threatened species that need to maintain a viable reproductive population size or that depend upon a few key habitats. Emissions of pollutants into the atmosphere from activities associated with the proposed action are expected to have minimal effects on offshore air quality because of the prevailing atmospheric conditions, emission heights, and pollutant concentrations. Such emissions are expected to have negligible effects on onshore air quality because of the atmospheric regime, emission rates, and distance of these emissions from the coastline. These judgments are based on average steady state conditions; however, there will be days of low mixing heights and low wind speeds that could decrease air quality. These conditions are characterized by fog formation, which in the Gulf occurs mostly during winter. However, impacts from offshore sources are reduced in winter because the frequency of significant onshore winds decreases (25%) and the removal of pollutants by rain increases. The summer is more conducive to air quality effects as onshore winds occur more frequently, approximately 50 percent of the time.

Helicopter and service-vessel traffic related to the proposed action could sporadically disturb feeding, resting, or nesting behavior of birds or cause abandonment of preferred habitat. These impact-producing factors could contribute to indirect population loss through reproductive failure resulting from nest abandonment. The FAA (Advisory Circular 91-36C) and corporate helicopter policy state that, when flying over land, the specified minimum altitude is 610 m (2,000 ft) over populated areas and biologically sensitive areas such as wildlife refuges and national parks. However, pilots traditionally have taken great pride in not disturbing birds. It is expected that approximately 10 percent of helicopter trips would occur at altitudes somewhat below the minimums listed above as a result of inclement weather or emergency situations. Although these incidents are only seconds in duration and sporadic in frequency, they can disrupt coastal bird behavior and, at worst, possibly result in habitat or nest abandonment.

Service vessels would use selected nearshore and coastal (inland) navigation waterways, or corridors, and adhere to protocol established by the USCG for reduced vessel speeds within these inland areas. Routine presence and low speeds of service vessels within these waterways would diminish the effects of disturbance from service vessels on nearshore and inland populations of coastal and marine birds. Therefore, the effects of routine service-vessel traffic on birds offshore would be negligible.

Seabirds (e.g., laughing gulls and petrels) may be attracted by lights and/or structures and may remain and feed in the vicinity of the PDQ. Operational discharges or runoff in the offshore environment could affect these individuals. Impacts may be both direct and indirect.

Coastal and marine birds are commonly observed entangled and snared in discarded trash and debris. In addition, many species ingest small plastic debris, either intentionally or incidentally. Such interactions can lead to serious injury and death. The MMS prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.300) and NTL 2002-G13. Thus, it is expected that coastal and marine birds would seldom become entangled in or ingest OCS-related trash and debris. MARPOL (Annex V, Public Law 100-220; 101 Statute 1458; effective January 1989) prohibits the disposal of any plastics at sea or in coastal waters. Thus, due to the low potential for interaction between coastal and marine birds and project-related debris, any effects would be negligible.

A spill ≥1,000 bbl at the site of the proposed action would have a spill risk for contacting the shoreline of 0.5 percent or greater only for Plaquemines Parish, Louisiana, (a 1% risk was calculated) and various birds along the coast could experience mortality and reproductive losses should a spill of that size occur. Recovery would depend on subsequent influxes of birds from nearby feeding, roosting, and nesting habitats.

Oil-spill cleanup methods often require heavy traffic on beaches and wetland areas, application of oil dispersants and bioremediation chemicals, and the distribution and collection of oil containment booms and absorbent material. The presence of humans, along with boats, aircraft, and equipment, could also disturb coastal birds after a spill. Investigations have shown that oil dispersant mixtures pose a threat to bird reproduction similar to that of oil (Albers, 1979; Albers and Gay, 1982). The external exposure of adult birds to oil/dispersant emulsions may reduce chick survival more than exposure to oil alone; however, successful dispersal of a spill would generally reduce the probability of exposure of coastal and marine birds to oil (Butler et al., 1988). It is possible that changes in the size of a breeding population may also be a result of disturbance from increased human activity related to cleanup, monitoring, and research efforts (Maccarone and Brzorad, 1994). A growing number of studies indicate that current rehabilitation techniques are not effective in returning healthy birds to the wild (Anderson et al., 1996; Boersma, 1995; Sharp, 1995 and 1996). Deterrent or preventative methods, such as scaring birds from the path of an approaching oil slick or the use of booms to protect sensitive colonies, have extremely limited applicability.

4.2.5.2. Threatened and Endangered Birds

Piping Plover

The impacts on shorebirds not listed as endangered or threatened discussed above also apply to the piping plover. A spill of ≥1,000 bbl at the site of the proposed action would have a spill risk for contacting the shoreline of 0.5 percent for all Gulf Coast areas with one exception; Plaquemines Parish, Louisiana, that has a spill risk of 1 percent. Birds along the coast could experience mortality and reproductive losses. Recovery would depend on subsequent influxes of birds from nearby feeding and roosting habitats.

Bald Eagle

The bald eagle feeds on fish, waterfowl, shorebirds, and carrion near water. This bird may come in contact with an oil spill by eating contaminated dead and dying prey. Bald eagles have narrow preferences for nesting habitat. Any oiling of aquatic feeding habitat resulting in nest site abandonment could lead to relocation of a nest to less preferred habitat. This event in turn would reduce population growth for this already threatened species. However, the bald eagle has high mobility and, when an oil slick enters the feeding habitat, may relocate feeding to unpolluted waters. When relocating feeding far from the nest, the eagle would successfully home to its nest after feeding because it prefers to build its nest in a highly visible place over the forest canopy with a clear short path from the water.

Brown Pelican

The brown pelican is a species of special concern in Louisiana and Mississippi although it is no longer listed as endangered or threatened in Florida or Alabama (USDOI, FWS, 1998). It is known to nest on Guillard Island, Alabama, a dredged material disposal island in Mobile Bay. There have been no reported nesting sites in Mississippi. Impacts to individual brown pelicans would be similar to those identified for the nonendangered and nonthreatened species discussed in preceding sections.

Conclusion

It is expected that the majority of effects from the major impact-producing factors on coastal and marine birds would be sublethal (behavioral effects and nonfatal intakes of discarded debris), causing temporary disturbance and displacement of localized groups, mostly in inshore areas. However, chronic stress such as digestive upset, partial digestive occlusion, sublethal ingestion, and behavioral changes are often difficult to detect. Such stresses can weaken individuals and make them more susceptible to infection and disease as well as making migratory species less fit for migration. A spill of ≥1,000 bbl at an offshore well site would have a spill risk for contacting the shoreline of 0.5 percent for all Gulf Coast areas with one exception; Plaquemines Parish, Louisiana, where a spill risk of 1 percent is calculated, and birds along the coast could experience mortality and reproductive losses, if the spill occurred. Recovery would depend on subsequent influxes of birds from nearby feeding, roosting, and nesting habitats.

4.2.6. Impacts on Fish Resources

4.2.6.1. Essential Fish Habitat and Fish Resources

Development activities that have the potential to affect fish and essential fish habitat (EFH) include discharge of muds and cuttings, and installation/construction effects on water quality. Production activities that may affect fish are those primarily associated with the "artificial reef effect."

Drill cuttings with mud adhering to them would be discharged to the water column at the well sites and may contain some contaminant metals. Toxicity as well as cadmium and mercury in barite limits are set in the Gulf's general offshore NPDES permit (GMG290000). Contaminant levels, however, would reach background levels about 1,000 m (3,281 ft) from the discharge area and would be undetectable beyond 3,000 m (9,843 ft) from the site (USDOI, MMS, 2000). The SBF's are virtually nontoxic, and cuttings with adherent SBF are expected to reach the seabed quickly in the form of clumps. Biological effects on the benthos are not expected beyond 500 m (1,640 ft) (Jensen et al., 1999). Numerous studies have demonstrated that mercury impurities associated with drilling mud barite are virtually not capable of being taken up by marine organisms that might come in contact with discharged drilling fluid solids (Neff, 1989).

Accidental oil spills or blowouts also have the potential to affect fish resources. Adult fish will, for the most part, avoid the oil (Malins et al., 1982; NRC, 1985; Baker et al., 1991; USDOI, MMS, 2000). Farr et al. (1995) reported the behavioral avoidance of dissolved concentrations of a polynuclear aromatic hydrocarbon (PAH) as low as 14.7 µg/l by a species of minnow. Furthermore, adult fish must become exposed to crude oil for some time, probably on the order of several months for doses and types of oil to be encountered in the field, to suffer serious biological damage (Payne et al., 1988). Adult fish also possess some capability for metabolizing oil (Spies et al., 1982).

On the other hand, invertebrate and fish eggs and larvae are known to be very sensitive to oil in water (Linden et al., 1979; Longwell, 1977; Baker et al., 1991). However, most fish species produce very large numbers of eggs, and larvae spread over wide areas. In order for an oil spill to affect fish resources at the population level, it would have to be very large and cover a very large area that corresponded to an area of highly concentrated eggs and larvae. In addition, the oil would have to disperse deep enough into the water column at levels high enough to cause toxic effects. None of these events would seem likely, even in the low-risk, large-spill scenario. However, it should be noted that the use of dispersants, while potentially beneficial for surface-using birds, turtles, and mammals, could increase the effects on water column organisms including ichthyoplankton. A worst case, in terms of location, would be a spill of fresh oil in a shallow, enclosed bay that contained eggs and larvae of important inshore species such as menhaden, shrimp, or blue crabs. Oil from the hypothetical offshore blowout would be well weathered before it hit shore, if it occurred. In addition, spawning areas of most species of marine fish are widespread enough to avoid catastrophic effects at the population level.

The spill risk (the probability of a spill ≥1,000 bbl occurring and contacting specific areas) is less than 0.5 percent for all Gulf Coast areas with one exception; Plaquemines Parish, Louisiana has a spill risk of 1 percent.

Conclusion

The PDQ and its risers are expected to attract a variety of fish species for food and cover.

Impacts on demersal fish from drilling activities would be negligible. There are no commercially-valuable demersal fish species in the area, and effects on bottom fish habitat from cuttings and adherent SBF's would likely be limited to within 500 m (1,640 ft) of the discharge.

Specific effects from oil spills would depend on several factors including timing, location, volume and type of oil, environmental conditions, and countermeasures used. The areas affected by the potential spill or blowout scenario would be avoided by adult fish. Fish eggs and larvae of some species of invertebrates and fish would be affected by a spill and some would suffer mortality in areas where their numbers are concentrated in the upper few meters of water and where oil concentrations under the slick are high enough. However, oil and fish concentrations, exposure times, and the area affected would not be great enough to cause significant impacts to northern GOM fish populations.

In summary, it is expected that marine environmental degradation from the proposed action would have little effect on fish resources or EFH. The level of marine environmental degradation from the Thunder Horse development is expected to cause a small, undetectable decrease in fish populations and EFH.

4.2.6.2. Gulf Sturgeon

The existing range of the Gulf sturgeon in 1996 extended from the Mississippi River to Charlotte Harbor in western Florida (Patrick, personal communication, 1996). Oil spills are the OCS-related factor with the most potential to impact the Gulf sturgeon. Gulf sturgeon can take up oil by direct ingestion, ingestion of oiled prey, or the absorption of dissolved petroleum products across gill mucus and gill epithelium. Upon any exposure to spilled oil, liver enzymes of adult fish oxidize soluble hydrocarbons into compounds that are easily excreted in the urine (Spies et al., 1982). Behavior studies of other fish species suggest that adult sturgeon are likely to actively avoid an oil spill, thereby limiting the effects and lessening the extent of damage (Baker et al., 1991; Malins et al., 1982). In adult Gulf sturgeon, contact with or ingestion/absorption of spilled oil could most likely result in nonfatal physiological irritation, especially of gill epithelium and the liver.

Conclusion

The potential exists that Gulf sturgeon could be impacted by oil spills resulting from the proposed action. These impacts could cause nonfatal irritation of gill epithelium or liver tissue in a few adults.

4.3. Socioeconomic Conditions and Other Concerns

4.3.1. Impacts on Economic and Demographic Conditions

The MMS defined the potential impact region as that portion of the GOM coastal zone whose social and economic well-being (population, labor, and employment) is directly or indirectly affected by the OCS oil and gas industry. In this section, the MMS projects how and where future changes may occur as they correlate with the proposed action and to possible future development within Grid 16.

4.3.1.1. Population and Education

The impact region's population will continue to grow but at a slower rate. Minimal effects on population are projected from activities associated with the proposed action and future actions. While some of the labor force is expected to be local to the Port Fourchon and Venice, Louisiana, areas, most of the additional employees associated with the proposed action are not expected to require local housing. Activities related to the proposed activity and future activities are not expected to significantly affect the region's educational level.

Conclusion

Activities related to the proposed activity and future activities in Grid 16 are not expected to significantly affect the region's population or educational level.

4.3.1.2. Infrastructure and Land Use

While OCS-related servicing should increase in Port Fourchon, Louisiana, no expansion of these physical facilities is expected to result from the proposed activities. Changes in land use throughout the region as a result of the proposed and future activities in Grid 16 are expected to be contained and minimal. While land use in the impact area will change over time, the majority of this change is estimated as general regional growth. Increased OCS deepwater activities are expected to impact Port Fourchon and other OCS ports with deepwater capability. The proposed activity is not expected to cause expansion to the Port Fourchon support base that BP plans to use as its primary onshore base.

Conclusion

The proposed action and future development in Grid 16 are not expected to significantly affect the region's infrastructure or land use.

4.3.1.3. Navigation and Port Usage

The proposed action would use the existing onshore support base located in Port Fourchon for completion, facility installation, commissioning, and production activities. During construction activities, the following round trips are planned for service vessels: 2 for manifold installation, 1 for flowline installation, 2 for jumper installation, 4 for umbilical installation support, 13 for large supply items, 14 for tug boats, 11 for large freight items, 1 for infield riser installation, and 2 for dive support. During drilling and completion activities, 4 round trips for workboats and 6 round trips for crew boats per week are expected. During production operations, 3 round trips for workboats and 4 round trip for crew boats per week are anticipated. Port Fourchon is capable of providing the services necessary for the proposed activities; therefore, no onshore expansion or construction is anticipated with respect to the proposed action.

BP plans to use the Venice shore base facility as its backup base. Both of these shore bases are preexisting onshore support facilities and operate 24 hours per day. A small amount of vessel and helicopter traffic may originate from bases other than Port Fourchon or Venice in order to address changes in weather, market, and operational conditions.

Conclusion

No impacts to navigation and port usage are expected as result of this proposed action.

4.3.1.4. Employment

The importance of the oil and gas industry to the coastal communities of the GOM is significant, particularly in Louisiana, eastern Texas, and coastal Alabama. Dramatic changes in the level of OCS oil and gas activities over recent years have resulted in similar fluctuations in population, labor, and employment in the GOM region. This economic analysis focuses on the potential direct, indirect, and induced impacts of the OCS oil and gas industry on the population and employment of the counties and parishes in the impacted region.

To improve regional economic impact assessments and to make them more consistent with each other, the MMS recently developed a methodology for estimating changes to employment and other economic factors. The methodology developed to quantify these impacts on population and employment takes into account changes in OCS-related employment, along with population impacts resulting from these employment changes within each individual coastal subarea.

The model for the GOM region has two steps. Since there are no publicly available models that estimate the expenditures resulting from offshore oil and gas activities, the first step in the model estimates the expenditures resulting from BP's Initial DOCD (for the construction and deployment of the semisubmersible PDQ structure, the drilling of 17 producing and 10 water injector wells and 16 re-completions and 16 sidetracks in mid to late life of the proposal) and assigns these expenditures to industrial sectors in the 10 MMS coastal subareas defined in Chapter 3. A contracted effort, "Modeling the Economic Impacts of Offshore Oil and Gas Activities in the Gulf of Mexico: Methods and Applications," was used for this. The second step in the model uses multipliers from the commercial input-output model IMPLAN (using the latest available data, 1999) to translate these expenditures into direct, indirect, and induced employment and other economic factors. Direct employment results from the first round of industry spending. It is the employment that results from the initial dollars spent by BP on the PDQ and development wells from their fabrication/installation or completion through their productive lives. Indirect employment results as the initial spending reverberates through the economy. First, the suppliers of the goods and services for the PDQ and wells spend the initial direct dollars from the industry. Then, these dollars are re-spent by other suppliers until the initial dollars have trickled throughout the economy. Labor income produces induced spending by the households receiving that income.

Both the level (the amount spent) and the sectoral (the industry in which it is spent) allocations of expenditures can vary considerably. Since local economies vary, a separate set of IMPLAN multipliers is used for each MMS coastal subarea to which expenditures are assigned. Each set of multipliers is based on the actual historical patterns of economic transactions in the area. Model results for employment are presented in number of jobs per year, where one job is defined as a year of employment. This does not necessarily mean only one person occupies the position throughout the year. One job may be equal to two part-time positions occupied over the year or one person occupying a position for 6 months, while another person occupies it for the other 6 months.

Table E-4 (in Appendix E) shows total employment projections for activities resulting from the proposed action for the peak year of 2004. The projections are expressed as absolute numbers and as a percentage of the employment levels expected if no development occurs. The baseline projections of employment used in this analysis are described in Chapter 3 and Table E-5 (Appendix E). Since these baseline projections assume the continuation of existing social, economic, and technological trends, they also include employment resulting from the continuation of current patterns in OCS Program activities. Based on model results, peak-year (2004) direct employment associated with the proposed action is estimated at about 810 jobs. Indirect employment for the peak year is projected at about 290 jobs, while induced employment is calculated to be about 360 jobs. Although the majority of employment is expected to occur in coastal subarea TX-2, employment is not expected to exceed 1 percent of the total employment in any given subarea. Direct, indirect, and induced employment through the productive life of the proposal (that associated with drilling and/or completing additional development wells, operation and maintenance and workover activities) is expected at about 1,460 jobs per year throughout all subareas and should be less than 1 percent of total employment in any subarea.

The resource costs of cleaning up an oil spill, both onshore and offshore, were not included in the above analysis for two reasons. First, oil-spill cleanup activities reflect the spill's opportunity cost. In other words, some of the resources involved in the cleanup of an oil spill, in the absence of that spill, would have produced other goods and services (e.g., tourism activities). Secondly, the occurrence of a spill is not a certainty. Spills are random accidental events. Given that the PDQ is fabricated and installed and the development wells are completed as described in the initial DOCD, the timing, numbers, sizes, offshore locations of occurrence, and onshore locations of contact of potential spills occurring over the drilling life of the plan are all unknown variables. Appendix B discusses oil spills in general and the expected sizes, number, and probability of a spill from the proposed action. Additionally, the cost involved in any given cleanup effort is influenced by a variety of factors: whether or not the oil comes ashore; the type of coastal environment contacted by the spill; weather conditions at the time of the incident; the type and quantity of oil spilled; and the extent and duration of the oiling. Nevertheless, the same two-step model used above to project employment for the proposed action was applied to project the opportunity cost employment associated with cleaning up an oil spill. In this case, the first step considered estimates of the expenditures resulting from oil-spill cleanup activities should a worst-case blowout scenario spill occur. The second step incorporated the IMPLAN regional model multipliers to translate those expenditures into direct, indirect, and induced employment associated with oil-spill cleanup activities. The size of a scenario spill (on which model results are based) is assumed to be as much as 141,000 bbl for an uncontrolled blowout. Based on model results, should such a spill occur, it is projected to cost about 4,800-11,200 person-years of employment for cleanup and remediation depending on whether some of the oil contacts land. Table E-5 (Appendix E) summarizes the direct, indirect, and induced opportunity cost employment (by subarea and planning area) for an oil-spill cleanup should such a spill occur. Employment impacts from the blowout scenario are expected to be minimal. These impacts combined with the employment projected for the proposed activities would only constitute less than 1 percent of the total employment in any subarea. Employment associated with oil-spill cleanup is expected to be of short duration (less than 6 months), aside from employment associated with the legal aspects of a spill.

Conclusion

No significant impacts to employment, including those that could result from a blowout and related spill cleanup scenario, are expected as a result of this proposed action.

4.3.2. Impacts on Environmental Justice

Federal agencies are directed by Executive Order 12898 to assess whether their actions would have a disproportionate and negative effect on the environment and health of people of ethnic or racial minorities or those with low income. The existing onshore facilities that can support the projected deepwater developments within Grid 16 are well established along the Gulf Coast.

Conclusion

Since sufficient onshore facilities are available to support offshore activities in Grid 16, no effects to minorities or people with low incomes in the Gulf counties and parishes are expected.

4.3.3. Impacts on Commercial Fisheries

Little or no impact is expected on commercial fishermen from routine project activities. Offshore operators do not normally require a large exclusion area, although the USCG could designate and enforce an area of 500 m (1,640 ft) from structures, if requested or required. Only seven deepwater structures to date have established official safety zones. Also, these safety zones do not restrict vessels less than 30.5 m (100 ft) in length.

In the event of a spill, commercial fishermen would actively avoid the area of a spill and the area where there are ongoing activities to control a blowout and contain the spilled oil. Even if fish resources successfully avoid spills, tainting (oily-tasting fish), public perception of tainting, or the potential of tainting commercial catches from oil or dispersants would prevent fishermen (either voluntarily or imposed by regulation) from initiating activities in or near the spill area. This in turn could decrease landings and/or the value of catches for several months. However, GOM species can be found in many adjacent locations; Gulf commercial fishermen do not fish in one locale and have responded to past petroleum spills without discernible loss of catch or income by moving elsewhere for a few months.

There are few new potential fisheries that could occur in the Thunder Horse project area. The most likely target species would be epipelagic species that are highly mobile and have the ability to avoid disturbed areas. This fishery is traditionally pursued using a highly mobile longliner fleet. This type of fishery is less vulnerable to disturbance or loss of fishing space than others, such as trap or bottom trawling fisheries. Desirable pelagic fish species may also be attracted to the Thunder Horse semisubmersible PDQ facility and could potentially improve commercial catches using fishing techniques other than longlining.

Conclusion

There would be some unavoidable loss of fishing space due to the physical presence of the development that could otherwise have been used for pelagic fishing such as longlining. This impact is not considered to be significant because the overall footprint of the development is not large compared to the total space available in the Gulf. A large oil spill might have commercial implications but, for the most part, the Gulf fishing fleets are highly mobile and cover a wide area. In addition, there are no commercially important demersal species at the water depth of this grid.

4.3.4. Impacts on Recreational Resources and Beach Use

Millions of annual visitors attracted to the coast are responsible for thousands of local jobs and billions of dollars in regional economic activity. They also are responsible, in large part, for the trash and debris that litter coastal lands, leaving behind nearly 75 tons of trash per week (Ocean Conservancy, 2001). Other sources of coastal trash are debris and small leaks from staffed structures in State and Federal waters where hydrocarbons are exploited, commercial shrimping and fishing, runoff from storm drains, antiquated storm and sewage systems in older cities, and commercial and recreational fishermen who discard plastics. In 1996, the U.S. National Park Service finished a study on the origins of marine debris on South Padre Island in Texas. They tentatively identified about 13 percent of the 63,000+ items collected as being associated with the offshore oil and gas industry (Miller and Echols, 1996:8+).

In September 2001, the USEPA published its comprehensive National Coastal Condition Report. For 5 years, USEPA scientists sampled, collected, and analyzed data on the health of coastal habitats, especially estuaries. They found that the overall condition of the Gulf of Mexico is poor according to the rankings of water clarity (fair), dissolved oxygen (good), and coastal wetland loss, eutrophic condition, sedimentation, benthos, and fish tissue (all of which ranked poor (USEPA, 2001).

Unfortunately, we do not know the specific sources of all the debris and degradation along the Gulf coastline; annual "beach sweeps" and the resulting cleanup totals include all coastal beaches – river, lake, and sea – and adjacent waters. The deltas and basins of the Mississippi-Atchafalaya and Mobile Rivers drain at least 50 percent of the land area of the central and eastern United States.

Conclusion

The risk of a large oil spill occurring due to the proposed development operations in Grid 16 is very small. In the event such a spill did occur, according to trajectory analysis from the OSRA model, there is a negligible chance that the spill would contact land within 30 days of a spill. Project aircraft will normally be flying high enough to avoid disturbance to beachgoers.

BP has an established waste management plan for all of their offshore operations. While some accidental loss of solid wastes may occur from time to time, it is expected to have a negligible impact on recreational resources.

4.3.5. Impacts on Archaeological Resources

4.3.5.1. Prehistoric

The blocks that compose the Thunder Horse project in Grid 16 (Mississippi Canyon, Blocks 775, 776, 777, 778, 819, 820, 821, and 822) are not specifically located within either of the MMS's designated high-probability areas for the occurrence of prehistoric or historic archaeological resources. Lease blocks with a high probability for prehistoric archaeological resources may only be found landward of a line that roughly follows the 60-m (197-ft) bathymetric contour. The MMS recognizes both the 12,000 B.P. date and 60-m (197 ft) water depth as the seaward extant of prehistoric archaeological potential on the OCS. The average water depth of the Grid 16 area is approximately 1,800 m (5,906 ft). Therefore, the water depth is approximately 1,740 m deeper than the earliest known prehistoric archaeological sites in the Gulf of Mexico area. Based on the extreme water depth of the grid, there is simply no potential for prehistoric archaeological resources in the area. Therefore, any oil and gas development directly associated with the Thunder Horse project or within Grid 16 cannot possibly impact prehistoric archaeological resources in that block.

Conclusion

Based on the extreme water depth of the Thunder Horse project and the Grid 16 area, the proposed oil or gas development will not impact any prehistoric archaeological resources.

4.3.5.2. *Historic*

There are areas of the northern Gulf of Mexico that are considered to have a high probability for historic period shipwrecks, as defined by two MMS-funded studies and shipwreck models (Garrison et al., 1989 and Pearson et al., 2002). These studies refined and expanded the MMS's shipwreck database in the Gulf of Mexico and list about 2,100 wrecks. Statistical analysis of the shipwreck location data identified two specific types of high-probability areas -- the first within 10 km (6 mi) of the shoreline, and the second proximal to historic ports, barrier islands, and other loss traps. The MMS created high-probability search polygons associated with individual shipwrecks to afford protection to wrecks located outside the two aforementioned high-probability areas.

An archaeological resources stipulation was included in all Gulf of Mexico lease sales from 1974 through 1994. The language of the stipulation was incorporated into the MMS's operating regulations on November 21, 1994, with few changes. All of the stipulation's protective measures were adopted in the regulations.

The MMS's Regional Director of the GOM signed NTL 2002-G01 on December 15, 2001. It supersedes all other archaeological NTL's and LTL's. This new NTL makes minor technical amendments, updates cited regulatory authorities, and continues to mandate a 50-m (164-ft) remote-sensing survey line spacing density for historic shipwreck surveys in water depths of 60 m (197 ft) or less. The NTL also requires submission of an increased amount of magnetometer data to facilitate the MMS's analyses. Survey and report requirements for prehistoric sites have not been changed.

Several OCS-related, impact-producing factors may cause adverse impacts to unknown historic archaeological resources. Offshore development activities that could result in impacts to an unknown historic shipwreck include drilling rig and platform installations (and anchoring associated with the installations), activities requiring derrick barges, and pipeline activities.

Direct physical contact with a shipwreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the time period from which the ship dates.

The proposed action includes the emplacement of two mobile drilling units, the *Ocean Confidence* and *Discoverer Enterprise.* The *Ocean Confidence* is self-propelled semisubmersible that can either be dynamically-positioned or moored. For this DOCD's proposed action, the rig will be dynamically positioned. If BP decides to moor the rig at a later date, they will be required to submit data regarding areas that may be disturbed by the rig's anchors and that portion of the mooring lines that would rest on the sea bottom. An archaeological evaluation of these areas will be required prior to installing the mooring system. BP also plans to use the *Discoverer Enterprise,* a dynamically-positioned drillship and to install a floating semisubmersible PDQ structure in Mississippi Canyon, Block 778. The anchors associated with the PDQ facility have the potential to cause physical impact to historic archaeological resources on the seafloor. Based on the plan submitted by the applicant, the manned PDQ floating production facility will be permanently anchored with a taut-leg, catenary mooring system consisting of conventional wire and chain and anchor piles. Emplacement of the anchor piles and the seafloor contact of the wire rope and chain catenary would directly disturb an area of approximately 3.5 ha per pattern. Components of a derrick barge's mooring system would directly disturb approximately 1.9 ha of the seafloor at each anchor point. Pile driving associated with the structure emplacement may also cause sediment liquefaction an unknown distance from the piling, disrupting upper seafloor stratigraphy in the area of liquefaction.

Pipeline installations also have the potential to cause a physical impact to historic archaeological resources. For example, an 8-in pipeline that was installed in March 2001 was laid across an historic shipwreck. The water depth was approximately 808 m (2,651 ft).

Oil spills have the potential to affect historic archaeological resources. Impacts to historic resources would be limited to visual impacts and, possibly, to physical impacts associated with spill cleanup operations. Offshore operations may also generate tons of ferromagnetic structures and debris, which will tend to mask magnetic signatures of significant historic archaeological resources during magnetometer surveys. The task of locating historic resources via an archaeological survey is, therefore, made more difficult as a result of operational activities.

The specific locations of archaeological sites cannot be identified without first conducting a remote-sensing survey of the seabed and near-surface sediments. The MMS, by virtue of its operational regulations under 30 CFR 250.196, requires that an archaeological survey be conducted prior to development of leases within the high-probability zones for historic and prehistoric archaeological resources. There are approximately 29 lease blocks within the Grid 16 area that falls within the MMS's high-probability shipwreck zone. However, none of the blocks located within the Thunder Horse project are located within this zone. In addition, a review of the geophysical report submitted by BP indicated that no seafloor features suggestive of historic shipwrecks were recorded during the side-scan sonar surveys. Therefore, the aforementioned survey requirement reduces the potential for an impact to occur to an historic archaeological resource by an estimated 90 percent.

Ferromagnetic debris associated with development and production activities has the potential to mask the magnetic signatures of historic shipwrecks. It is expected that most ferromagnetic debris associated with the proposed action would be removed from the seafloor during the required postlease site clearance and verification procedures. Site clearance, however, takes place after the useful life of the structure is complete. Therefore, there remains the potential for masking the signatures of historic shipwrecks as a result of ferromagnetic debris from OCS oil and natural gas activities.

Onshore historic properties include sites, structures, and objects such as historic buildings, forts, lighthouses, homesteads, cemeteries, and battlefields. Sites already listed on the National Register of Historic Places and those considered eligible for the National Register have already been evaluated as being able to make a unique or significant contribution to science. At present, unidentified historic sites may contain unique historic information and would have to be assessed after discovery to determine the importance of the data.

Onshore development in support of the proposed action, such as construction of new onshore facilities or pipelines, could result in the direct physical impact to previously unidentified historic sites. This direct physical contact with an historic site could cause physical damage to, or complete destruction of, information on the history of the region and the Nation. Each facility constructed must receive approval from the pertinent Federal, State, county/parish, and/or community involved. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes involved. There is, therefore, no expected impact to onshore historic sites from any onshore development in support of the proposed action or for future Grid 16 activities.

Should an oil spill contact a coastal historic site, such as a fort or a lighthouse, the major impact would be visual from petroleum contamination of the site and its environment. Impacts to coastal historic sites are expected to be temporary and reversible.

The greatest potential impact to a historic shipwreck as a result of the proposed action would result from the emplacement of a derrick barge and its associated anchors and this vessel's support to the installation of the PDQ and associated semi-taut or catenary mooring system. The remote-sensing survey and archaeological clearance of sites required prior to an operator beginning oil and gas activities on a lease are estimated to be 90 percent effective at identifying possible historic shipwreck sites. Since the survey and clearance provide a significant reduction in the potential for a damaging interaction between an impact-producing factor and a historic shipwreck, there is a very small possibility of the proposed OCS activities impacting a historic site.

According to Garrison et al. (1989) and Pearson et al. (2002), the shipwreck database lists 8 shipwrecks and 29 high-probability shipwreck blocks that fall within the Grid 16 area. These shipwrecks are listed in Table 3-3. Six of these wrecks are 50 years or older and are eligible for listing in the National Register of Historic Places.

Most other activities associated with the proposed action are not expected to impact historic archaeological resources. Ferromagnetic debris has the potential to mask the magnetic signatures of historic shipwrecks. It is expected that onshore archaeological resources would be protected through the review and approval processes of the various Federal, State, and local agencies involved in permitting onshore activities. There is a small chance of contact from an oil spill associated with the proposed action. Furthermore, the major impact from a spill contact on an historic coastal site, such as a fort or lighthouse, would be visual contamination. These impacts would be temporary and reversible.

Conclusion

Oil and gas activities associated with the proposed development of the Thunder Horse project located within Grid 16 could impact an historic shipwreck because of incomplete knowledge on the location of shipwrecks in the Gulf. Although this occurrence is not probable, such an event would result in the disturbance or destruction of important historic archaeological information. Other factors associated with the proposed action are not expected to affect historic archaeological resources.

4.4. CUMULATIVE EFFECTS

The MMS addressed the cumulative effects of OCS- and non-OCS-related activities for the CPA and the Gulf Coast region as part of the NEPA documentation completed for proposed multisale lease activities. The most recent Final EIS applicable to Grid 16 was prepared for Central GOM Lease Sales 185, 190, 194, 198, and 201 (USDOI, MMS, 2002). This document provides additional information applicable to cumulative effects. Specific OCS-related effects from the proposed activities in Grid 16 and those related to the Thunder Horse project are addressed in Chapters 4.1-4.3.

The following discussion provides a summary of cumulative effects for potentially affected resources in the CPA of the GOM. For all of the resources discussed below, the incremental contribution of the Thunder Horse project to cumulative impacts would be negligible.

4.4.1. Water Quality

4.4.1.1. Coastal

Sources of contamination to coastal waters include large volumes of water entering the Gulf from rivers that drain over two-thirds of the contiguous U.S. (Bedinger, 1981; Brooks and Giammona, 1988), municipal and industrial point- and nonpoint-source discharges, and accidental spill events.

Numerous industries and activities contribute to the contamination of Gulf coastal waters. These include the petrochemical industry (inclusive of oil and gas development and processing), agriculture, urban expansion, municipal and recreational sewerage treatment processes, marinas, commercial fishing, maritime shipping, hydromodification activities, forestry, recreational boating, livestock farming, manufacturing industry activities, nuclear power plant operations, and pulp and paper mills. Runoff, wastewater discharge, accidental spills, and atmospheric deposition from these sources will cause water quality changes that may result in nonattainment of Federal water quality standards for some coastal waters. Onshore service companies that support the OCS oil and gas industry will contribute to cumulative water quality degradation to a minor extent (less than 10%). Spill events from OCS-support operations are estimated to constitute about 10 percent of the total spills projected. Spills will result in degradation of water quality. Vessel traffic will degrade coastal water quality through routine releases of bilge and ballast waters, fuel and tank spills, trash, and domestic and sanitary discharges. The greatest impacts from vessel traffic will occur along navigation channels within highly populated, confined harbors and anchorages and boat yards due to increased biological oxygen demand (BOD) from sanitary and domestic waste discharges and the presence of other compounds used in boat servicing such as tributyltin in marine paints.

Dredging to support coastal development, access for oil and gas activities in State waters, and pipeline emplacements are expected to continue to increase each year. Increased turbidity from these dredging operations and dumping of sediments into the coastal water will affect the water quality of the coastal area.

Degradation of water quality from the inputs discussed above is expected to continue. The Gulf Coast has been heavily used and presently shows some signs of environmental stress. Large areas experience nutrient over-enrichment, low-dissolved oxygen, toxin and pesticide contamination, shellfish ground closures, and wetland loss.

4.4.1.2. Offshore

Offshore sources of contaminants besides OCS oil and gas operations include marine transportation, commercial fishing, and natural hydrocarbon seeps. Contaminants released to coastal waters can also be transported to offshore marine waters.

Spills of oil and other substances may occur from vessels transporting crude oil and petroleum products, from vessels transporting other products through Gulf waters between U.S. ports, from OCS oil and gas production operations, and from vessels associated with other offshore activity (marine transportation, recreational ships, etc.). Bottom area disturbances resulting from trawling, anchoring, facility and pipeline emplacement, and some well activities would increase water-column turbidity in the overlying offshore waters. The extent of anchoring by the maritime industry is not known. Sediment disturbance can also result in resuspension of accumulated pollutants (such as trace metals and chlorinated hydrocarbons) and nutrients. Bottom disturbances resulting from structure installation on the OCS have produced short-lived effects on water quality conditions in the immediate vicinity of the emplacement operations (Arthur D. Little, Inc., 1985). Should installation operations occur frequently and in proximity of each other, there would be an increased risk of water quality degradation.

Certain types of blowouts can disturb the bottom and increase turbidity. Should one of these blowouts occur, localized, short-term changes in water quality would be expected. However, impacts to regional water quality would not be expected to be of consequence.

Daily operational discharges to offshore waters occur from vessels moving through Gulf waters and from oil and gas drilling rigs and production facilities. Vessel traffic associated with the extensive maritime industry, oil and gas support operations, and recreational and commercial fishing operations routinely discharge contaminants including domestic and sanitary wastes and bilge and ballast waters into offshore waters. Bilge and ballast waters can contain petroleum and metallic compounds from incidental machinery leaks. Diluted and discharged slowly over large areas, vessel wastes are assumed to contribute in a very small way to the long-term, regional degradation of water quality.

The discharge of drilling fluids, cuttings, and produced water accounts for the bulk of effluent volumes from oil and gas exploration, development, and production operations. Major contaminants in oil-field wastes can include high salinity and dissolved solids, low pH, high BOD and chemical oxygen demand (COD), suspended solids, heavy metals, hydrocarbon compounds, organic acids, priority pollutants, hazardous wastes, and radionuclides. The discharge of treated sanitary and domestic wastes from rigs and structures may increase suspended solids and nutrients in the receiving water that exert a high BOD. Very low levels of residual chlorine will be contained in the treated sanitary waste effluent and may affect a small area near the point of discharge.

Numerous studies have examined the water quality impacts of OCS discharges (such as Avanti Corporation, 1993; CSA, 1997a and b; Kennicutt et al., 1995; Neff, 1997). These studies concluded that contaminants in produced water and drilling discharges should be undetectable in the water column beyond approximately 1,000 m (3,281 ft) from the discharge point. Sediment contamination from discharges is primarily dependent on the water depth and current speed. Sediment contaminants from OCS discharges may occur from several hundred to several thousand meters from the discharge point depending on the volume of discharges. Despite possible sediment accumulation, biological responses to contaminant levels retained by the sediments are not expected to be detectable beyond a couple hundred meters, and toxic effects to the benthos are expected to be very localized, limited to within a hundred meters from the discharge, and of a relatively small magnitude. Toxic effects beyond 100 m (381 ft) should be controlled through the USEPA's NPDES permit requirements.

Some information is available on the volumes of petroleum hydrocarbon compounds entering Gulf waters from various sources (USDOI, MMS, 1997). The OCS oil and gas industry contributes about 4 percent of the Gulf's regional, long-term hydrocarbon contamination. Natural seepage accounts for approximately 27 percent of the total input. Natural hydrocarbon seeps have been documented in the deepwater area of the GOM (Brooks et al., 1986 a or b and 1990; USDOI, MMS, 1996). MacDonald et al. (1996) identified 63 oil slicks from one or more remote-sensing images. These seeps contribute soluble hydrocarbon components into the water column. Seepage of a selected area in the GOM was estimated from two images. The data suggest that the natural seepage is on the order of 4.3×10^3 to 7.8×10^4 $m^3 \cdot y^{-1}$ in the 8,200-km^2 image area and 1.1×10^4 to 4.8×10^5 $m^3 \cdot y^{-1}$ in the 15,000-km^2 image area (USDOI, MMS, 1996).

Although the Gulf comprises one of the world's most prolific offshore oil-producing provinces, onshore sources of hydrocarbons to Gulf waters far outweigh the contributions from offshore production. Coastal sources contribute an order of magnitude more petroleum hydrocarbons to Gulf waters than offshore anthropogenic sources.

Contaminants and high levels of nutrients found in land-based effluents and runoff have been identified as potential causes of hypoxia and, possibly, more frequent occurrence of red tide outbreaks. It is believed that hypoxia occurring in bottom waters in some areas of the open Gulf is caused by nutrient loading coming from the Mississippi River, combined with high summer temperatures, and/or phytoplankton blooms in surface waters (Rabalais, 1992).

Information on elevated levels of contaminants of environmental concern measured in northern Gulf offshore waters was summarized by Kennicutt et al. (1988). Some areas within the Gulf (northern Texas coast, Louisiana, and Alabama) show signs of contamination. Volatile organic compounds (VOC's) were generally present in the highest levels in coastal and nearshore waters, were highest near known onshore point-source discharges, and generally decreased with distance from shore. Chlorinated VOC's were generally restricted to nearshore waters, whereas petroleum-related VOC's were detected at offshore locations. The highest levels of petroleum hydrocarbons were measured near point sources in coastal environments and near natural seeps. Trace organochlorine residues appear to exist in many marine species. Higher concentrations of pollutants were generally found in organisms from the Mississippi Delta in comparison to offshore biota (Kennicutt et al., 1988).

Gulf Coast States sample the edible tissue of estuarine and marine fish for total mercury. The results have been combined in a regional database, the Gulfwide Mercury in Tissue Database. All of the Gulf Coast States have published fish consumption advisories for large king mackerel (Ache et al., 2000).

The Mississippi River will continue to be the major source of contamination of the Gulf. Over time, continuing coastal water quality contamination will degrade offshore water quality. As the assimilative capacity of coastal waters is exceeded, there will be a subsequent, gradual movement of the area of degraded waters farther offshore over time. This degradation will cause short-term loss of the designated uses of large areas of shallow offshore waters due to hypoxic and red tide episodes.

4.4.2. Air Quality

Effects on air quality within the study area will come primarily from industrial, power generation, and urban emissions. Most of the Gulf's coastal areas are currently designated as "attainment" for all the National Ambient Air Quality Standards-regulated pollutants. However, the USEPA has designated Lafourche Parish in Louisiana as an area of "nonattainment" for ground-level ozone (USEPA, 2001).

4.4.3. Sensitive Coastal Environments

4.4.3.1. Coastal Barrier Beaches and Associated Dunes

Coastal barrier beaches have experienced severe erosion and landward retreat because of human activities and natural processes. These adverse effects on barrier beaches and associated dunes have come from changes to the natural dynamics of water and sediment flow along the coast. Examples of these activities include pipeline canals, channel stabilization structures, beach stabilization structures, recreational use of vehicles on dunes and beaches, recreational and commercial development, and removal of coastal vegetation. Human activities cause direct impacts as well as accelerate natural processes that deteriorate coastal barrier features. Natural processes that contribute to most effects include storms, subsidence, and sea-level rise acting upon shorelines with inadequate sand content and supply.

Deterioration of Gulf barrier beaches is expected to continue in the future. Federal, State, and parish governments have made efforts over the last 10 years to slow beach erosion.

4.4.3.2. Wetlands

Wetland loss in the Deltaic Plain of coastal Louisiana is primarily due to subsidence, erosion, and reduced sediment input from the Mississippi River. The conversion of wetlands to agricultural, residential, and commercial uses has also been the major cause of wetland loss. Commercial uses include dredging for both waterfront developments and coastal oil and gas activities. Wetland loss is projected to continue around the Gulf.

4.4.3.3. Seagrasses

Seagrasses are adversely affected by several human activities. These activities include changes to water quality resulting from riverine input, stream channelization, urban runoff, and industrial discharges; physical removal of plants by various forms of dredging, anchoring, and grounding of vessels; and severe storms. These impacts and the general decline of seagrasses are expected to continue into the near future. Various local, State, and Federal programs are focused upon reversing this trend.

4.4.4. Deepwater Benthic Communities/Organisms

4.4.4.1. Chemosynthetic Communities

No impacts to chemosynthetic communities from non-OCS-related activities are expected. Normal fishing practices should not disturb these areas. Other bottom-disturbing activities such as trawling and anchoring are virtually nonexistent at water depths greater than 400 m (1,312 ft).

Several pipelines are proposed with the Thunder Horse project. The pipeline applications will undergo individual chemosynthetic community evaluations. Mitigative measures may be included with these proposals to ensure dense chemosynthetic communities will not be impacted.

The most se rious impact-producing factor that may affect deepwater benthos and sediment communities is the physical disturbance of the sea bottom. Impacts to deepwater communities in the Gulf of Mexico from sources other than OCS activities are considered negligible. Hypoxic conditions at the seafloor may affect the deepwater benthos and associated communities.

4.4.4.2. Coral Reefs

All of the recognized topographic features in the CPA are protected by "no activity zones" and by other operational restriction zones to minimize effects on associated coral reefs. Uncontrolled anchoring remains a threat to these areas. Increasing pressure is being exerted on these features from both commercial and recreational sources.

4.4.4.3. Deepwater Benthos and Sediment Communities

The most serious impact-producing factor that may affect deepwater benthos and sediment communities is the physical disturbance of the sea bottom. Within anchoring depths, marine transportation vessels may affect localized areas; however, the Grid 16 area is too deep for practical vessel anchoring. Hypoxic conditions at the seafloor may affect the deepwater benthos and associated communities.

4.4.5. Marine Mammals

Cumulative impacts to GOM marine mammals include the degradation of water quality resulting from operational discharges, vessel traffic, noise generated at offshore structures, MODU's, helicopters, seismic surveys, explosive structure removals, oil spills, oil-spill response activities, loss of debris from ocean-going vessels and OCS structures, commercial fishing (capture and removal), pathogens, and negative impacts to prey populations. Cumulative impacts on marine mammals are expected to result in a number of chronic and sporadic sublethal effects (behavioral effects and nonfatal exposure to or intake of non-OCS and OCS-related contaminants or discarded debris) that may stress and/or weaken individuals of a local group or population and predispose them to infection from natural or anthropogenic sources. Few deaths are expected from oil spills, chance collisions with OCS service vessels, ingestion of debris such as plastic material, commercial fishing, and pathogens. Oil spills and associated slicks of any size are infrequent events that have the potential to contact marine mammals. Serious injuries or deaths as a result of explosive structure removals are not expected due to mitigative measures contained in Endangered Species Act (ESA) Section 7 consultations. Disturbance (noise from vessel traffic and drilling operations, etc.) and/or exposure to sublethal levels of anthropogenic contaminants may stress animals, weaken their immune systems, and make them more vulnerable to parasites and diseases. Collisions between cetaceans and ships, though expected to be rare events, could cause serious injury or mortality.

The net result of any disturbance would be dependent upon the size and percentage of the population likely to be affected; ecological importance of the disturbed area; environmental and biological parameters that influence an animal's sensitivity to disturbance and stress; or the accommodation time in response to prolonged disturbance (Geraci and St. Aubin, 1980).

4.4.6. Sea Turtles

Cumulative impact-producing factors that may affect sea turtles and their habitats include structure installation, water quality and habitat degradation, trash and flotsam, vessel traffic, seismic surveys, explosive structure removals, oil spills, spill-response activities, natural catastrophes, pollution, dredge operations, commercial and recreational fishing, beach lighting, and power plant entrainment. Sea turtles could be injured or killed from eating marine debris, particularly plastic items, lost from OCS structures and/or ocean-going vessels. Deaths due to explosive structure removal operations should be rare occurrences due to mitigation measures established in ESA Section 7 consultations. Noise from service vessels and from offshore drilling rigs and structures may disrupt the sea turtles' normal activities and may cause physiological stress that make these animals more susceptible to disease or predation. Contaminants in waste discharges and drilling muds might indirectly affect sea turtles. Oil spills and spill-response activities are potential threats that may be adversely affect sea turtles. Contact with, and consumption of, oil and oil-contaminated prey may seriously affect sea turtles. The majority of OCS-related effects are expected to be sublethal, such as behavioral effects and nonfatal exposures (intake of contaminants or debris).

4.4.7. Coastal and Marine Birds

Possible impacts to coastal and marine birds can come from air emissions, water quality degradation, habitat loss and modification resulting from coastal construction and development, collisions with aircraft or vessels, noise from aircraft and vessels, trash and debris, and lighting. Any effects could be especially critical to endangered or threatened species that must maintain a viable reproductive population size or that are dependent on a few key habitat factors. Aircraft or vessel traffic could sporadically disturb feeding, resting, or nesting behavior of birds or cause abandonment of preferred habitat. Birds could become entangled and snared in trash and debris. In addition, they may ingest small plastic debris that could lead to injury or death.

Cumulative activities could detrimentally affect coastal and marine birds. It is expected that the majority of effects from the major impact-producing factors on coastal and marine birds are sublethal (behavioral effects and nonfatal exposure to or intake of contaminants or discarded debris) and will usually cause temporary disturbances and displacement of localized groups inshore. However, chronic sublethal stress is often undetectable in birds. It can serve to weaken individuals (which is especially serious for migratory species) and expose them to infection and disease. Lethal effects, resulting primarily from uncontained coastal oil spills and associated spill-response activities in wetlands and other biologically sensitive coastal habitats, are expected to remove a number of individuals from any or all groups through primary effects from physical oiling and the ingestion of oil, and secondary effects resulting from the ingestion of oiled prey. Most birds can potentially produce two or more eggs in one breeding season and have them survive to maturity. Populations would increase and recover if the average reproductive rate were greater than two offspring successfully surviving to maturity per pair of parents, but the time period for recovery would depend on the average reproductive rate. Therefore, recruitment of birds through successful reproduction is expected to take a year or more, depending upon the species and existing conditions. The net effect of habitat loss from oil spills, new construction, and maintenance and use of pipeline corridors and navigation waterways will alter species composition and reduce the overall carrying capacity of disturbed area(s) in general.

The incremental contribution of the proposed action to the cumulative impact would be negligible because the effects of the most probable impacts, such as OCS-related operational discharges and helicopters and service-vessel noise and traffic, are expected to be sublethal, although some displacement of local individuals or groups may occur. It is expected that there will be little interaction between OCS-related oil spills and coastal and marine birds.

The cumulative effect on coastal and marine birds is expected to result in a discernible decline in the numbers of birds that form localized groups or populations, with associated change in species composition and distribution. Some of these changes are expected to be permanent, as exemplified in historic census data, and to stem from a net decrease in preferred and/or critical habitat.

4.4.8. Essential Fish Habitat and Fish Resources

Degradation of water quality, loss of essential habitat (including wetland loss), pathogens, trash and debris, riverine influences, and overfishing could affect fish resources. Eggs and larvae are more susceptible than adults to environmental 0contaminants. Portions of the Gulf experience hypoxia during portions of the year (LATEX B; Murray, 1998). However, areas of hypoxia typically occur only on the continental shelf.

4.4.9. Gulf Sturgeon

The Gulf sturgeon can be impacted by cumulative activities such as oil spills, alteration and destruction of habitat, and commercial fishing. The effects from contact with spilled oil are expected to be nonfatal and last for less than one month. Substantial damage to Gulf sturgeon habitats is expected from inshore alteration activities and natural catastrophes. As a result, it is expected that the Gulf sturgeon will experience a decline in population sizes and a displacement from their current distribution that will last more than one generation. Deaths of adult sturgeon are expected to occur from commercial fishing. The incremental contribution of the proposed action to the cumulative impact would be negligible because the effect of contact between oil spills from the proposed action and Gulf sturgeon is expected to be nonfatal and last less than one month.

4.4.10. Economic and Demographic Conditions

The economic and demographic conditions evaluated in this PEA are limited to that portion of the GOM's coastal zone whose social and economic well-being (population, labor, and employment) is directly or indirectly affected by the OCS oil and gas industry. The energy industry has become increasingly more global. While the OCS Program, in general, has played a significant role in the GOM region's economy and demography, the activities proposed in Grid 16 are expected to have minimal economic and demographic consequences to the region.

4.4.10.1. Population and Education

The impact area's population is expected to grow at an average annual rate of 1.5 to 1.0 percent over the next 40 years with that growth slowing over time. This population growth is based on the continuation of existing conditions including OCS energy development. Activities in Grid 16 are not expected to affect the population's growth rate. Education levels are expected to remain unchanged by activities within Grid 16.

4.4.10.2. Infrastructure and Land Use

Sufficient infrastructure is in place to support activities within Grid 16. Sufficient land is designated in commercial and industrial parks and adjacent to the existing ports to minimize potential disruption to current residential and business use patterns. While land use in the area will change over time, the majority of this change is expected to be general regional growth.

4.4.10.3. Navigation and Port Usage

There are approximately 50 shore bases that are traditionally used by the oil and gas industry to support activities on the Federal OCS. Certain companies favor some of these bases for their offshore operations. No new expansion or construction is expected at these existing shore bases to support offshore activities within Grid 16.

4.4.10.4. Employment

The oil and gas industry is very important to many of the coastal communities of the GOM, especially in Louisiana and eastern Texas. Changes in OCS oil and gas activities have significant employment implications to these communities, particularly in industries directly and indirectly related to oil and gas development. However, the energy industry has global markets (both for the supply of goods and services needed to produce energy and demand for energy products). While mergers, relocations, and consolidation of oil and gas companies' assets have affected employment in the GOM region in recent years, employment changes to the coastal communities as a result of activities in Grid 16 are expected to be negligible.

4.4.11. Environmental Justice

Federal agencies are directed by Executive Order 12898 to assess whether their actions will have a disproportionate environmental effect on people of ethnic or racial minorities or with low incomes. Since sufficient onshore facilities are available to support offshore activities in Grid 16, no effects to minorities or people with low incomes in the Gulf counties and parishes are expected.

4.4.12. Commercial Fisheries

Federal and State fishery management agencies will control the "take" of commercial fishes. The agencies' primary responsibility is to manage effectively the fishery stock to perpetuate commercially important species. Various management plans aimed at selected species have been and will continue to be prepared. The Central GOM will remain one of the Nation's most important commercial fisheries area.

4.4.13. Recreational Resources and Beach Use

Factors such as land development, civil works projects, and natural phenomena have affected, and will continue to affect, beach stabilization, which ultimately affects the recreational use of beaches. Many of the people in the adjacent coastal states live in the coastal zone. Pressure on the natural resources within the coastal zone is expected to continue or possibly increase.

Man-induced debris and litter derived from both offshore and onshore sources are likely to diminish the tourist potential of beaches and degrade the ambience of shoreline recreational beaches, thereby affecting the enjoyment of recreational beaches throughout the planning area. MARPOL Annex V and cooperation and support from offshore industries to reduce marine debris through the GOM Program's Marine Debris Action Plan should lead to a decline in the level of human-generated trash that may adversely affect recreational beaches throughout the Gulf.

Although trash from onshore sources will continue to adversely affect the ambience of recreational beaches, the level of chronic pollution should decline. Beach use at the regional level is unlikely to change.

4.4.14. Archaeological Resources

4.4.14.1. Prehistoric

Grid 16 is located in deep water (greater than 1,000 m or 3,281 ft). It is not located in one of the MMS's designated high-probability areas for prehistoric sites. No potential exists to affect prehistoric archaeological resources.

4.4.14.2. Historic

According to Garrison et al. (1989) and Pearson et al. (2002), the shipwreck database lists 8 shipwrecks and 29 high-probability shipwreck blocks that fall within the Grid 16 area. These shipwrecks are listed in Table 3-3. Six of these wrecks are 50 years or older and are eligible for listing in the National Register of Historic Places.

Seafloor-disturbing activities such as anchoring have the potential to affect shipwrecks, if present. In-place mitigating measures would eliminate or minimize potential impacts to these resources.

5. CONSULTATION AND COORDINATION

The States of Louisiana and Mississippi have approved Coastal Zone Management (CZM) Programs. Therefore, Certificates of Coastal Zone Consistency from the States were required for the proposed activities. The MMS mailed the plan and other required and necessary information to the States' appropriate CZM agencies on September 4, 2001. The State of Mississippi provided a letter of its concurrence with the CZM Program on September 18, 2002. On September 20, 2002, the Governor's Office from the State of Mississippi also provided a letter regarding the Thunder Horse project. The State of Louisiana provided a letter of its concurrence with the CZM Program on September 20, 2002.

To provide the public with official notice of the proposed activities planned for the Thunder Horse development, the MMS published a description of the BP proposal in The *Times-Picayune* newspaper (southeast Louisiana coverage) and in the *Mobile Register* (southern Mississippi and southern Alabama coverage). In these public notices, the MMS requested interested parties to submit comments on issues that should be addressed in the PEA. The notices appeared in the newspapers on September 12, 2002. No comments were received by the MMS from the newspaper notice.

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8. APPENDICES

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APPENDIX A

Proposed Activity Schedule

APPENDIX A

PROPOSED ACTIVITY SCHEDULE FOR THE THUNDER HORSE PROJECT

The following table depicts the proposed activity schedules for the development of the Thunder Horse project.

Thunder Horse Project Schedule

Proposed Activity	Starting Date	Ending Date	Activity Duration
	Drilling, Completion, & Cleanup Operations		
	Drill Center 31		
Drilling & Completions	06/29/04	08/04/04	36 days
Well Cleanup	08/04/04	08/05/04	2 days
Drilling & Completions	08/02/05	12/20/05	140 days
Well Cleanup	12/20/05	12/21/05	2 days
Drilling & Completions	03/28/06	07/24/06	118 days
Drilling & Completions	07/12/06	11/13/06	124 days
Drilling & Completions	08/20/11	11/30/11	102 days
Well Cleanup	11/30/11	12/01/11	2 days
	Drill Center 32		
Drilling & Completions	04/10/04	05/21/04	41 days
Well Cleanup	05/21/04	05/22/04	2 days
	Drill Center 33		
Drilling & Completions	09/25/04	02/06/05	133 days
Well Cleanup	02/06/05	02/07/05	2 days
Drilling & Completions	01/04/05	02/09/05	36 days
Well Cleanup	02/09/05	02/10/05	2 days
Drilling & Completions	04/03/05	08/22/05	141 days
Drilling & Completions	12/23/05	04/04/06	102 days
Well Cleanup	04/04/06	04/05/06	2 days
Drilling & Completions	12/21/11	03/30/12	100 days
Well Cleanup	03/30/12	03/31/12	2 days
	Drill Center 41		
Drilling & Completions	02/19/03	06/23/03	124 days
Well Cleanup	06/23/03	06/28/03	6 days
Drilling & Completions	07/02/03	10/26/03	116 days
Well Cleanup	10/26/03	11/01/03	6 days
Drilling & Completions	01/26/04	02/27/04	32 days
Well Cleanup	02/27/04	03/03/04	6 days
Drilling & Completions	05/19/07	10/21/07	155 days
Well Cleanup	10/21/07	10/22/07	2 days
Drilling & Completions	08/11/08	11/24/08	105 days
Drilling & Completions	11/26/08	03/21/09	115 days
Well Cleanup	03/21/09	03/22/09	2 days
Drilling & Completions	11/23/11	03/11/12	109 days
Drilling & Completions	12/15/12	04/26/13	132 days
Drilling & Completions	09/19/13	12/21/14	124 days
Drilling & Completions	09/28/14	01/21/15	115 days

Thunder Horse Project Schedule (continued).

Proposed Activity	Starting Date	Ending Date	Activity Duration
	Drill Center 42		
Drilling & Completions	07/19/03	08/22/03	34days
Well Cleanup	05/01/05	05/02/05	2days
	Drill Center 44		
Drilling & Completions	04/12/05	08/24/05	134 days
Well Cleanup	08/24/05	08/25/05	2 days
Drilling & Completions	09/14/05	01/05/06	113 days
Well Cleanup	01/05/06	01/06/06	2 days
Drilling & Completions	12/30/05	05/22/06	143 days
Well Cleanup	05/22/06	05/23/06	2 days
	Drill Center 45		
Drilling & Completions	08/22/03	10/30/03	69 days
Well Cleanup	06/01/05	06/02/05	2 days
	Installation Operations		
	Drill Center 31		
Flowline Installation (incl. PLETs & Sleds)	07/05/04	07/07/04	3 days
Jumper Measurement	08/15/04	12/21/04	1 day
Umbilical Installation	01/31/05	02/02/05	3 days
	Drill Center 32		
Manifold Installation	12/21/04	01/21/05	15 days
Flowline Installation (incl. PLETs & Sleds)	07/02/04	07/16/04	12 days
Jumper Measurement	08/07/04	08/14/04	5 days
Jumper Installation	09/26/04	09/29/04	4 days
Umbilical Installation	01/06/05	01/10/05	5 days
	Drill Center 33		
Manifold Installation	07/08/04	07/12/04	5 days
Flowline Installation (incl. PLETs & Sleds)	05/27/04	06/12/04	17 days
Jumper Measurement	08/11/04	08/13/04	3 days
Jumper Installation	09/23/04	09/25/04	3 days
Jumper Installation	02/15/05	02/18/05	4 days
Umbilical Installation	01/10/05	01/15/05	5 days
	Drill Center 41		
Prelay PDQ Mooring	05/01/04	06/01/04	32 days
Manifold Installation	06/02/04	06/25/04	24 days
Flowline Installation (incl. PLETs & Sleds)	05/01/04	04/04/04	65 days
Jumper Measurement	07/11/04	08/05/04	20 days
Jumper Installation	08/27/04	09/15/04	20 days
PDQ Mooring	11/21/04	12/10/04	19 days
Jumper Installation	01/30/05	02/03/05	5 days
Umbilical Installation	01/23/05	03/08/05	45 days
Tow Rig to Location	11/06/04	11/21/04	15 days
Remaining Hook Up & Commissioning	11/21/04	12/03/04	13 days

Thunder Horse Project Schedule (continued).

Proposed Activity	Starting Date	Ending Date	Activity Duration
	Drill Center 43		
Jumper Measurement	07/19/04	07/20/04	2 days
Jumper Installation	09/16/04	09/17/04	2 days
Umbilical Installation	12/29/04	12/31/04	3 days
	Drill Center 44		
Single well—no installation activity other than what captured under Drill Center 41			
Jumper Installation	09/21/04	09/22/04	2 days
Umbilical Installation	12/26/04	12/28/04	3 days
	PDQ Operations		
	Drill Center 41		
First Oil	04/11/05		
Production*	04/11/05	04/11/31	9,490 days
PDQ Drilling	06/10/05	08/27/13	2,998 days

*Three injector wells under the PDQ will be cleaned up back to the PDQ, but these operations will not involve flaring or storing.

APPENDIX B

Accidental Oil Spill Review

APPENDIX B

ANALYSIS OF THE POTENTIAL FOR AN ACCIDENTAL OIL SPILL AND POTENTIAL FOR IMPACTS FROM THE THUNDER HORSE PROJECT IN GRID 16

Mississippi Canyon Block 777 Unit (Blocks 775, 776, 777, 778, 819, 820, 821, and 822) Plan Number N-7469

Introduction

The National Environmental Policy Act, as amended, (NEPA) requires Federal agencies to consider potential environmental impacts (direct, indirect, and cumulative) of proposed actions as part of an agency's planning and decisionmaking processes. The NEPA analyses address many issues relating to potential impacts, including issues that may have a very low probability of occurrence, but which the public considers important or for which the environmental consequences could be significant.

The past several decades of spill data show that effects from accidental oil spills associated with oil and gas exploration and development are low probability events in Federal Outer Continental Shelf (OCS) waters of the Gulf of Mexico (GOM), yet the issue of oil spills is important to the public. This document summarizes key information about the probability of accidental spills from offshore oil and gas activities in the GOM.

Spill Prevention

The MMS has comprehensive pollution prevention requirements that include numerous redundant levels of safety devices, as well as inspection and testing requirements to confirm that these devices work. Many of these requirements have been in place since about 1980. Spill trends analysis for the GOM OCS show that spills from facilities have decreased over time, indicating that the MMS's engineering and safety requirements have minimized the potential for spill occurrence and associated impacts. Details regarding the MMS's engineering and safety requirements can be found at 30 CFR 250.800, Subpart H.

OCS Spills in the Past

This summary of past OCS spills presents data for the period 1985-1999. The 1985-1999 time period was chosen to reflect more modern engineering and regulatory requirements and because OCS spill rates are available for this period. For the period 1985-1999, there were no spills ≥1,000 barrels (bbl) from OCS platforms, eight spills ≥1,000 bbl from OCS pipelines, and no spills ≥1,000 bbl from OCS drilling activities (Tables B-1 through B-3). It should be noted that past OCS spills (Tables B-1 through B-3), some of which are considerably >1,000 bbl, have not resulted in any documented significant impacts to shorelines or other resources. The Final Multisale EIS (USDOI, MMS, 2002) and Final Lease Sale 181 EIS (USDOI, MMS, 2001) in the Eastern Planning Area provide additional information on past OCS spills.

Estimating Future Potential Spills

The MMS estimates the risk of future potential spills by using a formula that multiplies several variables to result in a numerical expression of risk. These variables include the potential of a spill occurring (based on historical OCS spill rates) and a variable for the potential for a spill to be transported to environmental resources (based on trajectory modeling). The following subsections describe the spill occurrence and transport variables used to estimate risk and the risk calculation for the proposed action.

Spill Occurrence Variable (SOV) Representing the Potential for a Spill

The SOV is derived based on past OCS spill frequency; that is, data from past OCS spills are used to estimate future potential OCS spills. The MMS has estimated spill rates from the following sources: facilities, pipelines, and blowouts.

Spill rates for facilities and pipelines have been developed for several time periods and an analysis of trends for spills is presented in *Update of Comparative Occurrence Rates for Offshore Oil Spills* (Spill Science & Technology Bulletin, 2000). Spill rates for the most recent period analyzed, 1985-1999, are presented here. Data for this recent period should reflect more modern spill-prevention requirements.

Spill rates for facilities and pipelines are based on the number of spills per volume of oil handled. Spill rates for drilling activities are based on the number of spills associated with activities occurring during drilling operations. These include spills from blowouts, drill rigs, supply vessels, fuel storage, and other drilling activities. Spill rates for the period 1985-1999 are shown in Table B-4. It should be noted that there were no platform or drilling spills $\geq$1,000 bbl for the period 1985-1999. Use of "zero" spills would result in a zero spill rate. To provide a non-zero spill rate for conservative future predictions of spill occurrence, the spill period was expanded to include older spill data. The spill data period is expanded to 1980 to include a spill for facilities. The spill data period is expanded to 1971 to include a spill for drilling activities. Spill rates are combined with site-specific data on production or pipeline volumes or number of wells being drilled to result in a site-specific SOV.

Transport Variable (TV) Representing the Potential for a Spill to be Transported to Important Environmental Resources

The TV is derived using an oil-spill trajectory model. This model predicts the direction that winds and currents would transport spills. The model uses an extensive database of observed and theoretically computed ocean currents and fields that represent a statistical estimate of winds and currents that would occur over the life of an oil and gas project, which may span several decades. This model produces the TV that can be combined with other variables, such as the SOV, to estimate the risk of future potential spills and impacts.

Risk Calculation for the Proposed Action

BP Exploration and Production, Inc.'s (BP) Initial Unit Development Operations Coordination Document (DOCD) and its amendments propose to initially drill and complete a total of 27 wells (17 production and 10 water injection wells). In addition, approximately 16 recompletions and 16 sidetracks are planned in the mid-to-late life of the fields. The wells will be drilled from eight drill centers and production will be tied back to a semisubmersible production facility (PDQ facility) in Mississippi Canyon Block 778. BP's Mississippi Canyon, Block 777 Unit is composed of the following blocks: Blocks 775 (OCS-G 19997), 776 (OCS-G 9866), 777 (OCS-G 9867), 778 (OCS-G 9868), 819 (OCS-G 12168), 820 (OCS-G 14656), 821 (OCS-G 14657), and 822 (OCS-G 14658). Liquid hydrocarbon production from the Thunder Horse project will depart the PDQ facility in a proposed right-of-way pipeline (ROW G-23429; Segment Number 13633) to be owned and operated by Proteus Oil Pipeline Company, LLC (MMS Qualification Number 2530). The proposed Proteus oil pipeline is a 61 to 71-cm (24-28 in) bi-directional pipeline that will carry liquid hydrocarbons approximately 111 km (69 mi) from the PDQ facility in Mississippi Canyon, Block 778, to a proposed Platform E in South Pass Area, South Addition, Block 89. A new four-pile, Platform E is proposed to be set as an accessory structure for the Proteus pipeline. From Platform E, liquid hydrocarbon production will depart in a proposed right-of-way pipeline (ROW G- 23068; Segment Number 13534) to be owned and operated by Endymion Oil Pipeline Company, LLC (MMS Qualification Number 2529). The proposed Endymion Oil Pipeline is a 76-cm (30-in) bi-directional pipeline. It will carry the liquid hydrocarbons approximately 87 km (54 mi) from Platform E to a landfall at the existing BP facilities on Grand Isle, Louisiana, and ultimately terminate at the Louisiana Offshore Oil Port (LOOP) storage facilities near the Clovelly Oil and Gas Field. Table B-5 presents an estimate of spill risk from the facility to resources. The risk estimate for the facility was calculated using the spill rate of 0.13 per billion barrels of oil produced, the estimated production for the proposed action, and oil-spill trajectory calculations.

The coastline and associated environmental resources are presented in Table B-5. The final column in Table B-5 presents the result of combining the SOV's and the TV's. The risk of a spill impact from the facility could be considered to be so low as to be near zero.

Given the low risk of resources being exposed to spills as a result of the proposed action, spill-prevention requirements, and spill-response requirements, significant impacts to environmental resources are unlikely. The Final Multisale EIS (USDOI, MMS, 2002) and Final Lease Sale 181 EIS (USDOI, MMS, 2001) in the Eastern Planning Area provide additional information on spills and potential impacts. The following section provides additional information regarding the spill-response preparedness requirements of the MMS.

Spill Response

The MMS has extensive requirements both for the prevention of spills and preparedness to respond to a spill in the event of an accident. The MMS spill-prevention requirements and the low incidence of past OCS spills were addressed earlier in this document. This section presents information on the MMS's requirements for spill-response preparedness.

MMS Spill-Response Program

The MMS Oil-Spill Program oversees the review of oil-spill response plans, coordinates inspection of oil-spill response equipment, and conducts unannounced oil-spill drills. This program also supports continuing research to foster improvements in spill prevention and response. Studies funded by the MMS address issues such as spill prevention and response, *in-situ* burning, and dispersant use.

In addition, MMS works with the U.S. Coast Guard and other members of the multiagency National Response System to further improve spill-response capability in the GOM. The combined resources of these groups and the resources of commercially contracted oil-spill response organizations result in extensive equipment and trained personnel for spill response in the GOM.

Spill Response for This Project

The subject operator has an oil-spill response plan on file with the MMS and has current contracts with offshore oil-spill response organizations.

Potential spill sources for this project include a production spill during the life of the development (25 years), an accidental blowout (141,000 bbl of oil per day), a spill of liquid oil stored on the platform (approximately 21,400 bbl total storage capacity), a spill of liquid oil stored on the largest rig (approximately 125,000 bbl total storage capacity), a spill from the offloading of well cleanup fluids (maximum transfer volume 60,000 bbl), or a spill from the associated oil flowlines (2,000 bbl), lease-term pipelines (13,000 bbl), or the export pipelines. The operator has demonstrated spill-response preparedness for accidental releases from these types of potential spills in their oil-spill response plan.

The MMS will continue to verify the operator's capability to respond to oil spills via the MMS Oil-Spill Program. The operator is required to keep their oil-spill response plan up-to-date in accordance with MMS regulations. The operator must also conduct an annual drill to demonstrate the adequacy of their spill preparedness. The MMS also conducts unannounced drills to further verify the adequacy of an operator's spill-response preparedness; such a drill could be conducted for this proposed action.

References

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Table B-1

Historical Record of OCS Spills ≥1,000 Barrels from OCS Facilities, 1985–1999

Spill Date	Area and Block (water depth and distance from shore)	Volume Spilled (barrels)	Cause of Spill

No OCS facility spills ≥1,000 bbl during the period 1985–1999.

Table B-2

Historical Record of OCS Spills ≥1,000 Barrels from OCS Pipelines, 1985–1999

Spill Date	Area and Block (water depth and distance from shore)	Volume Spilled (barrels)	Cause of Spill
February 7, 1988	South Pass 60 (75 ft, 3.4 mi)	15,576	Service vessel's anchor damaged pipeline
January 24, 1990	Ship Shoal 281 (197 ft, 60 mi)	14,423*	Anchor drag, flange and valve broke off
May 6, 1990	Eugene Island 314 (230 ft, 78 mi)	4,569	Trawl drag pulled off valve
August 31, 1992	South Pelto 8 (30 ft, 6 mi)	2,000	Hurricane Andrew, loose drilling rig's anchor drag damaged pipeline
November 22, 1994	Ship Shoal 281 (197 ft, 60 mi)	4,533*	Trawl drag
January 26, 1998	East Cameron 334 (264 ft, 105 mi)	1,211*	Service vessel's anchor drag damaged pipeline during rescue operation
September 29, 1988	South Pass 38 (110 ft, 6 mi)	8,212	Hurricane Georges, mudslide parted pipeline
July 23, 1999	Ship Shoal 241 (133 ft, 50 mi)	3,200	Jack-up barge sat on pipeline

* Denotes a condensate spill.

Table B-3

Historical Record of OCS Spills ≥1,000 Barrels from OCS Blowouts, 1985–1999

Spill Date	Area and Block (water depth and distance from shore)	Volume Spilled Barrels	Cause of Spill

No OCS blowout spills ≥1,000 bbl during the period 1985–1999.

Table B-4

Spill Rates Used to Estimate the Future Potential for Spills

Spill Source	Volume of Oil Handled in Billions of Barrels	Number of Wells Drilled	No. of Spills ≥1,000 Barrels	Risk of Spill from Facilities or Pipelines per Billion Barrels	Risk of Spill from Drilling Blowout per Well
Facilities	7.41 [a]	Not Applicable	1[a]	>0 to <0.13[c]	Not Applicable
Pipelines	5.81	Not Applicable	8	1.38	Not Applicable
Drilling	Not Applicable	23,610	1[b]	Not Applicable	>0 to <0.00004[c]

[a] There were actually zero spills of ≥1,000 bbl from facilities during the period 1985-1999. The data shown represent 1980-1999. The spill period for facility spills was expanded to 1980 to include a spill for facilities to result in a nonzero risk.

[b] There have been no spills of ≥1,000 bbl from drilling activities during the period 1985-1999. Drilling activities include spills from blowouts, drilling rigs, supply vessels, fuel storage, and other drilling activities. The data shown represent 1971-1999. One spill of ≥1,000 bbl occurred during this period – a 1,500-bbl diesel spill from a drilling rig damaged in a storm.

[c] There were no facility or drilling spills of ≥1,000 bbl for the period 1985-1999; however, a nonzero spill rate was calculated by expanding the facility and drilling period to 1980 and 1971. Therefore, the spill rates for these categories are presented as greater than zero but below the rates calculated by expanding the data period.

Table B-5

Spill Risk Estimate for Facilities

Environmental Resource	Spill Occurrence Variable (1) (%)	Transport Variable (2) within 30 days (%)	Spill Risk (3) within 30 days (%)
Counties/Parishes			
Cameron, TX	26	<0.5	<0.5
Willacy, TX	26	<0.5	<0.5
Kenedy, TX	26	<0.5	<0.5
Kleburg, TX	26	<0.5	<0.5
Nueces, TX	26	<0.5	<0.5
Aransas, TX	26	<0.5	<0.5
Calhoun, TX	26	<0.5	<0.5
Matagorda, TX	26	<0.5	<0.5
Brazoria, TX	26	<0.5	<0.5
Galveston, TX	26	<0.5	<0.5
Chambers, TX	26	<0.5	<0.5
Jefferson, TX	26	<0.5	<0.5
Cameron, LA	26	1	<0.5
Vermilion, LA	26	<0.5	<0.5
Iberia, LA	26	<0.5	<0.5
St. Mary, LA	26	<0.5	<0.5
Terrebonne, LA	26	2	1
Lafourche, LA	26	2	1
Jefferson, LA	26	1	<0.5
Plaquemines, LA	26	10	3
St. Bernard, LA	26	2	1
Harrison, MS	26	<0.5	<0.5
Jackson, MS	26	<0.5	<0.5
Baldwin, AL	26	<0.5	<0.5
Mobile, AL	26	<0.5	<0.5
Escambia, FL	26	<0.5	<0.5
Santa Rosa, FL	26	<0.5	<0.5
Okaloosa, FL	26	<0.5	<0.5
Walton, FL	26	1	<0.5
Bay, FL	26	1	<0.5
Gulf, FL	26	<0.5	<0.5
Franklin, FL	26	<0.5	<0.5
Wakulla, FL	26	<0.5	<0.5
Jefferson, FL	26	<0.5	<0.5
Taylor, FL	26	<0.5	<0.5
Dixie, FL	26	<0.5	<0.5
Levy, FL	26	<0.5	<0.5
Citrus, FL	26	<0.5	<0.5
Hernando, FL	26	<0.5	<0.5
Pasco, FL	26	<0.5	<0.5
Pinellas, FL	26	<0.5	<0.5
Hillsborough, FL	26	<0.5	<0.5
Manatee, FL	26	<0.5	<0.5
Sarasota, FL	26	<0.5	<0.5
Charlotte, FL	26	<0.5	<0.5

Table B-5. Spill Risk Estimate for Facilities (continued).

Environmental Resource	Spill Occurrence Variable (1) (%)	Transport Variable (2) within 30 days (%)	Spill Risk (3) within 30 days (%)
Lee, FL	26	<0.5	<0.5
Collier, FL	26	<0.5	<0.5
Monroe, FL	26	<0.5	<0.5
State Offshore Waters			
TX State Offshore Waters	26	1	<0.5
LA (Western) State Offshore Waters	26	17	4
LA (Eastern) State Offshore Waters	26	6	2
MS State Offshore Waters	26	1	<0.5
AL State Offshore Waters	26	1	<0.5
FL Panhandle State Offshore Waters	26	4	1
FL Peninsula State Offshore Waters	26	<0.5	<0.5
Major Recreational Beach Areas			
TX Coastal Bend area beaches	26	<0.5	<0.5
TX Matagorda area beaches	26	<0.5	<0.5
TX Galveston area beaches	26	<0.5	<0.5
TX Sea Rim State Park	26	<0.5	<0.5
LA beaches	26	3	1
AL/MS Gulf Islands	26	1	<0.5
AL Gulf Shores	26	<0.5	<0.5
FL Panhandle beaches	26	3	1
FL Big Bend beaches	26	<0.5	<0.5
FL Southwest beaches	26	<0.5	<0.5
FL Ten Thousand Islands	26	<0.5	<0.5

(1) The percent chance of a spill event occurring from the proposed action.

(2) The percent chance that winds and currents will move a point projected onto the surface of the Gulf beginning within the area of the Mississippi Canyon Block 777 Unit and ending at specified shoreline segments or environmental resources within 30 days. These results are the results of a numerical model that calculates the trajectory of a drifting point projected onto the surface of the water using temporally and spatially varying winds and ocean current fields. These probabilities do not factor in the risk of spill occurrence, consideration of the spill size, any spill response or cleanup actions, or any dispersion and weathering of the slick with time. Model results used are for C6-2 cluster area.

(3) The probability of a spill occurring and contacting identified environmental features represents the weighted risk that accounts for both the risk that a large spill will occur and the risk that it will contact locations where the resources occur, given the assumptions already described in (1) and (2).

(4) <0.5 = less than 0.5%.

APPENDIX C

Waste Tables

Table C-1

Drilling Wastes Table - 4-Way Subsalt Wells (estimated 7 wells)

Waste Generated during Drilling	Composition/Description	Projected Amount	Disposal Method	Maximum Discharge Rate	Treatment & Discharge Method	Name/Location of Facility
Water-based drilling fluids	N/A	None (see "Muds, cuttings, and cement at the sea floor" below)	N/A	N/A	N/A	N/A
Nonaqueous drilling fluids	Internal olefin/ester blend; or internal olefin/ester/paraffin blend	2,800 bbl/well discharged (<6.9% retention on cuttings (ROC) with drilled cuttings)	Discharge overboard	1,000 bbl/hr	Discharge through shunt line 40 ft below seawater surface	N/A
Drill cuttings associated with water-based fluids	N/A	None (see "Muds, cuttings, and cement at the seafloor" below)	N/A	N/A	N/A	N/A
Drill cuttings associated with nonaqueous based fluids	Cuttings coated with synthetic-based drilling mud	4,000 bbl/well	Discharge overboard	1,000 bbl/hr	Discharge through shunt line 40 ft below seawater surface	N/A
Sanitary wastes	Human body waste from toilets and urinals	30 gal/person/day	Discharge overboard	Continuous	Marine sanitation device treatment & discharge overboard	N/A
Domestic wastes	Discharge from galleys, sinks, and showers (gray water)	50 gal/person/day	Discharge overboard	Continuous	Discharge overboard	N/A
Deck drainage	Platform washings, drains	Dependent on rainfall	Discharge overboard	Dependent on rainfall	Treat with separator to remove free oil	N/A

Table C-1. Drilling Wastes Table - 4-Way Subsalt Wells (estimated 7 wells) (continued)

Waste Generated during Drilling	Composition/Description	Projected Amount	Disposal Method	Maximum Discharge Rate	Treatment & Discharge Method	Name/Location of Facility
Well treatment, work-over, or completion fluids	Calcium chloride ($CaCl_2$)/ Calcium bromide (CaBr)	Discharge 2,500 bbl/well; dispose as waste onshore: 500 bbl/well; send to shore for reclamation: 2,500 bbl/well	Discharge overboard; dispose of as waste onshore and send to shore for reclamation	N/A	N/A	Waste to shore: Newpark or Environmental Treatment Team Reclamation: return to fluid vendor
Muds, cuttings, and cement at the seafloor	Seawater NaCl polymer, drill cuttings, cement (prior to installation of marine riser)	NaCl WBM–12,000 bbl Cuttings–1,800 bbl	Discharge at seabed	N/A	N/A	N/A
Uncontaminated seawater	Seawater returned to the sea without the addition of chemicals	Drilling rig once-through noncontact cooling water–35,000 bbl/day	Discharge overboard	Continuous	N/A	N/A
Desalinization unit water	Chemically treated seawater associated with the process of creating freshwater from seawater	25,000 bbl/day	Discharge overboard	Continuous	N/A	N/A
Uncontaminated bilge & ballast water			Discharge overboard			
Excess cement with cementing chemicals	Excess cement	100 bbl	Discharge overboard	N/A	Discharge at seabed without treatment	
RCRA exempt wastes in quantities >50 bbl/month	N/A	N/A	N/A	N/A	N/A	N/A
Non-RCRA exempt wastes in quantities >50 bbl/month	Mud sacks, pails, pallets, shrink wrap, drums	7,000 sacks, 100 pails, 12 drums, 145 pallets, 145 shrink wrap	Shipment to shore base for collection by municipal operations			Local landfill
Hazardous wastes in reportable quantities						
NORM- contaminated wastes	N/A	N/A	N/A	N/A	N/A	N/A
Wastes not addressed in listing above in quantities >50 bbl/month						

Table C-2

Drilling Wastes Table - 4-Way Extra Salt Well (estimated 3 wells)

Waste Generated during Drilling	Composition/ Description	Projected Amount	Disposal Method	Maximum Discharge Rate	Treatment & Discharge Method	Name/Location of Facility
Water-based drilling fluids	N/A	None (see "Muds, cuttings, & cement at the seafloor" below)	N/A	N/A	N/A	N/A
Nonaqueous drilling fluids	Internal olefin/ester blend or internal olefin/ paraffin blend	3,000 bbl/well discharged (<6.9% ROC with drilled cuttings)	Discharge overboard	1,000 bbls/hr	Discharge through shunt line 40 ft below seawater surface	N/A
Drill cuttings associated with water-based fluids	N/A	None (see "Muds, cuttings, & cement at the seafloor" below)	N/A	N/A	N/A	N/A
Drill cuttings associated with nonaqueous based fluids	Cuttings coated with synthetic-based drilling mud	3,100 bbl/well	Discharge overboard	1,000 bbl/hr	Discharge through shunt line 40 ft below seawater surface	N/A
Sanitary wastes	Human body waste from toilets & urinals	30 gal/person/day	Discharge overboard	Continuous	Marine sanitation device treatment & discharge overboard	N/A
Domestic wastes	Discharge from galleys, sinks, and showers (gray water)	50 gal/person/day	Discharge overboard	Continuous	Discharge overboard	N/A
Deck drainage	Platform washings, drains	Dependent on rainfall	Discharge overboard	Dependent on rainfall	Treat with separator to remove free oil	N/A
Well treatment, work-over, or completion fluids	Calcium chloride ($CaCl_2$)/Calcium bromide (CaBr)	Discharge: 2,500 bbl/well; dispose as waste on shore: 500 bbl/well; send to shore for reclamation: 2,500 bbl/well	Discharge overboard, dispose as waste on shore, and send to shore for reclamation	N/A	N/A	Waste to shore: Newpark or Environmental Treatment Team Reclamation: Return to fluid vendor

Table C-2. Drilling Wastes Table - 4-Way Extra Salt Well (estimated 3 wells) (continued).

Waste Generated during Drilling	Composition/ Description	Projected Amount	Disposal Method	Maximum Discharge Rate	Treatment & Discharge Method	Name/Location of Facility
Muds, cuttings, & cement at the seafloor	Seawater, NaCl polymer, drill cuttings, cement (Prior to installation of the marine riser).	NaCl water-based mud (WBM)–20,000 bbl Cuttings–3,000 bbl	Discharge at seabed	N/A	N/A	N/A
Uncontaminated seawater	Seawater returned to the sea without the addition of chemicals	Drilling rig once-through noncontact cooling water– 35,000 bbl/day	Discharge overboard	Continuous	N/A	N/A
Desalinization unit water	Chemically treated sea water associated with the process of creating freshwater from seawater	25,000 bbl/day	Discharge overboard	Continuous	N/A	N/A
Uncontaminated Bilge Water			Discharge overboard			
Uncontaminated ballast water			Discharge overboard			
Excess cement with cementing chemicals	Excess cement	100 bbl	Discharge overboard	N/A	Discharge at seabed without treatment	
RCRA exempt wastes in quantities >50 bbl/month	N/A	N/A	N/A	N/A	N/A	N/A
Non-RCRA exempt wastes in quantities >50 bbl/month	Mud sacks, pails, pallets, shrink wrap, drums	7,800 sacks, 100 pails, 12 drums, 160 pallets, 160 shrink wrap	Shipment to shore base for collection by municipal operations			Local landfill
Hazardous wastes in reportable quantities						
NORM- contaminated wastes	N/A	N/A	N/A	N/A	N/A	N/A
Wastes not addressed in listing above in quantities >50 bbl/month						

Table C-3

Drilling Wastes Table - 3-Way Subsalt Wells (estimated 8 wells)

Waste Generated during Drilling	Composition/ Description	Projected Amount	Disposal Method	Maximum Discharge Rate	Treatment & Discharge Method	Name/Location of Facility
Water-based drilling fluids	N/A	None (see "Muds, cuttings, & cement at the seafloor" below)	N/A	N/A	N/A	N/A
Nonaqueous drilling fluids	Internal olefin/ester blend or internal olefin/ paraffin blend	2,300 bbl/well discharge (<6.9% ROC with drilled cuttings	Discharge overboard	1,000 bbl/hr	Discharge through shunt line 40 ft below seawater surface	N/A
Drill cuttings associated with water-based fluids	N/A	None (see "Muds, cuttings, & cement at the seafloor" below)	N/A	N/A	N/A	N/A
Drill cuttings associated with nonaqueous based fluids	Cuttings coated with synthetic-based drilling mud	2,400 bbl/well	Discharge overboard	1,000 bbl/hr	Discharge through shunt line 40 ft below seawater surface	N/A
Sanitary wastes	Human body waste from toilets & urinals	30 gal/person/day	Discharge overboard	Continuous	Treat with marine sanitation device and discharge overboard	N/A
Domestic wastes	Discharge from galleys, sinks, and showers (gray water)	50 gal/person/day	Discharge overboard	Continuous	Discharge overboard	N/A
Deck drainage	Platform washings, drains	Dependent on rainfall	Discharge overboard	Dependent on rainfall	Treat with separator to remove free oil	N/A
Well treatment, work-over, or completion fluids	Calcium chloride ($CaCl_2$)/Calcium bromide (CaBr)	Discharge: 2,500 bbl/well; dispose as waste on shore: 500 bbl/well; send to shore for reclamation: 2,500 bbl/well	Discharge overboard dispose as waste onshore and send to shore for reclamation	N/A	N/A	Waste to shore: Newpark or Environmental Treatment Team Reclamation: return to fluid vendor
Muds, cuttings, & cement at the seafloor	Seawater NaCl polymer, drill cuttings, cement (Prior to installation of marine riser)	NaCl WBM–100,000 bbl Cuttings–2,300 bbl	Discharge at seabed	N/A	N/A	N/A

Table C-3. Drilling Wastes Table - 3-Way Subsalt Wells (estimated 8 wells) (continued).

Waste Generated during Drilling	Composition/ Description	Projected Amount	Disposal Method	Maximum Discharge Rate	Treatment & Discharge Method	Name/Location of Facility
Uncontaminated seawater	Seawater returned to the sea without the addition of chemicals	Drilling rig once-through noncontact cooling water–35,000 bbl	Discharge overboard	Continuous	N/A	N/A
Desalinization unit water	Chemically treated seawater associated with the process of creating freshwater from seawater	25,000 bbl/day	Discharge overboard	Continuous	N/A	N/A
Uncontaminated bilge water			Discharge overboard			
Uncontaminated ballast water			Discharge overboard			
Excess cement with cementing chemicals	Excess cement	100 bbl	Discharge overboard	N/A	Discharge at seabed without treatment	
RCRA exempt wastes in quantities >50 bbl/month	N/A	N/A	N/A	N/A	N/A	N/A
Non-RCRA exempt wastes in quantities >50 bbl/month	Mud sacks, pails, pallets, shrink wrap, drums	5,000 sacks, 100 pails, 12 drums, 125 pallets, 125 shrink wrap	Shipment to shore base for collection by municipal operations			Local landfill
Hazardous wastes in reportable quantities						
NORM-contaminated wastes	N/A	N/A	N/A	N/A	N/A	N/A
Wastes not addressed in listing above in quantities >50 bbl/month						
Produced water	Formation water containing scale inhibitors and methanol	140,000 bbl/day (max)	Injected for formation pressure support	N/A	N/A	N/A
Wastes from use of production chemicals	Ethylene glycol Low-dosage hydrate inhibitor	20 gal/day 1,000 bbl (notional)	Pipe to shore; injected/pipe to shore-3 times/yr	N/A	N/A	N/A

Table C-3. Drilling Wastes Table - 3-Way Subsalt Wells (estimated 8 wells) (continued).

Waste Generated during Drilling	Composition/ Description	Projected Amount	Disposal Method	Maximum Discharge Rate	Treatment & Discharge Method	Name/Location of Facility
Produced sand	Oil-contaminated produced sand	400 bbl/yr	Transport onshore for disposal	N/A	N/A	New Park Transfer Station (Venice, LA) or Environ-mental Treatment Team
Sanitary wastes	Human body waste discharge from toilets and urinals	5,400 gal/day	Discharge overboard	Continuous	Treat with marine sanitation device/ chlorine and discharge overboard	
Domestic wastes	Discharge from galleys, sinks, and showers (gray water)	9,000 gal/day	Discharge overboard	Continuous	Treat to remove floating solids and discharge overboard	
Deck drainage	Platform washings, drains	Dependent on rainfall	Discharge overboard	15 bbl/hr	Treat to remove free oil	

Table C-4

Production Wastes Table - All Wells

Waste Generated during Production	Composition/ Description	Projected Amount	Disposal Method	Maximum Discharge Rate	Treatment & Discharge Method	Name/ Location of Facility
Uncontaminated freshwater or seawater	Seawater returned to the sea without the addition of chemicals--no freshwater	5,000 bbl/day	Discharge overboard	N/A	N/A	
Desalinization unit water	Water associated with the process of creating freshwater from seawater	25,000 bbl	Discharge overboard	Continuous	N/A	N/A
Uncontaminated bilge water		345 bbl/day	Discharge overboard		No free oil; no treatment; discharge overboard	
Uncontaminated ballast water		345 bbl/day	Discharge overboard		No free oil; no treatment; discharge overboard	
Freshwater or seawater with treatment chemicals added	Seawater-- hypochlorite treated-once-through noncontact cooling water	1,000,000 bbl/day	Discharge overboard		No treatment; discharge overboard	
Hydrostatic tests	Seawater used to pressure test new piping and subsea system	6,000 bbl total operation	Discharge overboard		No treatment; discharge overboard	
RCRA exempt wastes in quantities >50 bbl/month	N/A	N/A	N/A	N/A	N/A	
Non-RCRA exempt solid wastes/trash	Plastic, paper, aluminum, food, & refuse	840 tons	Transported to shore base for municipal pickup			Local landfill
Waste Generated during Production	Composition/ Description	Projected Amount	Disposal Method	Maximum Discharge Rate	Treatment & Discharge Method	Name/ Location of Facility
Hazardous wastes in reportable quantities		N/A				
NORM- contaminated wastes		N/A				
Wastes not address to listing above in quantities >50 bbl/ month	Refuse generated during painting operations	N/A		N/A	N/A	

BP stated in their DOCD that they will adhere to all requirements of the USEPA's offshore general NPDES discharge permit's limitations. In addition, BP stated that their corporate expectations dictate that new projects will use the best available techniques for handling operational discharges. The following Table provides data on BP's use of synthetic-based drilling fluid to drill the proposed production wells. BP is not proposing to use oil-based drilling fluids on this project.

Table C-5

Synthetic-Based Drilling Fluid and Cuttings Disposition

Type of Drilling Fluid	Estimated Volume of Mud Used per Well	Mud Disposal Method	Estimated Volume of Cuttings Generated per Well	Cuttings Disposal Method
Synthetic	16,000 bbl	Return to vendor	4,500 bbl	Discharge overboard if <6.9% ROC

APPENDIX D

Geology

APPENDIX D

GEOLOGY

General Description

The present day Gulf of Mexico (GOM) is a small ocean basin with an area of more than 1.6 million km^2 (0.62 million mi^2); its greatest water depth is approximately 3,700 m (12,140 ft). It is almost completely surrounded by land, opening to the Atlantic Ocean through the Straits of Florida and to the Caribbean Sea through the Yucatan Channel. Underlying the present GOM and the adjacent coast is the larger geologic basin that began forming in Triassic time. Over the last 20 million years, clastic sediments (sands and silts) have poured into the GOM Basin from the north and west. The centers of sediment deposition shifted progressively eastward and southward in response to changes in the source of sediment supply. Sediments of more than 15 km (9.32 mi) in thickness have been deposited. Each sediment layer is different, reflecting the source of the material and the geologic processes occurring during deposition. In places where the Gulf was shallow and intermittently dry, evaporitic deposits such as salt were formed. Where gradual subsidence and shallow seas persisted over time, marine plants and animals created reefs. Where marine life was abundant, the deposition of limestone was dominant.

The physiographic provinces in the GOM — shelf, slope, rise, and abyssal plain — reflect the underlying geology. In the Gulf, the continental shelf extends seaward from the shoreline to about the 200-m (656-ft) water depth and is characterized by a gentle slope (less than 1 degree). The shelf is wide off Texas, but it is narrower or absent where the Mississippi River delta has extended across the entire shelf. The continental slope extends from the shelf edge to the continental rise, usually at about the 2,000-m (6,562 ft) water depth. The topography of the slope in the Gulf is uneven and is broken by canyons, troughs, and escarpments. The gradient on the slope is characteristically 3-6 degrees, but it may exceed 20 degrees in some places, particularly along escarpments. The continental rise is the apron of sediment accumulated at the base of the slope. It is a gentle incline, with slopes of less than 1 degree, to the abyssal plain. The abyssal plain is the flat region of the basin floor at the base of the continental rise.

The Western Gulf, which includes both the Western and Central Planning Areas, is a clastic province. Many wells have been drilled in the Western Gulf, and the geology has been studied in detail for the identification and development of natural gas and oil resources. Exploration and development in the GOM have resulted in the identification of more than 1,000 fields.

Sedimentary features, such as deltas, fans, canyons, and sediment flow forms, are formed by the erosion of land and deposition of sediments. Structural features, such as faults, folds, and ridges, are produced by displacement and deformation of rocks. The regional dip of sediments in the GOM is interrupted by salt diapirs, shale diapirs, and growth faults. Deformation has been primarily in response to heavy sediment loading.

The most significant factor controlling the hydrocarbon potential in the northern GOM is the environment of deposition. Sediments deposited on the outer shelf and upper slope have the greatest potential for hydrocarbon accumulation because it is the optimum zone for encountering the three factors necessary for the successful formation and accumulation of oil and gas: source material, reservoir space, and geologic traps. The massive shale beds with high organic content are excellent source beds. The thick sands and sandstones with good porosity (pore space between the sand grains where oil and gas can exist) and permeability (connections between the pore spaces through which oil and gas can flow) provide reservoir space. Impermeable shales, salt dome caprocks, and faults serve as seals, trapping oil and gas in the pore spaces of the reservoir rocks.

The geologic horizons with the greatest potential for hydrocarbon accumulation on the continental shelf of the northern GOM are of Pliocene and Pleistocene age. Producing horizons become progressively younger in a seaward direction. Recent developments in high-energy, 3-D seismic technology allow the oil and gas industry to "see" below the regional salt layers and to identify potential "subsalt plays" or hydrocarbon traps.

The presence of hydrogen sulfide (H_2S) within formation fluids occurs sporadically throughout the GOM OCS. Oil and gas containing certain levels of H_2S is called "sour." Approximately 65 operations have encountered H_2S-bearing zones on the GOM OCS to date. Occurrences of H_2S offshore Texas are in Miocene-age rocks and occur principally within a geographically narrow band. There is some debate as to the origin of the H_2S in these offshore Texas wells, as they were reported mostly from deep, high-temperature wells drilled with a ligno-sulfonate mud component, which is widely believed to break down under high wellbore temperature to generate H_2S. The occurrences of H_2S offshore Louisiana are mostly on or near piercement domes with caprock and are associated with salt and gypsum deposits. The H_2S from a caprock environment is generally thought to be a reaction product of sulfates and hydrocarbons in the presence of sulfate-reducing microbes. In some areas offshore Louisiana, H_2S-rich hydrocarbons are produced from lower Cretaceous-age limestone deposits not associated with piercement domes. Generally, formations of Lower Cretaceous age or older (which are deeply buried in the Gulf) are prone to contain H_2S in association with their hydrocarbons (cf. Bryan and Lingamallu, 1990). There has also been some evidence that petroleum from deepwater plays contain significant amounts of sulfur (cf. Smith, written communication, 1996; Thorpe, 1996).

The concentrations of H_2S found in conjunction with hydrocarbons vary extensively. The examination of in-house data suggest that H_2S concentrations vary from as low as fractional parts per million (ppm) to as high as 650,000 ppm in one isolated case (the next highest concentrations of H_2S reported are about 55,000 and 19,000 ppm). The concentrations of H_2S found to date are generally greatest in the eastern portion of the Central Planning Area.

Geologic Hazards

The major geologic hazards that may affect oil and gas activities within the GOM north of 26°N. latitude can be generally grouped into the following categories: (1) slope instability and mass transport of sediments; (2) gas hydrates; (3) sediment types and characteristics; and (4) tectonics.

Geologic conditions that promote seafloor instability are variable sediment types, steep slopes, high-sedimentation rates, gas hydrates at or near the seafloor, interstitial gas, faulting, areas of lithified and mounded carbonates, salt and shale mobilization, and mudflows. Some features that may indicate a possible unstable condition include step faulting, deformed bedding, detached blocks, detached masses, displaced lithologies, acoustically transparent layers, anomalously thick accumulations of sediment, and shallow faulting and fissures. These features can be identified on seismic survey profiles or through sea bottom coring samples.

Mass movement of sediments includes landslides, slumps, and creeps. Sediment types, accumulation rates, sediment accumulation over features with seafloor relief, and internal composition and structure of the sedimentary layers are all factors that affect seafloor stability. Rapidly accumulated sediments that have not had the opportunity to dewater properly are underconsolidated. These underconsolidated sediments can be interbedded with normal or overconsolidated sediments and may act as slide zones causing mass movement or collapse. A slope of less than 1 degree can be sufficient to cause sliding or slumping when high sedimentation rates have resulted in underconsolidation or high pore-pressure conditions in the sediments.

In the deepwater areas of the Gulf, slope stability and soil properties are of great concern in the design of oil and gas operations. Slopes steep enough to create conditions conducive to mass transport are found regionally on the continental slope. Steeper slopes are found locally along the walls of canyons and channels, adjacent to salt structures, and at fault scarps.

Some of the gas hydrates that occur in the upper sediments of the deepwater Gulf are of biogenic rather than petrogenic origin. Methane is the major and often the only component. Gas hydrates are more prevalent in deeper waters because of the lower temperature and high pressures at these depths. The effect of gas pressure, distribution of gas in pores, solution-dissolution potential, and upward dispersal characteristics are factors considered in the engineering design of production facilities.

Overpressured salt, shale, and mud have a tendency to become plasticized and mobile. Movements of overpressured salts and shales could form mounds and diapirs. Large diapirs formed by the upward movement of shale or salt originates from a greater depth and do not form an environmental geologic hazard by itself. These features have associated faulting and sometimes collapse structures. Their upward movement causes slope steepening and consequently slumping. Movement of overpressured mud could form mud volcanoes at the seafloor. Soft mud diapirs resulting from delta front muds are excellent indicators of an unstable sediment at shallow depths.

Evidence of geologic hazards includes hydrocarbon seeps, deformed bedding, detached blocks or masses, anomalously thick accumulations of sediments, shallow faulting and fissures, diapirs, sediment dikes or mud lumps, displaced lithologies, internal chaotic masses, hummocky topography, en echelon faulting, and horst and graben blocks. Evidence of geologic hazards can be obtained or seen by using core sampling techniques, high-resolution seismic surveying, and side-scan sonar. Geologic hazards pose engineering, structural design, and operational concerns that can usually be effectively mitigated through existing technologies or may require the development of new technologies and designs.

References

Bryan, F. and S.N. Lingamalu. 1990. Hydrogen sulfide occurrence in Gulf of Mexico outer continental shelf operations. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. 8 pp.

Smith, M. 1996. Written communication. Notes on GRI Offshore Gas Processing Workshop, February 13, 1996, New Orleans, LA.

Thorpe, H. 1996. Oil and water. Texas Monthly 24(2):88-93 and 140-145.

APPENDIX E

Socioeconomic Tables

Table E-1

Onshore Allocations

Sector	Sector Definition	TX-1	TX-2	LA-1	LA-2	LA-3	MA-1	FL-1	FL-2	FL-3	FL-4	Gulf-Other	US-Other
38	Oil & Gas Operations	0.00	0.34	0.09	0.06	0.15	0.00	0.00	0.00	0.00	0.00	0.23	0.12
50	New Gas Utility Facilities	0.07	0.38	0.05	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.11	0.07
53	Misc. Natural Resource Facility Construction	0.03	0.21	0.23	0.15	0.30	0.02	0.00	0.00	0.00	0.00	0.01	0.03
56	Maintenance and Repair, Other Facilities	0.06	0.31	0.04	0.08	0.09	0.08	0.00	0.00	0.00	0.00	0.21	0.11
57	Other Oil & Gas Field Services	0.00	0.30	0.26	0.12	0.16	0.00	0.00	0.00	0.00	0.00	0.07	0.05
160	Office Furniture and Equipment	0.15	0.54	0.00	0.00	0.08	0.23	0.00	0.00	0.00	0.00	0.00	0.00
178	Maps and Charts (Misc. Publishing)	0.12	0.59	0.02	0.06	0.11	0.10	0.00	0.00	0.00	0.00	0.01	0.00
206	Explosives	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
209	Chemicals, NEC	0.03	0.64	0.04	0.10	0.04	0.04	0.00	0.00	0.00	0.00	0.04	0.04
210	Petroleum Fuels	0.11	0.50	0.09	0.16	0.09	0.05	0.00	0.00	0.00	0.00	0.00	0.00
232	Hydraulic Cement	0.00	0.10	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.50	0.30
258	Steel Pipe and Tubes	0.00	0.50	0.31	0.05	0.07	0.00	0.00	0.00	0.00	0.00	0.08	0.04
284	Fabricated Plate Work	0.04	0.63	0.06	0.09	0.05	0.14	0.00	0.00	0.00	0.00	0.00	0.00
290	Iron and Steel Forgings	0.00	0.81	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.14	0.00
307	Turbines	0.05	0.65	0.00	0.10	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
311	Construction Machinery & Equipment	0.06	0.42	0.00	0.06	0.19	0.11	0.00	0.00	0.00	0.00	0.11	0.06
313	Oil & Gas Field Machinery & Equipment	0.03	0.18	0.27	0.18	0.22	0.00	0.00	0.00	0.00	0.00	0.05	0.04
331	Special Industrial Machinery	0.00	0.00	0.00	0.38	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.03
332	Pumps & Compressors	0.04	0.30	0.17	0.22	0.09	0.00	0.00	0.00	0.00	0.00	0.12	0.06
354	Industrial Machines, NEC	0.05	0.66	0.06	0.10	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00
356	Switchgear	0.00	0.63	0.00	0.07	0.11	0.07	0.00	0.00	0.00	0.00	0.11	0.00
374	Communication Equipment, NEC	0.13	0.50	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.13	0.00
392	Shipbuilding and Ship Repair	0.09	0.24	0.05	0.24	0.18	0.19	0.00	0.00	0.00	0.00	0.00	0.00
399	Transportation Equipment, NEC	0.00	0.78	0.06	0.11	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00
401	Lab Equipment	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
403	Instrumentation	0.01	0.13	0.39	0.27	0.08	0.00	0.00	0.00	0.00	0.00	0.08	0.04

Table E-1. Onshore Allocations (continued).

Sector	Sector Definition	TX-1	TX-2	LA-1	LA-2	LA-3	MA-1	FL-1	FL-2	FL-3	FL-4	Gulf-Other	US-Other
435	Demurrage/Warehousing/ Motor Freight	0.11	0.37	0.21	0.09	0.09	0.01	0.00	0.00	0.00	0.00	0.07	0.00
436	Water Transport	0.02	0.27	0.10	0.25	0.22	0.04	0.01	0.00	0.01	0.00	0.06	0.00
437	Air Transport	0.03	0.42	0.11	0.11	0.08	0.02	0.00	0.00	0.00	0.01	0.21	0.00
441	Communications	0.09	0.51	0.07	0.11	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.00
443	Electric Services	0.13	0.36	0.06	0.15	0.12	0.18	0.00	0.00	0.00	0.00	0.00	0.00
444	Gas Production/Distribution	0.10	0.54	0.08	0.07	0.05	0.03	0.00	0.00	0.00	0.00	0.05	0.04
445	Water Supply	0.08	0.43	0.08	0.12	0.05	0.11	0.00	0.00	0.00	0.00	0.01	0.01
446	Waste Treatment/Disposal	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
454	Eating/Drinking	0.00	0.24	0.28	0.08	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00
455	Misc. Retail	0.09	0.48	0.06	0.10	0.15	0.11	0.00	0.00	0.00	0.00	0.00	0.00
459	Insurance	0.04	0.47	0.07	0.12	0.09	0.00	0.00	0.00	0.00	0.00	0.17	0.03
462	Real Estate	0.09	0.47	0.04	0.08	0.11	0.08	0.00	0.00	0.00	0.00	0.11	0.01
469	Advertisement	0.06	0.45	0.06	0.08	0.15	0.08	0.00	0.00	0.00	0.00	0.12	0.01
470	Other Business Services	0.00	0.60	0.11	0.09	0.06	0.00	0.00	0.00	0.00	0.00	0.09	0.05
473	Misc. Equipment Rental & Leasing	0.09	0.26	0.22	0.10	0.10	0.01	0.00	0.00	0.00	0.00	0.18	0.03
490	Doctors & Veterinarian Services	0.09	0.53	0.06	0.09	0.14	0.08	0.00	0.00	0.00	0.00	0.00	0.00
494	Legal Services	0.07	0.48	0.07	0.11	0.19	0.08	0.00	0.00	0.00	0.00	0.00	0.00
506	Environmental/Engineering Services	0.06	0.38	0.11	0.08	0.08	0.03	0.01	0.00	0.02	0.00	0.20	0.01
507	Acct/Misc. Business Services	0.06	0.46	0.05	0.09	0.13	0.07	0.00	0.00	0.00	0.00	0.11	0.01
508	Management/Consulting Services	0.04	0.54	0.04	0. 09	0.11	0.05	0.00	0.00	0.00	0.00	0.11	0.01
509	Testing/Research Facilities	0.00	0.38	0.14	0.14	0.05	0.00	0.00	0.00	0.00	0.00	0.21	0.11

Table E-2

Population Forecast from 2000 to 2041 by Year and by Coastal Subarea (in thousands)

Year	LA-1	LA-2	LA-3	MA-1	TX-1	TX-2	FL-1	FL-2	FL-3	FL-4	CGOM	WGOM	EGOM	GOM
2000	667.12	1,009.54	1,337.60	920.12	920.58	5,158.08	774.39	128.07	3,954.32	2,340.67	3,934.36	6,078.66	7,197.46	17,210.48
2001	672.18	1,020.72	1,343.62	930.79	930.98	5,238.54	787.39	129.53	4,022.21	2,362.41	3,967.32	6,169.52	7,301.53	17,438.37
2002	677.35	1,032.14	1,350.07	941.63	941.65	5,320.26	800.68	131.07	4,091.10	2,384.86	4,001.19	6,261.91	7,407.70	17,670.81
2003	682.66	1,043.66	1,356.53	952.61	952.50	5,402.58	813.98	132.59	4,160.29	2,408.00	4,035.47	6,355.07	7,514.87	17,905.41
2004	688.01	1,055.31	1,363.03	963.72	963.47	5,486.16	827.51	134.14	4,230.65	2,431.38	4,070.07	6,449.64	7,623.67	18,143.38
2005	693.29	1,066.73	1,369.47	974.61	974.23	5,567.43	840.64	135.65	4,298.86	2,454.36	4,104.10	6,541.66	7,729.51	18,375.26
2006	698.70	1,078.41	1,376.22	985.73	985.30	5,650.56	854.05	137.23	4,368.60	2,478.49	4,139.06	6,635.87	7,838.37	18,613.29
2007	704.16	1,090.21	1,382.99	996.98	996.51	5,734.94	867.67	138.82	4,439.48	2,502.86	4,174.34	6,731.45	7,948.83	18,854.62
2008	709.66	1,102.14	1,389.80	1,008.35	1,007.84	5,820.57	881.51	140.44	4,511.50	2,527.47	4,209.96	6,828.41	8,060.92	19,099.29
2009	715.20	1,114.20	1,396.65	1,019.86	1,019.30	5,907.49	895.57	142.07	4,584.70	2,552.32	4,245.91	6,926.78	8,174.66	19,347.36
2010	720.38	1,125.14	1,403.21	1,030.25	1,029.64	5,983.33	907.72	143.54	4,647.77	2,575.09	4,278.97	7,012.97	8,274.12	19,566.06
2011	726.20	1,137.43	1,410.76	1,041.94	1,041.44	6,069.85	921.64	145.17	4,720.05	2,601.26	4,316.33	7,111.28	8,388.12	19,815.73
2012	732.08	1,149.85	1,418.35	1,053.77	1,053.36	6,157.62	935.78	146.82	4,793.45	2,627.70	4,354.04	7,210.98	8,503.74	20,068.76
2013	738.00	1,162.40	1,425.99	1,065.73	1,065.43	6,246.66	950.13	148.48	4,868.00	2,654.41	4,392.11	7,312.09	8,621.01	20,325.21
2014	743.97	1,175.09	1,433.66	1,077.82	1,077.63	6,336.99	964.70	150.17	4,943.70	2,681.38	4,430.54	7,414.62	8,739.95	20,585.11
2015	749.53	1,186.60	1,440.99	1,088.74	1,088.63	6,416.17	977.37	151.69	5,009.36	2,706.02	4,465.86	7,504.81	8,844.44	20,815.11
2016	755.65	1,199.33	1,449.10	1,100.87	1,100.92	6,505.30	991.66	153.38	5,083.64	2,733.69	4,504.94	7,606.21	8,962.38	21,073.53
2017	761.83	1,212.18	1,457.25	1,113.13	1,113.34	6,595.66	1,006.17	155.09	5,159.02	2,761.65	4,544.39	7,708.99	9,081.93	21,335.31
2018	768.05	1,225.18	1,465.45	1,125.53	1,125.90	6,687.28	1,020.90	156.81	5,235.52	2,789.89	4,584.21	7,813.17	9,203.11	21,600.50
2019	774.33	1,238.32	1,473.70	1,138.06	1,138.60	6,780.17	1,035.83	158.56	5,313.15	2,818.42	4,624.40	7,918.77	9,325.96	21,869.12
2020	780.19	1,250.28	1,481.58	1,149.44	1,150.11	6,862.28	1,048.94	160.14	5,381.16	2,844.53	4,661.48	8,012.39	9,434.78	22,108.65
2021	786.67	1,263.57	1,490.31	1,162.08	1,162.96	6,954.70	1,063.76	161.94	5,460.95	2,873.84	4,702.62	8,117.67	9,560.49	22,380.77
2022	793.20	1,276.99	1,499.09	1,174.87	1,175.96	7,048.36	1,078.79	163.76	5,538.93	2,903.44	4,744.15	8,224.32	9,684.92	22,653.39
2023	799.79	1,290.56	1,507.92	1,187.80	1,189.10	7,143.29	1,094.04	165.60	5,618.02	2,933.35	4,786.07	8,332.39	9,811.00	22,929.46
2024	806.43	1,304.27	1,516.81	1,200.87	1,202.39	7,239.49	1,109.49	167.46	5,698.24	2,963.56	4,828.38	8,441.88	9,938.75	23,209.01
2025	812.61	1,316.73	1,525.25	1,212.71	1,214.41	7,324.63	1,123.09	169.14	5,765.56	2,991.12	4,867.31	8,539.04	10,048.91	23,455.25
2026	819.36	1,330.72	1,534.24	1,226.06	1,227.98	7,423.27	1,138.95	171.03	5,847.89	3,021.93	4,910.38	8,651.25	10,179.81	23,741.44
2027	826.17	1,344.86	1,543.28	1,239.55	1,241.70	7,523.25	1,155.05	172.95	5,931.39	3,053.06	4,953.86	8,764.95	10,312.46	24,031.26
2028	833.03	1,359.15	1,552.38	1,253.19	1,255.58	7,624.57	1,171.37	174.90	6,016.09	3,084.51	4,997.74	8,880.15	10,446.86	24,324.75
2029	839.95	1,373.59	1,561.52	1,266.98	1,269.61	7,727.25	1,187.92	176.86	6,101.99	3,116.29	5,042.04	8,996.86	10,583.05	24,621.95
2030	846.93	1,388.18	1,570.73	1,280.92	1,283.80	7,831.32	1,204.70	178.84	6,189.12	3,148.39	5,086.75	9,115.12	10,721.06	24,922.93
2031	853.96	1,402.93	1,579.98	1,295.01	1,298.15	7,936.79	1,221.72	180.85	6,277.50	3,180.82	5,131.89	9,234.93	10,860.89	25,227.71
2032	861.06	1,417.83	1,589.29	1,309.26	1,312.65	8,043.68	1,238.98	182.88	6,367.14	3,213.58	5,177.45	9,356.33	11,002.59	25,536.36
2033	868.21	1,432.90	1,598.66	1,323.67	1,327.32	8,152.01	1,256.49	184.93	6,458.06	3,246.69	5,223.43	9,479.33	11,146.17	25,848.93
2034	875.42	1,448.12	1,608.08	1,338.23	1,342.16	8,261.79	1,274.24	187.01	6,550.27	3,280.13	5,269.86	9,603.95	11,291.65	26,165.46
2035	882.70	1,463.50	1,617.56	1,352.96	1,357.16	8,373.06	1,292.25	189.11	6,643.80	3,313.92	5,316.72	9,730.22	11,439.08	26,486.01
2036	890.03	1,479.05	1,627.09	1,367.85	1,372.32	8,485.82	1,310.50	191.23	6,738.67	3,348.06	5,364.02	9,858.15	11,588.46	26,810.63
2037	897.42	1,494.77	1,636.68	1,382.90	1,387.66	8,600.11	1,329.02	193.38	6,834.90	3,382.54	5,411.76	9,987.77	11,739.84	27,139.37
2038	904.88	1,510.65	1,646.32	1,398.12	1,403.17	8,715.93	1,347.80	195.55	6,932.49	3,417.39	5,459.96	10,119.10	11,893.23	27,472.28
2039	912.39	1,526.69	1,656.02	1,413.50	1,418.85	8,833.31	1,366.84	197.75	7,031.48	3,452.59	5,508.61	10,252.16	12,048.66	27,809.43
2040	919.97	1,542.91	1,665.78	1,429.05	1,434.70	8,952.28	1,386.15	199.96	7,131.89	3,488.16	5,557.72	10,386.98	12,206.16	28,150.86
2041	927.62	1,559.31	1,675.60	1,444.78	1,450.74	9,072.84	1,405.74	202.21	7,233.72	3,524.09	5,607.30	10,523.58	12,365.76	28,496.63

Table E-3

Employment Forecast from 2000 to 2041 by Year and by Subarea (in thousands)

Year	LA-1	LA-2	LA-3	MA-1	TX-1	TX-2	FL-1	FL-2	FL-3	FL-4	CGOM	WGOM	EGOM	GOM
2000	377.47	571.95	781.67	515.20	454.25	3,046.85	427.04	44.99	2,248.28	1,306.73	2,246.29	3,501.10	4,027.03	9,774.42
2001	381.65	580.15	787.95	522.71	460.67	3,095.53	435.03	45.55	2,298.83	1,324.75	2,272.46	3,556.20	4,104.15	9,932.81
2002	386.15	590.66	793.66	529.89	466.67	3,143.66	442.85	46.10	2,347.94	1,341.81	2,300.36	3,610.33	4,178.69	10,089.39
2003	391.13	597.79	799.20	537.22	472.64	3,192.77	450.71	46.63	2,396.65	1,358.41	2,325.34	3,665.41	4,252.40	10,243.15
2004	396.19	605.00	804.77	544.65	478.68	3,242.66	458.72	47.17	2,446.37	1,375.22	2,350.61	3,721.33	4,327.47	10,399.42
2005	401.12	612.06	810.28	551.90	484.58	3,291.14	466.47	47.69	2,494.20	1,391.66	2,375.37	3,775.72	4,400.02	10,551.11
2006	406.59	620.40	816.60	559.63	490.78	3,342.60	474.56	48.24	2,543.53	1,408.55	2,403.22	3,833.38	4,474.86	10,711.47
2007	412.12	628.86	822.98	567.47	497.06	3,394.87	482.78	48.79	2,593.82	1,425.64	2,431.43	3,891.93	4,551.03	10,874.39
2008	417.74	637.43	829.40	575.41	503.42	3,447.96	491.15	49.34	2,645.12	1,442.94	2,459.98	3,951.38	4,628.55	11,039.90
2009	423.43	646.11	835.87	583.47	509.87	3,501.87	499.66	49.92	2,697.43	1,460.44	2,488.88	4,011.74	4,707.45	11,208.07
2010	428.46	653.79	841.92	590.56	515.60	3,548.60	506.92	50.41	2,740.96	1,476.14	2,514.73	4,064.20	4,774.43	11,353.35
2011	434.19	662.57	849.67	598.72	522.23	3,603.53	515.28	50.97	2,791.75	1,494.05	2,545.16	4,125.76	4,852.05	11,522.97
2012	440.01	671.47	857.50	606.99	528.94	3,659.31	523.78	51.53	2,843.48	1,512.18	2,575.96	4,188.25	4,930.98	11,695.20
2013	445.90	680.48	865.39	615.38	535.74	3,715.96	532.42	52.10	2,896.18	1,530.54	2,607.16	4,251.70	5,011.24	11,870.09
2014	451.88	689.62	873.36	623.88	542.62	3,773.49	541.20	52.68	2,949.85	1,549.11	2,638.74	4,316.11	5,092.84	12,047.68
2015	457.17	697.71	880.71	631.38	548.75	3,823.42	548.75	53.20	2,995.06	1,565.76	2,666.96	4,372.16	5,162.78	12,201.90
2016	463.11	706.94	889.98	639.94	555.91	3,882.59	557.39	53.77	3,047.79	1,585.13	2,699.96	4,438.50	5,244.08	12,382.54
2017	469.12	716.29	899.34	648.63	563.16	3,942.68	566.16	54.35	3,101.45	1,604.74	2,733.38	4,505.84	5,326.69	12,565.92
2018	475.22	725.76	908.80	657.43	570.51	4,003.70	575.07	54.93	3,156.06	1,624.59	2,767.22	4,574.21	5,410.64	12,752.07
2019	481.39	735.36	918.37	666.36	577.96	4,065.66	584.12	55.52	3,211.62	1,644.68	2,801.48	4,643.62	5,495.94	12,941.04
2020	486.90	743.91	927.09	674.27	584.60	4,119.61	591.98	56.06	3,259.01	1,662.71	2,832.17	4,704.20	5,569.74	13,106.11
2021	493.05	753.66	937.98	683.29	592.41	4,183.83	600.92	56.64	3,314.18	1,683.95	2,867.98	4,776.24	5,655.69	13,299.91
2022	499.28	763.55	948.98	692.43	600.34	4,249.05	610.00	57.23	3,370.29	1,705.46	2,904.24	4,849.39	5,742.98	13,496.61
2023	505.58	773.56	960.12	701.70	608.37	4,315.29	619.21	57.83	3,427.35	1,727.25	2,940.97	4,923.66	5,831.64	13,696.26
2024	511.97	783.70	971.39	711.09	616.50	4,382.57	628.56	58.43	3,485.38	1,749.31	2,978.16	4,999.07	5,921.69	13,898.91
2025	517.67	792.71	981.53	719.41	623.71	4,440.89	636.71	58.98	3,535.04	1,768.97	3,011.32	5,064.60	5,999.70	14,075.62
2026	524.21	803.11	993.05	729.03	632.05	4,510.12	646.33	59.60	3,594.89	1,791.57	3,049.40	5,142.18	6,092.38	14,283.96
2027	530.83	813.64	1,004.71	738.79	640.50	4,580.44	656.09	60.22	3,655.75	1,814.46	3,087.97	5,220.94	6,186.52	14,495.42
2028	537.54	824.31	1,016.50	748.67	649.07	4,651.84	666.01	60.85	3,717.65	1,837.64	3,127.02	5,300.91	6,282.13	14,710.06
2029	544.33	835.12	1,028.43	758.69	657.75	4,724.36	676.07	61.48	3,780.59	1,861.11	3,166.57	5,382.11	6,379.25	14,927.93
2030	551.20	846.08	1,040.50	768.84	666.55	4,798.01	686.28	62.12	3,844.59	1,884.89	3,206.62	5,464.56	6,477.88	15,149.06
2031	558.17	857.17	1,052.71	779.13	675.46	4,872.81	696.65	62.77	3,909.68	1,908.97	3,247.18	5,548.27	6,578.07	15,373.52
2032	565.22	868.41	1,065.07	789.55	684.50	4,948.77	707.17	63.43	3,975.88	1,933.35	3,288.25	5,633.27	6,679.83	15,601.35
2033	572.36	879.80	1,077.57	800.12	693.65	5,025.92	717.85	64.09	4,043.19	1,958.05	3,329.85	5,719.57	6,783.18	15,832.60
2034	579.59	891.34	1,090.22	810.83	702.93	5,104.27	728.70	64.76	4,111.64	1,983.06	3,371.97	5,807.20	6,888.16	16,067.33
2035	586.91	903.03	1,103.01	821.68	712.33	5,183.85	739.70	65.43	4,181.25	2,008.40	3,414.63	5,896.17	6,994.79	16,305.59
2036	594.32	914.88	1,115.96	832.67	721.86	5,264.66	750.88	66.11	4,252.05	2,034.06	3,457.83	5,986.51	7,103.09	16,547.44
2037	601.83	926.87	1,129.06	843.81	731.51	5,346.73	762.22	66.80	4,324.03	2,060.04	3,501.57	6,078.24	7,213.10	16,792.92
2038	609.43	939.03	1,142.31	855.10	741.29	5,430.08	773.74	67.50	4,397.24	2,086.36	3,545.87	6,171.38	7,324.84	17,042.09
2039	617.13	951.34	1,155.72	866.54	751.21	5,514.74	785.42	68.21	4,471.69	2,113.01	3,590.74	6,265.94	7,438.33	17,295.01
2040	624.93	963.82	1,169.28	878.14	761.25	5,600.71	797.29	68.92	4,547.40	2,140.00	3,636.17	6,361.96	7,553.61	17,551.74
2041	632.82	976.46	1,183.01	889.89	771.44	5,688.02	809.33	69.64	4,624.39	2,167.34	3,682.18	6,459.45	7,670.70	17,812.33

Source: Woods and Poole Economics, Inc., 2002

Table E-4

Estimated Employment Impacts for BP's DOCD for the Proposed Action Known as Thunder Horse
(peak employment is projected for the year 2004 as shown)

Onshore Subarea	Direct Employment	Indirect Employment	Induced Employment	Total Employment	Baseline Employment	Plan as a % of Baseline
FL-1	1	1	0	2	458,721	0.00%
FL-2	0	0	0	0	47,166	0.00%
FL-3	2	1	1	4	2,446,369	0.00%
FL-4	0	0	0	1	1,375,217	0.00%
EGOM	3	2	2	7	2,952,256	0.00%
LA-1	156	30	56	242	396,186	0.06%
LA-2	119	41	48	208	605,001	0.03%
LA-3	194	54	73	320	804,768	0.04%
MA-1	13	4	5	21	544,654	0.00%
CGOM	482	129	181	792	1,805,955	0.04%
TX-1	20	5	7	33	478,678	0.01%
TX-2	306	155	168	628	3,242,655	0.02%
WGOM	326	160	175	661	3,721,334	0.02%
Total GOM	811	291	357	1460	6,712,356	0.02%

Table E-5

Estimated Opportunity Cost Employment Associated with the Cleanup and Remediation of a Worst Case Spill
(based on 141,000 bbl spilled; Year 2004)

	Direct		Indirect		Induced		Total		Baseline Employment	Plan as a % of Baseline	
	Low	High	Low	High	Low	High	Low	High		Low	High
FL-1	5	11	3	7	2	5	9	24	458,721	0.00%	0.01%
FL-2	0	0	0	0	0	0	0	0	47,166	0.00%	0.00%
FL-3	8	20	5	14	4	10	17	43	2,446,369	0.00%	0.00%
FL-4	1	3	1	2	1	2	3	7	1,375,217	0.00%	0.00%
EGOM	14	35	9	23	7	17	29	74	2,952,256	0.00%	0.00%
LA-1	257	708	57	161	128	313	442	1,182	396,186	0.11%	0.30%
LA-2	322	831	63	168	151	352	536	1,351	605,001	0.09%	0.22%
LA-3	490	1,082	102	232	279	595	871	1,909	804,768	0.11%	0.24%
MA-1	210	443	41	88	112	234	363	765	544,654	0.07%	0.14%
CGOM	1,279	3,065	263	649	671	1,493	2,213	5,207	1,805,955	0.12%	0.29%
TX-1	231	493	54	118	118	248	402	860	478,678	0.08%	0.18%
TX-2	1,067	2,588	342	827	693	1,570	2,102	4,984	3,242,655	0.06%	0.15%
WGOM	1,298	3,081	395	946	811	1,818	2,504	5,844	3,721,334	0.07%	0.16%
Total GOM	2,592	6,180	667	1,617	1,488	3,327	4,747	11,125	6,712,356	0.07%	0.17%

APPENDIX F

Meteorological Conditions

APPENDIX F

METEOROLOGICAL CONDITIONS

General Description

The Gulf of Mexico (GOM) is influenced by a maritime subtropical climate controlled mainly by the clockwise circulation around the semipermanent area of high barometric pressure commonly known as the Bermuda High -- a high-pressure cell. The center of the high is usually located in the Atlantic Ocean or sometimes near the Azores Islands off the coast of Spain (Henry et al., 1994). The GOM is located to the southwest of this center of circulation. This proximity to the high-pressure system results in a predominantly east to southeasterly flow in the GOM region. Two important classes of cyclonic storms are occasionally superimposed on this circulation pattern. During the winter months of December through March, cold fronts associated with cold continental air masses influence mainly the northern coastal areas of the GOM. Behind the fronts, strong north winds bring drier air into the region. During the summer and fall months of June through October, tropical cyclones may develop or migrate into the GOM. These storms may affect any area of the GOM and substantially alter the local wind circulation around them. In coastal areas, the sea breeze effect may become the primary circulation feature during the summer months of May through October. In general, however, the maritime subtropical climate is the dominant feature in driving all aspects of the weather in this region; as a result, the climate shows relatively small diurnal variation in summer.

Two types of air masses primarily govern the climatology of the GOM region. One type of air mass is the warm and moist, maritime tropical air; the other type is very cold and dry, continental polar air. During summer months, the mid-latitude polar jet retreats northward, allowing maritime air to dominate through the GOM. In the southeastern region of the GOM, the climate is dominated by the warm and moist, maritime tropical air year round.

Pressure, Temperature, and Relative Humidity

The western extension of the Bermuda High into the GOM dominates the circulation throughout the year; the high-pressure center is weakening in winter and strengthening in summer. The average monthly pressure shows a west to east gradient during the summer. In the winter, the monthly pressure is more uniform. The minimum average monthly pressure occurs during the summer. The maximum pressure occurs during the winter as a result of the pressure and influence of transitional continental cold air.

At coastal locations, the average air temperatures vary with latitude and exposure. Winter temperatures depend on the frequency and intensity of penetration by polar air masses from the north. Air temperatures over the open Gulf exhibit much smaller variation on a daily and seasonal basis due to the moderating effect of the large body of water.

Due to the presence of the warm, moist, maritime tropical air mass in the southern GOM, the relative humidity in this region is high throughout the year. Minimum humidities occur during the late fall and winter when cold, continental air masses bring dry air into the northern Gulf. Maximum humidities occur during the spring and summer.

Surface Winds

Winds are more variable near the coast than over open waters because coastal winds are more directly influenced by the moving cyclonic storms that are characteristic of the continent and because of the land and sea breeze regime. During the relatively constant summer conditions, the southerly positions of the Bermuda High generate predominantly southeasterly winds in the northern Gulf and easterly winds in the southern parts of the Gulf. Winter winds usually blow from northeasterly directions and become more easterly in the southern parts of the Gulf.

Precipitation and Visibility

Precipitation is frequent and abundant throughout the year but does show distinct seasonal variation. The highest precipitation rates occur during the warmer months of the year. The warmer months usually have convective cloud systems that produce showers and thunderstorms; however, these thunderstorms rarely cause any damage or have attendant hail (USDOC, 1967; Brower et al., 1972). Hail can occur when water droplets freeze in the strong updraft of a convective cloud system. Winter rains are associated with the frequent passage of frontal systems through the area. Rainfalls are generally slow, steady, and relatively continuous, often lasting several days. For example, the annual average precipitation in Lake Charles, Louisiana, is 1.35 m (53 in). In the northern parts of the Gulf, snowfalls are rare, and when frozen precipitation does occur, it usually melts upon contact with the ground. Incidence of frozen precipitation decreases with distance offshore and rapidly reaches zero. In the southern portions of the GOM, because of warm climate, the frozen precipitation is unlikely to occur.

Warm, moist Gulf air blowing slowly over chilled land or water surfaces brings about the formation of fog. Fog occurrence decreases seaward, but visibility has been less than 800 m (less than ½ mile) due to offshore fog in the coastal area. Coastal fogs generally last 3 or 4 hours, although particularly dense sea fogs may persist for several days. The poorest visibility conditions occur during winter and early spring. The period from November through April has the most days with low visibility. Industrial pollution and agricultural burning also impact visibility.

Atmospheric Stability and Mixing Height

Mixing height is very important because it determines the volume of air available for dispersing pollutants. Mixing height is directly related to vertical mixing in the atmosphere. A mixed layer is expected to occur under neutral and unstable atmospheric conditions. Vertical mixing is most vigorous during unstable conditions. Vertical motion is suppressed during stable conditions. The mixing height tends to be lower in winter, and daily variations are smaller than in summer.

Not all of the Pasquill-Gifford stability classes are found offshore in the GOM. Specifically, the F stability class seldom occurs and the G stability class is markedly absent. The G stability class is the extremely stable condition that only develops at night over land with rapid radiative cooling. This large body of water is simply incapable of losing enough heat overnight to set up a strong radiative inversion. Likewise, the A stability class is rarely present but could be encountered during cold air outbreaks in the wintertime, particularly over warmer waters. Category A is the extremely unstable condition that requires a very rapid warming of the lower layer of the atmosphere, along with cold air aloft. This is normally brought about when cold air is advected aloft, and in strong insolation rapidly warms the earth’s surface, which, in turn, warms the lowest layer of the atmosphere. Once again, the ocean surface is incapable of warming rapidly; therefore, you would not expect to find stability class A over the ocean. For the most part, the stability is neutral to slightly unstable.

In this area, the over-water stability is predominantly unstable, with neutral conditions making up the bulk of the remainder of the time (Hsu, 1996; Marks, written communication, 1996 and 1997; Nowlin et al., 1998). Stable conditions do occur, although infrequently.

The mixing heights offshore are quite shallow, 900 m or less (Hsu, 1996; Nowlin et al., 1998). The exception to this is close to shore, where the influence of the land penetrates out over the water for a short distance. Transient cold fronts also have an impact on the mixing heights; some of the lowest heights can be expected to occur with frontal passages and on the cold-air side of the fronts. This effect is caused by the frontal inversion.

Severe Storms

The GOM is part of the Atlantic tropical cyclone basin. Tropical cyclones generally occur in summer and fall seasons; however, the Gulf also experiences winter storms or extratropical storms. These winter storms generally originate in middle and high latitudes and have winds that can attain speeds of 15-26 m/sec (11.2-58.2 mph). The Gulf is an area of cyclone development during cooler months due to the contrast of the warm air over the Gulf and the cold continental air over North America. Cyclogenesis, or the formation of extratropical cyclones, in the GOM is associated with frontal overrunning (Hsu, 1992). The most severe extratropical storms in the Gulf originate when a cold front encounters the subtropical jetstream over the warm waters of the Gulf. Statistics of 100-year data of extratropical cyclones reveal that most activity occurs above 25^{o}N. latitude in the Western GOM. The mean number of these storms ranges from 0.9 storms per year near the southern tip of Florida to 4.2 over central Louisiana (USDOI, MMS, 1988).

The frequency of cold fronts in the Gulf exhibits similar synoptic weather patterns during the four-month period of December through March. During this time the area of frontal influence reaches south to 10°N latitude. Frontal frequency is about nine fronts per month in February (1 front every 3 days on the average) and about seven fronts per month in March (1 front every 4-5 days on the average). By May, the frequency decreases to about four fronts per month (1 front every 7-8 days), and the region of frontal influence retreats to about 15°N latitude. During June through August, frontal activity decreases to almost zero and fronts seldom reach below 25°N latitude. (USDOI, MMS, 1988).

Tropical cyclones affecting the Gulf originate over the equatorial portions of the Atlantic Ocean, the Caribbean Sea, and the GOM. Tropical cyclones occur most frequently between June and November. Based on 42 years of data, there are about 9.9 storms per year with about 5.5 of those becoming major hurricanes in the Atlantic Ocean (Gray, written communication, 1992). Data from 1886 to 1986 show that 44.5 percent of these storms, or 3.7 storms per year, will affect the GOM (USDOI, MMS, 1988). The Yucatan Channel is the main entrance of Atlantic storms into the GOM, and a reduced translation speed over Gulf waters leads to longer residence times in this basin. The probability of occurrence for a tropical storm in Louisiana and Mississippi is on average about 15 percent.

There is a high probability that tropical storms will cause damage to physical, economic, biological, and social systems in the Gulf. Tropical storms also affect OCS operations and activities; platform design needs to consider the storm surge, waves, and currents generated by tropical storms. Most of the damage is caused by storm surge, waves, and high winds. Storm surge depends on local factors, such as bottom topography, coastline configuration, and storm intensity. Water depth and storm intensity control wave height during hurricane conditions. Sustained winds for major hurricanes (Saffir-Simpson Category 3 and above) are higher than 49 m/sec (109.6 mph).

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APPENDIX G

Physical Oceanography

APPENDIX G

Physical Oceanography

The Gulf of Mexico (GOM) is a semienclosed, subtropical sea with a surface area about 1.6 million km^2 (0.62 million mi^2) (USDOI, MMS, 2000). The main physiographic regions of the Gulf Basin are the continental shelf (including the Campeche, Mexican, and U.S. shelves), continental slopes and associated canyons, abyssal plains, the Yucatan Channel, and Florida Straits.

The Gulf of Mexico is unique oceanographically with a basin depth of 3,000 m (9.843 ft) and two shallow entrances of Yucatan Channel (1,600-m or 5,250-ft depth) and the Straits of Florida (1,000-m or 3,281 ft) (USDOI, MMS, 2000). These "shallow" sills prevent the input of cold (2°C or 35.6°F) Atlantic bottom water and thus bottom water in the Gulf basin remains relatively warm (about 4°C or 39.2°F). The offshore oceanography is dominated by the Loop Current, the main origin of the Gulf Stream, and the inshore oceanography is heavily influenced by major freshwater input from precipitation and numerous river systems, including some extremely large ones such as the Mississippi and Atchafalaya Rivers.

There are at least five major identifiable watermasses in the Central/Western Gulf of Mexico (USDOI, MMS, 2000):

- Gulf of Mexico Water—(0-250 m; 0-820 ft);
- Tropical Atlantic Central Water—(250-400 m; 820-1,312 ft);
- Antarctic Intermediate Water (phosphate maximum)—(500-700 m; 1,641-2,297 ft);
- Antarctic Intermediate Water (salinity maximum)—(600-860 m; 1,969-2,822 ft); and
- Mixed Upper North Atlantic Deep and Caribbean mid water—(1,000-1,100 m; 3,281-3,609 ft).

These watermasses can be identified by their different temperatures and chemical signatures based on salinity, dissolved oxygen, nitrate, phosphate, and silicate concentrations. Below about 1,650 m (5,414 ft), temperature, salinity, and oxygen remain fairly constant to the bottom at about 4ºC (39.2ºF), 35-36 ppt, 5.0 ml/l, respectively (Gulf Basin Water) (Gallaway et al., 2001).

In addition to the above watermasses, there is an upper mixed isothermal layer that varies in thickness but averages about 75 m (246 ft) in thickness (Pequegnat, 1983). Sea surface (i.e., 0-m depth) temperatures within the relevant area are fairly constant throughout the Gulf in August, about 30°C (86°F). In January, surface waters cool considerably in northern coastal areas (14-15°C or 57.2-59°F) and slightly in the center of the Loop Current to 25°C (77°F). At 1,000-m (3,281 ft) depths, the water temperatures are more or less constant at a cool 4.9°C (40.8°F) (USDOI, MMS, 2000).

Oceanographic fronts are important features of marine systems because they tend to be productive areas and also concentrate drifting material such as plankton, which attracts fish, birds, turtles, and mammals for feeding purposes. Unfortunately, fronts also may collect debris such as floating plastics or contaminants such as oil slicks or tarballs.

Fronts form along sharp discontinuities in temperature and or salinity; they can be horizontal or vertical and surface or subsurface. In the Gulf, semipermanent fronts form along the interface between the low salinity coastal or riverine water and offshore water and along edges of major currents (e.g., the Loop Current) and eddies.

The Loop Current, a dominant feature of the Gulf, enters through the Yucatan Strait and exits through the Straits of Florida where it becomes the Gulf Stream. The Current flows clockwise around the fairly static water in the center of the Gulf. Its influence can be seen in hydrographic data to depths as deep as 800-1,000 m (2,625-3,281 ft). It is a highly variable current in geographic extent (may go as far north as Mississippi-Alabama Shelf), width (25- to 50-km or 16- to 31-mi), and velocity [normally 100-200 cm/sec (39.4-78.7 in/sec) but up to 300 cm/sec (118.1 in/sec)] (USDOI, MMS, 2000).

On average, about once a year and on no regular pattern, the Loop Current will form into a "warm core eddy" with a diameter of 300-400 km (186-249 mi), a depth to 1,000 m (3,281 ft), and velocities of 50-200 cm/sec (19.7-78.7 in/sec). These warm-core eddies normally move to the Western Gulf at speeds between 2 and 5 km (1and 3 mi) per day, out of the study area and have a life span of about one year. Smaller eddies (both clockwise and counterclockwise) are also created by the Loop Current and by other less known sources. Other currents are also present in the Gulf as ephemeral; semipermanent and permanent features, primarily wind-driven by prevailing winds and by extreme events such as hurricanes. The mechanisms of some currents are poorly known and are still subject to study (USDOI, MMS, 2001). Short-lived, intense current jets have been reported at mid-depths (to about 200 m (656 ft); see Figure 3-17 *in* USDOI, MMS, 2001) along the Louisiana-Texas slope but little is known about them (USDOI, MMS, 2000). Loop Current eddies may be found to about 1,500 m (4,922 ft) and topographic Rossby Wave activity may be encountered below 500 m (1,640 ft), with possible intensification below 2,500-m (8,202-ft) depth (see Figure 3-17 *in* USDOI, MMS, 2001). Warm-core Loop Current eddies interacting with the continental slope to the north can result in strong eastward flow and negative offshore temperature gradients to at least 500 m (1,640 ft) water depth, and cold-core Loop Current frontal eddies interacting with the slope can result in westward flow following the slope bathymetry. The most characteristic flow pattern in the DeSoto Canyon continental slope region is a two-layer jet with eastward flow at the surface and a return flow at depth. The transition between the upper and lower flows varies with the offshore forcing but is typically between 200 and 300 m (656 and 984 ft) (Hamilton et al., 2000).

Coastal currents, based on historical current meter data, for the northern Gulf of Mexico are described in Dinnel et al. (1997); their predominant directions are alongshore, east or west depending upon location.

High frequency currents in continental slope regions near the DeSoto Canyon are dominated by inertial oscillations, with periods of about 1 day, that are present in deep water throughout the year. At the shelf break, inertial oscillations are present in the summer but not in the winter because of lack of stratification in winter. Hurricanes passing over the slope produce a strong inertial response, which can persist for many days (Hamilton et al., 2000).

Average wave heights for the northern Gulf have been reported at 1 m (3 ft) with 94 percent being 2 m (6.6 ft) or less, with a maximum height to 9.5 m (31 ft) (Quayle and Fulbright, 1977 *in* USDOI, MMS, 2001). Because the Gulf of Mexico is an enclosed sea, and thus fetch is somewhat limited, long period, large amplitude waves are rare except during extreme events such as hurricanes (McGrail and Carnes, 1983; NDBC, 1990; and others *in* USDOI, MMS, 2001). The maximum 100-yr wave height has been estimated by Ward et al. (1979) as 21 m (69 ft) for water depths of 100 m (328 ft) and greater (USDOI, MMS, 2000).

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APPENDIX H

Other Information on Grid 16

Table H-1

Lease Status

Area	Block	Lease	Company Name	Lease Status
AT	21	G24206	BHP Petroleum (GOM) Inc.	Primary
AT	22	G24207	Chevron U.S.A. Inc.	Primary
AT	23	G23009	Samedan Oil Corporation	Primary
AT	24	G24208	BHP Petroleum (GOM) Inc.	Primary
AT	25	G24209	BHP Petroleum (GOM) Inc.	Primary
AT	64	G13199	Chevron U.S.A. Inc.	Unit
AT	65	G24214	BHP Petroleum (GOM) Inc.	Primary
AT	66	G23010	Samedan Oil Corporation	Primary
AT	67	G23011	Samedan Oil Corporation	Primary
AT	68	G24215	Dominion Exploration & Production, Inc.	Primary
AT	70	G24216	Dominion Exploration & Production, Inc.	Primary
AT	109	G23015	Exxon Mobil Corporation	Primary
AT	111	G20136	Conoco Inc.	Primary
AT	112	G23016	Dominion Exploration & Production, Inc.	Primary
AT	113	G24218	Dominion Exploration & Production, Inc.	Primary
AT	114	G24219	Dominion Exploration & Production, Inc.	Primary
AT	154	G23020	Exxon Mobil Corporation	Primary
AT	155	G18504	Conoco Inc.	Primary
AT	156	G18505	Conoco Inc.	Primary
AT	157	G24224	Dominion Exploration & Production, Inc.	Primary
AT	196	G23023	Exxon Mobil Corporation	Primary
AT	197	G24228	Exxon Mobil Corporation	Primary
AT	198	G24229	Enterprise Oil Gulf of Mexico Inc.	Primary
AT	199	G20142	Conoco Inc.	Primary
AT	200	G18516	Conoco Inc.	Primary
AT	201	G20143	Conoco Inc.	Primary
AT	202	G18517	Chevron U.S.A. Inc.	Primary
AT	203	G18518	Chevron U.S.A. Inc.	Primary
AT	241	G18528	BP Exploration & Production Inc.	Primary
AT	244	G20146	BHP Petroleum (GOM) Inc.	Primary
AT	245	G20147	BHP Petroleum (GOM) Inc.	Primary
AT	246	G18529	Kerr-McGee Oil & Gas Corporation	Primary
AT	247	G18530	Kerr-McGee Oil & Gas Corporation	Primary
AT	284	G21833	Chevron U.S.A. Inc.	Primary
AT	285	G18546	Chevron U.S.A. Inc.	Primary
AT	286	G18547	Chevron U.S.A. Inc.	Primary
AT	287	G18548	Chevron U.S.A. Inc.	Primary
AT	288	G16895	BHP Petroleum (GOM) Inc.	Primary
AT	289	G18549	BHP Petroleum (GOM) Inc.	Primary
AT	328	G18564	Chevron U.S.A. Inc.	Primary
AT	329	G18565	Chevron U.S.A. Inc.	Primary
AT	330	G18566	Chevron U.S.A. Inc.	Primary

Table H-1. Lease Status (continued).

Area	Block	Lease	Company Name	Lease Status
AT	331	G18567	Chevron U.S.A. Inc.	Primary
AT	332	G16898	BHP Petroleum (GOM) Inc.	Primary
AT	333	G16899	BHP Petroleum (GOM) Inc.	Primary
AT	336	G18569	Kerr-McGee Oil & Gas Corporation	Primary
AT	372	G18586	Chevron U.S.A. Inc.	Primary
AT	373	G18587	Chevron U.S.A. Inc.	Primary
AT	374	G18588	Chevron U.S.A. Inc.	Primary
AT	375	G18589	Chevron U.S.A. Inc.	Primary
AT	376	G18590	Chevron U.S.A. Inc.	Primary
AT	379	G21837	BHP Petroleum (GOM) Inc.	Primary
AT	380	G16906	BHP Petroleum (GOM) Inc.	Primary
AT	424	G18602	BP Exploration & Production Inc.	Primary
MC	36	G24038	Spinnaker Exploration Company, L.L.C.	Primary
MC	37	G24039	Amerada Hess Corporation	Primary
MC	38	G15462	Shell Offshore Inc.	Primary
MC	39	G22857	BP Exploration & Production Inc.	Primary
MC	40	G21741	Vastar Resources, Inc.	Primary
MC	80	G24042	Amerada Hess Corporation	Primary
MC	81	G24043	Amerada Hess Corporation	Primary
MC	82	G24044	BP Exploration & Production Inc.	Primary
MC	84	G08484	BP Exploration & Production Inc.	Unit
MC	85	G08797	BP Exploration & Production Inc.	Unit
MC	121	G14631	Shell Offshore Inc.	Primary
MC	122	G14632	Exxon Mobil Corporation	Primary
MC	123	G22862	Samedan Oil Corporation	Primary
MC	124	G24049	Spinnaker Exploration Company, L.L.C.	Primary
MC	125	G24050	Spinnaker Exploration Company, L.L.C.	Primary
MC	126	G18194	Vastar Resources, Inc.	Primary
MC	127	G19925	Vastar Resources, Inc.	Primary
MC	128	G08485	BP Exploration & Production Inc.	Unit
MC	128	G08485	BP Exploration & Production Inc.	Unit
MC	129	G10977	BP Exploration & Production Inc.	Unit
MC	162	G21746	Shell Offshore Inc.	Primary
MC	163	G21747	Shell Offshore Inc.	Primary
MC	164	G14633	Shell Offshore Inc.	Primary
MC	165	G24051	Conoco Inc.	Primary
MC	166	G24052	Conoco Inc.	Primary
MC	167	G08801	Exxon Mobil Corporation	Producing
MC	168	G24053	Conoco Inc.	Primary
MC	170	G16589	BP Exploration & Production Inc.	Primary
MC	171	G15469	BP Exploration & Production Inc.	Primary
MC	172	G15470	BP Exploration & Production Inc.	Primary
MC	173	G09789	BP Exploration & Production Inc.	Unit
MC	204	G24054	Samedan Oil Corporation	Primary
MC	205	G22864	Mariner Energy, Inc.	Primary
MC	208	G18202	Chevron U.S.A. Inc.	Primary

Table H-1. Lease Status (continued).

Area	Block	Lease	Company Name	Lease Status
MC	209	G24055	Spinnaker Exploration Company, L.L.C.	Primary
MC	210	G24056	Spinnaker Exploration Company, L.L.C.	Primary
MC	211	G08803	Exxon Mobil Corporation	Producing
MC	212	G24057	Conoco Inc.	Primary
MC	213	G24058	Dominion Exploration & Production, Inc.	Primary
MC	214	G24059	Dominion Exploration & Production, Inc.	Primary
MC	215	G24060	Dominion Exploration & Production, Inc.	Primary
MC	216	G24061	Conoco Inc.	Primary
MC	249	G16593	Chevron U.S.A. Inc.	Primary
MC	250	G18206	BP Exploration & Production Inc.	Primary
MC	251	G14636	BHP Petroleum (GOM) Inc.	Primary
MC	252	G18207	Chevron U.S.A. Inc.	Primary
MC	253	G24062	Conoco Inc.	Primary
MC	254	G24063	Conoco Inc.	Primary
MC	255	G24064	Conoco Inc.	Primary
MC	256	G22865	Conoco Inc.	Primary
MC	257	G24065	Conoco Inc.	Primary
MC	258	G24066	LLOG Exploration Offshore, Inc.	Primary
MC	259	G24067	Conoco Inc.	Primary
MC	287	G18214	Kerr-McGee Oil & Gas Corporation	Primary
MC	288	G18215	Murphy Exploration & Production Company	Primary
MC	290	G19934	TotalFinaElf E&P USA, Inc.	Primary
MC	292	G08806	Chevron U.S.A. Inc.	Producing
MC	293	G16596	Chevron U.S.A. Inc.	Primary
MC	294	G16597	Marathon Oil Company	Primary
MC	295	G15472	Exxon Mobil Corporation	Primary
MC	296	G21164	Chevron U.S.A. Inc.	Primary
MC	297	G15473	Exxon Mobil Corporation	Primary
MC	298	G15474	Exxon Mobil Corporation	Primary
MC	299	G21752	Murphy Exploration & Production Company	Primary
MC	300	G22868	Conoco Inc.	Primary
MC	301	G24069	Conoco Inc.	Primary
MC	302	G24070	Conoco Inc.	Primary
MC	303	G16598	BP Exploration & Production Inc.	Primary
MC	330	G18221	Kerr-McGee Oil & Gas Corporation	Primary
MC	331	G18222	Shell Offshore Inc.	Primary
MC	332	G18223	Chevron U.S.A. Inc.	Primary
MC	336	G16601	Texaco Exploration and Production Inc.	Primary
MC	337	G16602	Chevron U.S.A. Inc.	Primary
MC	338	G16603	Amerada Hess Corporation	Primary
MC	339	G18224	Amerada Hess Corporation	Primary
MC	341	G24071	Conoco Inc.	Primary
MC	342	G24072	Conoco Inc.	Primary
MC	343	G24073	Murphy Exploration & Production Company	Primary
MC	344	G24074	Conoco Inc.	Primary
MC	345	G24075	Murphy Exploration & Production Company	Primary

Table H-1. Lease Status (continued).

Area	Block	Lease	Company Name	Lease Status
MC	374	G19943	TotalFinaElf E&P USA, Inc.	Primary
MC	375	G18231	Burlington Resources Offshore Inc.	Primary
MC	376	G19944	Anadarko Petroleum Corporation	Primary
MC	377	G19945	Anadarko Petroleum Corporation	Primary
MC	378	G21166	Murphy Exploration & Production Company	Primary
MC	379	G21167	Murphy Exploration & Production Company	Primary
MC	380	G16604	Chevron U.S.A. Inc.	Primary
MC	381	G16605	Chevron U.S.A. Inc.	Primary
MC	382	G21168	Amerada Hess Corporation	Primary
MC	383	G07937	Shell Offshore Inc.	SOP
MC	385	G07938	Shell Offshore Inc.	Unit
MC	386	G21753	Shell Offshore Inc.	Primary
MC	387	G22873	Conoco Inc.	Primary
MC	418	G19948	Amerada Hess Corporation	Primary
MC	419	G19949	Amerada Hess Corporation	Primary
MC	421	G19950	Anadarko Petroleum Corporation	Primary
MC	422	G21757	Exxon Mobil Corporation	Primary
MC	424	G16606	Chevron U.S.A. Inc.	Primary
MC	425	G16607	Chevron U.S.A. Inc.	Primary
MC	426	G21170	Amerada Hess Corporation	Primary
MC	427	G16608	EEX Corporation	Primary
MC	429	G07944	Shell Offshore Inc.	Unit
MC	430	G09808	Shell Offshore Inc.	Unit
MC	462	G15485	BP Exploration & Production Inc.	Primary
MC	463	G24076	Exxon Mobil Corporation	Primary
MC	464	G19955	Exxon Mobil Corporation	Primary
MC	465	G19956	Exxon Mobil Corporation	Primary
MC	466	G21761	Exxon Mobil Corporation	Primary
MC	469	G16610	Chevron U.S.A. Inc.	Primary
MC	470	G24077	Conoco Inc.	Primary
MC	471	G24078	BP Exploration & Production Inc.	Primary
MC	472	G15486	Shell Offshore Inc.	Primary
MC	473	G24079	Conoco Inc.	Primary
MC	505	G14006	BP Exploration & Production Inc.	Primary
MC	506	G14007	BP Exploration & Production Inc.	Primary
MC	507	G14008	BP Exploration & Production Inc.	Primary
MC	508	G21764	Exxon Mobil Corporation	Primary
MC	509	G21765	Exxon Mobil Corporation	Primary
MC	511	G18250	Chevron U.S.A. Inc.	Primary
MC	512	G21766	Exxon Mobil Corporation	Primary
MC	514	G24085	Conoco Inc.	Primary
MC	515	G24086	Spinnaker Exploration Company, L.L.C.	Primary
MC	516	G24087	Conoco Inc.	Primary
MC	517	G22882	Conoco Inc.	Primary
MC	551	G19964	Exxon Mobil Corporation	Primary
MC	552	G16616	Shell Offshore Inc.	Primary

Table H-1. Lease Status (continued).

Area	Block	Lease	Company Name	Lease Status
MC	553	G21175	Amerada Hess Corporation	Primary
MC	554	G21769	Exxon Mobil Corporation	Primary
MC	555	G21770	Exxon Mobil Corporation	Primary
MC	556	G16617	Chevron U.S.A. Inc.	Primary
MC	557	G16618	Chevron U.S.A. Inc.	Primary
MC	558	G15491	Exxon Mobil Corporation	Primary
MC	559	G15492	Exxon Mobil Corporation	Primary
MC	560	G24092	Conoco Inc.	Primary
MC	561	G19965	Burlington Resources Offshore Inc.	Primary
MC	592	G22889	Shell Offshore Inc.	Primary
MC	593	G19969	BP Exploration & Production Inc.	Primary
MC	594	G19970	Shell Offshore Inc.	Primary
MC	595	G21177	Dominion Exploration & Production, Inc.	Primary
MC	596	G22890	Marathon Oil Company	Primary
MC	597	G21178	Amerada Hess Corporation	Primary
MC	598	G19971	Exxon Mobil Corporation	Primary
MC	599	G19972	Exxon Mobil Corporation	Primary
MC	600	G16627	Chevron U.S.A. Inc.	Primary
MC	601	G16628	Chevron U.S.A. Inc.	Primary
MC	602	G22891	Samedan Oil Corporation	Primary
MC	605	G19973	Burlington Resources Offshore Inc.	Primary
MC	636	G15499	Shell Offshore Inc.	Primary
MC	637	G15500	Shell Offshore Inc.	Primary
MC	639	G21180	Dominion Exploration & Production, Inc.	Primary
MC	640	G16630	Chevron U.S.A. Inc.	Primary
MC	642	G16631	Chevron U.S.A. Inc.	Primary
MC	643	G19979	BP Exploration & Production Inc.	Primary
MC	644	G16632	BP Exploration & Production Inc.	Primary
MC	645	G16633	BP Exploration & Production Inc.	Primary
MC	648	G14644	BP Exploration & Production Inc.	Primary
MC	649	G16634	BHP Petroleum (GOM) Inc.	Primary
MC	680	G18271	TotalFinaElf E&P USA, Inc.	Primary
MC	681	G18272	Amerada Hess Corporation	Primary
MC	682	G21776	Chevron U.S.A. Inc.	Primary
MC	683	G16636	Chevron U.S.A. Inc.	Primary
MC	684	G16637	Chevron U.S.A. Inc.	Primary
MC	686	G05862	Shell Offshore Inc.	Unit
MC	687	G05863	Shell Offshore Inc.	Unit
MC	688	G19984	Mobil Oil Exploration & Producing Southeast Inc.	Primary
MC	689	G21777	Exxon Mobil Corporation	Primary
MC	691	G16638	BP Exploration & Production Inc.	Primary
MC	692	G16639	BP Exploration & Production Inc.	Primary
MC	693	G16640	BHP Petroleum (GOM) Inc.	Primary
MC	724	G22897	Chevron U.S.A. Inc.	Primary
MC	725	G22898	BP Exploration & Production Inc.	Primary
MC	726	G24101	BP Exploration & Production Inc.	Primary

Table H-1. Lease Status (continued).

Area	Block	Lease	Company Name	Lease Status
MC	727	G24102	BP Exploration & Production Inc.	Primary
MC	728	G16644	Dominion Exploration & Production, Inc.	Primary
MC	729	G19988	Dominion Exploration & Production, Inc.	Primary
MC	730	G07954	Shell Offshore Inc.	Unit
MC	731	G07955	Shell Offshore Inc.	Unit
MC	732	G19989	Mobil Oil Exploration & Producing Southeast Inc.	Primary
MC	733	G19990	Mobil Oil Exploration & Producing Southeast Inc.	Primary
MC	734	G21778	Dominion Exploration & Production, Inc.	Primary
MC	735	G19991	Shell Offshore Inc.	Primary
MC	736	G14652	BP Exploration & Production Inc.	Primary
MC	737	G16645	Chevron U.S.A. Inc.	Primary
MC	768	G22900	Phillips Petroleum Company	Primary
MC	769	G24106	Samedan Oil Corporation	Primary
MC	771	G24107	Dominion Exploration & Production, Inc.	Primary
MC	772	G16647	Dominion Exploration & Production, Inc.	Primary
MC	773	G19996	Dominion Exploration & Production, Inc.	Primary
MC	774	G21186	Murphy Exploration & Production Company	Primary
MC	775	G19997	BP Exploration & Production Inc.	Unit
MC	776	G09866	BP Exploration & Production Inc.	Unit
MC	777	G09867	BP Exploration & Production Inc.	Unit
MC	778	G09868	BP Exploration & Production Inc.	Unit
MC	779	G19998	Shell Offshore Inc.	Primary
MC	812	G22903	BP Exploration & Production Inc.	Primary
MC	814	G24114	BP Exploration & Production Inc.	Primary
MC	815	G18294	BP Exploration & Production Inc.	Primary
MC	816	G18295	BP Exploration & Production Inc.	Primary
MC	817	G18296	Chevron U.S.A. Inc.	Primary
MC	819	G12168	BP Exploration & Production Inc.	Unit
MC	820	G14656	BP Exploration & Production Inc.	Unit
MC	821	G14657	BP Exploration & Production Inc.	Unit
MC	822	G14658	BP Exploration & Production Inc.	Unit
MC	823	G18297	BP Exploration & Production Inc.	Primary
MC	856	G24119	Amerada Hess Corporation	Primary
MC	857	G22908	Amerada Hess Corporation	Primary
MC	859	G16652	BP Exploration & Production Inc.	Primary
MC	860	G18301	Chevron U.S.A. Inc.	Primary
MC	862	G18302	Shell Offshore Inc.	Primary
MC	863	G18303	Shell Offshore Inc.	Primary
MC	864	G15519	Chevron U.S.A. Inc.	Primary
MC	900	G22911	Amerada Hess Corporation	Primary
MC	901	G22912	Amerada Hess Corporation	Primary
MC	903	G16655	BP Exploration & Production Inc.	Primary
MC	904	G18309	Chevron U.S.A. Inc.	Primary
MC	906	G24124	Dominion Exploration & Production, Inc.	Primary
MC	907	G24125	Dominion Exploration & Production, Inc.	Primary
MC	908	G16656	Chevron U.S.A. Inc.	Primary

Table H-1. Lease Status (continued).

Area	Block	Lease	Company Name	Lease Status
MC	944	G15522	BHP Petroleum (GOM) Inc.	Primary
MC	945	G15523	BHP Petroleum (GOM) Inc.	Primary
MC	948	G15524	Chevron U.S.A. Inc.	Primary
MC	949	G18311	Chevron U.S.A. Inc.	Primary
MC	988	G15528	Shell Offshore Inc.	Primary
MC	989	G15529	Shell Offshore Inc.	Primary
MC	990	G18317	Chevron U.S.A. Inc.	Primary
MC	991	G18318	Chevron U.S.A. Inc.	Primary
MC	992	G24133	BHP Petroleum (GOM) Inc.	Primary
MC	993	G24134	Marathon Oil Company	Primary
VK	872	G19907	Shell Offshore Inc.	Primary
VK	873	G19908	Shell Offshore Inc.	PROD
VK	874	G24015	Chevron U.S.A. Inc.	Primary
VK	913	G08784	Shell Offshore Inc.	Unit
VK	913	G08784	Amoco Production Company	Unit
VK	914	G08785	BP Exploration & Production Inc.	PROD
VK	915	G06894	BP Exploration & Production Inc.	Unit
VK	916	G21733	Shell Offshore Inc.	Primary
VK	917	G15441	BP Exploration & Production Inc.	Primary
VK	956	G06896	Shell Offshore Inc.	Unit
VK	957	G08475	BP Exploration & Production Inc.	Unit
VK	957	G08475	Shell Offshore Inc.	Unit
VK	959	G22837	Murphy Exploration & Production Company	Primary
VK	960	G14617	BP Exploration & Production Inc.	Primary
VK	961	G15444	BP Exploration & Production Inc.	Primary
VK	962	G15445	BP Exploration & Production Inc.	Primary
VK	999	G21158	Vastar Resources, Inc.	Primary
VK	1000	G16559	Vastar Resources, Inc.	Primary
VK	1001	G16560	Vastar Resources, Inc.	Primary
VK	1002	G21159	Vastar Resources, Inc.	Primary
VK	1003	G21160	TotalFinaElf E&P USA, Inc.	Primary
VK	1004	G14620	BP Exploration & Production Inc.	Primary
VK	1006	G21737	Kerr-McGee Oil & Gas Corporation	Primary

Notes: AT = Atwater Valley
MC = Mississippi Canyon
VK = Viosca Knoll

Table H-2

Plans Status

Area	Block	Control No.	Plan	Company Name	Action Date
AT	111	N-6413	EP	Conoco Inc.	11-May-98
AT	155	N-6213	EP	Conoco Inc.	21-Oct-98
AT	155	R-3520	EP	Conoco Inc.	31-Aug-00
AT	156	N-6213	EP	Conoco Inc.	21-Oct-98
AT	199	N-6359	EP	Conoco Inc.	02-Feb-99
AT	200	N-6359	EP	Conoco Inc.	02-Feb-99
AT	287	N-7326	EP	Chevron U.S.A. Inc.	30-Jan-02
AT	331	N-7326	EP	Chevron U.S.A. Inc.	30-Jan-02
AT	336	N-6571	EP	The Louisiana Land and Exploration Company	22-Oct-99
AT	375	N-6300	EP	Chevron U.S.A. Inc.	13-Nov-98
AT	376	N-6300	EP	Chevron U.S.A. Inc.	13-Nov-98
AT	380	N-7313	EP	BHP Billiton Petroleum (GOM) Inc.	21-Feb-02
MC	84	N-4208	EP	BP America Production Company	24-Jan-92
MC	84	N-5841	DOCD	BP America Production Company	22-Sep-97
MC	84	R-2835	EP	BP America Production Company	14-Oct-92
MC	84	S-3630	EP	BP America Production Company	31-May-95
MC	85	N-4418	EP	BP America Production Company	26-Feb-93
MC	85	N-5841	DOCD	BP America Production Company	22-Sep-97
MC	85	R-3398	DOCD	BP America Production Company	20-Apr-00
MC	85	S-3779	EP	BP America Production Company	03-Nov-95
MC	126	N-6208	EP	Vastar Resources, Inc.	30-Nov-98
MC	126	R-3359	EP	Vastar Resources, Inc.	14-Oct-99
MC	127	N-6208	EP	Vastar Resources, Inc.	30-Nov-98
MC	127	N-7195	DOCD	Vastar Resources, Inc.	21-Feb-02
MC	127	R-3298	EP	Vastar Resources, Inc.	25-May-99
MC	127	R-3320	EP	Vastar Resources, Inc.	28-Jun-99
MC	127	R-3339	EP	Vastar Resources, Inc.	03-Sep-99
MC	127	S-5417	EP	Vastar Resources, Inc.	04-Jan-01
MC	129	N-4208	EP	BP America Production Company	24-Jan-92
MC	129	N-5841	DOCD	BP America Production Company	22-Sep-97
MC	129	R-3398	DOCD	BP America Production Company	20-Apr-00
MC	129	R-3539	DOCD	BP America Production Company	04-Dec-00
MC	129	S-3779	EP	BP America Production Company	03-Nov-95
MC	167	N-5701	EP	Exxon Mobil Corporation	24-Mar-97
MC	173	N-5963	DOCD	BP America Production Company	26-Feb-98
MC	173	R-3550	DOCD	BP America Production Company	26-Mar-01
MC	173	R-3568	DOCD	BP America Production Company	07-Dec-00
MC	205	N-7221	EP	Mariner Energy, Inc.	28-Sep-01
MC	211	N-3540	EP	Exxon Mobil Corporation	01-Feb-90
MC	211	N-5701	EP	Exxon Mobil Corporation	24-Mar-97
MC	211	N-6665	DOCD	Exxon Mobil Corporation	07-Apr-00
MC	211	R-3507	DOCD	Exxon Mobil Corporation	30-Aug-00

Table H-2. Plans Status (continued).

Area	Block	Control No.	Plan	Company Name	Action Date
MC	252	N-6521	EP	Texaco Exploration and Production Inc.	16-Jul-99
MC	292	N-4711	EP	Texaco Inc.	30-Mar-94
MC	292	N-6152	DOCD	Texaco Exploration and Production Inc.	14-Oct-98
MC	292	R-3269	DOCD	Texaco Inc.	22-Jan-99
MC	292	S-4082	EP	Texaco Exploration and Production Inc.	30-Aug-96
MC	299	N-6982	EP	Murphy Exploration & Production Company	11-Jan-01
MC	343	N-7501	EP	Murphy Exploration & Production Company	21-Aug-02
MC	379	N-6549	EP	Murphy Exploration & Production Company	22-Sep-99
MC	382	N-6670	EP	Vastar Resources, Inc.	21-Jan-00
MC	383	N-7443	DOCD	Shell Offshore Inc.	17-Jul-02
MC	383	S-5449	EP	Shell Deepwater Development Inc.	15-Jun-01
MC	418	N-6980	EP	Amerada Hess Corporation	03-Jan-01
MC	419	N-6980	EP	Amerada Hess Corporation	03-Jan-01
MC	429	N-4993	EP	BP America Production Company	20-Apr-95
MC	429	N-7458	DOCD	Shell Offshore Inc.	20-Aug-02
MC	429	R-3194	EP	BP America Production Company	22-Apr-98
MC	429	S-4895	EP	Shell Deepwater Development Inc.	22-Feb-99
MC	429	S-5732	EP	Shell Offshore Inc.	26-Oct-01
MC	465	N-7046	EP	Exxon Mobil Corporation	23-Mar-01
MC	506	N-4918	EP	BP Exploration & Oil Inc.	22-Feb-96
MC	507	N-4919	EP	BP Exploration & Oil Inc.	12-Mar-96
MC	508	N-7046	EP	Exxon Mobil Corporation	23-Mar-01
MC	508	S-5712	EP	Exxon Mobil Corporation	10-Sep-01
MC	509	N-7046	EP	Exxon Mobil Corporation	23-Mar-01
MC	509	R-3641	EP	Exxon Mobil Corporation	04-May-01
MC	509	S-5712	EP	Exxon Mobil Corporation	10-Sep-01
MC	553	N-6607	EP	Amerada Hess Corporation	29-Oct-99
MC	554	N-7233	EP	Exxon Mobil Corporation	16-Oct-01
MC	555	N-7120	EP	Exxon Mobil Corporation	23-May-01
MC	561	N-6986	EP	Burlington Resources Offshore Inc.	02-Feb-01
MC	595	N-6905	EP	Dominion Exploration & Production, Inc.	29-Sep-00
MC	597	N-6607	EP	Amerada Hess Corporation	29-Oct-99
MC	598	N-7233	EP	Exxon Mobil Corporation	16-Oct-01
MC	605	N-6986	EP	Burlington Resources Offshore Inc.	02-Feb-01
MC	636	N-7338	EP	Shell Offshore Inc.	27-Feb-02
MC	637	N-7338	EP	Shell Offshore Inc.	27-Feb-02
MC	637	S-6031	EP	Shell Offshore Inc.	01-Nov-02
MC	687	N-5492	DOCD	Shell Offshore Inc.	28-Jan-97
MC	687	R-3558	EP	Shell Deepwater Development Inc.	28-Nov-00
MC	687	R-3564	EP	Shell Deepwater Production Inc.	30-Nov-00
MC	687	S-3813	EP	Shell Offshore Inc.	15-Dec-95
MC	687	S-3998	EP	Shell Offshore Inc.	21-Jun-96
MC	687	S-5302	EP	Shell Deepwater Production Inc.	31-Jul-00
MC	725	N-7585	EP	BP Exploration & Oil Inc.	03-Dec-02
MC	728	N-5861	EP	Chevron U.S.A. Inc.	30-Sep-97

Table H-2. Plans Status (continued).

Area	Block	Control No.	Plan	Company Name	Action Date
MC	728	R-3279	EP	Chevron U.S.A. Inc.	08-Sep-99
MC	728	R-3697	EP	Chevron U.S.A. Inc.	19-Sep-01
MC	728	R-3798	EP	Dominion Exploration & Production, Inc.	17-May-02
MC	728	S-5653	EP	Chevron U.S.A. Inc.	06-Aug-01
MC	728	S-5866	EP	Dominion Exploration & Production, Inc.	10-Apr-02
MC	730	S-5964	EP	Shell Offshore Inc.	02-Aug-02
MC	737	N-7178	EP	Chevron U.S.A. Inc.	31-Aug-01
MC	772	N-5861	EP	Chevron U.S.A. Inc.	30-Sep-97
MC	772	R-3697	EP	Chevron U.S.A. Inc.	19-Sep-01
MC	772	S-5618	EP	Chevron U.S.A. Inc.	30-May-01
MC	772	S-5653	EP	Chevron U.S.A. Inc.	06-Aug-01
MC	773	N-6493	EP	Mariner Energy, Inc.	11-Jun-99
MC	773	R-3431	EP	Mariner Energy, Inc.	17-Apr-00
MC	773	S-5544	EP	Dominion Exploration & Production, Inc.	23-Mar-01
MC	773	S-5744	EP	Dominion Exploration & Production, Inc.	02-Nov-01
MC	773	S-5823	EP	Dominion Exploration & Production, Inc.	22-Jan-02
MC	773	S-5881	EP	Dominion Exploration & Production, Inc.	08-Apr-02
MC	776	N-5964	EP	BP Exploration & Oil Inc.	12-Jan-98
MC	776	R-3261	EP	BP Exploration & Oil Inc.	02-Dec-98
MC	776	R-3409	EP	BP Exploration & Oil Inc.	21-Mar-00
MC	776	S-5817	EP	BP Exploration & Oil Inc.	24-Jan-02
MC	776	S-5995	EP	BP Exploration & Production Inc.	17-Sep-02
MC	777	N-5964	EP	BP Exploration & Oil Inc.	12-Jan-98
MC	777	R-3261	EP	BP Exploration & Oil Inc.	02-Dec-98
MC	777	S-5899	EP	BP Exploration & Production Inc.	21-May-02
MC	777	S-5995	EP	BP Exploration & Production Inc.	17-Sep-02
MC	778	N-5964	EP	BP Exploration & Oil Inc.	12-Jan-98
MC	778	R-3261	EP	BP Exploration & Oil Inc.	02-Dec-98
MC	778	S-5817	EP	BP Exploration & Oil Inc.	24-Jan-02
MC	778	S-5995	EP	BP Exploration & Production Inc.	17-Sep-02
MC	815	N-6524	EP	Vastar Resources, Inc.	14-Jul-99
MC	815	R-3334	EP	Vastar Resources, Inc.	15-Sep-99
MC	822	N-6604	EP	BP Exploration Inc.	01-Dec-99
MC	822	R-3652	EP	BP Exploration & Oil Inc.	12-Jul-01
MC	822	S-5995	EP	BP Exploration & Production Inc.	17-Sep-02
MC	860	N-7372	EP	Chevron U.S.A. Inc.	22-Apr-02
MC	864	N-6328	EP	Chevron U.S.A. Inc.	30-Jun-99
MC	864	R-3538	EP	Chevron U.S.A. Inc.	16-Nov-00
MC	864	R-3574	EP	Chevron U.S.A. Inc.	16-Jan-01
MC	904	N-6774	EP	Chevron U.S.A. Inc.	22-Jun-00
MC	944	N-6567	EP	BHP Billiton Petroleum (GOM) Inc.	02-Nov-99
MC	948	N-6774	EP	Chevron U.S.A. Inc.	22-Jun-00
MC	949	N-6774	EP	Chevron U.S.A. Inc.	22-Jun-00
MC	988	N-6625	EP	Chevron U.S.A. Inc.	28-Dec-99
MC	988	N-6715	EP	Shell Deepwater Development Inc.	02-Mar-00

Table H-2. Plans Status (continued).

Area	Block	Control No.	Plan	Company Name	Action Date
MC	989	N-6625	EP	Chevron U.S.A. Inc.	28-Dec-99
VK	872	N-6264	EP	Shell Deepwater Production Inc.	15-Oct-98
VK	872	N-7119	DOCD	Shell Deepwater Development Inc.	18-Jul-01
VK	872	R-3722	DOCD	Shell Offshore Inc.	14-Nov-01
VK	913	N-4420	EP	BP America Production Company	08-Apr-93
VK	913	N-4421	EP	BP America Production Company	25-Mar-93
VK	914	N-4421	EP	BP America Production Company	25-Mar-93
VK	914	N-6813	DOCD	BP America Production Company	27-Oct-00
VK	914	R-3132	EP	BP America Production Company	17-Apr-97
VK	914	R-3291	EP	BP America Production Company	25-Mar-99
VK	914	S-4166	EP	BP America Production Company	20-Dec-96
VK	915	N-2908	EP	BP America Production Company	04-Mar-88
VK	915	N-5739	DOCD	BP America Production Company	26-Jun-97
VK	915	R-2826	EP	BP America Production Company	28-Sep-92
VK	915	R-3066	EP	BP America Production Company	20-May-96
VK	915	R-3104	EP	BP America Production Company	25-Sep-96
VK	915	R-3240	DOCD	BP America Production Company	23-Nov-98
VK	915	R-3268	DOCD	BP America Production Company	08-Jan-99
VK	915	R-3761	EP	BP America Production Company	07-Feb-02
VK	915	R-3771	EP	BP Exploration & Production Inc.	06-Mar-02
VK	915	S-5427	DOCD	BP America Production Company	18-Jan-01
VK	915	S-5847	EP	BP Exploration & Production Inc.	28-Feb-02
VK	915	S-5865	EP	BP Exploration & Production Inc.	22-Mar-02
VK	916	N-6937	EP	Shell Deepwater Development Inc.	01-Nov-00
VK	916	R-3692	EP	Shell Offshore Inc.	10-Oct-01
VK	916	R-3721	EP	Shell Offshore Inc.	13-Nov-01
VK	917	N-7265	EP	Mariner Energy, Inc.	19-Oct-01
VK	956	N-5588	DOCD	Shell Offshore Inc.	13-Mar-97
VK	956	S-3845	EP	Shell Offshore Inc.	10-Apr-96
VK	957	R-2217	EP	BP America Production Company	20-Oct-88
VK	962	N-7265	EP	Mariner Energy, Inc.	19-Oct-01
VK	1000	N-5695	EP	Vastar Resources, Inc.	28-Mar-97
VK	1001	N-5695	EP	Vastar Resources, Inc.	28-Mar-97
VK	1001	N-5695	EP	Vastar Resources, Inc.	10-Mar-99
VK	1001	R-3202	EP	Vastar Resources, Inc.	12-Jun-98
VK	1003	N-6562	EP	TotalFinaElf E&P USA, Inc.	08-Sep-99

Notes: AT = Atwater Valley
EP = Eploration Plan
DOCD = Development Operations Coordination Document
MC = Mississippi Canyon
VK = Viosca Knoll

Table H-3

Well Status

Area	Block	Company Name	Well	Type	Status	Spud Date	TD Date	Water Depth (ft)
AT	24	Conoco Inc.	001	E	PA	6/29/2000	8/7/2000	5,896
AT	67	BP Exploration & Oil Inc.	001	E	CNL			5,195
AT	113	Shell Deepwater Development Inc.	001	E	ST	7/10/2000	7/27/2000	6,224
AT	113	Shell Deepwater Development Inc.	001	D	PA	8/2/2000	8/12/2000	6,224
AT	153	Chevron U.S.A. Inc.	001	E	PA	5/5/2001	8/9/2001	4,785
AT	155	Conoco Inc.	001	E	APD			5,229
AT	336	Kerr-McGee Oil & Gas Corporation	001	E	PA	3/17/2000	5/11/2000	6,221
AT	378	Chevron U.S.A. Inc.	001	D	ST	7/11/1997	8/29/1997	5,843
AT	378	Chevron U.S.A. Inc.	001	D	PA	11/13/1997	11/25/1997	5,843
MC	79	Exxon Mobil Corporation	001	E	PA	7/13/1996	8/18/1996	3,849
MC	84	BP Exploration & Production Inc.	001	E	PA	10/18/1992	1/17/1993	5,149
MC	84	BP Exploration & Production Inc.	002	D	TA	1/16/2002	2/3/2002	5,430
MC	85	BP Exploration & Production Inc.	001	E	ST	7/2/1996	7/20/1996	5,370
MC	85	BP Exploration & Production Inc.	001	E	ST	8/15/1996	8/30/1996	5,370
MC	85	BP Exploration & Production Inc.	001	E	TA	9/15/1996	9/25/1996	5,370
MC	85	BP Exploration & Production Inc.	SS002	D	COM	12/1/2000	12/22/2000	5,173
MC	126	Vastar Resources, Inc.	001	E	ST	10/31/1999	11/12/1999	5,308
MC	126	Vastar Resources, Inc.	001	E	ST	11/17/1999	11/21/1999	5,308
MC	126	Vastar Resources, Inc.	001	E	PA	11/22/1999	11/26/1999	5,308
MC	127	Vastar Resources, Inc.	001	E	ST	7/2/1999	7/27/1999	5,423
MC	127	Vastar Resources, Inc.	001	D	ST	7/29/1999	8/6/1999	5,423
MC	127	Vastar Resources, Inc.	001	E	ST	8/12/1999	8/17/1999	5,423
MC	127	Vastar Resources, Inc.	001	E	ST	8/23/1999	8/26/1999	5,423
MC	127	Vastar Resources, Inc.	001	E	TA	8/27/1999	9/1/1999	5,423
MC	127	Vastar Resources, Inc.	002	E	ST	9/14/1999	9/25/1999	5,468
MC	127	Vastar Resources, Inc.	002	D	ST	9/29/1999	9/30/1999	5,468
MC	127	Vastar Resources, Inc.	002	E	ST	10/3/1999	10/9/1999	5,468
MC	127	Vastar Resources, Inc.	002	E	TA	10/19/1999	10/23/1999	5,468
MC	127	Vastar Resources, Inc.	A001	D	TA	4/22/2001	6/8/2001	5,422
MC	127	Vastar Resources, Inc.	A002	D	TA	5/10/2001	10/23/2001	5,422
MC	127	Vastar Resources, Inc.	A003	D	TA	4/30/2001	7/26/2001	5,422
MC	127	Vastar Resources, Inc.	A004	D	TA	5/2/2001	8/12/2001	5,422

Table H-3. Well Status (continued).

Area	Block	Company Name	Well	Type	Status	Spud Date	TD Date	Water Depth (ft)
MC	127	Vastar Resources, Inc.	A005	D	TA	5/6/2001	9/12/2001	5,422
MC	127	Vastar Resources, Inc.	A006	D	TA	10/1/2001	11/17/2001	5,422
MC	127	Vastar Resources, Inc.	A007	D	TA	5/9/2001	9/26/2001	5,422
MC	127	Vastar Resources, Inc.	A008	D	TA	4/22/2001	5/25/2001	5,422
MC	127	Vastar Resources, Inc.	A009	D	ST	4/24/2001	6/25/2001	5,422
MC	127	Vastar Resources, Inc.	A009	D	TA	7/1/2001	7/6/2001	5,422
MC	127	Vastar Resources, Inc.	A010	D	TA	5/4/2001	8/29/2001	5,422
MC	129	BP Exploration & Production Inc.	002	D	APD			5,318
MC	129	BP Exploration & Production Inc.	SS003	D	ST	12/11/2000	3/29/2001	5,317
MC	129	BP Exploration & Production Inc.	SS003	D	COM	4/6/2001	4/8/2001	5,317
MC	162	BP Exploration & Oil Inc.	001	E	PA	8/5/1994	11/30/1994	3,425
MC	162	BP Exploration & Oil Inc.	002	E	PA	5/30/1996	6/14/1996	3,402
MC	162	BP Exploration & Oil Inc.	003	E	PA	6/2/1997	6/26/1997	3,724
MC	173	BP Exploration & Production Inc.	SS002	D	COM	12/13/2000	1/1/2001	6,390
MC	205	Mariner Energy, Inc.	001	E	TA	11/25/2001	12/8/2001	3,771
MC	211	Exxon Mobil Corporation	001	E	ST	2/8/1990	4/5/1990	
MC	211	Exxon Mobil Corporation	001	E	PA	4/17/1990	5/25/1990	4,356
MC	211	Exxon Mobil Corporation	001	E	ST	3/28/1997	5/24/1997	4,270
MC	211	Exxon Mobil Corporation	001	E	ST	6/8/1997	6/18/1997	4,274
MC	211	Exxon Mobil Corporation	001	E	ST	7/22/1997	9/6/1997	4,270
MC	211	Exxon Mobil Corporation	001	E	TA	9/12/1997	9/16/1997	4,270
MC	211	Exxon Mobil Corporation	MA001	D	COM	6/23/2000	7/24/2000	4,317
MC	211	Exxon Mobil Corporation	MA002	D	COM	6/25/2000	9/2/2000	4,350
MC	211	Exxon Mobil Corporation	MA003	E	DRL	6/15/2002	7/25/2002	4,318
MC	247	Texaco Exploration and Production Inc.	001	D	ST	11/6/1997	12/5/1997	3,080
MC	247	Texaco Exploration and Production Inc.	001	D	PA	12/20/1997	2/18/1998	3,080
MC	248	Chevron U.S.A. Inc.	001	E	ST	1/11/2000	2/4/2000	3,290
MC	248	Chevron U.S.A. Inc.	001	D	ST	2/16/2000	2/22/2000	3,290
MC	248	Chevron U.S.A. Inc.	001	D	PA	2/27/2000	3/14/2000	3,290
MC	248	Chevron U.S.A. Inc.	002	E	CNL			3,290
MC	252	Chevron U.S.A. Inc.	001	E	ST	9/26/1999	10/6/1999	5,225
MC	252	Chevron U.S.A. Inc.	001	E	ST	10/19/1999	10/20/1999	5,225
MC	252	Chevron U.S.A. Inc.	001	E	TA	10/21/1999	11/29/1999	5,225
MC	291	Texaco Exploration and Production Inc.	001	E	PA	8/13/1997	10/20/1997	3,634
MC	292	Chevron U.S.A. Inc.	001	E	COM	5/6/1995	9/7/1995	3,405
MC	292	Chevron U.S.A. Inc.	002	E	ST	9/5/1996	10/1/1996	4,120
MC	292	Chevron U.S.A. Inc.	002	E	ST	1/24/1997	2/13/1997	4,120
MC	292	Chevron U.S.A. Inc.	002	E	TA	2/5/1997	3/13/1997	4,153
MC	292	Chevron U.S.A. Inc.	003	D	ST	2/8/1999	4/15/1999	3,393
MC	292	Chevron U.S.A. Inc.	003	E	COM	6/8/1999	6/21/1999	3,393

Table H-3. Well Status (continued).

Area	Block	Company Name	Well	Type	Status	Spud Date	TD Date	Water Depth (ft)
MC	292	Chevron U.S.A. Inc.	004	D	ST	2/1/1999	3/13/1999	3,393
MC	292	Chevron U.S.A. Inc.	004	D	COM	7/8/1999	7/16/1999	3,393
MC	299	Murphy Exploration & Production Company	001	E	ST	4/8/2001	5/4/2001	5,881
MC	299	Murphy Exploration & Production Company	001	E	PA	5/14/2001	5/23/2001	5,881
MC	300	Exxon Mobil Corporation	001	E	PA	9/13/1997	10/25/1997	5,844
MC	379	Murphy Exploration & Production Company	001	E	PA	1/18/2000	3/17/2000	4,316
MC	382	Amerada Hess Corporation	001	E	PA	9/3/2001	11/19/2001	5,432
MC	383	Shell Offshore Inc.	001	E	PA	6/27/1987	8/31/1987	5,759
MC	383	Shell Offshore Inc.	003	D	ST	9/7/2001	10/1/2001	5,739
MC	383	Shell Offshore Inc.	003	D	ST	10/2/2001	10/4/2001	5,739
MC	383	Shell Offshore Inc.	003	D	DSI	10/10/2001		5,739
MC	383	Shell Offshore Inc.	K001	D	ST	9/9/2001	10/25/2001	5,735
MC	383	Shell Offshore Inc.	K001	D	DRL	10/26/2001		5,735
MC	429	Shell Offshore Inc.	001	E	TA	11/8/1995	11/20/1995	6,274
MC	429	Shell Offshore Inc.	002	D	ST	3/18/1999	4/21/1999	6,132
MC	429	Shell Offshore Inc.	002	D	ST	5/1/1999	5/2/1999	6,132
MC	429	Shell Offshore Inc.	002	D	ST	12/31/2001	1/1/2002	6,134
MC	429	Shell Offshore Inc.	002	D	ST	1/4/2002	1/4/2002	6,134
MC	429	Shell Offshore Inc.	002	D	TA	1/7/2002		6,134
MC	429	Shell Offshore Inc.	003	D	ST	11/2/2001	11/12/2001	6,101
MC	429	Shell Offshore Inc.	003	D	ST	11/18/2001	12/2/2001	6,101
MC	429	Shell Offshore Inc.	003	D	TA	12/5/2001	12/12/2001	6,101
MC	505	Shell Offshore Inc.	001	E	PA	8/28/1986	11/8/1986	3,174
MC	509	Exxon Mobil Corporation	001	E	TA	5/11/2001	11/20/2001	4,174
MC	553	Amerada Hess Corporation	001	D	PA	11/16/1999	1/28/2000	4,513
MC	555	Exxon Mobil Corporation	001	E	ST	5/25/2001	5/27/2001	4,749
MC	555	Exxon Mobil Corporation	001	E	PA	6/13/2001	10/30/2001	4,749
MC	561	Burlington Resources Offshore Inc.	001	E	ST	5/1/2001	6/19/2001	6,308
MC	561	Burlington Resources Offshore Inc.	001	E	PA	6/29/2001	7/21/2001	6,266
MC	595	Dominion Exploration & Production, Inc.	001	E	PA	10/15/2000	11/29/2000	4,608
MC	638	Texaco Exploration and Production Inc.	001	E	PA	6/28/1996	8/16/1996	4,263
MC	687	Shell Offshore Inc.	001	E	PA	12/19/1995	1/2/1996	5,305
MC	687	Shell Offshore Inc.	002	E	ST	3/19/2001	7/27/2001	5,150
MC	687	Shell Offshore Inc.	002	E	ST	8/13/2001	8/20/2001	5,150
MC	687	Shell Offshore Inc.	002	E	TA	9/5/2001	2/11/2002	5,150
MC	687	Shell Offshore Inc.	A001	E	COM	9/10/1996	12/31/1996	5,292
MC	687	Shell Offshore Inc.	A002	E	COM	11/23/1997	6/15/1998	5,292
MC	687	Shell Offshore Inc.	A003	E	COM	9/10/1996	8/20/1997	5,295
MC	727	Chevron U.S.A. Inc.	001	E	PA	8/21/2000	1/17/2001	4,891
MC	728	Dominion Exploration & Production, Inc.	004	E	DRL	6/7/2002		5,432
MC	730	Shell Offshore Inc.	001	E	PA	6/10/1988	8/12/1988	5,328

Table H-3. Well Status (continued).

Area	Block	Company Name	Well	Type	Status	Spud Date	TD Date	Water Depth (ft)
MC	731	Shell Offshore Inc.	001	D	ST	11/20/1986	12/1/1986	5,400
MC	731	Shell Offshore Inc.	001	E	PA	2/23/1987	3/14/1987	5,400
MC	772	Dominion Exploration & Production, Inc.	001	E	ST	8/30/1998	1/27/1999	5,567
MC	772	Dominion Exploration & Production, Inc.	001	E	TA	2/10/1999	3/1/1999	5,567
MC	773	Dominion Exploration & Production, Inc.	001	E	PA	11/17/1999	11/17/1999	5,610
MC	773	Dominion Exploration & Production, Inc.	002	E	TA	11/17/1999	12/13/1999	5,610
MC	773	Dominion Exploration & Production, Inc.	002	E	TA	12/8/2001	3/15/2002	5,610
MC	773	Dominion Exploration & Production, Inc.	003	E	ST	5/16/2000	6/4/2000	5,595
MC	773	Dominion Exploration & Production, Inc.	003	E	TA	6/18/2000	7/4/2000	5,595
MC	773	Dominion Exploration & Production, Inc.	003	E	TA	4/16/2002	5/13/2002	5,610
MC	773	Dominion Exploration & Production, Inc.	004	E	TA	4/5/2001	5/2/2001	5,610
MC	773	Dominion Exploration & Production, Inc.	005	E	ST	4/8/2001	6/3/2001	5,610
MC	773	Dominion Exploration & Production, Inc.	005	E	TA	6/5/2001	6/6/2001	5,610
MC	773	Dominion Exploration & Production, Inc.	006	E	DSI	12/4/2001	1/2/2002	5,610
MC	773	Dominion Exploration & Production, Inc.	007	E	ST	12/6/2001	1/18/2002	5,610
MC	773	Dominion Exploration & Production, Inc.	007	E	TA	2/6/2002	2/13/2002	5,610
MC	773	Dominion Exploration & Production, Inc.	009	D	TA	1/28/2002	4/4/2002	5,610
MC	776	BP Exploration & Production Inc.	001	D	AST			5,636
MC	776	BP Exploration & Production Inc.	001	E	ST	4/26/2000	7/23/2000	5,700
MC	776	BP Exploration & Production Inc.	001	D	ST	8/3/2000	8/16/2000	5,700
MC	776	BP Exploration & Production Inc.	001	D	ST	8/29/2000		5,700
MC	776	BP Exploration & Production Inc.	001	D	TA	9/26/2000	11/11/2000	5,636
MC	776	BP Exploration & Production Inc.	002	D	ST	3/7/2002	4/23/2002	5,660
MC	776	BP Exploration & Production Inc.	002	D	TA	5/1/2002	5/19/2002	5,660
MC	777	BP Exploration & Production Inc.	001	E	DRL	6/14/2002	7/25/2002	5,624
MC	778	BP Exploration & Production Inc.	001	E	ST	1/8/1999	4/24/1999	6,050
MC	778	BP Exploration & Production Inc.	001	E	TA	5/5/1999	6/21/1999	6,037
MC	778	BP Exploration & Production Inc.	001	D	DSI	4/22/2002		6,031
MC	778	BP Exploration & Production Inc.	002	E	TA	4/20/2002	6/21/2002	6,037
MC	778	BP Exploration & Production Inc.	004	E	DSI	4/27/2002	4/28/2002	6,037
MC	815	BP Exploration & Production Inc.	001	D	ST	12/9/1999	2/1/2000	5,395
MC	815	BP Exploration & Production Inc.	001	D	PA	2/14/2000	3/13/2000	5,395
MC	822	BP Exploration & Production Inc.	001	E	TA	12/20/1999	11/30/2000	6,327
MC	822	BP Exploration & Production Inc.	002	E	TA	9/24/2001	10/18/2001	6,255
MC	822	BP Exploration & Production Inc.	003	E	TA	11/6/2001	1/29/2002	6,255
MC	864	Chevron U.S.A. Inc.	001	E	PA	1/23/2001	3/14/2001	6,265
MC	988	Shell Offshore Inc.	001	E	ST	4/1/2000	5/11/2000	4,400
MC	988	Shell Deepwater Development Inc.	001	D	PA	5/16/2000	6/17/2000	4,400
VK	872	Shell Offshore Inc.	001	E	ST	11/20/1998	12/6/1998	3,480
VK	872	Shell Offshore Inc.	SS001	E	COM	12/15/1998	12/18/1998	3,463
VK	873	Shell Offshore Inc.	001	E	PA	2/21/1988	3/25/1988	3,810

Table H-3. Well Status (continued).

Area	Block	Company Name	Well	Type	Status	Spud Date	TD Date	Water Depth (ft)
VK	914	BP Exploration & Production Inc.	SS001	E	ST	4/20/1997	4/30/1997	3,535
VK	914	BP Exploration & Production Inc.	SS001	E	ST	6/9/1997	6/25/1997	3,535
VK	914	BP Exploration & Production Inc.	SS001	E	ST	6/27/1997	7/2/1997	3,535
VK	914	BP Exploration & Production Inc.	SS001	E	COM	4/12/1999	5/2/1999	3,535
VK	915	BP Exploration & Production Inc.	A001	E	ST	4/14/1993	6/6/1993	3,236
VK	915	BP Exploration & Production Inc.	A001	E	TA	6/7/1993	7/7/1993	3,236
VK	915	BP Exploration & Production Inc.	A002	E	PA	10/20/1996	12/4/1996	3,236
VK	915	BP Exploration & Production Inc.	A003	D	ST	8/15/1997	1/6/1998	3,240
VK	915	BP Exploration & Production Inc.	A003	D	TA	2/25/1998	2/28/1998	3,240
VK	915	BP Exploration & Production Inc.	A004	D	ST	9/13/1997	1/8/1998	3,232
VK	915	BP Exploration & Production Inc.	A004	D	COM	1/11/1998	1/4/2001	3,232
VK	915	BP Exploration & Production Inc.	A005	D	COM	9/16/1997	12/1/1997	3,232
VK	915	BP Exploration & Production Inc.	A006	D	COM	8/17/1997	4/10/1998	3,232
VK	915	BP Exploration & Production Inc.	SS001	D	COM	1/27/2001	4/2/2001	3,460
VK	915	BP Exploration & Production Inc.	SS002	D	COM	1/9/2002	2/23/2002	3,460
VK	915	BP Exploration & Production Inc.	SS003	D	TA	2/12/2002	3/9/2002	3,865
VK	915	BP Exploration & Production Inc.	SS004	D	ST	3/18/2002	3/25/2002	3,560
VK	915	BP Exploration & Production Inc.	SS004	D	ST	3/29/2002	4/17/2002	3,560
VK	915	BP Exploration & Production Inc.	SS004	D	ST	4/24/2002	4/26/2002	3,560
VK	915	BP Exploration & Production Inc.	SS004	D	TA	5/4/2002	5/6/2002	3,560
VK	915	BP Exploration & Production Inc.	SS005	D	TA	5/18/2002	6/15/2002	3,850
VK	916	Shell Offshore Inc.	001	E	PA	11/27/2001	12/18/2001	3,690
VK	917	BP Exploration & Production Inc.	001	E	TA	11/21/2001	12/8/2001	4,370
VK	956	Shell Offshore Inc.	001	E	ST	11/16/1985	1/1/1986	3,112
VK	956	Shell Offshore Inc.	002	E	TA	1/17/1986	2/17/1986	3,112
VK	956	Shell Offshore Inc.	002	E	ST	2/20/1987	4/30/1987	3,553
VK	956	Shell Offshore Inc.	002	E	ST	5/27/1987	6/4/1987	3,553
VK	956	Shell Offshore Inc.	002	E	ST	6/11/1987	6/29/1987	3,553
VK	956	Shell Offshore Inc.	002	E	PA	7/7/1987	7/21/1987	3,553
VK	956	Shell Offshore Inc.	A001	E	ST	4/2/1997	6/26/1997	0
VK	956	Shell Offshore Inc.	A001	E	ST	6/25/1997	7/9/1997	0
VK	956	Shell Offshore Inc.	A001	E	COM	7/30/1997	8/16/1997	3,214
VK	956	Shell Offshore Inc.	A002	E	ST	4/6/1996	4/15/1996	3,218
VK	956	Shell Offshore Inc.	A002	E	ST	9/19/1996	9/24/1996	3,218
VK	956	Shell Offshore Inc.	A002	E	COM	1/28/1997	2/7/1997	3,214
VK	956	Shell Offshore Inc.	A003	E	ST	12/19/1996	1/18/1997	3,214
VK	956	Shell Offshore Inc.	A003	E	ST	10/16/1997	11/22/1997	3,214
VK	956	Shell Offshore Inc.	A003	D	ST	12/5/2001	12/11/2001	3,214
VK	956	Shell Offshore Inc.	A003	D	COM	12/16/2001		3,214
VK	956	Shell Offshore Inc.	A004	E	ST	11/3/1996	12/4/1996	3,218
VK	956	Shell Offshore Inc.	A004	E	ST	12/4/1996	12/16/1996	3,218

Table H-3. Well Status (continued).

Area	Block	Company Name	Well	Type	Status	Spud Date	TD Date	Water Depth (ft)
VK	956	Shell Offshore Inc.	A004	E	COM	2/11/1998	3/5/1998	3,214
VK	956	Shell Offshore Inc.	A005	E	ST	4/3/1996	4/23/1996	3,214
VK	956	Shell Offshore Inc.	A005	E	ST	4/30/1998	4/30/1998	3,214
VK	956	Shell Offshore Inc.	A005	E	COM	5/14/1998	6/27/1998	3,214
VK	956	Shell Offshore Inc.	A006	E	ST	3/8/1997	8/8/1998	3,214
VK	956	Shell Offshore Inc.	A006	E	ST	8/27/1998	10/28/1998	3,214
VK	956	Shell Offshore Inc.	A006	E	COM	11/6/1998	1/11/1999	3,214
VK	956	Shell Offshore Inc.	A007	E	DSI	4/1/1996	2/20/1997	3,214
VK	956	Shell Offshore Inc.	A008	E	ST	4/4/1996	2/10/1999	3,214
VK	956	Shell Offshore Inc.	A008	E	ST	2/20/1999	3/4/1999	3,214
VK	956	Shell Offshore Inc.	A008	E	COM	3/10/1999	3/15/1999	3,214
VK	956	Shell Offshore Inc.	A009	E	DSI	4/5/1996	3/13/1997	3,214
VK	956	Shell Offshore Inc.	A010	E	DSI	3/30/1996	2/24/1997	3,214
VK	956	Shell Offshore Inc.	A011	E	DSI	3/23/1996	3/2/1997	3,214
VK	956	Shell Offshore Inc.	A012	E	DSI	4/9/1996	3/7/1997	3,214
VK	956	Shell Offshore Inc.	A013	E	ST	4/4/1996	10/1/1999	3,214
VK	956	Shell Offshore Inc.	A013	E	COM	10/5/1999	10/29/1999	3,214
VK	956	Shell Offshore Inc.	A014	E	COM	9/27/1997	9/6/1999	3,214
VK	956	Shell Offshore Inc.	A015	E	DSI	4/5/1996	2/26/1997	3,214
VK	956	Shell Offshore Inc.	A016	E	DSI	3/28/1996	3/5/1997	3,214
VK	956	Shell Offshore Inc.	A017	E	COM	3/14/1997	5/27/1999	3,214
VK	956	Shell Offshore Inc.	A018	E	DSI	3/31/1996	3/10/1997	3,214
VK	956	Shell Offshore Inc.	A019	E	DSI	3/31/1996	3/1/1997	3,214
VK	956	Shell Offshore Inc.	A020	E	DSI	3/23/1996	3/3/1997	3,214
VK	957	Shell Offshore Inc.	001	E	ST	1/5/1989	3/20/1989	3,492
VK	957	Shell Offshore Inc.	001	E	ST	4/2/1989	4/19/1989	3,500
VK	957	Shell Offshore Inc.	001	E	TA	6/22/1989	7/4/1989	3,500
VK	957	Shell Offshore Inc.	003	E	ST	5/24/1989	6/10/1989	3,492
VK	962	BP Exploration & Production Inc.	001	E	TA	10/27/2001	11/15/2001	4,677
VK	1001	Vastar Resources, Inc.	001	E	ST	3/20/1999	4/25/1999	4,126
VK	1001	Vastar Resources, Inc.	001	E	ST	5/2/1999	5/9/1999	4,126
VK	1001	Vastar Resources, Inc.	001	D	ST	5/13/1999	5/14/1999	4,126
VK	1001	Vastar Resources, Inc.	001	D	PA	5/15/1999	6/19/1999	4,113
VK	1003	TotalFinaElf E&P USA, Inc.	001	E	ST	10/1/1999	10/18/1999	4,942
VK	1003	TotalFinaElf E&P USA, Inc.	001	E	TA	11/2/1999	12/19/1999	4,942

Notes: APD = approval for permit to drill
AST = approved sidetrack
CNL = canceled
COM = completed
D = development
DRL = drilling
DSI = drilling shut-in
E = exploration
PA = permanently abandoned
ST = sidetrack
TA = temporarily abandoned

Table H-4

Platforms in Grid 16

Area	Block	Lease No.	Complex ID No.	Water Depth (ft)	Company Name
VK	915	G06894	235	3,236	BP Exploration & Production Inc.
VK	956	G06896	24229	3,216	Shell Offshore Inc.
MC	211	G08803	714	4,350	Exxon Mobil Corporation
MC	127	G19925	876	5,400	Vastar Resources, Inc.

Notes: MC = Mississippi Canyon
VK = Viosca Knoll

Table H-5

Proposed Plan Platforms

Area	Block	Control No.	Plan	Company Name	Action Date	Site	Water Depth (ft)
MC	85	R-3398	DOCD	Amoco Production Company	4/20/2000	1	5,453
MC	127	N-7195	DOCD	Vastar Resources, Inc.	2/21/2002	A	5,422
VK	872	N-7119	DOCD	Shell Deepwater Development Inc.	7/18/2001	NO 1	3,480
VK	915	N-5739	DOCD	Amoco Production Company	6/26/1997	A	3,250
VK	915	R-3240	DOCD	Amoco Production Company	11/23/1998	A	3,250
VK	956	N-5588	DOCD	Shell Offshore Inc.	3/13/1997	A	3,214

Notes: DOCD = Development Operations Coordination Document
MC = Mississippi Canyon
VK = Viosca Knoll

APPENDIX I

Air Emissions Data

APPENDIX I

AIR EMISSIONS DATA

The projected air emissions submitted by BP Exploration and Production for the Thunder Horse project are below the MMS exemption levels. BP Exploration and Production has estimated the emissions associated with this project. These emission projections are required to represent the worst case. They are summarized below.

Total Emissions (tons) for MC 776 Drill Center 31

Year	PM	SO_x	NO_x	VOC	CO
2004	4.20	19.28	144.78	4.61	33.28
2005	13.27	60.89	456.53	13.96	101.30
2006	22.00	100.92	756.18	22.69	164.98
2011	9.27	42.51	318.82	9.83	71.25
2012	10.92	50.10	375.44	11.26	81.92
2014	33.17	152.18	1140.32	34.21	248.80
2015	10.47	48.03	359.91	10.80	78.53
MMS Exemption Level	2131.20	2131.20	2131.20	2131.20	54400.00

Total Emissions (tons) for MC 776 Drill Center 32

Year	PM	SO_x	NO_x	VOC	CO
2004	11.23	51.53	386.44	11.86	86.00
2005	1.86	8.52	63.81	1.91	13.92
2014	21.83	100.15	750.41	22.51	163.73
MMS Exemption Level	2131.20	2131.20	2131.20	2131.20	54400.00

Total Emissions (tons) for MC 776 Drill Center 33

Year	PM	SO_x	NO_x	VOC	CO
2004	15.40	7.06	529.48	15.88	115.52
2005	21.94	100.68	754.98	23.18	168.10
2006	8.46	38.82	291.17	9.00	65.22
2011	22.82	104.68	784.41	23.53	171.14
2012	19.00	87.16	653.43	19.87	144.26
2014	21.83	100.15	750.41	22.51	163.73
2015	10.92	50.10	375.44	11.26	81.92
MMS Exemption Level	2131.20	2131.20	2131.20	2131.20	54400.00

Total Emissions (tons) for MC 776 Drill Center 41

Year	PM	SO_x	NO_x	VOC	CO
2004	21.83	100.17	753.16	24.83	178.67
2005	52.15	239.24	1793.99	54.94	398.59
2006	21.02	98.60	1862.56	71.70	885.48
2007	16.74	79.68	2088.57	83.65	1091.59
2008	16.74	79.68	2088.57	83.65	1091.59
2009	16.74	79.68	2088.57	83.65	1091.59
2011	16.74	79.68	2088.57	83.65	1091.59
2012	16.74	79.68	2088.57	83.65	1091.59
2013	16.74	79.68	2088.57	83.65	1091.59
2014	16.74	79.68	2088.57	83.65	1091.59
2015	16.74	79.68	2088.57	83.65	1091.59
MMS Exemption Level	2264.40	2264.40	2264.40	2264.40	56643.69

Total Emissions (tons) for MC 776 Drill Center 42

Year	PM	SO_x	NO_x	VOC	CO
2003	12.10	55.49	416.12	12.75	92.48
MMS Exemption Level	2331.00	2331.00	2331.00	2331.00	57748.97

Total Emissions (tons) for MC 776 Drill Center 43

Year	PM	SO_x	NO_x	VOC	CO
2003	6.30	28.91	217.94	7.66	54.72
2004	1.50	6.87	51.46	1.54	11.23
2007	10.92	50.10	375.44	11.26	81.92
2014	10.92	50.10	375.44	11.26	81.92
MMS Exemption Level	2131.20	2131.20	2131.20	2131.20	54400.00

Total Emissions (tons) for MC 776 Drill Center 44

Year	PM	SO_x	NO_x	VOC	CO
2005	22.28	102.22	766.27	23.25	168.87
2006	13.18	60.49	453.86	14.14	102.40
2020	3.37	15.45	115.77	3.47	25.26
MMS Exemption Level	2197.80	2197.80	2197.80	2197.80	55527.51

Total Emissions (tons) for MC 776 Drill Center 45

Year	PM	SO_x	NO_x	VOC	CO
2003	6.27	28.75	215.75	6.74	48.76
2004	10.92	50.10	375.44	11.26	81.92
2008	10.92	50.10	375.44	11.26	81.92
MMS Exemption Level	2264.40	2264.40	2264.40	2264.40	56643.69

The projected air emissions submitted, by BP Exploration and Production, for the Thunder Horse (categorical exclusion review) project are below the MMS exemption levels. BP Exploration and Production has estimated the emissions associated with this project. These emission projections are required to represent the worst case. They are summarized below:

Total Emissions (tons) for MC 776

Year	PM	SO_x	NO_x	VOC	CO
2002	4.19	19.24	144.17	4.33	31.46
MMS Exemption Level	2131.20	2131.20	2131.20	2131.20	54400.00

Total Emissions (tons) for MC 777

Year	PM	SO_x	NO_x	VOC	CO
2002	102.10	46.84	350.97	10.53	76.57
MMS Exemption Level	2131.20	2131.20	2131.20	2131.20	54400.00

Total Emissions (tons) for MC 778

Year	PM	SO_x	NO_x	VOC	CO
2002	8.90	40.81	305.78	9.17	66.72
2003	2.11	9.66	72.39	2.17	15.79
MMS Exemption Level	2264.40	2264.40	2264.40	2264.40	56643.69

Total Emissions (tons) for MC 778

Year	PM	SO_x	NO_x	VOC	CO
2002	2.48	11.37	85.20	2.56	18.59
MMS Exemption Level	2331.00	2331.00	2331.00	2331.00	57748.97

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.