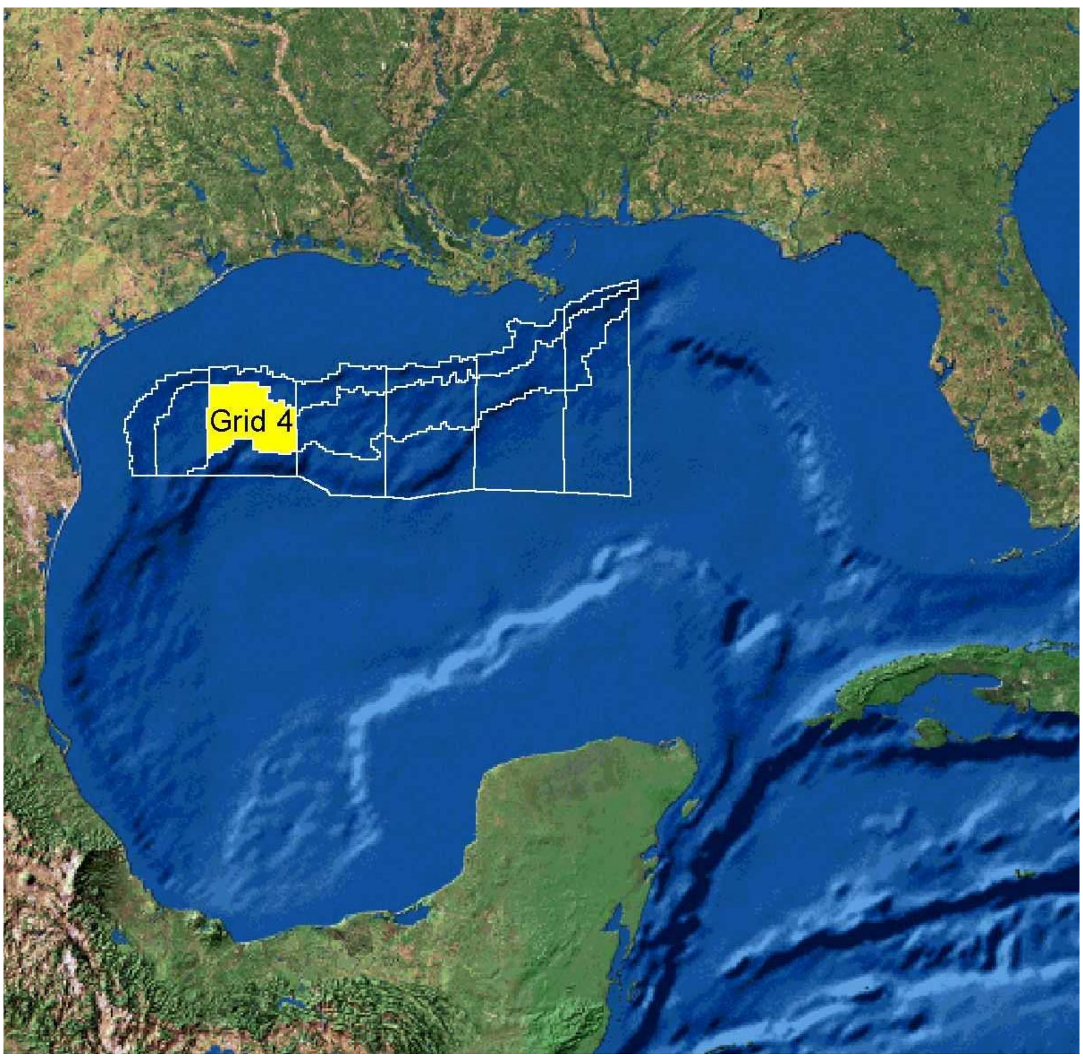
OCS EIS/EA
MMS 2001-075

Programmatic Environmental Assessment for Grid 4

Evaluation of Kerr-McGee Oil and Gas Corporation's Development Operations Coordination Document, N-7045

Nansen Project
East Breaks, Blocks 602 and 646



U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

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Prepared by

Minerals Management Service
Gulf of Mexico OCS Region

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PROGRAMMATIC ENVIRONMENTAL ASSESSMENT FOR GRID 4 DETERMINATION — FONSI

Kerr-McGee Oil and Gas Corporation's Initial Development Operations Coordination Document (DOCD) and its amendments to complete and produce eight wells (three of which are subsea wells) in East Breaks, Block 602 (OCS-G 14205) and four wells in East Breaks, Block 646 (OCS-G 20725), have been reviewed. Our programmatic environmental assessment (PEA) on the subject action (N-7045) is complete and results in a Finding of No Significant Impact (FONSI). Our PEA has also addressed categorical exclusion criterion C.(10)(1) by summarizing information to characterize the environment of Grid 4. Based on the conclusions of this PEA, there is no evidence that the proposed action will significantly (40 CFR 1508.27) affect the marine and human environments. Preparation of an environmental impact statement is not required.

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ABBREVIATIONS AND ACRONYMS

AC	Alaminos Canyon
ASI	Airborne Support Inc.
BOD	biochemical oxygen demand
B.P.	before present
CEI	Coastal Environments, Inc.
CFR	Code of Federal Regulations
CPA	Central Planning Area
CSA	Continental Shelf Associates
DDT	Dichlorodiphenyltrichloroethane
DGoMB	Deepwater Program: Northern Gulf of Mexico Continental Slope Habitats and Benthic Ecology
DOCD	Development Operations Coordination Document
DO	dissolved oxygen
DOI	Department of the Interior (U.S.) (also: USDOI)
EB	East Breaks
E&D	Exploration and Development
EA	environmental assessment
EEZ	Exclusive Economic Zone
EFH	essential fish habitat
EIS	environmental impact statement
EP	Exploration Plan
EPA	Eastern Planning Area
et al.	and others
et seq.	and the following
FMC	Fishery Management Council
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impact
FR	*Federal Register*
FWS	Fish and Wildlife Service
GB	Garden Banks
GERG	Geochemical and Environmental Research Group
GIS	geographical information system
GMFMC	Gulf of Mexico Fishery Management Council
GOM	Gulf of Mexico
H_2S	hydrogen sulfide
HMS	highly migratory species
HMWHC	high molecular weight hydrocarbons
ITC	Intertribal Council
LATEX	Texas-Louisiana Shelf Circulation and Transport Process Program (MMS-funded study)
MARPOL	International Convention for the Prevention of Pollution from Ships
MBO	million bbl of oil
MMS	Minerals Management Service
MSA	Metropolitan Statistical Area
MWA	military warning area
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act, as amended
NGOMCS	Northern Gulf of Mexico Continental Slope Study
NMFS	National Marine Fisheries Service
NOEC	No observable effect concentration
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant and Discharge Elimination System
NRC	National Response Corporation
NS&T	National Status & Trends Program (NOAA)
NTL	Notice to Lessees and Operators
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act, as amended
OSRA	Oil Spill Risk Analysis
OSRO	Oil Spill Removal Organizations
P&A	plugged and abandoned
PAH	polynuclear aromatic hydrocarbon
PEA	Programmatic Environmental Assessment
P.L.	Public Law
PCB	polychlorinated biphenyl
PLEM	pipeline end manifold
ppb	parts per billion
ppt	parts per thousand
ROSRP	Regional Oil Spill Response Plan
SIC	Standard Industrial Classification
SOP	suspension of production
TA	temporarily abandoned
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
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 of greater than 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 a proposed development project within each of the 17 grids. These Grid PEA's will be comprehensive in terms of the impact-producing factors and environmental and socioeconomic resources described and analyzed.

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 to focus on specific issues and effects related to the proposals.

This PEA will characterize the environment and the effects of Grid 4 that may result from Kerr-McGee Oil and Gas Corporation's Initial Development Operations Coordination Document (DOCD) for the Nansen Project (N-7045).

Figure 1 shows the relationship of Grid 4 to the Gulf's coastline and to the other 17 grids. East Breaks, Block 602 is highlighted to show the proposed spar location.

Figure 2 depicts the protraction diagrams and blocks that are contained in Grid 4. The highlighted block (East Breaks, Block 602) is the proposed location for the Nansen spar.

Current Status of Grid 4

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 4. See Appendix E for additional information and supportive data.

Grid 4 includes portions of four Outer Continental Shelf (OCS) protraction diagrams. Table 1 provides information on the protraction diagrams, blocks, leases, and acreage in Grid 4.

Table 1

Protraction Diagrams, Blocks, Leases, and Acreage in Grid 4

Protraction Diagrams	No. of Grid Blocks	Approximate Acreage in Grid	No. of Grid Blocks Leased	Percentage of Grid Blocks Leased
East Breaks	287	1,653,120	116	40.4%
Alaminos Canyon	258	1,486,080	96	37.2%
Garden Banks	43	247,680	26	60.5%
Keathley Canyon	108	622,080	44	40.7%
Grid Totals	696	4,008,960	282	40.5%

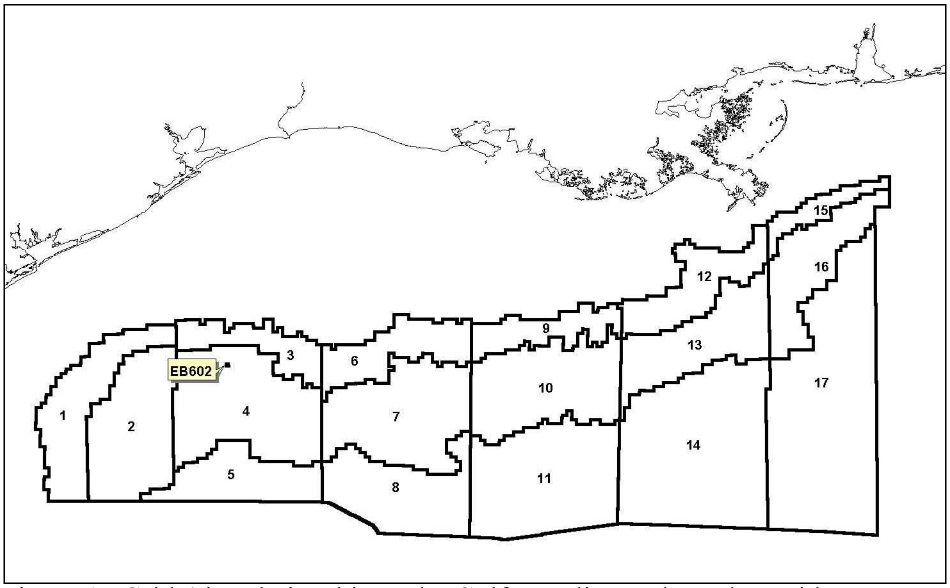

Figure 1. Grid 4 in relationship to the Gulf coastline and to other grids.

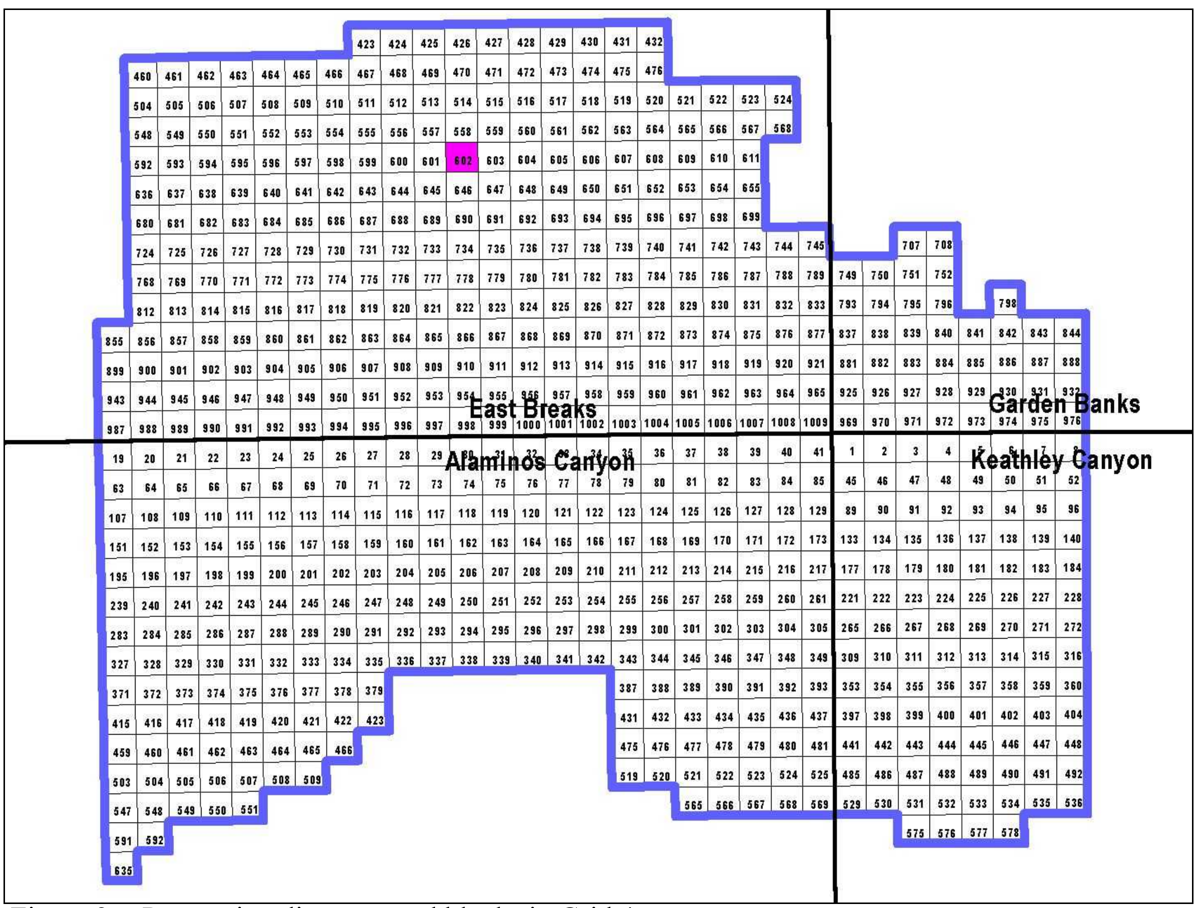

Figure 2. Protraction diagrams and blocks in Grid 4.

Figure 3 depicts the bathymetry of Grid 4 in 10-meter contour intervals.

Two Military Warning Areas (MWA's) are located within Grid 4—W-147D and W-602. See Figure 4 for the boundaries of these MWA's. Note that there is an area of overlap between the two MWA's in the northwest central portion of the Grid. All leased blocks within the Grid and that are contained within the MWA's will have stipulations in their lease 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 Final Environmental Impact Statement (EIS) for Western GOM Lease Sales 171, 174, 177, and 180 (USDOI, MMS, 1998).

Figure 4 also depicts one block (East Breaks, Block 914) that has known concentrations of hydrogen sulfide (H_2S) that require special precautions and plans from the operator. See the MMS's Operating Regulations (30 CFR 250) for specific H_2S requirements based on operational considerations (e.g., Subparts D, E, F, and H).

Figure 4 also shows that an ordnance disposal area is located immediately north of Grid 4. Though this disposal area is inactive, it may contain unexploded munitions and other ordnance. Northern pipeline routes from the Grid may require the operator to deviate their course to avoid this area.

Grid 4 contains a total of 696 blocks. Of these blocks, 282 (40.5%) are leased.

Currently, there are 14 operators with leases in Grid 4. These operators include

Amerada-Hess	Exxon-Mobil	Samedan
Anadarko	Kerr-McGee	Shell
BP/Amoco	Marathon	Sonat
Burlington	Phillips	Unocal
Elf	Reading & Bates	

Figure 5 geographically depicts the leasehold position of these operators within Grid 4.

The Grid's active lease status and plans submitted data are portrayed in Figure 6. A total of 44 (15.6%) of the leased blocks have Exploration Plans (EP's) approved by the MMS. Twelve (27.3%) of the 44 leases with EP's also have DOCD's approved or under evaluation. Five leases are currently producing within the Grid (Alaminos Canyon, Blocks 25 and 26, and East Breaks, Blocks 945, 946, and 989).

There are eight publicly announced prospects contained within Grid 4. Figure 7 shows their locations as well as the location of two other nearby prospects, Baha and Gunnison (outside of the Grid). Drilled well locations within the Grid and its surrounding area are also shown on Figure 7.

Figure 8 depicts the number and percentage of wells drilled, sidetracked, completed, temporarily abandoned, and/or permanently abandoned within Grid 4.

There is one existing surface structure in the Grid and two new structures are proposed for 2001. All three structures are spars. Table 2 provides additional information about the structures.

Table 2

Existing and Proposed Structures for Grid 4

Project	Area	Structure	Year Installed	Wells	Remarks
Diana Hoover	AC 25	Spar	2000	8	8 slots with 3 subsea tiebacks. Also included Diana subsea system which consists of two, 4 well manifolds
Nansen	EB 602	Spar	2001	9	9 slots with 3 subsea tiebacks
Boomvang	EB 688	Spar	2001	6	6 slots with 3 subsea tiebacks

Note: AC is Alaminos Canyon
EB is East Breaks

There are active and proposed right-of-way pipeline routes contained within the Grid. Figure 9 shows these routes in two enlarged panels and in a smaller composite map that shows the routes in relationship to the Grid. The existing pipelines support the Diana-Hoover Projects (see Area 2). The proposed pipelines in the Area 2 map are for the Marshall and Madison Projects. The Area 1 map shows the proposed pipelines for the Nansen and Boomvang Projects.

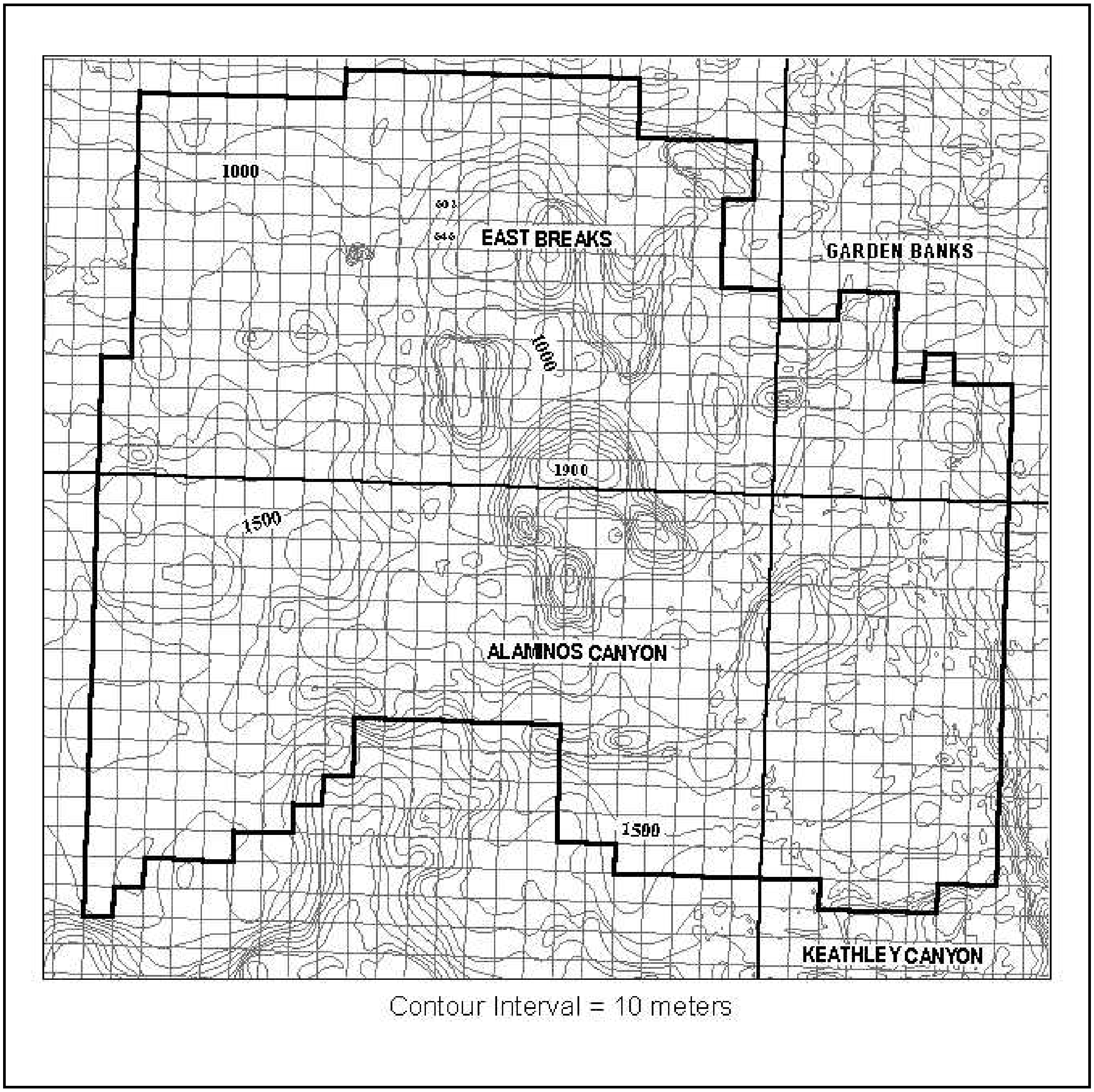

Figure 3. Bathymetry of Grid 4.

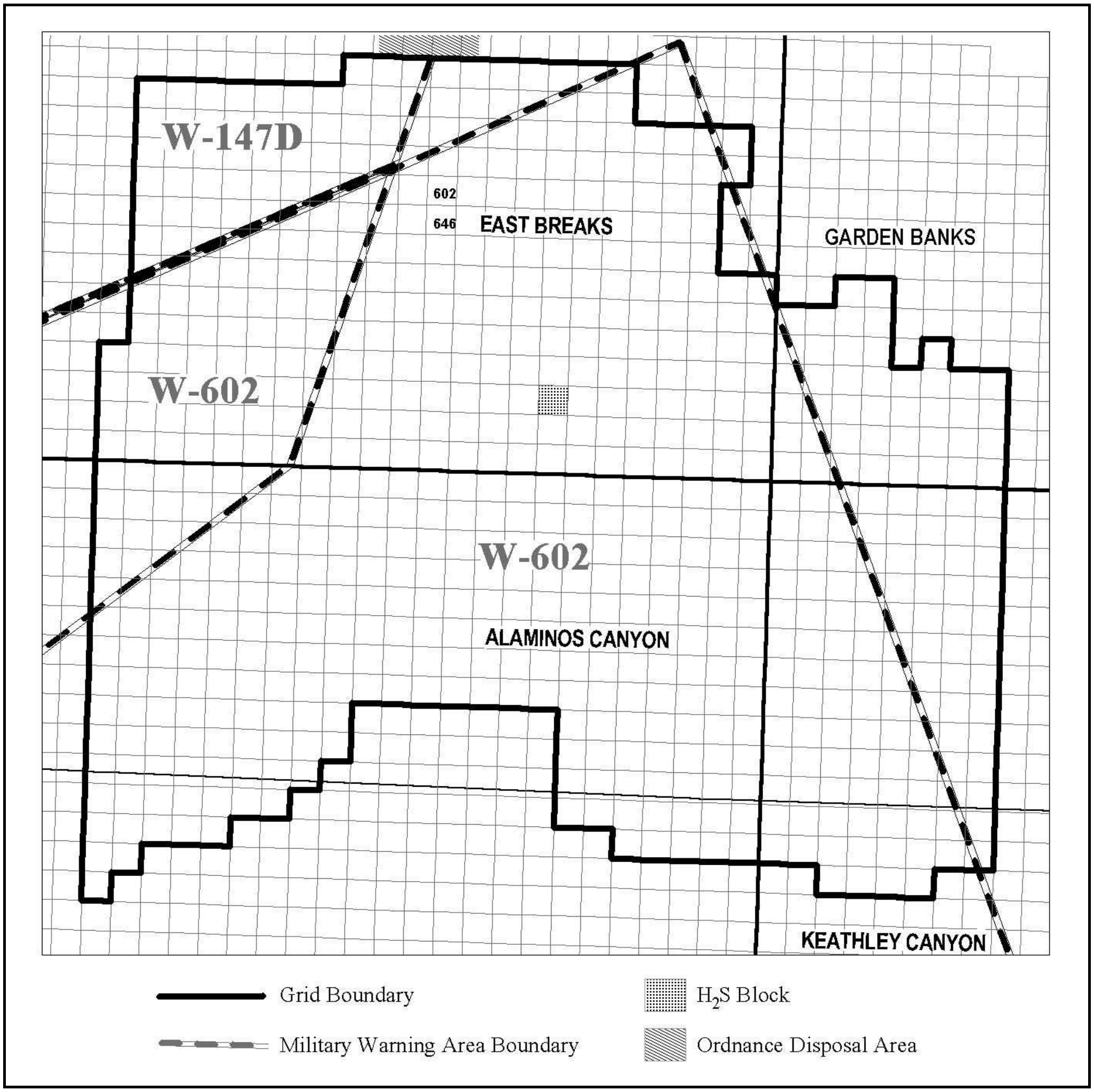

Figure 4. Military Warning Areas, H_2S Block, and Ordnance Disposal Area.

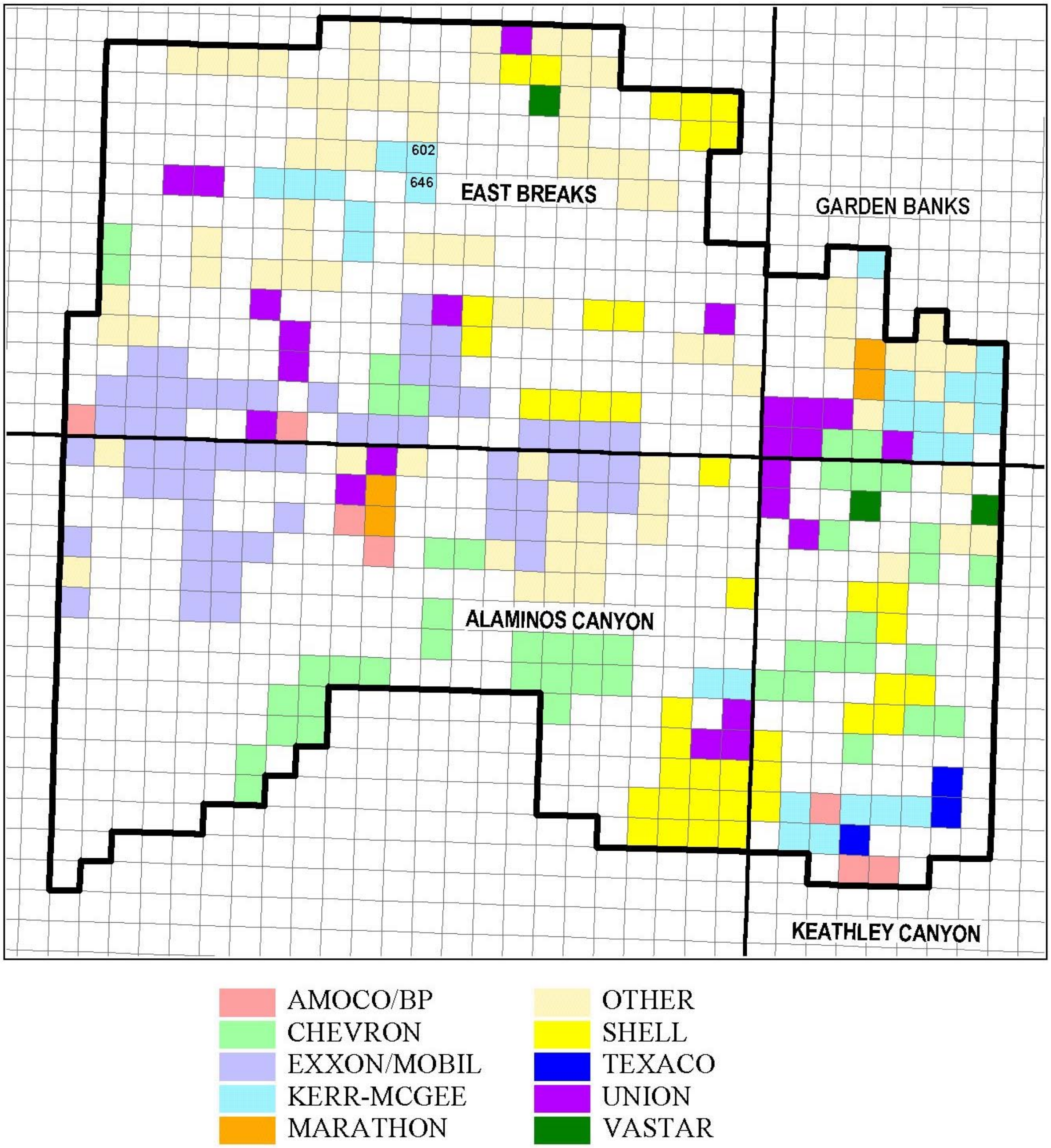

Figure 5. Leasehold Position of Operators within the Grid 4.

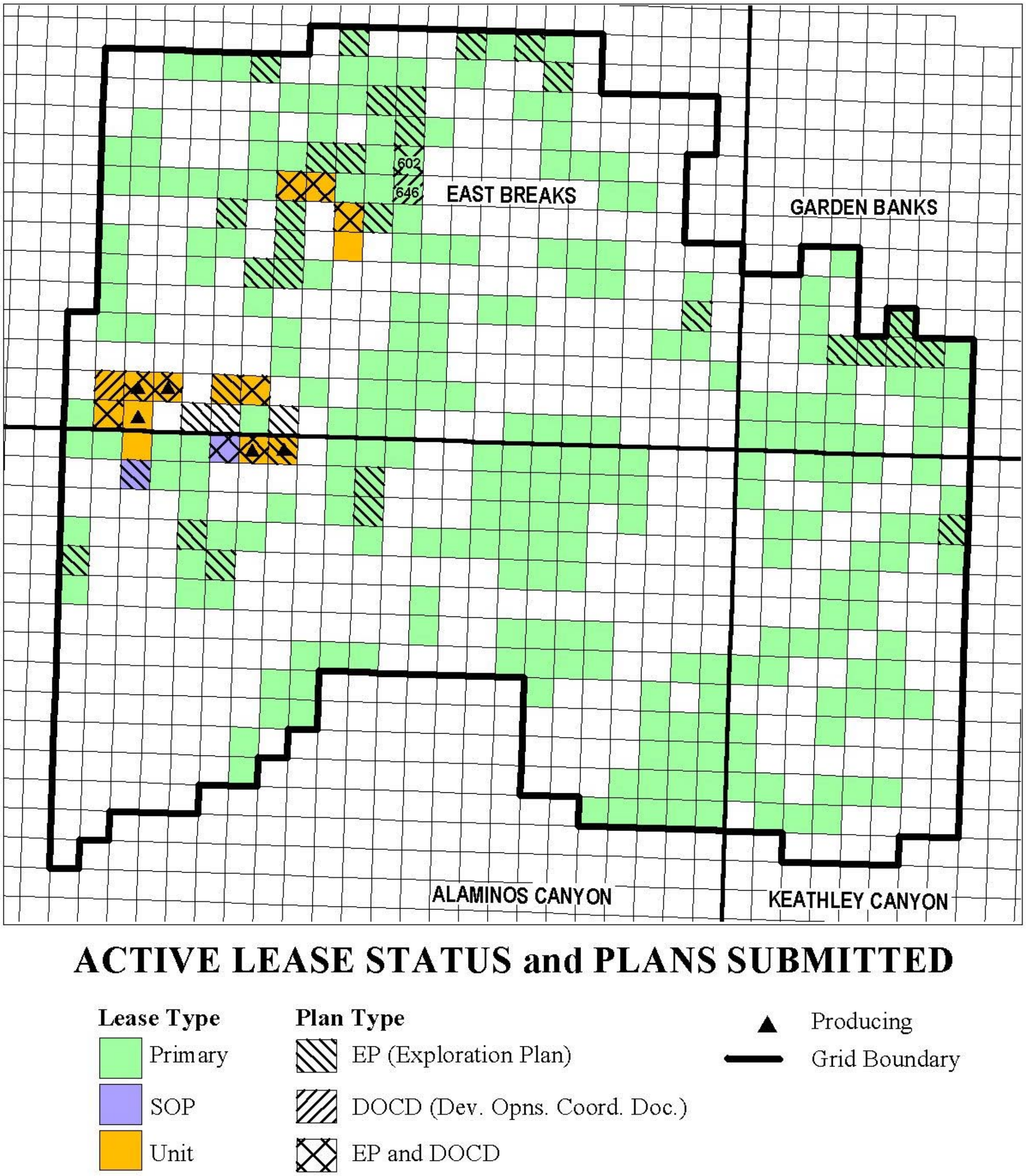

Figure 6. Active Lease Status and Plans Submitted.

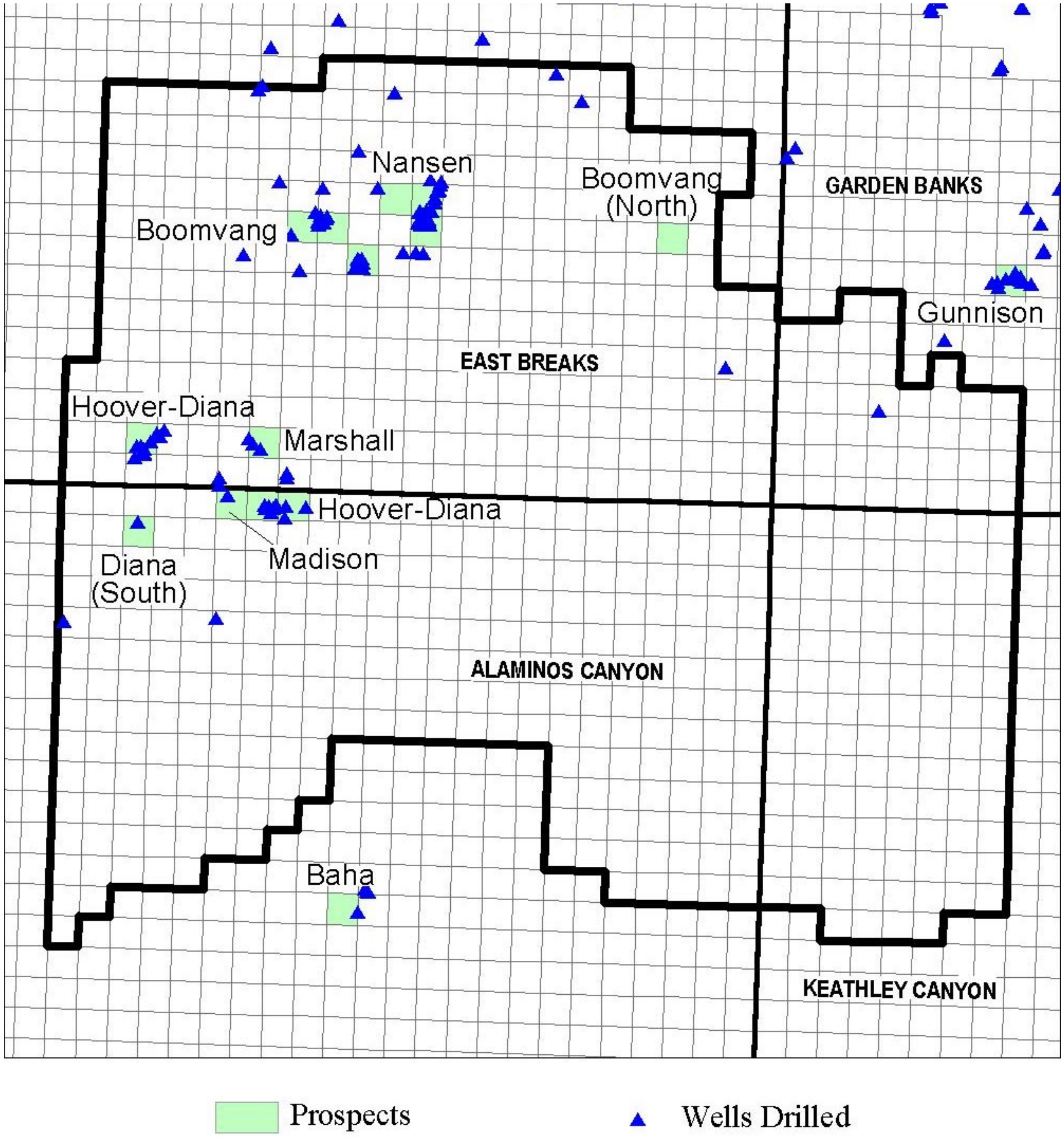

Figure 7. Publicly Announced Prospects and Wells Drilled in Grid 4.

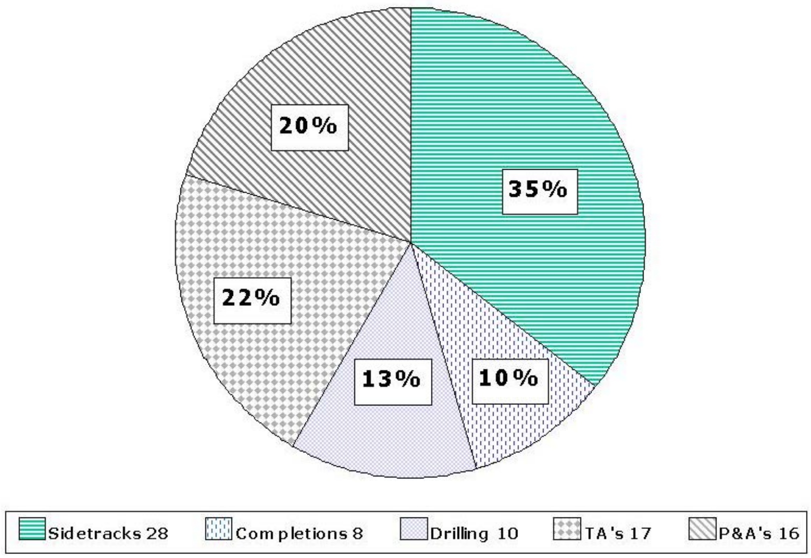

Figure 8. Exploration and Development Drilling Activities Conducted in Grid 4.

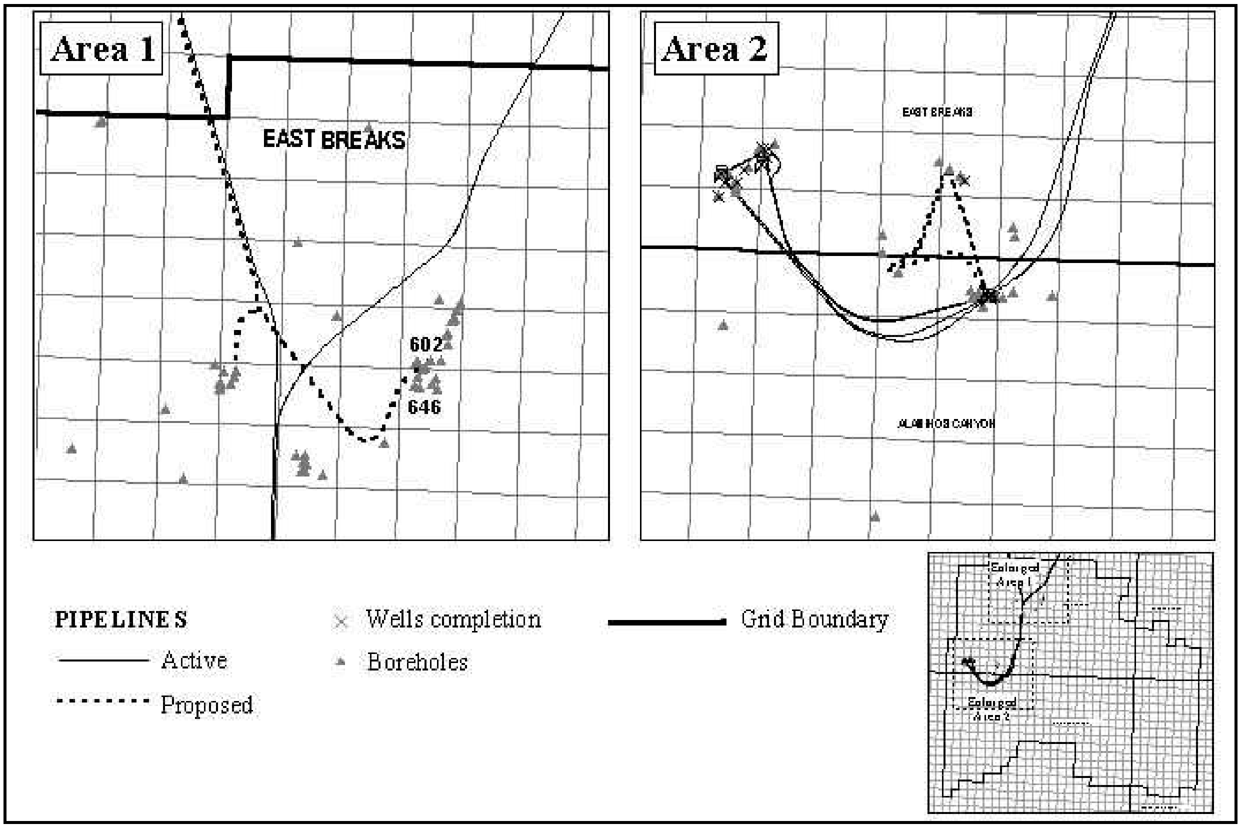

Figure 9. Existing and proposed pipeline rights-of-way within Grid 4.

There are numerous onshore support bases that are available along the Gulf Coast and that could serve as logistical infrastructure for Grid 4. In the current proposal, Kerr-McGee has chosen both Galveston and Sabine Pass as their onshore bases to support the proposed operations. Figure 10 shows the relationship of Grid 4 to these shore bases. The distance in miles from the Grid to each of Kerr-McGee's selected bases is also depicted on Figure 10.

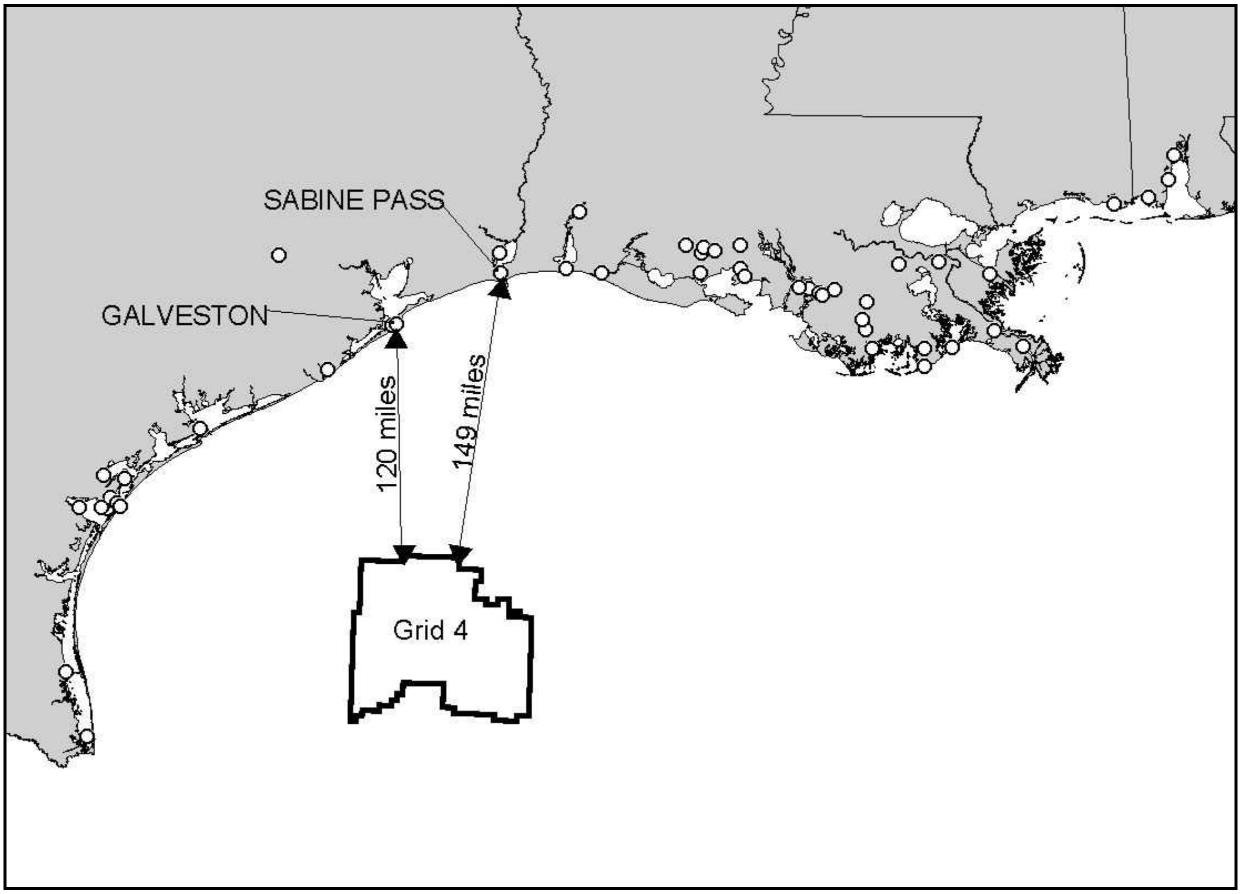

Figure 10. Distance from Grid 4 to Kerr-McGee's selected shore bases.

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 (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 to assess the specific and cumulative impacts associated with proposed oil and gas development and production activities within Grid 4. 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.

Kerr-McGee Oil and Gas Corporation's (Kerr-McGee) Initial 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 Final Environmental Impact Statement (EIS) for Western GOM Lease Sales 171, 174, 177, and 180 (USDOI, MMS, 1998), and by 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 MMS GOM Region, Office of Field Operations, received an Initial DOCD from Kerr-McGee that proposes to develop and produce hydrocarbon reserves located in East Breaks, Blocks 602 (Lease OCS-G 14205) and 646 (Lease OCS-G 20725). Kerr-McGee will complete and produce a total of 12 wells that were drilled under previously approved Exploration Plans (N-6569, S-5076, S-5077, S-5089, S-5103, S-5149, N-6750, S-5223, S-5281, S-5381, and S-5396) for the subject blocks. No new drilling operations are proposed as a part of this Initial DOCD; only completion operations are proposed. All of the wells, except the three subsea wells, will share a common surface location (a truss spar floating production system) in East Breaks, Block 602. Table 1-1 depicts the spar's proposed location.

Table 1-1

Proposed Location of the Nansen Truss Spar

Surface Location	Distance from Lease Lines	Lambert X-Y Coordinates	Latitude/Longitude
Nansen Truss Spar	FWL 7,885.00 ft FSL 1,980.60 ft	X = 1,164,205.00 Y = 9,933,660.60	Lat. 27° 22′ 01.690" N. Long. 94° 28′ 03.553" W.

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

The Nansen truss spar is a manned, floating production facility that will be permanently anchored on location by a nine-leg, taut catenary mooring system composed of conventional wire, chain, and anchor piles. The hull portion of the spar measures approximately 27.4 m (90 ft) in diameter and has an overall length of 165.5 m (543 ft). The spar is designed to accommodate nine top-tensioned, dry tree risers; eight subsea risers; and two export pipeline risers. No hydrocarbons will be stored in the hull of the spar; however, methanol will be stored in an in-hull tank. The spar is not drilling rig capable; however, a 1,000-hp completion/ workover platform rig will be installed. This rig will be used for the initial completion operations. If any additional drilling activities would be necessary, a mobile offshore drilling unit (MODU) such as a semisubmersible rig would be utilized. The spar may be offset to accommodate positioning of the MODU. The spar will have a 20-person permanent accommodation unit installed. Temporary, portable quarters for up to 48 people may be provided if it is needed on the spar.

Table 1-2 shows the activity schedule proposed by Kerr-McGee for their Nansen Project.

Table 1-2

Proposed Activity Schedule for the Nansen Project

Activity	Start Date	End Date
Install lease-term pipelines and umbilicals	May 1, 2001	June 30, 2001
Spar mooring installation	July 1, 2001	July 31, 2001
Spar hull installation	August 1, 2001	September 30, 2001
Spar topsides and buoyancy can installation	September 1, 2001	September 30, 2001
Pull in risers and umbilicals for subsea wells	October 1, 2001	October 31, 2001
First production from subsea wells	November 1, 2001	N/A
Complete, hookup, and initiate production from dry tree wells	November 1, 2001	September 30, 2002

The water depth at the truss spar location is approximately 1,120 m (3,675 ft). The deepwater development is located approximately 189 km (117.5 mi) from shore. The project will use an existing onshore support base in Sabine Pass, Texas, to support the production activities. During completion or workover operations, either the onshore base in Sabine Pass, Texas, or an existing onshore base in Galveston, Texas, will be used to support these activities.

Crude oil and natural gas produced at the Nansen project will be transported off lease by third-party owned and operated right-of-way pipelines. Tables 1-3 through 1-5 provide information on the proposed "paired" production pipelines.

Table 1-3

Proposed Nansen Pipelines

Applicants	Gas — Williams Field Services - Gulf Coast Company, L.P. Oil — Williams Oil Gathering, L.L.C.
Control Numbers	Gas — Right-of-Way Grant OCS-G 22444, Pipeline Segment No. P-13280 Oil — Right-of-Way Grant OCS-G 22447, Pipeline Segment No. P-13283
Pipeline Size (O.D.) and Type	Gas — 12.75-in, bidirectional, natural gas Oil — 12.75-in, crude oil
Area and Blocks Involved	East Breaks, Blocks 602, 646, 645, 689, 644, 600, and 599
Approximate Length	Gas — 13.66 mi Oil — 13.64 mi
Start Point and Water Depth	Nansen Spar in East Breaks, Block 602; WD = 3,080 ft
End Point and Water Depth	PLEM in East Breaks, Block 599; WD = 2,400 ft
Overall Estimated Completion Time	Gas — 121 days Oil — 90 days

Oil and gas from the nearby Boomvang Project (East Breaks, Blocks 642, 643, and 688) will be commingled with the production from the Nansen Project for transport to their final onshore destinations. Table 1-4 provides information on these pipelines to show the cumulative aspects of proposed activities within Grid 4.

Table 1-4

Proposed Boomvang Pipelines

Applicants	Gas — Williams Field Services — Gulf Coast Company, L.P. Oil — Williams Oil Gathering, L.L.C.
Control Numbers	Gas — Right-of-Way Grant; OCS-G 22445, Pipeline Segment No., P-13281 Oil —Right-of-Way Grant; OCS-G 22448, Pipeline Segment No., P-13284
Pipeline Size (O.D.) and Type	Gas — 18-in, bidirectional, natural gas Oil — 16-in, crude oil
Area and Blocks Involved	East Breaks, Blocks 643 and 599
Approximate Length	Gas — 3.73 mi Oil — 3.57 mi
Start Point and Water Depth	Boomvang Spar in East Breaks, Block 643; WD =3,450 ft
End Point and Water Depth	PLEM in East Breaks, Block 599; WD = 2,400 ft
Overall Estimated Completion Time	131 days (for overall project)

From the pipeline end manifold (PLEM), paired transmission pipelines will move the oil and gas to a proposed shallow water, right-of-way junction platform located in Galveston Area, Block A-244 (Table 1-5). The proposed paired pipelines generally parallel the 20-in HOOPS Deepwater Holdings East Breaks Gathering System Pipeline.

Table 1-5

Proposed Transmission Pipelines

Applicants	Gas — Williams Field Services — Gulf Coast Company, L.P. Oil — Williams Oil Gathering, L.L.C.
Control Numbers	Gas — Right-of-Way Grant OCS-G 22446, Pipeline Segment No. P-13282, Oil — Right-of-Way Grant OCS-G 22449, Pipeline Segment No. P-13285
Pipeline Size (O.D.) and Type	Gas — 18-in, bidirectional, natural gas Oil — 16-in, crude oil
Area and Blocks Involved	East Breaks, Blocks 599, 555, 511, 467, 466, 422, 378, 334, 333, 289, 245, 201, 157, 113, and 112 Galveston Area, Blocks A-245 and A-244
Approximate Length	Gas — 38.17 mi Oil — 38.19 mi
Start Point and Water Depth	PLEM docking base in East Breaks, Block 599; WD = 2,400 ft
End Point and Water Depth	Proposed right-of-way junction platform in Galveston Area, Block A-244
Overall Estimated Completion Time	154 days

Final destinations for the hydrocarbons transported in the pipelines described above are as follows:

- 18-in, bidirectional gas pipeline — At the junction platform located in Galveston Area, Block A-244, produced natural gas will depart the facility via a proposed 24-in pipeline to be installed by Williams. The gas will then travel to Transco's existing junction platform located in Brazos Area, Block 538 for delivery to shore through Transco's existing pipeline system.
- 16-in, crude oil pipeline — This pipeline will parallel the existing Exxon-Mobil Diana 20-in crude oil pipeline. At the junction platform located in Galveston Area, Block A-244, produced crude oil will be commingled with oil from a proposed 20-in incoming crude oil pipeline. The liquid hydrocarbons will then depart via a 20-in pipeline for entry into the Exxon-Mobil Diana System for ultimate delivery to shore facilities.

In addition to the six pipeline segment described above, Williams Oil Gathering, L.L.C., proposes to install a new 4-pile, junction processing platform in Galveston Area, Block A-244. This will be an appurtenance to the pipeline right-of-way grant, OCS-G 22449 (Pipeline segment number 13285). The proposed platform will be manned. It will be located in a water depth of approximately 111 m (363 ft). The platform's proposed location is

X = 1,063,720	Lat. 27° 54′ 59.622" N.
Y = 10,134,728	Long. 94° 47′ 10.293" W.

2. ALTERNATIVES TO THE PROPOSED ACTION

2.1. NONAPPROVAL OF THE PROPOSAL

Kerr-McGee would not be allowed to complete and produce the 12 wells proposed in the Initial 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 very 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 Kerr-McGee proposes to implement to limit potential environmental effects are discussed in the Initial DOCD. 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 can be found in the Final EIS for Western GOM Lease Sales 171, 174, 177, and 180 (USDOI, MMS, 1998). Considering the above mitigative measures, this alternative was selected for evaluation in this PEA.

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1. PHYSICAL ELEMENTS OF THE ENVIRONMENT

3.1.1. Water Quality

3.1.1.1. Coastal Water Quality

The description of coastal water quality focuses on the area between Corpus Christi, Texas and the Chenier Plain of Louisiana. Man's impact on water quality is usually the greatest in the immediate vicinity of the activity of concern, with effects decreasing in severity with increasing distance from the impact source. This zone is identified because it is the area encompassing where

(1) projected offshore spills would most likely make landfall,
(2) the pipeline system would make landfall,
(3) gas processing will occur,
(4) the service base(s) is located, and
(5) marine transportation used to access these areas occurs.

The pipeline carrying the oil produced as a result of this proposed action is composed of both new and existing right-of-way. The new oil pipeline departs the spar and goes to Platform A in Galveston Area, Block A-244. From there, the oil production enters the existing hoops and Deepwater Holding East Breaks Gathering System. The gas pipeline will be routed to Platform A in Brazos Area, Block 538. The pipeline will continue to the shore at onshore at Markem, Texas where Williams is currently constructing a gas plant.

Kerr McKee proposes to use an existing onshore base located in Sabine Pass, Texas to support production activities. Travel routes used by vessels normally will be from Sabine Pass, Texas directly to the platform; however, from time to time this route may vary. During completion activities or workovers, either the onshore base in Sabine Pass or another base in Galveston, Texas will be utilized. Travel routes used by vessels will normally be from Galveston, Texas directly to the platform; however, from time to time this route may vary.

If a spill should occur, the spill analysis (Appendix A) shows that the coastal waters associated with the shoreline between Kenedy County and Cameron Parish, Louisiana could be affected. This is because this county and parish represent the most likely landfall of modeled spill simulations originating from the offshore facility. However, the probability of a spill reaching these land segments is very low (1-6%).

The existing coastal waters within this area are showing signs of stress. Some of the estuary systems are considered "impaired" due to nutrient enrichment, the influx of pathogens, increases in oil and grease concentrations, habitat alteration, salinity and/or chloride intrusion, siltation, or organic enrichment (USEPA, 1999). More than 3,700 major point sources of contamination flow into the GOM (Weber et al., 1992); 192 of these sources are in Texas and 79 are in Louisiana. Most of the sources of contamination are petroleum refineries and petrochemical plants. The Houston Ship Channel is heavily impacted by point sources from both municipal and industrial facilities, receiving wastewater from approximately 400 point-source discharges (Crocker and Koska, 1996).

Despite significant point sources, nonpoint sources have had the greatest impact on the area's coastal water quality. Urban and agricultural runoff contribute large quantities of pesticides, nutrients, and fecal coliform bacteria to the coastal waters in these areas. Hydrodynamics modification, including channelization, wetland dredge and fill modifications, and natural subsidence, can also alter the Gulf's coastal water quality. The Lower Laguna Madre and Matagorda Bay in Texas ranked in the top 10 estuarine drainage areas in the U.S. for carrying pesticides to coastal waters (USDOC, NOAA, 1992a). An excess of nutrients, primarily found in river runoff, is one of the greatest sources of contamination to Gulf coastal waters. Nitrogen and phosphorus loading in the Gulf coastal waters have risen dramatically over the last three decades (Rabalais, 1992). Excessive nutrient enrichment has been a particular problem for the Lower and Upper Laguna Madre in Texas.

A good indicator of coastal and estuarine water quality is the frequency of fish kill events and closures of commercial oyster harvesting. Of the 10 most extensive fish kills reported in the United States between 1980 and 1989, five occurred in Texas (3 in Galveston County, 1 in Harris County, and 1 in Chambers County) (USDOC, NOAA, 1992b).

Contaminants were measured in mussels and oysters taken from U.S. coastal areas, including oysters from Gulf coastal waters, from 1986 to 1999 as part of NOAA's National Status and Trends (NS&T) Mussel Watch Program. Nationally, the highest chemical contamination consistently occurred near large urban/industrial areas. Fewer sites along the Gulf were contaminated compared to other U.S. coastal areas, probably because urban centers along the Gulf are farther inland than urban centers along other coasts. Of the 21 sites identified as exhibiting both a "high" concentration for one or more of the contaminant compounds and a temporal trend of increasing concentration for that same compound, eight sites were located along the Gulf, including one in Texas. This implies that the source for the high levels of these compounds continue to be bioavailable in these areas. Texas sites having oysters containing at least three compounds with "high" concentrations include Brazos River, Matagorda, and Corpus Christi, Texas (O'Connor and Beliaeff, 1995). The highest concentrations of chlorinated hydrocarbons in GOM oysters included Galveston Bay. Mercury concentration were found to be very high in Matagorda Bay, Texas, and were attributed to a major discharge of this element from a chloralkali operation in the area (USDOC, NOAA, 1992c).

Sediment data were also collected and examined (O'Connor, 1990). Higher levels of sediment contamination were associated with highly populated/industrialized areas, and, in general, sites in the GOM had lower concentrations of toxic contaminants than the rest of the country. The likely reason for this finding was that sampling sites in the GOM coastal area were farther removed from urban areas, which typically have large numbers of point-source discharges. The distribution of organochlorine loading in sediments followed those observed in oysters. One site in Texas had contaminant concentrations that ranked in the top 20 for the entire U.S. (USDOC, NOAA, 1992c). The Texas site ranked in the top 20 only for total DDT. Sediments with chemical concentrations exceeding high levels were identified in Galveston Bay, Texas.

The NOAA National Status and Trends distribution of polynuclear aromatic hydrocarbons (PAH's), which are toxic components of petroleum, indicates that, in spite of more extensive oil production in the GOM, concentrations are within the range of those found in East and West coast samples (Jackson et al., 1994). The distribution of PAH's indicates chronic contamination from combustion sources in coastal estuaries with additional insults from occasional small-scale petroleum spills.

3.1.1.2. Offshore Water Quality

The chemical oceanography of the GOM is primarily influenced by its configuration and the large volumes of land runoff it receives. The GOM is a semienclosed waterbody with oceanic input through the Yucatan Channel and principal outflow through the Straits of Florida. Freshwater from approximately two-thirds of the United States and more than one-half of Mexico comes into the Gulf via the Mississippi River and other major rivers.

This large amount of runoff, with its non-oceanic composition, mixes into the surface water of the Gulf, making the chemistry of parts of this system quite different from that of the open ocean. In general, degradation of the GOM marine waters is associated with riverine inputs, as well as coastal runoff discharge.

East Breaks Blocks 602 and 646 are located in water depths greater than 400 m (1,312 ft) and are on the continental slope region of the GOM. Data on the condition of the water quality of the deep water in the Western GOM are very limited. More data exist for the shelf area associated with these deepwater sites. The major chemical constituents of concern in the GOM are salinity, nutrients, trace metals, hydrocarbons, and synthetic organics. The most apparent offshore water quality problems in the Gulf are floating debris, hypoxic (oxygen-depleted) conditions, and toxic and pathogen contamination.

The Mississippi and Atchafalaya Rivers are the primary sources of water, sediment, and pollutants to the Louisiana shelf west of the Mississippi River (Murray, 1998). For example, during the summer of 1993, extreme flooding resulted in unusually high freshwater outflows from the Mississippi and Atchafalaya Rivers. Not only were lower salinities and increased nutrient loading measured on a considerable portion of the GOM, there were also increased loading of agricultural chemicals and sediments (Dowgiallo, 1994). In the *Texas-Louisiana Shelf Circulation and Transport Process Study*

(LATEX A; Nowlin et al., 1998), samples were collected on transects from the 10- to 200-m isobaths over a three-year period during May, August, and November. In addition, all prior historical data back to 1961 was included in the data analysis. Surface temperatures were influenced by the atmospheric temperature and ranged from 20 to 30°C, while bottom temperatures were from 16 to 28°C, decreasing with increasing depth. Salinity was as high as 36.6 parts per thousand (ppt), but there is a freshening near the coast to less then30 ppt due to the influence of rivers and run-off. While the average river discharge from the Mississippi River exceeds the input of all other rivers along the Texas-Louisiana coast by a factor of 10, during low-flow periods, the Mississippi River can have a flow less than all the other rivers combined. During summer months, the low salinity water from the Mississippi River spreads out over the shelf, resulting in a stratified water column. Suspended particles along the shelf are from the Mississippi and Atchafalaya River plumes. A turbid surface layer associated with the freshwater plume is also observed. Nitrate, phosphate, and silicate were primarily influenced by input from the rivers. Surface oxygen concentrations were saturated during the fall and winter months and near saturation for the other seasons. Hypoxia, defined as oxygen concentrations less than 2 ml/l O_2, was observed in bottom waters during the summer months.

A second study, *An Observational Study of the Mississippi-Atchafalaya Coastal Plume* (LATEX B; Murray, 1998), included investigations of hypoxia along the Louisiana shelf as well as trace organic and inorganic compounds. The zone of hypoxia on the Louisiana-Texas shelf is one of the largest areas in the world's coastal waters. The oxygen-depleted bottom waters occur seasonally and are affected by the timing of the Mississippi and Atchafalaya River discharges carrying nutrients to the surface waters. This, in turn, increases the carbon flux to the bottom, which, under stratified conditions, results in oxygen depletion to the point of hypoxia (less than 2 ml/l O_2). The hypoxic conditions last until local wind-driven circulation mixes the water again. The area of hypoxia stretched over 17,000 km^2 at its peak and was observed as far away as Freeport, Texas. Researchers have expressed concern that this zone may be increasing in frequency and intensity. Although the causes of this hypoxic zone have yet to be conclusively determined, high summer temperatures combined with freshwater runoff carrying large amounts of excess nutrients from the Mississippi River have been implicated.

Information on elevated levels of organic compounds of environmental concern that have been measured in northern GOM offshore waters was summarized by Kennicutt et al. (1988). Volatile organic compounds (VOC's) were generally more abundant in coastal and nearshore waters near point sources, 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. Major sources of high-molecular-weight hydrocarbons (HMWHC) include biological production, natural seepage, offshore petroleum production, shipping activities, coastal and riverine run-off, and atmospheric exchange and fallout. The highest levels of HMWHC were measured near point sources in coastal environments and near natural seeps. Large areas of the Gulf off southern Texas appear to be relatively pristine, whereas areas off northern Texas, Louisiana, and Alabama show detectable levels of petroleum hydrocarbons, likely from natural seepage. Organochlorine residues appear to exist in many marine species. Higher concentrations of pollutants were generally found in organisms from the Mississippi Delta than in offshore biota (Kennicutt et al., 1988). Trace organic pollutants in the GOM's western shelf area were analyzed in more than 200 water samples from five cruises (LATEX B; Murray, 1998). Polynuclear aromatic hydrocarbons (PAH's), herbicides, chlorinated pesticides, and polychlorinated biphenyls (PCB's) were detected in some to all of the samples. A large suite of trace metals was also analyzed in the three phases. The report did not draw any conclusions about the data other than to note the pervasive distribution of the herbicide, Atrazine, in all areas.

There are several watermasses in the Central/Western GOM. The watermasses are identified as

- GOM 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 chemical signatures based on salinity, dissolved oxygen, nitrate, phosphate, and silicate concentrations. These watermasses are related to potential density surfaces (Morrison et al., 1983). Depth variation of potential density surfaces and related watermass characteristics are closely related to the current regime. In the Western/Central GOM, there are no important variations in the watermass property/potential density relationship at depths greater than 250 m (Morrison et al., 1983).

The depth distribution of nutrients and dissolved oxygen (DO) in the deep GOM are similar to those of the Atlantic deep ocean. The DO has a surface maximum due to exchange with the atmosphere and production from photosynthesis. The DO concentration generally decreases with depth as decomposition of organic matter (respiration) depletes the oxygen. The nutrient profiles are the opposite of the DO profile. Their concentration in surface water is very low because they are being used up to produce plant matter. In deeper waters, nutrient concentrations increase as organisms die and decay. Nutrient concentrations are highest in deeper water. The GOM deep water is similar to ocean waters, and the major chemical constituents are not affected, to any measurable extent, by anthropogenic inputs.

A common phenomenon in the Gulf, especially on the shelf, is the local presence of greatly elevated levels of suspended material (i.e., greater than 1 ppm). Termed the nepheloid layer, this near-bottom turbid water is separated from the overlying water by a sharp discontinuity in suspended particulate matter. These nepheloid layers may be associated with resuspension of sediments by bottom currents, internal waves, intense at-depth biological activity, or a complex combination of these factors. These features appear to occur naturally at nearly all locations on the shelf and upper slope environment, except within the upper portions of substantial topographic highs (Brooks et al., 1981). The nepheloid layer may be part of a process of transport of materials, including contaminants, from nearshore to offshore.

Red tides, which are blooms of single-cell algae that produce potent toxins harmful to marine organisms and humans, are a natural phenomenon in the GOM, occurring primarily off southwestern Florida and Mexico. These can result in severe economic and public health problems and are associated with fish kills and invertebrate mortalities. The first documented case of a red tide in the GOM occurred in 1972. In 1996, there was a particularly widespread outbreak. Starting in May and spreading northwest from southwestern Florida, red tides were reported in the waters of Alabama, Mississippi, Louisiana, and Texas. Beaches and oyster beds were closed. There are ongoing studies to determine whether human activity that increases nutrient loading to GOM waters contributes to the frequency and intensity of red tides.

There has been relatively little evaluation of anthropogenic inputs to the GOM slope area (depths greater than 200 m [656 ft]). This is due to the distance of the slope area from potential input sources and the fact that processes that would transport contaminants that far would likely spread the contamination over a large area (dilution). Exceptions are atmospheric transport and deposition of contaminants, oil production operations, and shipping operations. Oil production and shipping activities normally would affect only a relatively small proportion of the slope area with the exception of catastrophic accidents such as platform "blowouts" or shipping spills of hazardous materials or large volumes of oil. Limited data are available regarding trace element concentrations in the deepwater GOM. Most data produced before the 1980's were biased by a factor of 10 to 1,000.

Many metals have been shown to behave in a manner similar to nutrients (Bruland, 1983). Reliable average concentrations of cadmium (0.0005 ppb), copper (0.082 ppb), and nickel (0.11 ppb) for deepwater GOM surface waters have been reported (Boyle et al., 1984). Nearshore average concentrations for a limited number of samples in the Mississippi River plume for cadmium.

The water at depths greater than 1,400 m (4,593 ft) is relatively homogeneous with respect to temperature, salinity, and oxygen. Temperature ranges from 4.0 to 4.5°C, salinity from 34.963 to 34.976 ppt, and oxygen from 4.58 to 5.61 ml/l O_2 (Nowlin, 1972). Most of this data were collected during a very comprehensive survey of the GOM conducted by Texas A&M University in the winter months of 1962. Subsequent studies have made the same observations (Pequegnat, 1983; Gallaway et al., 1988). Of importance, as pointed out by Pequegnat (1983), is the flushing time of the GOM. Oxygen in deep water must come from the surface and be mixed into the deep water by some mechanism. If the replenishment of the water occurs over a long period of time, the addition of hydrocarbons through the discharge from oil and gas activities could lead to creating low oxygen, and potentially hypoxic conditions in the deep water of the GOM. The mechanism for maintaining the constant oxygen levels in the deep Gulf is unknown. Limited analyses of trace metals and hydrocarbons for the water column and sediments exist (Trefry, 1981; Gallaway et al., 1988). There are no known analyses on the levels of manmade contaminants (e.g., chlorinated organic compounds, PCB's and pesticides) in the deep waters of the Gulf.

Hydrocarbon seeps are extensive throughout the continental slope and contribute hydrocarbons to the surface sediments and water column, especially in the Central Gulf (Gallaway, 1988; Sassen et al., 1993). Superficial sediments with elevated hydrocarbon concentrations may likely serve as an additional natural source of petroleum hydrocarbons to overlying waters. In addition to hydrocarbon seeps, other fluids leak from the underlying sediments into the bottom water along the slope. These fluids have been identified to have three origins: (1) seawater trapped during the settling of sediments; (2) dissolution of underlying salt diapirs; and (3) deep-seated formation waters (Fu and Aharon, 1998). The first two fluids are the source of authigenic carbonate deposits, while the third is rich in barium and is the source of barite deposits such as chimneys.

3.1.2. Air Quality

The proposed operations would occur west of 87.5 degrees west longitude and hence fall under the MMS's jurisdiction for enforcement of the Clean Air Act. The air over the offshore OCS water is not classified, but it is presumed to be better than the National Ambient Air Quality Standards for all criteria pollutants. The leases involved in the proposed action are East Breaks, Blocks 602 and 646. These leases are located south of Chambers County, Texas. Chambers County is in attainment of the National Ambient Air Quality Standards (USEPA, 2001).

The primary meteorological influences upon air quality and the dispersion of emissions are the wind speed and direction, the atmospheric stability, and the mixing height. The general wind flow for this area is driven by the clockwise circulation around the Bermuda High, resulting in a prevailing southeasterly to southerly flow. Superimposed upon this circulation are smaller scale effects such as the sea breeze effect, tropical cyclones, and mid-latitude frontal systems. Because of the various factors, the winds blow from all directions in the area of concern (USDOI, MMS, 1988).

Not all of the Pasquill-Gifford stability classes are routinely found offshore in the GOM. Specifically, the F stability class is rare. This is the extremely stable condition that usually develops at night over land with rapid radiative cooling; this large segment 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. It 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 in aloft and strong insolation rapidly warms the earth's surface that, 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 the A stability class over the GOM. For the most part, the stability is slightly unstable to neutral.

The mixing heights offshore are quite shallow, generally 900 m (2,953 ft) or less. 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.

Table 3-1depicts Kerr-McGee's projected emissions for the Nansen Project.

Table 3-1

Projected Emissions for the Nansen Project

Date	TSP (tons)	SO_X (tons)	NO_X (tons)	VOC (tons)	CO (tons)
2001	19.20	84.43	785.89	71.79	172.09
2002	23.51	94.11	1,614.13	331.82	355.97
2003	6.19	14.64	101.66	313.95	226.05

Note: The MMS's exemption level for each of the above components is 3,929.40 tons.

3.2. BIOLOGICAL RESOURCES

3.2.1. Sensitive Coastal Environments

3.2.1.1. Coastal Barrier Beaches and Associated Dunes

Coastal barriers of the Western GOM are generally divided into two physiographic areas: the Chenier Plain, of eastern Texas and western Louisiana, and the Texas barrier islands. These coastal barriers are relatively low landmasses that can be divided into several interrelated environments, including the unvegetated foreshore, the dune zone, and the backshore. When coastal storms occur, Gulf waters may become elevated enough to overwash a coastal barrier, leveling the areas of beach and dunes, creating overwash fans or terraces. Within a week, overwashed beaches will reestablish their typical structure. Over longer periods, terraces will become revegetated by opportunistic species, and the formation of dunes will begin again with the availability and nature of wind-blown sand at each terrace.

Landform changes can be seasonal and cyclical. Coastal barriers are dynamic habitats and provide a variety of niches that support many avian, terrestrial, aquatic, and amphibian species, some of which are endangered or threatened.

Accumulations and movements of sediments that make up barrier landforms are often described in terms of transgressive and regressive sequences. A transgressive sequence moves the shore landward allowing marine deposits to form on terrestrial sediments. A regressive sequence is one in which terrestrial sediments are deposited over marine deposits as land builds out, into the sea. Although transgressive landforms are dominant in the western and northern GOM, both transgressive and regressive barriers may occur in the region.

For additional information, see the Final EIS for Western GOM Lease Sales 171, 174, 177, and 180 (USDOI, MMS, 1998).

3.2.1.2. Wetlands

Wetland habitats of the Western Gulf Coast include fresh, brackish, and saline marshes; mud flats; and forested wetlands, including mangroves in the southernmost regions. They may occur as narrow bands around streams, lakes, bays, and sounds or as broad inshore expanses. The Chenier Plain, found in Texas and Louisiana, is the largest concentration of coastal wetlands in the region. Along the southern coast of Texas, the greatest wetland concentrations are associated with the Laguna Madre and other sounds behind barrier islands and with the tidal portions of rivers that flow into the various bays of the state.

Coastal wetlands are characterized by high organic productivity, high detritus production, and efficient nutrient recycling. Wetlands provide habitat for a great number and wide diversity of invertebrates, fish, reptiles, birds, and mammals, and are particularly important nursery grounds for many economically important fish and shellfish.

3.2.1.3. Seagrasses

Three million hectares of submerged seagrass beds are estimated to exist in protected, shallow coastal waters of the northern GOM and its higher salinity estuaries; however, Texas and Louisiana contain less than 0.5 percent of these seagrass beds. Seagrass beds grow best in shallow, relatively clear and protected waters with predominantly sand bottoms. Their distribution depends on an interrelationship among a number of environmental factors that include temperature, water depth, turbidity, salinity, turbulence, and substrate suitability.

Seagrass beds are important habitat for immature shrimp, black drum, spotted sea trout, and southern flounder. They are also are a food source for several species of wintering waterfowl.

The distribution of seagrass beds in the Western Gulf has diminished during recent decades. Primary factors believed to be responsible include dredging, dredged material disposal, trawling, water quality degradation, hurricanes, and a combination of flood protection, saltwater intrusion, and infrequent freshwater diversions from the Mississippi River into coastal areas during flood stage.

For additional information, see the Final EIS for Western GOM Lease Sales 171, 174, 177, and 180 (USDOI, MMS, 1998).

3.2.2. Deepwater Benthic Communities/Organisms

3.2.2.1. Chemosynthetic Communities

Chemosynthetic communities are defined as persistent, largely sessile assemblages of marine organisms dependent upon chemosynthetic bacteria as their primary food source (MacDonald, 1992). Chemosynthetic clams, mussels, and tube worms, similar to (but not identical with) the hydrothermal vent communities of the eastern Pacific (Corliss et al., 1979) have been discovered in association with hydrocarbon seeps in the northern GOM. 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, 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) (MacDonald, 1992). Four general community types have been described by MacDonald et al. (1990). These communities are 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.

Evidence indicates that tube-worm communities are slow growing (Bergquist et al., 2000), and individual tubeworms live between 170 and 250 years and may live even longer. MacDonald found that juvenile mussels at hydrocarbon seeps initially grow rapidly, but the growth rate drops markedly in adults. To date, there are 45 sites (in 42 blocks) across the northern GOM continental slope where the presence of chemosynthetic metazoans (dependent on hydrocarbon seepage) have been definitively documented (MacDonald, 1992). The locations of all chemosynthetic communities in the Gulf are not known and there is reason to believe that there are many more—probably hundreds.

Figure 3-1 depicts the locations of chemosynthetic communities within or in proximity to Grid 4.

3.2.2.2. Coral Reefs

Topographic features, along with their associated coral reef communities, are typically located on the shelf edge, shelf, and mid-shelf of the Western and Central Planning Areas of the GOM. These hard-bottom benthic communities support areas of high biomass, high diversity, and high numbers of plant and animal species. Additionally, topographic features support, either as shelter or food, or both, large numbers of commercially and recreationally important fishes; and they provide a relatively pristine area suitable for scientific research. There are 39 known topographic features in the GOM that support various, diverse reef ecosystems; 23 in the Western Planning Area and 16 in the Central Planning Area. Of these 39 features, there are three in the Western Planning Area that support major coral reef ecosystems. The East and West Flower Garden Banks and Stetson Bank comprise the Flower Gardens National Marine Sanctuary; all three banks are located a substantial distance from the proposed action. The West Flower Garden Bank is located approximately 74 km (46 mi) from East Breaks, Block 602. Likewise, the East Flower Garden Banks is located approximately 97 km (60 mi) from the block. Stetson Bank is even farther from the proposed action. See Figure 3-2 for a depiction of the closest WPA topographic features in relation to East Breaks, Block 602, the proposed Nansen spar location.

3.2.2.3. Deepwater Benthos

The study of the deep benthos of the GOM began prior to the 19^{th} century with exploratory zoogeographic investigations (Continental Shelf Associates, Inc., 2000). In the 1960's, Willis E. Pequegnat initiated modern investigations of the standing stock of megafauna, and in the 1980's the MMS supported an investigation of the continental slope that encompassed state-of-the-art quantitative sampling of the meiofauna, macrofauna, and megafauna.

Faunal groups studied from the deep Gulf include crustaceans (Pequegnat, 1970; Roberts, 1970; Firth, 1971), echinoderms (Booker, 1971; Carney, 1971), mollusks (James, 1972), and fishes (Bright, 1968), among others. Kennedy (1976) compared the species composition of the eastern and western Gulf faunas and concluded that they were not the same. The macrofauna appeared to be grouped into assemblages that were distributed within zones down the slope onto the abyssal plain (Kennedy, 1976; Roberts, 1977); however, the abyssal plain fauna was not divided into zoogeographic provinces by latitude or longitude.

Beginning in 1981 through 1988, LGL Ecological Research Associates, Inc. (with support from the MMS) characterized the sediment biota of the continental slope of the northern GOM during one of the most extensive sampling projects to date known as The Northern GOM Continental Slope Study (NGOMCS). Two interpretations of faunal zonation with depth on the continental slope have been proposed:

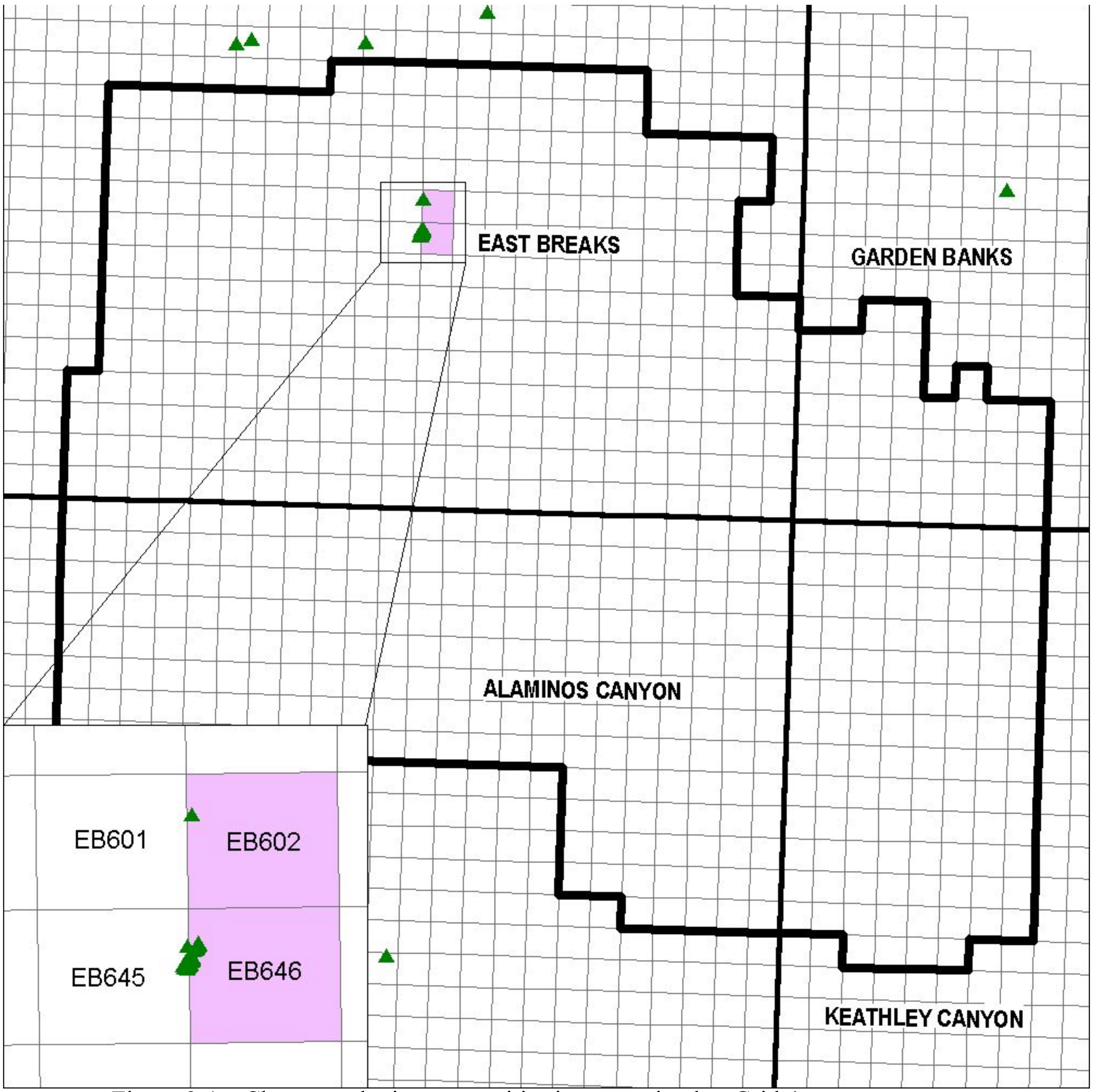

Figure 3-1. Chemosynthetic communities in or proximal to Grid 4.

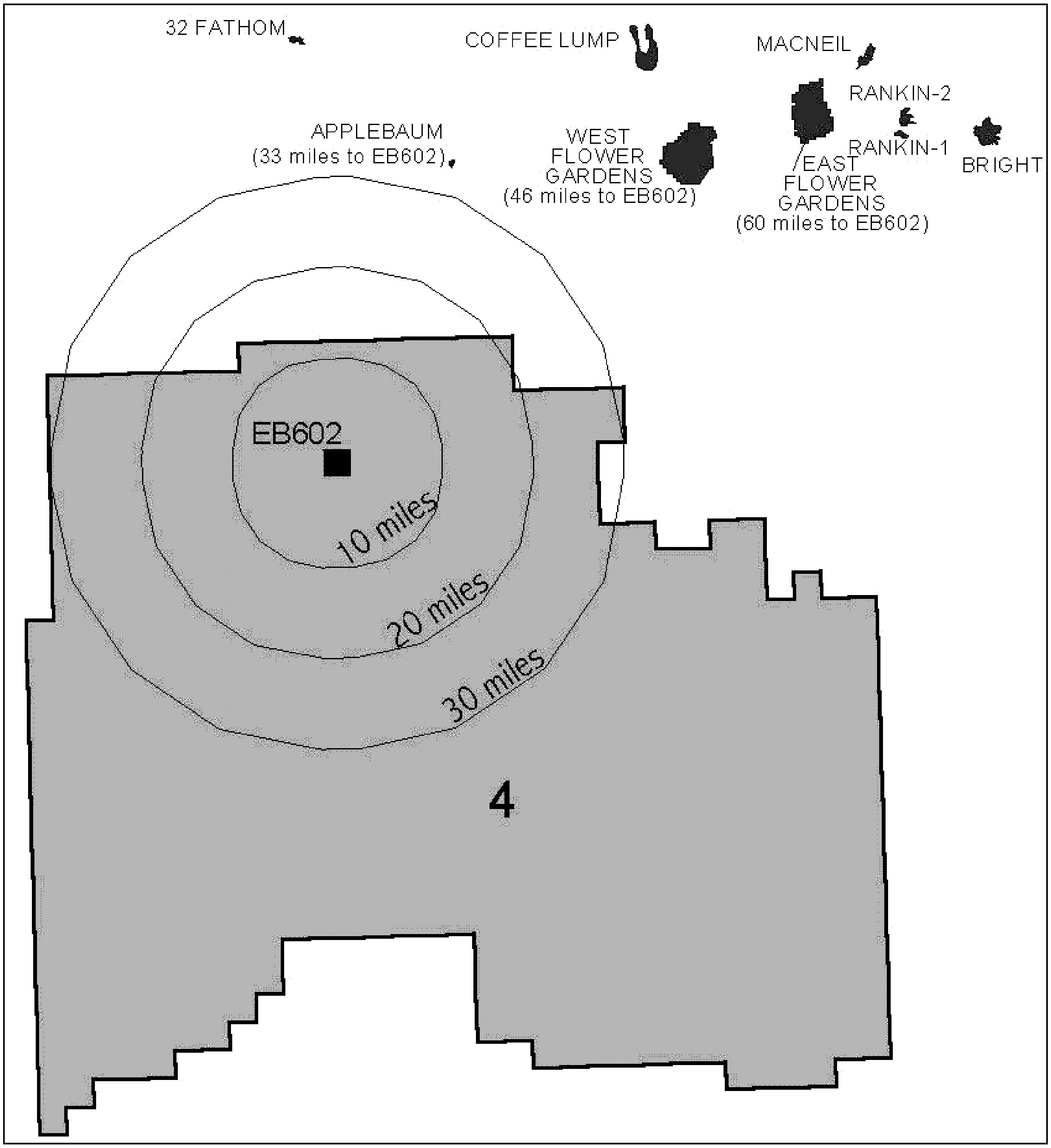

Figure 3-2. Topographic features of the Western Planning Area, including the East and West Flower Garden Banks coral reef ecosystem, in relation to with East Breaks, Block 602.

(1) The coarser-scaled zonation pattern proposed (Carney et al., 1983) has a "distinct shelf" fauna down to about 1,000 m (3,281 ft), a "distinct slope" fauna from 2,000 m to 3,000 m (6,562 ft to 9,843 ft), and a zone in between with both shelf and slope taxa; and

(2) The finer-scaled scheme from Pequegnat (1983), based largely on abundances of megafauna and macroepifauna (Table 3-2).

Table 3-2

Description of Faunal Zonation on the Continental Slope of the Gulf of Mexico
(Pequegnat, 1983; from Gallaway, 1988)

Zone	Depth Range (m)	Comments
Shelf /Slope Transition	150-450 (300)*	Demersal fish predominate, as do predatory asteroids and brachyurans; 90 species of demersal fish; 66 species of demersal fish reach maximum populations in this zone; gastropods and polychaetes also prevalent; Brissopsis urchins extremely abundant; very few sea cucumbers.
Archibenthal Horizon A	475-750 (612)*	79 species of demersal fish; asteroids abundant; sea cucumbers doubled in number; caridian shrimps also doubled in number; Brissopsis almost absent, replaced by Phormosa placenta and Plesiodiadema antillarium.
Archibenthal Horizon B	775-950 (862)*	Demersal fish numbers reduced, less than half of those in Horizon A; drastic reduction of brachyuran crabs; gastropods and polychaetes still abundant.
Upper Abyssal	975-2,250 (1,612)*	Demersal fish reduced to half of Archibenthal zone; substantial increase in species of large sea cucumbers; brachyurans continue to drop; gastropod and sponge species reach peak; polychaetes still abundant.
Mesoabyssal Horizon C	2,275-2,700 (2,488)*	Sharp break in fauna of Upper Abyssal and Horizon C of Mesoabyssal; demersal fish max population drops from 49 to 3; similar reduction in maximum populations noted for other species as well.

Note: * is the mean depth for the range.

A major objective of the NGOMCS study was to evaluate the previously reported faunal zonation patterns, not only for the megafauna, but also for the macrofauna.

Recently, a new investigation, Deepwater Program: Northern Gulf of Mexico Continental Slope Habitats and Benthic Ecology (commonly called DGoMB), has been initiated by the MMS to revisit the deep-sea ecosystems of the GOM (Geochemical and Environmental Research Group (GERG), 2000). Community structure is being used to test hypotheses about what controls the distribution of animal communities in the deep sea. The program study area covers the entire northern GOM continental slope from water depths of 300 m to greater than 3,000 m (984 ft to 9,843 ft) seaward of the Sigsbee and Florida escarpments (Figure 3-3). The "community structure" survey was completed in May and June 2000. Preliminary assessments indicate that densities of meio- and macrofauna were observed in several areas of the eastern GOM, but the western Gulf shows more typical patterns of reduced densities with increasing depth.

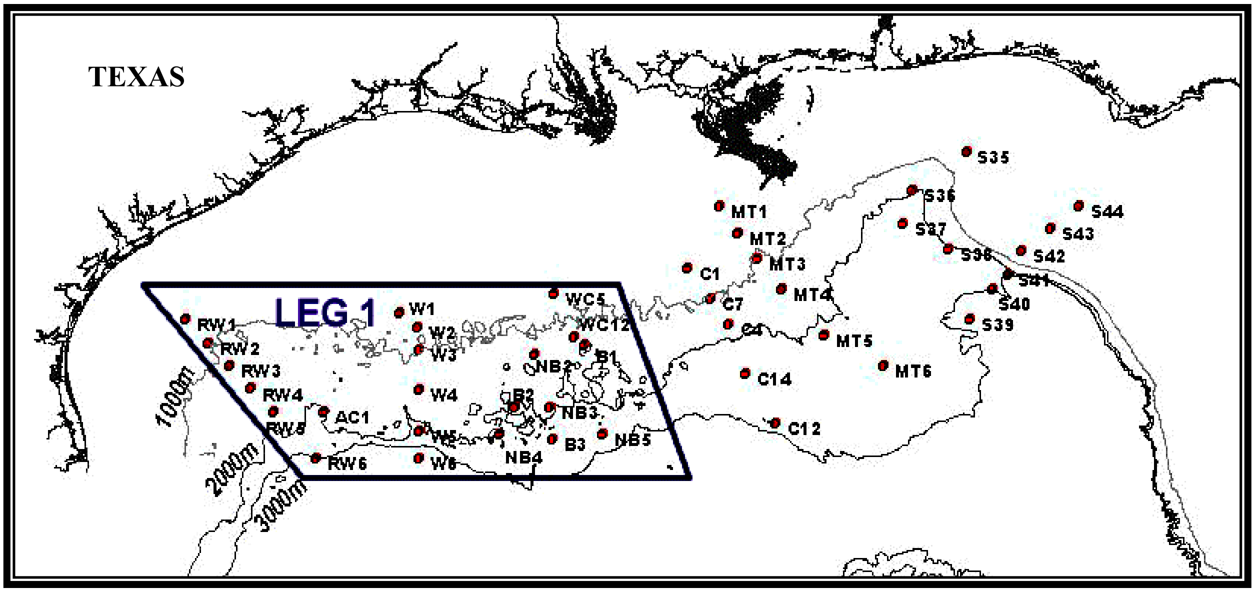

Figure 3-3. Sample sites of the "Deepwater Program: Northern Gulf of Mexico Continental Slope Habitats and Benthic Ecology" (DGoMB) program (funded by the MMS) (GERG, 2000).

The most abundant taxon in both the meio- and the macrofauna size groupings were the nematode worms. To date, there is no strong indication of any major biological hard bottom "hotspots" of concern located in the Western Gulf other than in chemosynthetic communities and gas seeps where some authigenic carbonate is precipitated by bacteria. The "ironstone" deposits of the eastern Gulf are unknown in the western Gulf.

3.2.2.3.1. Macrofauna

Macrofauna collections reported from the NGOMCS study (Gallaway et al., 1988) contained nearly 50,000 organisms representing 1,569 distinct taxa; 1,121 species were identified, with a high proportion being new to science. The macrofaunal of the continental slope of the GOM are abundant and highly diverse, largely consisting of "rare species." However, when compared to the U.S. Atlantic slope, the Gulf slope macrofauna appear to be neither as abundant nor as diverse (Blake et al., 1985; Maciolik et al., 1986). It is suggested that food limitation is the likely explanation for the differences rather than a low-standing stock due to higher turnover rates in the Gulf, e.g. Rowe and Menzel (1971) (Gallaway, 1988). Gallaway also found most species exhibited restricted depth distributions, with variation "across" isobaths being greater than variation "along" isobaths. During the survey, samples were taken from depths ranging from approximately 350 to 3,000 m (1,148-9,843 ft). The results suggest that the Shelf/Upper Slope Zone extended to at least 650 m (2,133 ft) in all areas of the Gulf (sampled). Based on the macrofauna, this zone was delineated to incorporate both the Shelf/Slope Transition [150-450 m (492-1,476 ft)] and most of the Archibenthal Horizon A [475-750 m (1,558-2,461 ft) zones. The data also defines a distinct zone between 800 and 2,000 m (2,625 and 6,562 ft) having two subzones—(1) from 800 to 1,200 m (2,625-3,937 ft) and (2) from 1,450 to 2,000 m (4,757-6,562 ft). The report emphasizes three macrofaunal zones on the continental slope of the GOM. Depth ranges of these zones are similar to that proposed by Pequegnat (1983) for the Gulf. However, based upon macrofauna, the Shelf/Slope Transition and Archibenthal Zones extend deeper than proposed by Pequegnat (1983) (which was based upon analyses of megafaunal distributions).

3.2.2.3.2. Meiofauna

The extensive sampling by the NGOMCS study discovered that the meiofauna appears to have a biomass that is higher than that of the macrofauna. The density of meiofauna was reported as approximately two orders of magnitude greater than the density of macrofauna throughout the depth range of the GOM continental slope by LGL/MMS (Gallaway et al., 1988). This confirms earlier studies in the Atlantic (Thiel, 1983; Rowe et al., 1991; Cruz-Kaegi, 1998) that implied that meiofaunal-sized organisms increase in importance at deep-sea depths relative to the macrofauna. The meiofaunal collections contained in excess of 230,000 individuals, representing 43 major groups of animals. Overall mean abundance was 707 individuals per 10 cm^2 (707,000 per m^2), with individual station values ranging from about 200 to 1,100 organisms/10 cm^2 (1,100,000 per m^2). These counts appear higher than comparable meiofaunal values for the western Atlantic (Wigley and McIntyre, 1964; Tietjen, 1971; and Coull et al., 1977, as shown in Thiel, 1983). Of the 43 major groups of identified animals, representatives of five taxa of permanent meiofauna (Nematoda, Harpacticoidea, Polychaeta, Ostracoda, and Kinorhyncha), along with temporary meiofauna, comprised 98 percent of the collections. Densities were generally similar to those previously reported and generally decreased with increasing depth. The range of density values obtained for meiofauna varied by one order of magnitude. Some comparisons with depth showed a decisive decrease of abundance with depth (at the 5% statistical level), but this trend was not consistent through all seasons and areas of the Gulf; however, community structure was reported to be consistent across all stations, regions, seasons, and years (Gallaway et al., 1988).

The NGOMCS study concluded that the meiofauna of the GOM was not well known; however, the study does suggest that meiofaunal densities on the continental slope of the Gulf are abundant and rival or exceed the macrofauna in biomass, supporting postulates of small size of Gulf macrofauna. The patterns of abundance as compared to the macrofauna support the proposal that when compared to other slope systems, food or energy availability in the Gulf may be low, thereby limiting population density levels.

3.2.2.3.3. Microbiota

As reported by Rowe (2000, as seen in CSA, Inc., 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, 1990), none has 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 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 is comprised of the manatee and the dugong. Within the GOM, there are 28 species of cetaceans (7 mysticete and 21 odontocete species) and one sirenian species, the manatee, which is further split into two subspecies (Jefferson et al., 1992).

3.2.3.1. Nonthreatened and Nonendangered Species

Two of the seven species of mysticetes known to occur in the Gulf are not currently listed as threatened or endangered. With the exception of the sperm whale, none of the odontocetes known to occur in the Gulf are currently listed as endangered or threatened.

Cetaceans – Mysticetes

The minke whale *(Balaenoptera acutorostrat*a) is widely distributed from tropical to polar seas. Minke whales may be found offshore but appear to prefer coastal and inshore waters. Their diet consists of invertebrates and fishes (Leatherwood and Reeves, 1983; Stewart and Leatherwood, 1985; Jefferson et al., 1993; Wursig et al., 2000). Sighting 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).

The Bryde's whale *(Balaenoptera edeni*) is generally confined to tropical and subtropical waters (i.e., between latitude 40°N. and latitude 40°S.). Unlike a few other 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 is represented by more sighting records than any other species of baleen whale in the Gulf. All Bryde's whale sightings made during the GulfCet I and II programs were from the continental shelf edge in the vicinity of DeSoto Canyon and along the 100-m (328-ft) isobath in the north-central Gulf. These data suggest that the Gulf may represent at least a portion of the range of a dispersed, resident population of Bryde's whale (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000). Bryde's whales feed on both fishes and invertebrates (Leatherwood and Reeves, 1983; Cummings, 1985; Jefferson et al., 1993).

Cetaceans – Odontocetes

Pygmy and Dwarf Sperm Whales

The pygmy sperm whale *(Kogia breviceps*) and its congener, the dwarf sperm whale *(K. simus*), are known from deep waters in tropical to warm temperate zones (Jefferson and Schiro, 1997). They appear to be most common on the continental slope and along the shelf edge, although field identification and differentiation of the two species is problematic. Little is known of their natural history. Data collected from stomach contents of stranded individuals suggest that these species feed on cephalopods, fishes, and crustaceans in deep water (Leatherwood and Reeves, 1983; Jefferson et al., 1993). *Kogia* has been sighted throughout the Gulf across a wide range of depths and bottom topographies, though they may be more commonly associated with watermass fronts along the continental shelf edge break and upper slope (Baumgartner, 1995).

Beaked Whales

Two genera and four species of beaked whales are known to occur in the GOM. These encompass (1) three species in the genus *Mesoplodon* (i.e., Sowerby's beaked whale [*M. bidens*], Blainville's beaked whale [*M. densirostris*], and Gervais' beaked whale [*M. europaeus*]), and (2) one species in the genus *Ziphius*, Cuvier's beaked whale *(Ziphius cavirostris*). Generally, beaked whales appear to prefer deep water, though little is known of their respective life histories. Stomach content analyses suggest that these whales feed primarily on deepwater cephalopods, although they will also take fishes and some benthic invertebrates (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the Gulf, beaked whales have been sighted at depths between approximately 700 m and 2,000 m (2,297 ft and 6,562 ft). Cuvier's beaked whale is probably the most common beaked whale in the Gulf (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000).

Delphinids

All remaining species of non-endangered and non-threatened cetaceans found in the Gulf are members of the taxonomically diverse family Delphinidae. The pygmy killer whale *(Feresa attenuata*) is apparently widely distributed in tropical waters, though little is known of its biology or life history. Its diet includes cephalopods and fishes, though reports of attacks on other delphinids have been reported (Leatherwood and Reeves, 1983; Jefferson et al., 1993). The pygmy killer whale does not appear to be commonly found in the GOM. Sightings of this species have been at depths of 500 m to 1,000 m (1,641 ft to 3,281 ft) (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000).

The short-finned pilot whale *(Globicephala macrorhynchus*) is found in warm temperate to tropical waters of the world. Short-finned pilot whales feed primarily on cephalopods and fishes. In the Gulf, it is most commonly sighted along the continental slope at depths of 250 m to 2,000 m (820 ft to 6,562 ft) (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000).

The Risso's dolphin *(Grampus griseus*) is a pantropical species that inhabits deep oceanic and continental slope waters. Risso's dolphins feed primarily on cephalopods and secondarily on fish and crustaceans (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Baumgartner, 1997; Wursig et al., 2000). In the Gulf, its distribution appears to be widespread at depths of 150 m to 2,000 m (492 ft to 6,562 ft), with aggregations sighted in areas along the upper continental slope with steep bottom topography (Baumgartner, 1995).

The Fraser's dolphin *(Lagenodelphis hose*i) has a pantropical distribution in oceanic waters and nearshore 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). 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; Jefferson and Schiro, 1997; Davis et al., 2000).

The killer whale *(Orcinus orc*a) is one of the most cosmopolitan of all of the delphinids. Generally, they appear to prefer nearshore, cold temperate to subpolar zones. Killer whales feed on marine mammals, marine birds, fishes, sea turtles, and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the Gulf, most sightings of killer whales have been along the continental slope, within a broad area of the north-central Gulf (Jefferson and Schiro, 1997; O'Sullivan and Mullin, 1997).

The melon-headed whale *(Peponocephala electr*a) is a deepwater, pantropical species. It is known to feed on cephalopods and fishes (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Mullin et al., 1994a; Jefferson and Schiro, 1997). Sightings of this species in the Gulf have been primarily in continental slope waters west of the Mississippi River (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000).

The false killer whale *(Pseudorca crassiden*s) is found in tropical to warm temperate zones in deep offshore waters. It feeds on primarily fishes and cephalopods, although it has been known to also feed on cetaceans (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the Gulf, most sightings of false killer whales have occurred along the continental slope, although some have been sighted in shallower shelf waters (Davis et al., 1998).

The pantropical spotted dolphin *(Stenella attenuat*a) is a tropical species known from the Atlantic, Pacific, and Indian Oceans. It is known to feed on epipelagic fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). The pantropical spotted dolphin is the most common and abundant cetacean on the slope, especially outer slope waters of the Gulf at depths greater than 1,200 m (3,937 ft) (Davis and Fargion, 1996; Jefferson and Schiro, 1997).

The rough-toothed dolphin *(Steno bredanensi*s) is a circumtropical and subtropical species that feeds on cephalopods and fishes (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the Gulf, they are sighted almost exclusively west of the Mississippi River at depths of 900 m to 2,000 m (2,953 ft to 6,562 ft), and occur year-round (Davis et al., 1998; Jefferson and Schiro, 1997).

The Clymene dolphin *(Stenella clymen*e) is endemic to the Atlantic and found only in tropical and subtropical waters. This species appears to feed on fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Mullin et al., 1994b). Data suggest that Clymene dolphins are widespread within deeper Gulf waters (i.e., shelf edge and slope) (Davis et al., 2000; Wursig et al., 2000).

The striped dolphin *(Stenella coeruleoalb*a) is primarily a tropical species, though it may also range into temperate seas. Striped dolphins are known to feed on cephalopods and fishes. In the Gulf, they are found offshore of the shelf edge, at depths of less than 200 m (less than 656 ft) (Jefferson and Schiro, 1997; Davis et al., 2000; Wursig et al., 2000).

The Atlantic spotted dolphin *(Stenella frontali*s) is endemic to the Atlantic within tropical to temperate waters. They are known to feed on a wide variety of fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). The Atlantic spotted dolphin is the only other species of cetacean (other than the bottlenose dolphin) that commonly occurs on the continental shelf of the GOM (Davis and Fargion, 1996; Jefferson and Schiro, 1997). Previous Gulf surveys sighted the Atlantic spotted dolphin primarily on the continental shelf and shelf edge at depths less than 250 m (820 ft), although some individuals were sighted along the slope at depths of up to approximately 600 m (1,969 ft) (Davis et al., 1998).

The spinner dolphin *(Stenella longirostri*s) is a pantropical species (Jefferson and Schiro, 1997). Spinner dolphins appear to feed on fishes and cephalopods (Wursig et al., 2000). In the Gulf, most sightings of spinner dolphins have been east of the Mississippi River at depths of 500 m to 1,800 m (1,641 ft to 5,906 ft) (Jefferson and Schiro, 1997; Davis et al., 2000).

The bottlenose dolphin *(Tursiops truncatu*s) is a common inhabitant of the continental shelf and upper slope waters of the Gulf. Sightings of this species in the Gulf are rare beyond approximately 1,200 m (3,937 ft) (Mullin et al., 1994c; Jefferson and Schiro, 1997; Davis et al., 2000). Opportunistic feeders, they prey on a wide variety of species (Davis and Fargion, 1996; Jefferson and Schiro, 1997). Current data suggest that there are genetically discrete inshore and offshore populations of bottlenose dolphins.

3.2.3.2. Threatened and Endangered Species

Five mysticete (or baleen) whales (the northern right, blue, fin, sei, and humpback), one odontocete (or toothed) whale (the sperm whale), and two subspecies of one sirenian (the West Indian manatee) occur or have been reported in the GOM and are currently listed as endangered species. No listed baleen whales normally occur in the Gulf (Jefferson and Schiro, 1997). Sperm whales are common and perhaps a resident species in certain deepwater areas of the Gulf. The West Indian manatee *(Trichechus manatus*) inhabits only coastal marine, brackish, and freshwater habitats.

Cetaceans – Mysticetes

The northern right whale *(Eubalaena glacialis*) inhabits primarily temperate and subpolar waters. The western North Atlantic population ranges between the Maritime Provinces of eastern Canada to northeastern Florida. Right whales forage primarily on subsurface and localized concentrations of zooplankton such as calanoid copepods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). Sparse, historical sightings and stranding records suggest that this species is not a normal inhabitant of the GOM. Records that do exist are considered to be those of extralimital strays from their wintering grounds off the southeastern United States (Jefferson and Schiro, 1997).

The sei whale *(Balaenoptera borealis*) is an oceanic species that is not commonly sighted near the coast. They occur from the tropics to polar zones in both hemispheres, but appear to be more common in mid-latitude temperate zones. Sei whales feed on localized concentrations of zooplankton, small fishes, and cephalopods (Gambell, 1985; Jefferson et al., 1993). Sparse sighting data in the GOM suggest that their presence there is rare, or of accidental occurrence (Jefferson and Schiro, 1997).

The blue whale *(Balaenoptera musculus*) is an oceanic species that moves into shallower habitats to feed. Blue whales are distributed from the equator to polar regions of both hemispheres. Blue whales feed almost exclusively on localized concentrations of zooplankton (Yochem and Leatherwood, 1985; Jefferson et al., 1993). Their presence in the GOM is considered to be very rare, as sighting records consist of two stranded individuals on the Texas coast and two non-confirmed sightings (Jefferson and Schiro, 1997).

The fin whale *(Balaenoptera physalus*) is also an oceanic species of both hemispheres and may be found from the tropics to polar zones. They are sighted near the coast in certain areas where deep water approaches the coast. Fin whales feed on localized concentrations of zooplankton, fishes, and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). Their presence in the GOM is considered to be uncommon to rare. Sparse sighting data on this species suggest that individuals in the Gulf may be extralimital strays from their western Atlantic population (Jefferson and Schiro, 1997; Wursig et al., 2000).

The humpback whale *(Megaptera novaeangliae*) feeds and breeds in coastal waters and migrates from its tropical breeding areas to polar or sub-polar regions. Humpback whales feed on localized concentrations of zooplankton and fishes (Winn and Reichley, 1985; Jefferson et al., 1993). Humpback whales sighted in the GOM may be extralimital strays during their breeding season or during their migrations (Wursig et al., 2000).

Cetaceans – Odontocetes

The sperm whale *(Physeter macrocephalus*) is the largest toothed whale and is distributed from the tropics to polar zones in both hemispheres. They are deep-diving mammals and inhabit oceanic waters, although they may come close to shore in certain areas where deep water approaches the coast. Sperm whales are known to feed 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 GOM (Jefferson and Schiro, 1997). Sighting data suggest a Gulfwide distribution on the slope. Congregations of sperm whales are commonly found in waters over the shelf edge in the vicinity of the Mississippi River delta in water depths of 500 m to 2,000 m (1,641 ft to 6,562 ft). From these consistent sightings, it is believed that there is a resident population of sperm whales in the Gulf consisting of adult females, calves, and immature individuals (Mullin et al., 1994a; Davis and Fargion, 1996; Sparks et al., 1996; Jefferson and Schiro, 1997; Davis et al., 2000). Recent minimum population estimates of sperm whales in the entire GOM totaled 411 individuals, as cited in the National Marine Fisheries Service's (NMFS) stock assessment report for 1996 (Waring et al., 1997). Subsequent abundance estimates of sperm whales in the "oceanic northern GOM" survey area totalled 387 individuals (Davis et al., 2000).

Sirenians

The West Indian manatee *(Trichechus manatus*) is the only sirenian found in tropical and subtropical coastal waters of the southeastern United States, GOM, Caribbean Sea, and Atlantic coast of northern and northeastern South America (Reeves et al., 1992; Jefferson et al., 1993; O'Shea et al., 1995). There are two subspecies of the West Indian manatee: the Florida manatee *(T. m. latirostri*s), which ranges from the northern GOM to Virginia; and the Antillean manatee *(T. m. manatu*s), which ranges from northern Mexico to eastern Brazil, including the islands of the Caribbean Sea. The West Indian manatee typically ranges no farther north than the Suwanee River in northwest Florida, though individuals are occasionally found as far west as Texas. West Indian manatees are herbivorous, feeding on aquatic plants.

Distributions of Cetaceans within Offshore Waters

Factors that may influence the spatial and temporal distribution and abundance of cetaceans may be environmental, biotic, or anthropogenic. Environmental factors encompass those that are physiochemical, climatological, or geomorphological. Biotic factors include the distribution and abundance of prey, inter- and intra-specific competition, reproduction, natural mortality, catastrophic events (e.g., die offs), and predation (Davis et al., 1998). Anthropogenic factors include such items as historical hunting pressure (in some species), pollution, habitat loss and degradation, shipping traffic, recreational and commercial fishing, oil and gas development and production, and seismic exploration.

Within the northern GOM, many of the aforementioned environmental and biotic factors are strongly influenced by various circulation patterns. These patterns are generally driven by river discharge, wind stress, and the Loop Current. The major river system in this area is the Mississippi-Atchafalaya. Most of the river discharge into the northern Gulf is transported to the west and along the coast. Circulation on the continental shelf is largely wind-driven, with localized effects from fresh water (i.e., riverine) discharge. Beyond the shelf, mesoscale circulation is largely driven by the Loop Current in the Eastern Gulf. Meanders of the Loop Current create warm-core anticyclonic eddies (anticyclones) once or twice annually that migrate westward. The anticyclones in turn spawn cold-core cyclonic eddies (cyclones). Together, anticyclones and cyclones govern the circulation of the continental slope in the Central and Western Gulf. The Loop Current and anticyclones are dynamic features that transport large quantities of high-salinity, nutrient-poor water across the near-surface waters of the northern Gulf. Cyclones, in contrast, contain high concentrations of nutrients and stimulate localized production. The combination of input of nutrients into the Gulf from river outflow and mesoscale circulation features enhances productivity, and thus the abundance of cetacean prey species such as fishes and cephalopods within the Gulf. The dynamics of these oceanographic features, in turn, affect the spatial and temporal distribution of prey species and ultimately influence cetacean diversity, abundance, and distribution (Mullin et al., 1994c; Davis et al., 2000).

Studies conducted during the GulfCet I program demonstrated correlation of cetacean distribution patterns with certain geomorphic features such as bottom depth or topographic relief. These studies suggested that bottom depth was the most important variable in habitat partitioning among cetacean species in the northern Gulf (Baumgartner, 1995; Davis et al., 1998). For example, GulfCet I surveys, along with other surveys (such as the subsequent GulfCet II program) and opportunistic sightings of cetaceans within the U.S. GOM, found that only the Atlantic spotted dolphin and the coastal form of the bottlenose dolphin were common inhabitants of the continental shelf. The remaining species of cetaceans known to regularly occur in the Gulf (with the possible exception of the Bryde's whale) were sighted on the continental slope (Mullin et al., 1994c; Jefferson, 1995; Davis et al., 1998 and 2000). During the GulfCet II program, the most commonly sighted cetaceans on the continental slope were bottlenose dolphins (pelagic form), pantropical spotted dolphins, Risso's dolphins, and dwarf/pygmy sperm whales. The most abundant species on the slope were pantropical spotted and spinner dolphins. Sperm whales sighted during GulfCet II surveys were found almost entirely in the north-central and northeastern Gulf, and near the 1,000-m (3,281-ft) isobath on the continental slope (Davis et al., 2000).

An objective of the GulfCet II program was to correlate a number of environmental parameters such as selected hydrographic features with cetacean sighting data in an effort to characterize cetacean habitats in the GOM (Davis et al., 2000). From GulfCet II surveys, sightings of cetaceans along the slope were concentrated in cyclones where production (in this case, measured chlorophyll concentration) was elevated; increased primary production within these cyclonic features enhances secondary production, including preferred prey items. Sightings of these deepwater species, however, were much less frequent in water depths greater than 2,000 m (6,562 ft) and in anticyclones. Sperm whales tended to occur along the mid-to-lower slope, near the mouth of the Mississippi River and, in some areas, in cyclones and zones of confluence between cyclones and anticyclones. From these data, it was suggested that the greater densities of cetaceans sighted along the continental slope, rather than abyssal areas, of the northern Gulf probably result from localized conditions of enhanced productivity, especially along the upper slope, and as a result of the collisions of mesoscale eddies with the continental margin (Davis et al., 2000).

In the north-central Gulf, the relatively narrow continental shelf south of the Mississippi River delta may be an additional factor affecting cetacean distribution, especially in the case of sperm whales (Davis et al., 2000). Outflow from the Mississippi River mouth transports large volumes of low salinity, nutrient-rich water southward across the continental shelf and over the slope. River outflow may also be entrained within the confluence of a cyclone-anticyclone eddy pair and transported beyond the continental slope. In either case, this input of nutrient-rich water leads to a localized deepwater environment with enhanced productivity and may explain the presence of a resident population of sperm whales within 50 km (31 mi) of the Mississippi River delta in the vicinity of the Mississippi Canyon.

Temporal variability in the distribution of cetaceans in the northern GOM may also be primarily dependent upon the extent of river discharge and the presence and dynamic nature of mesoscale hydrographic features such as cyclones. Consequently, the distribution of cetacean species will change in response to the movement of prey species associated with these hydrographic features. GulfCet I and II survey data determined that most of the cetacean species that were routinely or commonly sighted in the northern Gulf apparently occur in these waters throughout the year, although seasonal abundance of certain species or species assemblages in slope waters may vary at least regionally (Baumgartner, 1995; Davis et al., 1998 and 2000).

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, paddlelike forelimbs that are substantially modified for swimming and shells that are depressed and streamlined (Marquez, 1990; Ernst et al., 1994; Pritchard, 1997). They depend on land only during the reproduction period, when females emerge to nest on sandy beaches. They are long-lived and slow-maturing. Generally, their distributions are primarily circumtropical, although the various species differ widely in their seasonal cycles, geographical ranges, and behavior. There are also considerable differences in behavior among populations of the same species (Marquez, 1990).

Most sea turtles (except perhaps the leatherback) exhibit differential distributions among their various life stages: hatchling, juvenile, and adult (Marquez, 1990; Musick and Limpus, 1997; Hirth, 1997). After reaching the sea, hatchling turtles actively swim directly away from the nesting beach until they encounter zones of watermass convergence and/or sargassum rafts that are rich in prey and provide shelter (USDOC, NMFS and USDOI, FWS, 1991a and b; USDOC, NMFS and USDOI, FWS, 1992a; Hirth, 1997). Most then undergo a passive migration, drifting pelagically within prevailing current systems such as oceanic gyres. After a period of years (the number varies among species), the juveniles actively move into neritic developmental habitats. When approaching maturity, subadult juvenile turtles move into adult foraging habitats, which in some populations are geographically distinct from their juvenile developmental habitats (Musick and Limpus, 1997).

All sea turtle species that inhabit the Gulf are listed as either endangered or threatened under the authority of the Endangered Species Act of 1973 (Pritchard, 1997). It is believed that human activities are the cause of the collapse of sea turtle numbers. These activities impact every stage of their life cycle and encompass (1) the loss of nesting beach and foraging habitats; (2) the harvesting of eggs and adults for consumption; (3) incidental mortalities at sea through pelagic and ground fishing practices; and (4) harm or mortality from increasing loads of non-biodegradable waste and pollutants (Lutcavage et al., 1997).

The loggerhead *(Caretta carett*a) is a large sea turtle that inhabits the continental shelves and estuaries of temperate and tropical environments of the Atlantic, Pacific, and Indian Oceans. This species typically wanders widely throughout the marine waters of its range and is capable of living in varied environments for a relatively long time (Marquez, 1990; USDOC, NMFS and USDOI, FWS, 1991b; Ernst et al., 1994). They may remain dormant during winter months, buried in moderately deep, muddy bottoms (Marquez, 1990). Loggerheads are carnivorous and, though considered primarily predators of benthic invertebrates, are facultative feeders over a wide range of food items (Ernst et al., 1994). Loggerheads are considered to be the most abundant sea turtle in the GOM (Dodd, 1988). Loggerhead nesting along the Gulf Coast occurs primarily along the Florida panhandle, although some nesting also has been reported from Texas through Alabama (USDOC, NMFS and USDOI, FWS, 1991b). The loggerhead is currently listed as a threatened species.

The green turtle *(Chelonia myda*s) is the largest hardshell turtle and considered to be a circumglobal species. They are commonly found throughout the tropics and as stragglers in a far more extensive area, generally between latitude 40° N. and latitude 40° S. (USDOC, NMFS and USDOI, FWS, 1991a; Hirth, 1997). In the continental U.S., they are found from Texas to Massachusetts. Green turtles are omnivorous; adults prefer feeding on plants, but juveniles and hatchlings are more carnivorous (Ernst et al., 1994; Hirth, 1997). The adult feeding habitats are beds or pastures 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. Movements between principal foraging areas and nesting beaches can be extensive, with some populations regularly carrying out transoceanic migrations (USDOC, NMFS and USDOI, FWS, 1991a; Ernst et al., 1994; Hirth, 1997). Green turtles occur in some numbers over grass beds along the south Texas coast and the Florida Gulf Coast. Reports of nesting along the Gulf Coast are infrequent, and the closest important nesting aggregations are along the east coast of Florida and the Yucatan Peninsula (USDOC, NMFS and USDOI, FWS, 1991a). The green turtle is currently listed internationally as a threatened species and as an endangered species in the State of Florida.

The hawksbill *(Eretmochelys imbricat*a) is a small to medium-sized sea turtle that occurs in tropical to subtropical seas of the Atlantic, Pacific, and Indian Oceans. In the continental U.S., the hawksbill has been recorded in all the Gulf States and along the Atlantic coast from Florida to Massachusetts, although sightings north of Florida are rare. They are considered to be the most tropical of all sea turtles and the least commonly reported sea turtle in the GOM (Marquez, 1990; Hildebrand, 1995). Coral reefs are generally recognized as the resident foraging habitat for juveniles and adults. Adult hawksbills feed primarily on sponges and demonstrate a high degree of selectivity, feeding on a relatively limited number of sponge species, primarily demosponges (Ernst et al., 1994). Nesting within the continental U.S. is limited to southeastern Florida and the Florida Keys. Juvenile hawksbills show evidence of residency on specific foraging grounds, although some migrations may occur (USDOC, NMFS and USDOI, FWS, 1993). Some populations of adult hawksbills undertake reproductive migrations between foraging grounds and nesting beaches (Marquez, 1990; Ernst et al., 1994). The hawksbill is presently listed as an endangered species.

The Kemp's ridley *(Lepidochelys kemp*i) is the smallest sea turtle. This species occurs mainly in the GOM and along the northwestern Atlantic coast as far north as Newfoundland. Juveniles and adults are typically found in shallow areas with sandy or muddy bottoms, especially in areas of seagrass habitat. Kemp's ridleys are carnivorous and feed primarily on crabs, though they also feed on a wide variety of other prey items as well (Marquez, 1990; USDOC, NMFS and USDOI, FWS, 1992a; Ernst et al., 1994). The major Kemp's ridley nesting area is near Rancho Nuevo, along the northeastern coast of Mexico (Tamaulipas), although scattered nests have also been reported in other areas of Mexico and in Texas (e.g., within the Padre Island National Seashore), Colombia, Florida, and South Carolina (USDOC, NMFS and USDOI, FWS, 1992a; Ernst et al., 1994). Adult Kemp's ridleys exhibit extensive internesting movements but appear to travel near the coast, especially within shallow waters along the Louisiana coast. The Kemp's ridley is currently regarded as the most endangered of all sea turtle species.

The leatherback *(Dermochelys coriace*a) is the largest and most distinctive living 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. This species is also the most pelagic and most wide-ranging sea turtle, undertaking extensive migrations from the tropics to boreal waters. Though considered pelagic, leatherbacks will occasionally enter the shallow waters of bays and estuaries. Leatherbacks feed primarily on gelatinous zooplankton such as jellyfish, siphonophores, and salps, though they may, perhaps secondarily, ingest some algae and vertebrates (Ernst et al., 1994). Data from analyses of leatherback stomach contents suggest that they may feed at the surface, nocturnally at depth within deep scattering layers, or in benthic habitats. Florida is the only site in the continental U.S. where the leatherback regularly nests (USDOC, NMFS and USDOI, FWS, 1992b; Ernst et al., 1994; Meylan et al., 1995). The leatherback is currently listed as an endangered species.

Distributions of Sea Turtles in the Offshore Waters of the Northern GOM

Surveys conducted during the GulfCet I and II programs represent the most recent assessments of sea turtle distribution and abundance within the oceanic northern GOM (Davis et al., 1998 and 2000). During these surveys, only three species of sea turtles were sighted: loggerheads, Kemp's ridleys, and leatherbacks.

GulfCet I and II surveys found the abundance of sea turtles in the GOM to be considerable higher on the continental shelf and within the eastern Gulf, east of Mobile Bay (Lohoefener et al., 1990; Davis et al., 2000). Kemp's ridleys were sighted only along the shelf. The number of sightings of loggerheads were also found to be considerably higher on the continental shelf than the slope. There were also sightings of individual loggerheads over very deep waters (>1,000 m). The importance of the oceanic Gulf to loggerheads was not clear from these surveys, though it was suggested that they may transit through these waters to distant foraging sites or while seeking warmer waters during winter (Davis et al., 2000). From historic sighting data, leatherbacks appear to spatially utilize both shelf and slope habitats in the GOM (Fritts et al., 1983a and b; Collard, 1990; Davis et al., 1998). GulfCet I and II surveys suggested that the region from Mississippi Canyon to DeSoto Canyon, especially near the shelf edge, appears to be an important habitat for leatherbacks (Davis et al., 2000).

Seasonally, loggerheads were widely distributed across the shelf during both summer and winter, though their abundance on the slope was considerably higher during winter surveys than summer (Davis et al., 2000). Temporally, variability in leatherback distribution and abundance suggest that specific areas may be important to this species, either seasonally or for short periods of time. Overall, leatherbacks occurred in substantial numbers during both summer and winter surveys, and the high variability in the relative numbers of individual leatherbacks sighted within specific areas suggest that their distribution patterns were irruptive in nature (Davis et al., 2000).

3.2.5. Birds

Nonendangered and Nonthreatened Species

The offshore waters, coastal beaches, and contiguous wetlands of the northern GOM are populated by both resident and migratory species of coastal and marine birds. They are separated into five major groups: seabirds, shorebirds, marsh birds, wading birds, and waterfowl. Recent surveys indicate that Louisiana and Texas are among the primary states in the southern and southeastern U.S. for nesting colony sites and total number of nesting coastal and marine birds (Martin and Lester, 1991; Martin, 1991). Seabirds are a diverse group of birds that spend much of their lives on or over saltwater; they live far from land most of the year, except at breeding time when they return to nesting areas along coastlines (Terres, 1991). Shorebirds are generally restricted to coastline margins (beaches, mudflats, etc.). An important characteristic of almost all shorebird species is their strongly developed migratory behavior.

The Central and Western GOM coastline serves as the southern terminus of the Mississippi Flyway (Alabama, Mississippi, and Louisiana) and the Central Flyway (Texas), respectively. The term "marsh bird" is a general term for birds that have adapted to living in marshes. Little blue herons, snowy egrets, and tricolored herons constitute the greatest number of coastal nesting pairs on the Western Gulf Coast (Texas Parks and Wildlife Department, 1990).

Waterfowl include swans, geese, and ducks. A total of 36 species are regularly reported along the north-central and western Gulf Coast. 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 north-central and western GOM coastal areas are recognized by the U.S. Fish and Wildlife Service (FWS) as either endangered or threatened: peregrine falcon, piping plover, whooping crane, eskimo curlew, bald eagle, brown pelican, and least tern.

Peregrines prey almost exclusively on birds. The peregrine falcon experienced drastic population declines as a result of the effects of organochlorine pesticides such as DDT and DDE (*Federal Register*, 1983). Recent surveys indicate that many local and regional populations of peregrines are reproducing well and are either stable or increasing (Kiff, 1988; Maechtle, 1992).

The piping plover, a migratory shorebird, is endemic to North America. Along the U.S. Gulf Coast, the highest number of wintering plovers occur along the Texas coast (Haig and Plissner, 1993). The whooping crane is an omnivorous, wading bird. Whooping cranes currently exist in three wild populations and at five captive locations (USDOI, FWS, 1994). These birds winter in coastal marshes and estuarine habitats along the GOM coast at Aransas National Wildlife Refuge, Texas, and represent the majority of the world's population of free-ranging whooping cranes. The eskimo curlew is a small American curlew that nests in Arctic tundra and migrates to its wintering habitat in the pampas grasslands of southern South America. Hunting and habitat alteration greatly reduced this species. The bald eagle is the only species of sea eagle that regularly occurs on the North American continent (USDOI, FWS, 1984). Most breeding pairs occur in Florida and Louisiana, and some in South Carolina, Alabama, and east Texas. The bald eagle was listed as endangered in 1967 in response to the 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).

The brown pelican is one of two pelican species in North America. 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. However, within the remainder of the range, which includes coastal areas of Texas, Louisiana, and Mississippi, where populations are not secure, the brown pelican remains listed as endangered (*Federal Register*, 1985). The least tern is the smallest North American tern. They prefer inshore habitats. Least terns are listed as endangered, except within approximately 80 km (50 mi) of the coast. Least terns are not expected to be affected by the proposed action.

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 GOM, 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 (HMS). The GOM 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 GOM Fishery Management Council's FMP's, separate Fishery Management Plans have been finalized by USDOC's NMFS for Atlantic tunas, swordfish and sharks, and the Atlantic billfish fishery. The GOM 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.

3.2.6.2. Description of Fish Resources

The GOM supports a great diversity of fish resources that are related to variable ecological factors, including salinity, water quality, primary productivity, and bottom type. These factors differ widely across the GOM and especially between the inshore and offshore waters. Characteristic fish resources are associated with the various environments and are not randomly distributed. High densities of fish resources are associated with particular habitat types. Approximately 46 percent of the southeastern United States wetlands and estuaries important to fish resources are located within the GOM (Mager and Ruebsamen, 1988). Consequently, estuary-dependent species of finfish and shellfish dominate the fisheries. Nearly all species significantly contributing to the GOM's commercial catches are estuarine dependent. Even the offshore demersal species are indirectly related to the estuaries because they influence the productivity and food availability on the continental shelf (Darnell and Soniat, 1979; Darnell, 1988).

The GOM provides more than 26 percent of the commercial fish landings in the continental United States (40% when Alaska is excluded) and yielded the Nation's second largest regional commercial fishery weight and third in value in 1999 (total for all species: 1,947 million pounds and $776 million) (USDOC, NMFS, 2001). Commercially important species include the estuary-dependent species such as Atlantic menhaden, shrimps, oyster, crabs, and sciaenids (drums). The GOM shrimp fishery is the most valuable in the United States, accounting for 71.5 % of the total domestic production (USDOC, NMFS, 1997). Menhaden was the most valuable finfish species landed in 1999, with a total value of $78.5 million.

About 10 percent of finfish in the GOM are not directly dependent on estuaries during their life history. This group can be divided into demersal and pelagic species. Coastal pelagics would include mackerels, cobia, bluefish, amberjack, and dolphin. These species move seasonally. Deep waters of the GOM appear to be a significant spawning area for other commercially important pelagic species such as tuna and swordfish. Information on fish larvae from deepwater areas of the GOM is limited.

Specific to this action, East Breaks, Block 602, is located approximately 188 km (117 mi) from the nearest shoreline at a water depth of about 1,120 m (3,675 ft). At this depth, there are no bottom-dwelling managed or commercially important fish species. Seafloor amplitude renderings using 3-D seismic data indicates that areas surrounding all proposed well locations are clear of seabed geological characteristics creating probabilities for chemosynthetic communities. Fish species of principal interest in this deepwater area are the oceanic pelagic species.

3.2.6.2.1. Oceanic Pelagics (including Highly Migratory Species)

Common oceanic pelagic species include tunas, marlins, sailfish, swordfish, dolphins, wahoo, and mako sharks. In addition to these large predatory species, there are 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. The occurrence of bluefin tuna larvae in the GOM associated with the Loop Current boundary and the Mississippi River discharge plume is evidence that these species spawn in the GOM (Richards et al., 1989). Many of the oceanic fishes associate with drifting *Sargassum*, which provides forage areas and/or nursery refugia.

Additional information on individual species of finfish and shellfish and their life histories can be found in Sections III.B.6. and III.C.2. of the Final EIS for Western GOM Lease Sales 171, 174, 177, and 180 (USDOI, MMS, 1998).

3.2.6.2.2. Mesopelagics (midwater fishes)

Mesopelagic fish assemblages in the GOM are numerically dominated by myctophids (lanternfishes), with gonostomatids (bristlemouths) and sternoptychids (hachetfishes) common but less abundant in collections. These fishes make extensive vertical migrations during the night from mesopelagic depths

(200-1,000 m or 656-3,280 ft) to feed in higher, food-rich 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 over each diel cycle.

Bakus et al. (1977) analyzed lanternfish distribution in the western Atlantic Ocean and recognized the GOM as a distinct zoogeographic province. Species with tropical and subtropical affinities were most prevalent in the GOM lanternfish assemblage. This was particularly true for the Eastern Gulf, where Loop Current effects on species distribution 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 southern, Central, and Eastern Gulf. The most abundant species in decreasing order of importance were *Ceratoscopleus warmingii*, *Notolychus valdiviae*, *Lepidophanes guentheri*, *Lampanyctus alatus*, *Diaphus dumerili*, *Benthosema suborbitale*, and *Myctophum affine*. Ichthyoplankton collections from oceanic waters yielded high numbers of mesopelagic larvae as compared with larvae of other species (Richards et al., 1989). Lanternfishes generally spawn year-round, with peak activity in spring and summer (Gartner, 1993).

3.2.7. Socioeconomic Conditions and Other Concerns

3.2.7.1. Economic and Demographic Conditions

3.2.7.1.1. 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 65 counties and parishes along the U.S. portion of the GOM (Table F-1). This area includes 24 counties in Texas, 23 parishes in Louisiana, 4 counties in Mississippi, 2 counties in Alabama, and 12 counties in the Florida Panhandle. 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.

Most of the probable changes in population, labor, and employment resulting from the proposed activity would occur in the 24 counties in Texas and the 23 parishes in Louisiana because the oil and gas industry is best established in this region and because the two onshore service bases associated with the proposed activity are located in Texas. Some of the likely changes in population, labor, and employment resulting from the proposed activity would occur to a lesser extent 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 activity would occur, to a much lesser extent, in the 12 counties of the Florida Panhandle because of its proximity to the proposed activity area.

For analysis purposes, the MMS has divided the impact area 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 GOM 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 F-2 presents these findings in percentage terms.

In Table F-2, 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 PEA. It is analogous to the standardized industry code (SIC). As shown in Table F-2, very little has been spent in the Florida subareas. This 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.

3.2.7.1.2. Population and Education

Table F-3 depicts baseline population projections for the potential impact area. Baseline projections are for the impact area in the absence of the proposed activity. According to Woods and Poole forecasts, most subareas in the region will experience an average annual growth in population of approximately 1-2 percent over next 25 years. On average, the percent of the population age 25 and over completing high school only in the impact area (53.82%) is less than that for the United States (54.90%). The same holds true for college graduates (13.85 versus 20.34). While several individual parishes, counties, and MSA's exhibit graduation percentages greater than the national average, most do not.

3.2.7.1.3. Infrastructure and Land Use

The GOM OCS Region has one of the highest concentrations of oil and gas activity in the world. The offshore oil and gas industry has experienced dramatic changes over recent years, particularly since 1981. Historically, most of the activity has been concentrated on the continental shelf off the coasts of Texas and Louisiana. Future activity is expected to extend into progressively deeper waters and into the EPA. 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 coastal impact area is mostly vast areas of wetlands; some small communities and industrial areas extend inward from the wetlands.

3.2.7.1.4. 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 activity is expected to impact Sabine Pass, Texas, and Galveston, Texas, the designated service bases for the proposed action.

3.2.7.1.5. Employment

Table F-4 depicts baseline employment projections for the potential impact area. Baseline projections are for the impact area in the absence of the proposed activity. According to Woods and Poole forecasts, most subareas in the region will experience an average annual growth in employment of approximately 1.5 percent for the next several years and decrease steadily to 1.25 percent during the last years of analysis. Unemployment in the impact area has averaged 4.4 percent during 2000, while the national average was 3.9 percent. Unemployment numbers varied widely by parish/county from a high of 10.5 percent to a low of 1.8 percent. Employment in the impact area by major industry sectors is shown in Table F-5. Service (36.06%) and retail (21.67%) jobs dominate the area, while manufacturing follows at 12.38 percent. Payroll distribution by major industry sectors, as seen in Table F-6 reflects the employment in the impact area.

3.2.7.1.6. Current Economic Baseline Data

Current crude oil and natural gas prices are substantially above the economically viable threshold for drilling in the GOM. As of May 14, 2001, Light Sweet Crude lists for $28.71 per barrel on the New York Mercantile Exchange, while Henry Hub Natural Gas closed at $4.394 per million Btu (www.oilnergy.com). In addition to oil and gas prices, drilling rig use is employed by the industry as a barometer of economic activity. According to Offshore Data Services, the year-end utilization rate for all marketed mobile rigs in the GOM was 95.4 percent. This breaks down as a 96.0 percent utilization rate for jackups, 94.1 percent for semisubmersibles, 83.3 percent for drillships, and 100 percent for submersibles. Platform rigs in the Gulf recorded a 71.2 percent utilization rate (*Gulf of Mexico Weekly Rig Locator*, 2001). Another indicator of the direction of the industry is the exploration and development (E&D) expenditures of the major oil and gas companies. After substantially cutting their E&D budgets during the 1998 and 1999 fiscal years, majors are once again increasing these areas on their balance sheets. According to Global Marine Chairman, President, and CEO, Bob Rose, "the outlook for 2001 is very bullish" (www.oilandgasonline.com, January 17, 2001).

3.2.7.1.7. How OCS Development Has Affected the Impact Area

The topic of how OCS development has affected the Western GOM Planning Area is discussed in the latest environmental assessment for this portion of the Gulf (USDOI, MMS, 2001a). The analysis describes the effects in multiyear segments, i.e., 1980-1989, 1990-1997, and 1998-present. The discussion explains the expansion and contraction of oil and gas activities in the GOM during these intervals.

3.2.7.1.8. 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 them from the outset of a proposed project. Low incomes also coincided with concentrations of minority populations: black, Hispanic, and/or Native American. Minority populations within the impact region include African-Americans living in all of the GOM Coast States and Asian-Americans in Alabama. Few Native Americans live in coastal counties. The Native American Data Center lists tribes that are located in the impact area (www.indiandata.com/eastern.htm) such as the Intertribal Council (ITC). The Council was established in the early 1970's by five tribes—the Chitimacha, Tunica-Biloxi, Coushatta, Houma, and Jena Band of Choctaws. At that time, only the Coushatta tribe was federally recognized. Today, four Louisiana tribes are federally recognized. The first of these to be recognized was the Coushatta in 1973, and the last was the Jena Band of Choctaw in 1995. The United Houma Nation is still awaiting a finding on its petition. Because its citizens live principally in Lafourche Parish and close to Port Fourchon, they could be directly affected by increases in oil and gas activity from the proposed action. Low-income populations living in the impact area include fishermen and timber harvesters.

3.2.8. Commercial Fisheries

The GOM provides nearly 21 percent of the commercial fish landings in the continental U.S. on an annual basis and yielded the nation's second largest regional commercial fishery by both weight and value in 1999. The most recent, complete information on landings and value of fisheries for the U.S. was compiled by NMFS for 1999. During 1999, commercial landings of all fisheries in the Gulf totaled over 1.9 billion pounds, valued at about $776 million (USDOC, NMFS, 2001).

Menhaden, with landings of about 1.5 billion pounds and valued at $78 million, was the most important Gulf species in quantity landed during 1999. Shrimp, with landings of nearly 242 million pounds and valued at about $478 million, was the most important Gulf species in value landed during 1999. The 1999 Gulf oyster fishery accounted for nearly 67 percent of the national total with landings of 14 million pounds of meats, valued at about $28 million. The Gulf blue crab fishery accounted for 24 percent of the national total with landings of 45 million pounds, valued at about $32 million (USDOC, NMFS, 2001).

Nearly all species significantly contributing to the GOM's commercial catches are estuarine dependent. The degradation of inshore water quality and loss of Gulf wetlands as nursery areas are considered significant threats to commercial fishing (Angelovic, written communication, 1989; Christmas et al., 1988; Gulf States Marine Fisheries Commission, 1988). Losses to commercial fishing resources and fishing gear could occur from production platform placement and oil spills. Localized populations of fish species are expected to experience sublethal effects. This could result in a temporary decrease in a local population on a local scale.

3.2.9. Recreational Resources and Beach Use

The northern GOM coastal zone is one of the major recreational regions of the United States, particularly for marine fishing and beach activities. Gulf Coast shorelines offer a diversity of natural and developed landscapes and seascapes. Major recreational resources include coastal beaches, barrier islands, estuarine bays and sounds, river deltas, and tidal marshes. Other resources include publicly owned and administered areas, such as national seashores, parks, beaches, and wildlife lands, as well as designated preservation areas, such as historic and natural sites and landmarks, wilderness areas, wildlife sanctuaries, and scenic rivers.

Beach use is a major economic component of many of the Gulf's coastal communities, especially during the peak-use seasons (spring and summer). According to USDOI, MMS (1997a), recreational resources, activities, and expenditures are not uniformly distributed along the Gulf but are focused where public beaches are close to major urban centers. Beach activities and the aesthetic value of the shoreline are important economic factors in the coastal zone. The scenic and aesthetic value of Gulf Coast beaches plays an important role in attracting both residents and tourists to the coastal zone. One of the major recreational activities occurring on the OCS is offshore marine recreational fishing and diving. A substantial recreational fishery, including scuba diving, is directly associated with oil and gas production platforms and stems from the fact that platforms beneficially function as high-profile, artificial reefs that attract fishes.

Commercial and private recreational facilities and establishments, such as resorts, marinas, amusement parks, and ornamental gardens, also serve as primary-interest areas. According to the Texas Department of Commerce's Tourism Division, 24 percent of Texas' out-of-state tourists visit the Gulf Coast region. This tourism represented an estimated 68 million person trips in 1993/94 with average spending at $93 per person per day (Texas General Land Office, 1996). The two major recreational areas most directly associated with and potentially affected by offshore leasing are the offshore marine environment and the coastal shorefront of the adjoining states. The major recreational activity occurring on the OCS is recreational fishing and diving. Interest remains high throughout the GOM region to acquire, relocate, and retain selected oil and gas structures in the marine environment to be used as dedicated artificial reefs to enhance marine fisheries when the structures are no longer useful for oil and gas production (Reggio, 1989). Other prominent natural features (e.g., Flower Garden Banks) also serve as primary diving destinations for sport divers.

3.2.10. 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 (30 CFR 250.2). The Archaeological Resources Regulation (30 CFR 250.26) 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 98-06).

3.2.10.1.Prehistoric

Available 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, the 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.

The MMS recognizes both the 12,000 B.P. and 60-m (197-ft) water depth as the seaward extant of prehistoric archaeological site potential on the OCS. The water depth of the Grid 4 Area is located in several thousand of feet of water. The water depth of lease blocks is deeper than the earliest known prehistoric sites in the Gulf. Based on the extreme water depth of this lease block, any oil or gas exploration or development will not impact any prehistoric archaeological resources.

3.2.10.2.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 is embedded in the seafloor. This includes vessels (except 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. Most of the remaining wrecks lie between 1.5 km and 10 km (0.9 mi 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 Garrison et al., (1989) shipwreck database lists seven shipwrecks that fall within the four protraction diagrams that make up the area in and around Grid 4. Three are modern wrecks, three are designated as wrecks by name only with no dates of their sinking, and one reported as lost in the year 1908 in East Breaks, Block 199 (Table 3-3). None of these wrecks specifically fall within the Grid 4 Area. Only one of these wrecks, the *Northern Eagle* lost in 1908, may be considered to be historic and could be eligible for nomination to the National Register of Historic Places. All of the wrecks listed are known only through the historical record and, to date, have not been located on the ocean floor. The MMS shipwreck database 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. In the deep water, temperature at the seafloor is extremely cold, which slows the oxidation of ferrous metals. The cold water would also eliminate the wood-eating shipworm *Terredo navalis* (Anuskiewicz, 1989; page 90).

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 MMS (Irion and Anuskiewicz, 1999) as scattered over the ocean floor in a swath over 457 m (1,500 ft). 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 OCS 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

Historic Shipwrecks near Grid 4

Vessel Name	Date of Wreck	Lease Block
Emily T. Eymard	Unknown	AC 607
Wa Wa	Unknown	GB 225
Northern Eagle	1908	EB 199
Little Howdy	1953	EB 673
Lady Beth	1969	EB 393
Dos Hombres	Unknown	EB 270
Unknown	Unknown	EB 73

Note: AC is Alaminos Canyon
GB is Garden Banks
EB is East Breaks

4. POTENTIAL ENVIRONMENTAL EFFECTS

4.1. PHYSICAL ELEMENTS OF THE ENVIRONMENT

4.1.1. Impacts on Water Quality

4.1.1.1. Coastal

The MMS has identified the following factors that could impact coastal waters related to the proposed action:

(1) discharges, runoff, and accidentally lost trash,
(2) spills from the use of onshore support infrastructure,
(3) spills at the offshore facility or along the pipeline routes,
(4) maintenance dredging operations, and
(5) discharges from associated vessel traffic.

The extent of the impact to coastal water quality from these actions is dependent upon the level of the perturbance as well as the transport and mixing processes dispersing contaminants entering the water column. The Clean Water Act provides State and Federal agencies the authority to prevent significant degradation of water quality from all of these impacting factors. East Breaks, Blocks 602 and 646 are located approximately 188 km (117.5 mi) from shore. Due to this distance, routine offshore operations at the production site are not expected to affect the Texas or Louisiana sensitive coastal areas.

Kerr-McGee will utilize existing support bases at Sabine Pass, Texas, and Galveston, Texas, for production and development activities. No new support facilities or new workers are anticipated as a result of the proposed activity. Discharges from existing facilities are regulated by the State to avoid significant impacts to the affected waterbody. Runoff, which is less controllable, can contain oil, particulate matter, heavy metals, petroleum products, process chemicals, fecal coliform bacteria, nutrients, and radionuclides. Because the level of use of the proposed onshore infrastructure is not expected to change, significant changes to water quality are not expected.

Projected onshore construction is limited to the new gas processing plant at Markam, Texas, which is already in the process of being built. This construction, combined with the dredging, construction, or modification of associated access routes, will alter the hydrology and geography of the impacted area, resulting in erosion and runoff. This runoff can affect local streams, estuaries, and bays, causing elevated levels of contaminants, low dissolved oxygen levels, and high turbidity. The level of degradation due to this construction is considered temporary and minor and is not directly attributable to the proposed action.

Workboats and crew boats will be utilized for transporting personnel and supplies from Sabine Pass, Texas, and/or Galveston, Texas, to the spar site. A workboat will make trips to the spar site two times a week during normal production operations. When wells are being worked over or completed, it is expected that an additional three vessel trips from the onshore base to the spar site will occur. The route traveled will normally be direct from the shore base to the spar site; however, boats operating in the field may travel from other facilities nearby.

Sediment disturbances from channel maintenance dredging and canal widening partially occurring to provide access to the two existing facilities that will service the proposed action may adversely affect coastal waters. Dredging operations are expected to occur to provide deep-draft access for the deepwater oil industry and to maintain the deep-draft status of the existing channels. Dredging operations release sediments into the water column, resulting in the degradation of water quality from increased turbidity, obstructed light penetration, and resuspension of released sediment contaminants that can include organic pollutants, heavy metals, oil and grease, pesticides, and other pollutants, some originating from the support infrastructure. Mixing of anaerobic sediments into the water column could affect oxygen levels and metal concentrations. Dredged-material disposal can result in changes in the natural flow or circulation of surface waters, causing secondary water quality effects. These changes are considered temporary and minor, and are a result of the many uses of the channels dredged, rather than directly attributable to the proposed action.

During the construction phase for the spar and the pipelines, there will be a slight increase in support vessel traffic from the shore base(s). Furthermore, the larger vessels associated with the deepwater support vessel fleet will increase vessel bilge water and sanitary and domestic waste discharges, bank erosion, and the likelihood of spills from vessels. Discharged bilge water can contain petroleum and metallic compounds leaked from machinery. Sanitary wastewater usually contains low levels of suspended solids, fecal coliform bacteria, and chlorine from the treatment process. These activities will result in a cumulatively adverse, but minor, change in localized water quality.

Appendix A provides detailed information on the low probability of spill occurrence from the offshore facility and associated pipeline. It also describes the very low likelihood of spill contact to the coastline, based only on transport processes from the deepwater site. In general, only the largest of deepwater spills are expected to result in slicks that would remain on the sea surface long enough for a substantial quantity of oil to be transported into coastal waters. If one were to occur, the estimates of its size and fate show that the slick would breakup and be dispersed (both chemically and naturally) before it would reach shoreline.

Conclusion

Impacts to coastal waters from the proposed activities are expected to be minimal. Existing shore bases have been selected to support the project. Sediment disturbances from the proposal will be minor and temporary. Discharges from support vessels may have minor effects, but the changes to water quality will be localized. Oil spills have a low probability of occurrence and an even lower probability of contacting the coastline. The spar is also located approximately 190 km (118 mi) from the shoreline. Containment and clean up activities should reduce the likelihood that the released oil would effect the coastal waters.

4.1.1.2. Offshore

In general, routine activities related to the proposed action that could result in marine water quality degradation include the emplacement and removal of the production facilities and the discharge of operational wastes during production. Accidental loss of debris, blowouts, or spills of oil and hazardous substances, should they occur, also have the potential to alter offshore water quality. There is no indication that coastal water degradation due to deepwater activities could have a significant effect on deepwater offshore waters.

Appendix A discusses what may be expected from oil spills occurring from OCS operations in deep water, the likelihood that spills from the proposed action will occur, and the expected fate and cleanup of such a spill should it occur. In general, the frequency and size of spills are the major factors determining offshore water quality degradation. Historically, changes in offshore water quality from any one spill have only been detected during the life of the spill and up to several months afterwards, depending upon the size of the spill. The worst case size projected to occur from the proposed action is approximately 26,400 bbl (Appendix A). The likelihood of such a spill occurring is very small (less than 10%) even when calculated over the entire life of the field. Most of the components of oil are insoluble in water and therefore float. Change in water quality is a function of the amount of petroleum hydrocarbons dispersed or dissolved within the water column. Appendix A estimates that by 20 days about 4 percent or 1,100 bbl will have naturally dispersed into the water column. It is expected that, in addition to natural dispersion, the slick will be treated with chemical dispersants to break it up prior to any land contact. It is likely that about 20-30 percent of the treated oil will be dispersed chemically, resulting in about 2,500-3,800 bbl in the water column. This quantity is expected to rapidly dilute in the water and only causes changes in water quality for a few days after chemical dispersant application is completed.

It is difficult to predict the fate of oil that would be spilled on the deepwater seafloor (e.g., blowout and pipeline break). Factors affecting the ascent of an oil plume through the water column would include ambient temperature and pressure, chemical behavior of the oil, phase changes, and transport. The MMS, in collaboration with industry, is funding a study that will provide an in-depth analysis of oil-spill behavior from seabed spills in deep water. How large quantities of oil entering the marine environment from thousands of feet below the surface will affect water quality is unknown. A recently completed modeling effort showed that solid methane/water hydrates might form from some of the gaseous components in a blowout fluid (S.L. Ross Environmental Research Ltd., 1997). Field trials and modeling efforts recently completed by IKU (Rye and Brandvik, 1997) showed that the stratification of the ambient watermasses may prevent the subsurface plume from reaching the sea surface. If the oil released were to reach the sea surface, the surface signature of the spill may be distanced from the subsea origin. The field trials also showed that oil droplets from a subsea spill would form a very thin surface slick spread out over a larger area, accelerating the speed that the slick breaks up and dissipates. Not all of the oil originally released is expected to reach the surface in the form of a surface slick.

Given that the potential for a large spill to occur at some point during the 20-year operation is very unlikely, and, that if one were to occur, the volume expected to disperse into the water column is not significant, changes in offshore water quality due to oil spills occurring in association with proposed action operations are expected to be negligible, short term, and localized.

Facilities proposed for construction under the Initial DOCD include the spar, the subsea lease-term pipelines, umbilicals, and the risers/umbilicals for the subsea wells. Emplacement of the spar system would only disturb minimal areas with its mooring system. There would be some disturbance caused by the pipelaying activity. Construction and pipelaying would cause an increase in the turbidity of the affected waters for the limited duration of the activity periods. Any localized disturbance would be mixed and diluted within the extremely large volume of water encountered. This resuspension could result in increases of turbidity, a water quality problem primarily because turbidity usually decreases light penetration. However, all bottom area disturbances in deep water will occur below the photic zone. Sediment quality in deep water is expected to be pristine; therefore, the resuspension of sediments should not contain settled pollutants such as trace metals, chlorinated hydrocarbons, and excess nutrients, which could be found in a nearshore environment. Therefore, it is not expected that the seafloor emplacement operations will result in the disturbance of settled pollutants in the immediate vicinity of the activity. In conclusion, during installation, there should no exceedances of water quality criteria.

All discharges into the ocean from production operations will be in accordance with the USEPA NPDES General Permit for Gulf of Mexico activities. Kerr-McGee has requested coverage under the USEPA Region VI NPDES General Permit, GMG 290000, for the discharges that will occur in East Breaks, Blocks 602 and 646. In general, the level of impact caused by operational waste discharged during production operations is proportional to the dispersal of the discharged plume and the deposition potential of the discharge. Historically, the major impact from OCS discharges is the contamination of superficial sediments close to the facility. Given this, the impacts of deepwater discharges are expected to be less consequential. Section IV.A.3.d. of the Final EIS for Western GOM Lease Sales 171, 174, 177, and 180 (USDOI, MMS, 1998) provides information on the characteristics, levels, and known impacts of OCS discharges in general.

Table 4-1 provides a summary of the anticipated major discharges for the proposed development operations in East Breaks, Blocks 602 and 646.

Table 4-1

Summary of Anticipated Major Discharges from the Proposed Action

Composition	Quantity	Discharge Rate	Comments
Drilling muds	700 bbl/well	Bulk	Water-based mud left in casing when wells were temporarily abandoned
Drill cuttings	None	None	No drilling proposed
Well treatment, Completion, and workover fluids	300 bbl/day	Intermittent	Based on average of 300 bbl/day during these types of operations
Produced water	40,000 bbl/day	Continuous	Maximum facility design
Sanitary and domestic waste	3,400 gal/day	Intermittent	Based on 50 gal/day/man; maximum facility manning
Cooling water	3,000,000 bbl/day	Continuous	Based on maximum facility design

The discharge of the water-based drilling muds, well treatment, completion, and workover fluids, and treated sewage would increase the levels of suspended solids, nutrients, chlorine, and biochemical oxygen demand (BOD) in a small area near the discharge point for a short period of time. Such limited volumes will have a negligible impact on water quality.

In order to discharge produced water overboard that is generated from the proposed action activities, the following minimum requirements must be met (Table 4-2). These limitations, prohibitions, and monitoring requirements are those found in the current NPDES general permit.

Table 4-2

Selected Discharge Requirements under the Current NPDES General Permit

Regulated discharge parameter	Discharge limitation/ prohibition	Monitoring and Reporting Requirement: Frequency	Monitoring Requirement: Methodology
Oil and grease	42 mg/l daily maximum 29 mg/l monthly average	Once/month Record daily maximum and monthly average	Grab sample at effluent port
Flow rate (bbl/month)	Monitor	Estimate and record monthly average	Once/month
Free oil	No free oil	Once/day and record number of days a sheen is observed	Visual sheen
Toxicity	7-day minimum NOEC* and monthly average minimum NOEC*	Record lowest NOEC on test run once per calendar quarter for discharge rates above 4,600 bbl/day	Grab sample at effluent port

Note: *NOEC means "no observable effect concentration."

The produced-water plume is not expected to reach the seafloor; therefore, no seafloor sediment contamination is expected at this water depth. The plume is only expected to be toxic when the effluent is present at levels greater than 10 percent of the receiving waters. This has only been shown to occur in very shallow water depth and is not expected to occur in deep water. However, the quantity of produced water projected is extremely large. Because of this, the USEPA has asked that the discharge monitoring reporting requirement be submitted quarterly to them for this facility to coincide with the toxicity testing requirements (Section D.4 of the General Permit, 64 FR 74, dated April 19, 1999). This requirement would not burden the operator with additional sampling and would provide information to the USEPA on how well the general permit is regulating high-volume discharges.

Wastewater discharges from support vessels will be rapidly diluted and dispersed (i.e., to ambient levels within several thousand meters of the discharge) – an adverse but not significant impact to offshore water quality.

Appendix A discusses Kerr-McGee's "blowout scenario" [8,800 bbl/day for three days (26,400 bbl)], what may be expected in general from an oil spill in deep water, the likelihood that a spill greater than 1,000 bbl could occur from the proposed action, and the expected fate and cleanup of the estimated 26,400 bbl-spill, should it occur.

The likelihood of a spill equal to or greater than 1,000 bbl occurring during the life of the proposed activities is very small (about 3%). If such a spill occurred, the amount of oil dispersed or dissolved within the water column and the length of time the water column would be affected are the major factors determining degradation of water quality. Appendix A estimates that, if the projected spill occurred at the sea surface, about 1,100 bbl will have naturally dispersed into the water column within 20 days. If dispersants were applied to a spill, about 2,500 to 3,750 bbl could be dispersed into the water column. This quantity is expected to rapidly dilute in the water and only cause changes in localized water quality for a few days after chemical dispersant application is completed.

It is difficult to predict the effect on water quality if such a spill were to occur on the deepwater seafloor (e.g., blowout and pipeline break). A recently completed modeling effort (S.L. Ross Environmental Research Ltd., 1997) and field trials in 1997 and 2000 showed that oil droplets from a deepwater subsea spill are likely to form a very thin surface slick spread out over a larger area, accelerating the speed that the slick breaks up and dissipates, thus speeding up any changes in the affected water quality conditions.

Conclusion

Construction and pipelaying operations would cause an increase in the turbidity of the affected waters for the duration of the activity periods and would disturb settled pollutants in the immediate vicinity of the activity. The discharge of treated sewage would increase the levels of suspended solids, nutrients, chlorine, and BOD in a small area near the discharge point for a short period of time. Small spills from the platform and discharge of produced water could result in increases of hydrocarbon levels and trace metal concentrations in the water column in the vicinity of the platforms.

The potential for a large spill to occur during the 15 years of reserve life of the project is very unlikely. If a spill were to occur, the volume expected to disperse into the water column would not be significant. Changes in offshore water quality due to an oil-spill event are expected to be negligible, short term, and localized.

4.1.2. Impacts on Air Quality

There will be a limited degree of degradation of air quality in the vicinity of the proposed operations for the period of the projected production activities. The air emissions are expected to increase in 2002 (Table 3-1 in Chapter 3.1.2.). This increase is due to the projected extended operational activities (273 days) in 2002. Air quality would be affected in the event of a blowout or oil spill. The volatile organic carbons (VOC's) that 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 was to occur on a hot sunny day in a NO_2-rich environment. The corresponding onshore area is in attainment for ozone (USEPA, 2001). If a fire occurs, particulate and combustible emissions will be released in addition to the VOC's.

Conclusion

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 chapter describes potential impacts to coastal barrier beaches and associated dunes from oil spills that might occur as a result of proposed activities in Grid 4. The spill model used (Price et al., 1999) describes probabilities of spill movement around the Gulf of Mexico and projected contacts with the shore. Appendix A lists potential sources of hydrocarbon spills that might result from the proposed action. Appendix A also 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 A.

Contact between an oil slick and a beach primarily depends upon environmental conditions and the nature of the oil spilled (Price et al., 1999) indicates that if a spill were to occur in Launch Area 21 and if it were to persist for 10 days, there is a very low probability of that spill contacting land.

The Sintef-model results, described in Appendix A, project volumes of oil that may remain in a slick through 20 days after a large spill occurs. Due to limitations of the oil-spill modeling efforts conducted for the spill from a hypothetical blowout from the proposed action, the quantity of spilled oil that could contact the barrier beaches and associated dunes was not estimated.

Should a contact occur, the volume of oil involved might range from a few very dispersed gallons of oil to a volume that approaches the projected volume of oil that might exist in the slick on the day of contact, as indicated by the Sintef model. The length of beach that might be contacted could range to about 20 km (12 mi). The possible range for dispersal patterns of contacting oil ranges from small, diffusely scattered specks to heavy concentrations spread over the beach.

Severe adverse impacts to dunes contacted by a spill are very unlikely. For storm tides to carry oil from a spill across and over the dunes, strong southerly or easterly winds must persist for an extended time, prior to or immediately after the spill. Strong winds required to raise water levels adequately to contact dunes would also accelerate oil slick dispersal, thereby reducing impact severity at a landfall site. In addition, a study in Texas showed that oil disposal on vegetated sand dunes had no deleterious effects on the existing vegetation or on the recolonization of the oiled sand by plants (Webb, 1988).

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 would 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 Galveston Island and the Louisiana Coast. State governments around the Gulf have recognized these problems and have established policies to limit sand removal by cleanup operations.

Conclusion

The proposed action is not projected 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 A. The information below regarding potential impacts of oil spills on wetlands is based on analyses in the Final EIS for Western GOM Lease Sales 171, 174, 177, and 180 (USDOI, MMS, 1998).

Data in Appendix A indicate a very low probability for an oil spill originating from the proposed action and for the spill contacting the U.S. shoreline. As discussed in USDOI, MMS (1998), distant offshore spills have a further diminished probability of impacting inland wetland shorelines and seagrasses, largely due to their sheltered locations.

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 also very small. Should a spill occur inshore or in nearshore waters, it presents a much greater potential for adversely impacting wetlands and seagrasses, due 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; and Fischel et al., 1989) were used to evaluate impacts of potential spills to wetlands (described in Chapter 3.2.1.2.). For wetlands along more stable coasts, such as in Texas, the critical oil concentration is assumed to be 1.0 l/m^2 of marsh. Concentrations above this will result in longer-term impacts to wetland vegetation, including some plant mortality and landloss. Concentrations less than this may cause die-backs for one growing season or less, depending upon the concentration and the season during which contact occurs.

4.2.1.3. Seagrasses

Seagrasses have generally experienced minor or no damage from oil spills (Zieman et al., 1984; Chan, 1977). The relative insusceptibility of seagrasses in the WPA 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 micro-tidal range. The lack of low-tide exposure protects seagrasses from direct contact with 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 seagrass insusceptibility 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 in the WPA would not be expected to directly cause anything but slight damage to the vegetation. Some seagrass die-back 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.

Only during extremely low water, wind-driven tidal events might seagrass beds be exposed to the air such that they might be directly impacted 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 sounds 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 may 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 the 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 since it will be degraded chemically and biologically (Zieman et al., 1984). Because estuaries have a greater suspended particulate load and greater microbial populations, oil degrades more rapidly there (Lee, 1977).

The probable danger under these more likely circumstances 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 density, solubility, emulsability 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 adequate 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).

Clean up of slicks that come to rest in shallow or protected waters [0 to 1.5 m (0 to 5 ft) deep] may be performed using "john" boats, booms, anchors and skimmers mounted on boats or shore vehicles. Personnel assisting in oil-spill clean up in water shallower than about one meter (3-4 ft) may readily wade through the water to complete their tasks. Foot traffic and 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 navigational channels can directly scar shallow beds of submerged vegetation with their props, keels (or flat bottoms), and anchors (Durako, et.al., 1992).

Conclusion

Adverse impacts to wetlands resulting from a proposed project-related spill are highly unlikely to occur. If a spill occurs at the project site, oceanographic and meteorological conditions are very unlikely to move oil far enough in a short enough time to cause oil contacts with wetlands or seagrasses. If an unlikely, related fuel-oil spill occurs inshore, some wetlands in the spill vicinity may be adversely impacted; seagrasses are unlikely to be impacted directly. A spill's secondary impacts including shading, suffocation and cleanup activities present a greater impact potential. Due to their low frequency of occurrence in the region in which project-related impacts are likely to occur, protection for seagrass beds should be promoted.

4.2.2. Impacts on Deepwater Benthic Communities/Organisms

4.2.2.1. Chemosynthetic Communities

The potential areas of concern for impact in this PEA include the well template area (including possible cuttings discharge accumulation from completion and other drilling activities), nine anchors/pilings for the Nansen spar itself, and the anchoring system used by the installation derrick barge. A review for potential chemosynthetic community impact was performed separately. The summary of this analysis determined that all impacting activities are well removed from all areas with the potential for the existence of chemosynthetic communities. East Breaks, Block 602 does have a record of one known chemosynthetic community. However, this community was sampled by a trawl and only the start location of the trawl is presently known. The start location of the trawl is located more than 3,353 m (11,000 ft) to the northwest of the proposed spar location. A second area that could hold the potential for chemosynthetic communities was discovered from geophysical survey data collected for the project. This area is located approximately 3,353 m (11,000 ft) south-southwest of the proposed spar location.

Conclusion

Both the known and likely areas for potential chemosynthetic communities are approximately 3,353 m (11,000 ft) to the northwest and south-southwest of the spar location, respectively. These areas are well away from any proposed anchor locations. Therefore, no impacts to dense chemosynthetic communities are expected as a result of the proposed activities.

4.2.2.2. Coral Reefs

All of the 23 topographic features in the WPA are found in waters less than 200 m (656 ft) deep and represent a small fraction of the Western Gulf area. The proposed action is in water depths greater than 1,000 m (3,281 ft), as illustrated in Figure 3. The closest topographic feature is Applebaum Bank, which is located about 53 km (33 mi) from the proposed Nansen spar location. Conclusion

Conclusion

The proposed action is not expected to result in adverse impacts to topographic features or associated coral reef ecosystems.

4.2.2.3. Deepwater Benthos and Sediment Communities

The most serious impact-producing factor threatening the deepwater benthic biota, including invertebrates, meio- and macrofauna, and microbiota, is the physical disturbance of the seafloor, which could destroy the organisms that comprise these communities. For the purposes of this PEA, such debilitating disturbances associated with the proposed action are the Nansen spar emplacement, pipelaying, anchoring of the installment barge, and potential seafloor blowouts. The level of information relative to deepwater benthic communities consists primarily of descriptive studies focusing on abundance, biomass, and zonation. Process-oriented studies and linkages to the water column are currently being addressed by the aforementioned MMS study, the DGoMB project. In addition to standard community characterization methodologies, the study includes process measurements of community metabolism, meiofaunal feeding rate, sediment community oxygen demand, and foodweb studies. One of the hypotheses being tested by the study is whether or not benthic communities underlying persistent water-column “hot spots” are different from those in otherwise similar areas (Continental Shelf Associates, 2000).

Besides being highly diverse and indicative of rare species, the deepwater benthic communities appear to be highly ubiquitous, thereby making impacts associated with OCS operations unavoidable. The new information that is forthcoming from the DGoMB study will give us the tools to make sound assessments regarding community disruption/impacts and associated recovery rates relative to those processes. Without this level of information, it is difficult to predict the recovery rate for these particular benthic communities. It is known, however, that seafloor disturbance is considered to be a threat to high-density communities, i.e., chemosynthetic assemblages. Impacts associated with the widely distributed, lower-density communities of the seafloor are not measurable at this time, but are not considered to be significant due to their ubiquitous nature.

Conclusion

Sediment-disturbing activities, e.g., anchoring, pipelines, and blowouts, will affect the benthos and sediment communities. Based on the best available scientific information, it is expected that impacts from the proposed activities will be localized and limited to the disturbed areas.

4.2.3. Impacts on Marine Mammals

Factors that could adversely affect cetaceans include increased vessel traffic, degradation of water quality from operational discharges, helicopter and vessel traffic noise, platform and drillship noise, structure removals, seismic surveys, oil spills, oil-spill-response activities, loss of debris from service vessels and OCS structures, commercial fishing, capture and removal, and pathogens. The cumulative impact on cetaceans is expected to result in a number of chronic and sporadic sublethal effects that may serve to stress and/or weaken individuals of a local group or population and make them more susceptible to infection from natural or anthropogenic sources. Few lethal effects are expected from oil spills, chance collisions with service vessels, ingestion of plastic material, fishing, and pathogens. Oil spills of any size are estimated to be aperiodic events that may contact cetaceans. Deaths as a result of structure removals are not expected to occur because of anticipated mitigation measures required by the NMFS. Disturbance (e.g., noise) and/or exposure to sublethal levels of biotoxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them more vulnerable to parasites and diseases that normally would not be fatal.

Another factor of concern is the ability that cetaceans (more specifically, sperm whales) possess for detecting and avoiding the various flowlines, risers, umbilicals, and mooring lines associated with the Nansen spar. Sperm whales are known to get entangled in deep-sea cables (Heezen, 1957). The net result of any disturbance would depend on the size and percentage of the population affected, ecological importance of the disturbed area, environmental and biological parameters that influence an animal's sensitivity to disturbance and stress, and the accommodation time in response to prolonged disturbance (Geraci and St. Aubin, 1980). Collisions between cetaceans and ships could cause serious injury or death (Laist et al., 2001). Sperm whales are one of 11 whale species that are hit commonly by ships (Laist et al., 2001). Collisions between OCS vessels and cetaceans in the grid area are expected to be unusual events.

Conclusion

The incremental contribution of the proposed action is minimal and is unlikely to have significant long-term adverse impacts on the size and productivity of any marine mammal species or population stock in the northern GOM.

4.2.4. Impacts on Sea Turtles

Factors that have potential to impact sea turtles include structure installation, dredging, water quality and habitat degradation, OCS-related trash and debris, vessel traffic, structure removals, oil spills, oil-spill-response activities, natural catastrophes (e.g., hurricanes), pollution, dredging operation, vessel traffic, commercial and recreational fishing, consumption by humans, beach lighting, and entrainment in power plants. Small numbers of turtles could be killed or injured by chance collision with service vessels or by eating indigestible trash, particularly plastic items, accidentally lost from drill rigs, production facilities, and service vessels. Deaths due to structure removals are not expected due to anticipated mitigation measures that are required by the NMFS. The presence of service vessels and the noise they produce could disrupt normal behavior patterns and physiologically stress the turtles, making them more susceptible to disease. Contaminants in waste discharges and drilling muds could indirectly affect turtles through food-chain biomagnification; there is uncertainty concerning the possible effect. Oil spills and oil-spill-response activities are potential threats that may be expected to cause turtle deaths, but the risks are greatly reduced by spill contingency planning and the habitat protection requirements of the Oil Pollution Act of 1990. Contact with oil and consumption of oil and oil-contaminated prey may seriously impact turtles.

Conclusion

Most OCS-related impacts are estimated to be sublethal. Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas could cause declines in survival or productivity, resulting in either acute or gradual population declines. The incremental contribution of the proposed action is minimal and is unlikely to have significant long-term adverse effects on the size and productivity of any sea turtles species or population stock in the northern GOM.

4.2.5. Impacts on Coastal and Marine Birds

This chapter discusses the possible effects of the proposed action on coastal and marine birds of the Gulf of Mexico and its contiguous waters and wetlands. Air emissions, water quality degradation resulting from discharges, helicopter and service-vessel traffic and noise, discarded trash and debris from service vessels and the drilling rig, an 8,800-bbl per day blowout at the proposed spar site, and spill-response activities are sources of potential adverse impacts. 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 habitat factors. Species of special concern are often populations at the edge of their range. These populations may be more vulnerable to impacts than populations of the same species living near the center of their range.

Emissions of pollutants into the atmosphere from the activities associated with the proposed action are projected to have minimum effects on offshore air quality because of the prevailing atmospheric conditions, emission heights, and pollutant concentrations. Such emissions are projected to have negligible effects on onshore air quality because of the atmospheric regime, emission rates, and distance of these emissions from the coastline. These judgements are based on average steady state conditions; however, there will be days of low mixing heights and low wind speeds that could further decrease air quality. These conditions are characterized by fog formation, which in the Gulf occurs about 35 days a year, mostly during winter. Impacts from offshore sources are reduced in winter because the frequency of significant onshore winds decreases (37%) and the removal of pollutants by rain increases. The summer is more conducive to air quality effects as onshore winds occur more frequently, approximately 61 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. Although these incidents are very short term 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 set forth 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. The effects of service-vessel traffic on birds offshore would be negligible.

Seabirds (e.g., laughing gulls) that remain and feed in the vicinity of the spar structure could be affected by operational discharges or runoff in the offshore environment. These impacts could also be both direct and indirect.

Coastal and marine birds are commonly entangled and snared in discarded trash and debris. In addition, many species will readily ingest small plastic debris, either intentionally or incidentally. Interaction with plastic materials is therefore very serious and can lead to permanent injuries and death. It is expected that coastal and marine birds would seldom become entangled in or ingest OCS-related trash and debris as a result of the MMS's prohibitions on the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which prohibits the disposal of any plastics at sea or in coastal waters, went into effect January 1, 1989. It is expected that plastic debris would seldom interact with coastal and marine birds, and therefore, the effect would be negligible.

An oil spill of 8,800 bbl per day for three days from a blowout at the well site is the operator's assumed oil-spill scenario (Appendix A). Various birds along contacted shoreline could experience mortality and reproductive losses. Recovery would depend on later influxes of birds from nearby feeding, roosting, and nesting habitat.

Oil-spill cleanup methods often require heavy trafficking of beaches and wetland areas, application of oil dispersant and bioremediation chemicals, and the distribution and collection of oil containment booms and absorbent material. The presence of humans, along with boats, aircraft, and other technological creations, will also disturb coastal birds after a spill. Investigations have shown that oil-dispersant mixtures pose a threat similar to that of oil in its effects to successful reproduction in birds (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 will 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 an established breeding population may also be a result of disturbance in the form of increased human activity for cleanup and monitoring efforts or to the intensified research activity after the oil spills (Maccarone and Brzorad, 1994). Studies are indicating that rescue and cleaning of oiled birds makes no effective contribution to conservation, except conceivably for species with a small world population (Clark, 1978 and 1984). 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). Preventative methods, such as scaring birds from the path of an approaching oil slick or the use of booms to protect sensitive colonies in an emergency, have extremely limited applicability (Clark, 1984).

Federally Endangered and Threatened Birds

Piping Plover

The impacts on shorebirds not listed as endangered or threatened discussed above also apply to the piping plover. A slick from an 8,800 bbl a day blowout, should it reach the coast, could injure or kill birds foraging or roosting along the shoreline. However, the amount of shoreline affected would be small compared to the extensive shoreline habitat available.

Bald Eagle

This bird feeds on fish, waterfowl, shorebirds, and carrion near water. The bald eagle may eat dead or dying contaminated fish and birds because it consumes carrion.

Brown Pelican

The brown pelican is a species of special concern in Louisiana and Mississippi, and it is no longer listed as endangered or threatened in Florida or Alabama (USDOI, FWS, 1998). This bird has no nesting reported in Mississippi. The bird nests on Guillard Island, Mobile Bay, which is a dredge spoil island in Alabama. Impacts on brown pelicans would be the same as for other nonendangered and nonthreatened seabirds, as analyzed above in this chapter.

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 intake of discarded debris), causing temporary disturbances and displacement of localized groups inshore. Chronic stress, such as digestive upset, partial digestive occlusion, sublethal poisoning, or behavior changes, however, 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. Death could result primarily from an 8,800 bbl per day blowout spill (Appendix A) and associated spill-response activities, and this could be especially serious for endangered/threatened species. Any reductions in population size represent a threat to their existence.

Conclusion

Coastal and marine birds may encounter periodic disturbance and temporary displacement of localized groups and individuals from the proposed action. Decreases in the numbers of adults and/or nests could occur as a result of an 8,800 bbl per day blowout spill (0.1 to 0.01% risk) if spill-related coastal habitat loss or degradation occurs. Groups experiencing the loss of individuals could require up to several years to recover to their state before disturbance. Given the species in the area and feeding strategies, the brown pelican is the species most likely to be impacted should a spill occur.

4.2.6. Impacts on Fish Resources

Minor sources of discharges associated with the proposed action to marine waters are muds and cuttings resulting from completion activities. A limited amount of mud discharge is expected from the completion operations. However, drilling muds contain materials, such as lead and cadmium, that in high concentrations are toxic to fishery resources (detailed in Section IV.A.3.b. of USDOI, MMS, 2001), the plume is expected to disperse rapidly, is very near background levels at a distance of 1,000 m (3,281 ft), and is usually undetectable at distances greater than 3,000 m (9,843 ft). In this specific action, discharges will be far less than during the drilling of the wells themselves.

Based on historical data, the MMS estimates the rate at which spills of 1,000 bbl or greater occur from platforms is 0.13 spills per billion bbl produced. See Appendix A for an in-depth evaluation of potential spill events.

The probability that a hypothetical oil spill greater than 1,000 bbl from the proposed facilities contacting a land segment within 3-10 days is less than 0.5 (Price et al., 1999). Only after 30 days do the probabilities increase and range from 1 to 6 percent for a spill event to contact a land segment. Although not a significant concern at the distance from shore for this action, discussion of impacts of oil spills to coastal and estuary environments and fisheries are detailed in Sections IV.D.1.a.(1) and (8) in the Final EIS for Western GOM Lease Sales 171, 174, 177, and 180 (USDOI, MMS, 1998), Discussions of impacts to essential fish habitat are detailed in Section IV.D.1.a.(10) of the Final EIS for Eastern GOM Lease Sale 181 (USDOI, MMS, 2001b).

If a blowout or a spill from any source was abated early, the impact on fisheries and commercial populations would likely be small.

There is no evidence at this time that commercial fisheries in the Gulf have been adversely affected on a regional population level by oil spills. However, the worst case blowout scenario could introduce a moderate amount of oil to surface waters over a short period of time. Adult fish would likely avoid the area of a spill, but fish eggs and larvae within the relatively small spill area of the northern Gulf of Mexico could be killed.

4.2.6.1. Adults

Regardless of spill size, adult fish 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). This behavior explains why there has never been a commercially important fish-kill on record following an oil spill. Observations at oil spills around the world, including the *Exxon Valdez* spill in Prince William Sound, consistently indicate that free-swimming fish are rarely at risk from oil spills (NRC, 1985). Some recent work has demonstrated avoidance of extremely small concentrations of hydrocarbons. Farr et al. (1995) reported the behavioral avoidance of dissolved concentrations of a PAH as low as 14.7 μg/l by a species of minnow.

Adult fish must experience continual exposure to relatively high levels of hydrocarbons over several months before secondary toxicological compounds that represent biological harm are detected in the liver (Payne et al., 1988). The direct effects of spilled oil on fish occur through the ingestion of oil or oiled prey and through the uptake of dissolved petroleum products through the gills and epithelium by adults and juveniles (NRC, 1985). Upon exposure to spilled oil, liver enzymes of fish oxidize soluble hydrocarbons into compounds that are easily excreted in the urine (Spies et al., 1982). Ordinary environmental stresses may increase the sensitivity of fish to oil toxicity. These stresses may include changes in salinity, temperature, and food abundance (Evans and Rice, 1974; NRC, 1985). Migratory species, such as mackerel, cobia, and crevalle jack, could be impacted if oil spills covered large areas of nearshore open waters.

The only adult fish-kill on record following an oil spill was on the French coast in 1978 when several tons of small rock-clinging fish (not commercially harvested) were killed at the site of the *Amoco Cadiz* wreck (volume of oil spilled was approximately six times that of the *Exxon Valdez*).

4.2.6.2. Eggs and Larvae

For OCS-related oil spills to have a substantial effect on a commercial fishery resource, whether estuary dependent or not, eggs and larvae would have to be concentrated in the immediate spill area. This area could be very large considering the maximum blowout discharge volume. Oil components also would have to be present in highly toxic concentrations when both eggs and larvae are in the pelagic stage (Longwell, 1977). When contacted by spilled oil, floating eggs and larvae (with their limited mobility and physiology), and most juvenile fish are killed (Linden et al., 1979; Longwell, 1977). However, fish overproduce eggs on an enormous scale and the overwhelming majority of them die at an early stage, generally as food for predators. It is likely that even a heavy death toll from a single large oil spill would not have a detectable effect on the adult populations that are exploited by commercial fisheries. This has been confirmed during and after the *Torrey Canyon* spill off southwest England and the *Argo Merchant* spill off Nantucket. In both cases, a 90 percent death of fish eggs and larvae, pilchard and pollack, respectively, was observed in the affected area, but this had no impact on the regional commercial fishery (Baker et al., 1991).

Oil spills that contact coastal bays, estuaries, and waters of the Gulf when pelagic eggs and larvae are present have the greatest potential to affect commercial fishery resources. An oil spill contacting a low-energy inshore area would affect localized populations of commercial fishery resources, such as menhaden, shrimp, and blue crabs.

In the event that oil spills should occur in coastal bays, estuaries, or waters of the OCS proximate to mobile adult finfish or shellfish, the effects are expected to be nonfatal and the extent of damages are expected to be limited and lessened due to the capability of adult fish and shellfish to avoid an oil spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. For floating eggs and larvae contacted by spilled oil, the effect is expected to be lethal.

The incremental contribution of the proposed action to the cumulative impacts would be small. The proposed action would add slightly to the overall offshore water quality degradation through the disposal of offshore operational wastes. Other activities of the proposed action potentially contributing to regional impacts would be the effects of potential petroleum spills. Impact-producing factors of the cumulative scenario in the area of the proposed action that are expected to substantially affect fish resources and EFH include overfishing. The incremental contribution of the proposed action to the cumulative impact is negligible.

Conclusion

It is expected that marine environmental degradation from the proposed action would have little effect on fish resources or EFH. The impact of marine environmental degradation is expected to cause an undetectable decrease in fish populations or EFH. It is expected that subsurface blowouts that may occur as a result of the proposed action would have a negligible effect on Gulf fish resources.

4.3. IMPACTS ON SOCIOECONOMIC CONDITIONS AND OTHER CONCERNS

4.3.1. Effects on Economic and Demographic Conditions

In Chapter 3.1.7.1.1, the MMS defined the potential impact region as that portion of the Gulf of Mexico 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 chapter, the MMS projects how and where future changes will occur and whether they correlate with the proposed action.

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. While some of the labor force is expected to be local to the Sabine Pass/Galveston area, most of the additional employees associated with the proposed action are not expected to require local housing. Activities relating to the proposed activity are not expected to significantly affect the region's educational levels.

4.3.1.2. Infrastructure and Land Use

While OCS-related servicing should increase in Sabine Pass and Galveston, Texas, there is sufficient land designated in commercial and industrial parks and adjacent to the existing port to minimize disruption to current residential and business use patterns. Changes in land use throughout the region as a result of the proposed action 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.

4.3.1.3. Navigation and Port Usage

The proposed action will use the existing onshore support bases located in Sabine Pass and/or in Galveston, Texas, for completion and workover activities. During these activities, three round-trip vessel trips per week are anticipated. The vessels to be utilized will be workboats. Both the Sabine Pass and Galveston shore bases are capable of providing the services necessary for the proposed activities; therefore, no onshore expansion or construction is anticipated with respect to the proposed action.

4.3.1.4. Employment

The importance of the oil and gas industry to the coastal communities of the Gulf of Mexico is significant, particularly in Louisiana, eastern Texas, and coastal Alabama. Dramatic changes in the level of OCS oil and gas activity over recent years have resulted in similar fluctuations in population, labor, and employment in the Gulf of Mexico 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 impact region.

To improve regional economic impact assessments and to make them more consistent with each other, the MMS recently developed a new 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 Gulf of Mexico region has two steps. Because 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 Kerr-McGee's Initial DOCD (for the fabrication/installation of a spar platform and the completion of 12 development wells) and assigns these expenditures to industrial sectors in the eight MMS coastal subareas defined in Table F-1. The second step in the model uses multipliers from the commercial input-output model IMPLAN (using 1998 data, the latest available data) 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 Kerr-McGee on the platform 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 platform and wells spend the initial direct dollars from the industry. These dollars are then 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) allocation of expenditures can vary considerably. Because 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 a 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 six months, while another person occupies it for the other six months.

Table F-4 shows total employment projections for activities resulting from the proposed action. The projections are expressed as absolute numbers and as a percentage of the employment levels expected if no development occurs. Note that Subareas LA-1, LA-2, LA-3, and MA-1 constitute the Central Planning Area; TX-1 and TX-2 represent the Western Planning Area; and FL-1 and FL-2 comprise the Eastern Planning Area. The baseline projections of employment used in this analysis are described in Chapter 3.1.7.1.5. Because 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 (year 2001) direct employment associated with the proposed action is estimated at 998 jobs. Indirect employment for the peak year is projected at 406 jobs, while induced employment is calculated to be 450 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 from 2002 through 2017 (that associated with operation and maintenance and workover activities) are expected to range about 40-50 jobs throughout all subareas and 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 mere occurrence of a spill is not a certainty. Spills are random accidental events. Given that the spar 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 DOCD are all unknown variables. Appendix A 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 8,800 bbl a day for three days (Appendix A). Based on model results, should such a spill occur, it is projected to cost about 900 person-years of employment for cleanup and remediation. Table F-7 summarizes the direct, indirect, and induced opportunity cost employment (by subarea and planning area) for an oil-spill cleanup should such a spill occur.

4.3.1.5. Environmental Justice

Executive Order 12898, entitled "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," directs Federal agencies to assess whether their actions have disproportionate environmental effects on people of ethnic or racial minorities or with low incomes. Those environmental effects encompass human health, social, and economic consequences.

The siting of onshore facilities related to OCS activities is usually based on economics, logistical considerations, zoning restrictions, and permitting requirements. Because of the need for contiguous land and the attraction of lower land values, such facilities, with their concomitant environmental implications, are often near low-income or minority populations. Within the impact region, the individuals potentially affected by the proposed action are African-Americans living in all of the Gulf of Mexico coastal states and low-income fishermen and timber harvesters in the coastal states. Native Americans are few and widely dispersed throughout the Gulf States. The impact region is not physically, culturally, or economically homogenous. Communities range in size from small municipalities to the urban. The racial and ethnic composition of the counties and parishes varies widely as does the distribution of income.

While people of these minority groups are scattered throughout the impact region, there are concentrations.

The MMS does not anticipate any negative environmental effects on the minority or poor persons in the Gulf counties or parishes. In addition, disproportionate and negative effects should not occur because the facilities, land use, and jobs already exist. If these change, especially if they increase and cause disruptions of local neighborhoods, then the relevant regulatory agencies should pay particular attention to how these neighborhoods are affected.

Conclusion

Should Kerr-McGee complete the activities described in their Initial DOCD, there would be very little economic stimulus to the Gulf of Mexico coastal impact area. Minimal effects, if any, on population and education are projected from activities associated with the proposed action. While land use in the impact area will change over time, the majority of this change is estimated as general regional growth. Sabine Pass, and Galveston, Texas, the designated service bases, are capable of providing the services necessary for the proposed activities; therefore, no onshore expansion or construction is anticipated with respect to the proposed action. Less than a 1 percent increase in employment in any impact subareas is expect as a result of the proposed action. The opportunity cost employment associated with oil-spill cleanup activities is expected to be temporary and of short duration.

4.3.2. Impacts on Commercial Fisheries

Commercial fishermen will actively avoid the area of a spill and the area where there are ongoing activities to control a blowout. 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 will prevent fishermen (either voluntarily or imposed by regulation) from initiating activities in the spill area. This in turn could decrease landings and/or the value of catch for several months. However, Gulf of Mexico 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.

Conclusion

There will be some unavoidable loss of space that could be utilized for pelagic fishing techniques such as long lines. Other unavoidable adverse impacts include loss of fishing space caused by the installation of pipelines, rigs, and platforms or by other OCS-related structures. These impacts are not considered to be significant. There are no commercially important species occurring at the water depth of this proposed action.

4.3.3. Impacts on Recreational Resources and Beach Use

The value of recreation and tourism in the Gulf of Mexico coastal zone from Texas through Florida has been estimated at almost $20 billion annually (USDOI, MMS, 1990). A significant portion of these expenditures is made in coastal counties, where major shoreline beaches are primary recreational attractions. In 1996, for example, well over 1 million people visited the beaches of Galveston Island and the Padre Island National Seashore, demonstrating the popularity of destination beach parks throughout the WPA as recreational resources.

The primary impact-producing factors associated with offshore oil and gas development, and most widely recognized as major threats to the enjoyment and use of recreational beaches, are oil spills (Appendix A) and trash and debris. Additional factors such as noise from aircraft can adversely affect a beach-related recreational experience. All these factors, either individually or collectively, may adversely affect the number and value of recreational beach visits. The major recreational activity occurring on the OCS is recreational fishing and diving. A substantial recreational fishery, including scuba diving, is directly associated with oil and gas production platforms and stems from the fact that platforms beneficially function as high-profile, artificial reefs that attract fish.

Conclusion

The risk of a large oil spill occurring due to the proposed development operations in East Breaks, Blocks 602 and 646 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.

Kerr-McGee 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.

4.3.4. Impacts on Archaeological Resources

4.3.4.1. Prehistoric

The Grid 4 area is 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 (200-ft) bathymetric contour. As stated in Chapter 3 of this document, the MMS recognizes both the 12,000 B.P. date and 60-m (200 ft) water depth as the seaward extant of prehistoric archaeological potential on the OCS. The water depth of the Grid 4 area, is deeper than 1,000 m (3,281 ft). Based on the extreme water depth of the Grid, there is simply no potential for prehistoric archaeological resources in this area. Therefore, any oil and gas development cannot possibly impact prehistoric archaeological resources.

Proposed Action Analysis

The proposed action includes the use of a derrick barge and its associated anchors, the emplacement of a truss spar production facility and its associated anchors, and the impacts of these anchors on the seafloor. The proposed offshore development as described in this plan cannot result in an impact to an inundated prehistoric archaeological site.

The MMS recognizes both the 12,000 B.P. date and 60-m (197 ft) water depth as the seaward extant of prehistoric potential on the OCS. The water depth of the Grid is greater than 1,000 m (3,281 ft). Therefore, the water depth is approximately 940 m (3,084 ft) deeper than the earliest known prehistoric archaeological sites in the Gulf of Mexico.

Conclusion

Based on the extreme water depth of Grid 4, the proposed oil or gas development will not impact any prehistoric archaeological resources.

4.3.4.2. 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 an MMS-funded study and shipwreck model (Garrison et al., 1989). The study expanded the shipwreck database in the Gulf of Mexico from 1,500 to more than 4,000 wrecks. Statistical analysis of 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. High-probability search polygons associated with individual shipwrecks were created to afford protection to wrecks located outside of the two aforementioned high-probability areas.

An Archaeological Resources Stipulation was included in all Gulf of Mexico lease sales from 1974 through 1994. The stipulation was incorporated into the MMS's Operational Regulations on November 21, 1994. The language of the stipulation was incorporated into the operational regulations under 30 CFR 250.26 with few changes, and all protective measures offered in the stipulation have been adopted by the regulation.

NTL 98-06, issued on August 10, 1998, supersedes all other archaeological NTL’s and LTL’s and makes minor technical amendments, updates cited regulatory authorities, and continues to mandate a

50-m (164-ft) remote-sensing survey linespacing 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 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 could result in a drilling rig, pipeline, or anchors associated with the truss spar and derrick barges impacting a historic shipwreck. 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 emplacement of anchors associated with a derrick barge and with the truss spar production facility has the potential to cause physical impact to historic archaeological resources on the seafloor. Based on the plan submitted by the applicant, the manned floating production facility (the Nansen truss spar) will be permanently anchored with a nine-leg taut catenary mooring system consisting of conventional wire and chain and anchor piles. Placing of these nine permanent piles, in a three-by-three pile patterns into the seafloor and allowing for wire rope and chain catenary to contact the seafloor, would directly disturb approximately an area of 2.1 ha per 3-pile pattern. The derrick barge with its 6-point anchoring 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 stratigraphy in the area of liquefaction.

Pipeline installation also has the potential to cause a physical impact to historic archaeological resources. In a recent pipeline installation in March 2001, an 8-in pipeline was laid across a historic shipwreck in a water depth of approximately 808 m (2,650 ft).

Petroleum 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. The OCS 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.

Proposed Action Analysis

The specific locations of archaeological site areas 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 250.26, requires that an archaeological survey be conducted prior to development of leases within the high-probability zones for historic and prehistoric archaeological resources. The Grid 4 area does not fall within the described MMS's high-probability zone. A review of the geophysical report submitted by the applicant indicated that no seafloor features suggestive of historic shipwrecks were recorded during the lease blocks' side-scan sonar survey. The aforementioned survey reduces the potential for an impact to occur by an estimated 90 percent.

The proposed action includes installation of the subsea lease-term pipelines and umbilicals, installation of the Nansen spar mooring system, installation of the spar topside facilities, completion of hookup, pull in of risers/umbilicals for the subsea wells, and initiation of production from dry tree and subsea wells.

Ferromagnetic debris associated with exploration 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 a 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.

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 truss spar facility. 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), the shipwreck database lists seven shipwrecks that fall within the Grid 4 area. Three are modern wrecks, three are only listed as wrecks by name and no date of sinking, and one is a historic wreck reported lost in 1908 (possibly in East Breaks, Block 199). All of the blocks within the Grid 4 area fall within the MMS GOM Region's low-probability area for the occurrence of historic shipwrecks.

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 a 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 proposed development in the Grid 4 area could impact a 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 Western Planning Areas and the Gulf Coast region for the years 1996 through 2036 as part of the NEPA documentation completed for proposed multisale lease activities. The latest publication applicable to Grid 4 is the Final EIS for Western GOM Lease Sales 171, 174, 177, and 180 (USDOI, MMS, 1998). Specific OCS-related effects from the proposed activities related to the Nansen Project are addressed in Chapters 4.1-4.3.

The following chapters discuss cumulative effects of non-OCS-related activities for selected resources in the Western Planning Area of the GOM.

4.4.1. Water Quality

4.4.1.1. Coastal

Major sources expected to contribute to the contamination of the GOM's coastal waters include the petrochemical industry, agriculture, urban expansion, municipal and camp sewerage treatment processes, marinas, commercial fishing, maritime shipping, and hydromodification activities.

The coastal waters of the Gulf have been heavily used by people and are now showing some signs of environmental stress. Large areas are experiencing nutrient overenrichment, low-dissolved oxygen, toxin and pesticide contamination, shellfish ground closures, and loss of wetlands. Contaminant inputs to coastal waters bordering the GOM will continue as a result of the large volumes of water entering the GOM from rivers that drain over two-thirds of the contiguous U.S. and from both municipal and industrial point and nonpoint-source discharges.

Lesser sources of contamination are likely to be forestry, recreational boating, livestock farming, manufacturing industries, nuclear power plant operations, and pulp and paper mills. Runoff and wastewater discharges from these sources may impact water quality to the extent that a significant percentage of the GOM's coastal waters may not attain certain Federal water quality standards.

4.4.1.2. Offshore

Major sources expected to contribute to effects on the GOM's offshore waters include marine transportation, commercial fishing, and hydrocarbon seeps. The GOM is a very active maritime province with both international and domestic waterborne commerce. Discharges and debris from these vessels will affect the offshore water quality of the GOM. Commercial fishing activities will disturb the GOM's sediments resulting in localized impacts to the offshore waters. Natural hydrocarbon seeps have been documented in the deepwater area of the GOM (Brooks et al., 1986b, 1987, 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 x 103 to 7.8 x 104 m^3 y^{-1} in the 8,200 km^2 area imaged and 1.1 x 104 to 4.8 x 105 m^3 y^{-1} in the 15,000 km^2 image (USDOI, MMS, 1996).

4.4.2. Air Quality

Effects on air quality within the study area will come primarily from industrial, power generation, and urban emissions. The coastal areas nearest the study area are currently designated as "attainment" for all the National Ambient Air Quality Standards-regulated pollutants except ozone. The USEPA has designated several areas along the Gulf Coast as "nonattainment" for ground-level ozone—Houston-Galveston-Brazoria, and Beaumont-Port Arthur areas in Texas and Lafouche Parish in Louisiana (USEPA, 2001).

4.4.3. Sensitive Coastal Environments

4.4.3.1. Coastal Barrier Beaches and Associated Dunes

Coastal barrier beaches of the Chenier Plain have experienced severe erosion and landward retreat because of human activities and natural processes. Over the last 50 years, most adverse effects to the Texas barrier islands have resulted from human activities. These adverse effects on barrier beaches and 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 process 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

In most areas that might be influenced by the proposed action, the conversion of wetlands to agricultural, residential, and commercial uses has generally been the major cause of wetland loss. Commercial uses including dredging for both waterfront developments and coastal oil and gas activities. In the Chenier Plain of Louisiana, natural and man-induced erosion and subsidence are also important causes of wetland loss. Wetland loss is projected to continue around the WPA and CPA of the Gulf.

4.4.3.3. Seagrasses

Seagrasses are adversely affected by several human activities. These 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 non-existent at water depths of greater than 400 m.

4.4.4.2. Coral Reefs

All 23 topographic features in the WPA are protected by "no activity zones" and other operational 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. Hypoxic conditions at the seafloor may affect the deepwater benthos and associated communities.

4.4.5. Marine Mammals

Marine mammals could be adversely affected by vessel traffic, degradation of water quality, aircraft and vessel noise, loss of debris from vessels, commercial fishing (capture and removal), pathogens, and negative impacts to prey populations. The cumulative impacts to marine mammals are expected to result in a number of chronic and sporadic lethal and sublethal effects. Sublethal effects may stress and/or weaken individuals of a local group or population, thus making them more susceptible to infection from natural or anthropogenic sources.

4.4.6. Sea Turtles

Factors with the potential to effect sea turtles include dredging operations, water quality and habitat degradation, trash and debris, vessel traffic, natural catastrophes (e.g., hurricanes, unseasonably cold weather), commercial and recreational fishing, beach and other lighting, and entrainment in industrial intakes (e.g., electrical generation plants). Small numbers of turtles could be killed or injured from chance collisions with vessels or from eating indigestible trash or debris (particularly plastic items). Noise from vessels could disrupt normal behavioral patterns and physiologically stress turtles making them more susceptible to disease. Pollution could indirectly affect sea turtles through food-chain biomagnification.

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.

4.4.8. Fish Resources

Degradation of water quality, loss of essential habitat (including wetlands loss), pathogens, trash and debris, riverine influences, and overfishing could affect fish resources. Eggs and larvae are more susceptible than adults to environmental contaminants. 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. 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 in Grid 4 are expected to have minimal economic and demographic consequences to the region.

4.4.9.1. 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 4 are not expected to affect the population's growth rate. Education levels are expected to remain unchanged by activities within Grid 4.

4.4.9.2. Infrastructure and Land Use

Sufficient infrastructure is in place to support activities within Grid 4. 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. Land use in the area will change over time; however, the majority of this change is expected to be general regional growth.

4.4.9.3. 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 4.

4.4.9.4. 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 4 are expected to be negligible.

4.4.9.5. 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 income. Since sufficient onshore facilities are available to support offshore activities in Grid 4, no effects to minorities or people with low incomes in the Gulf counties and parishes are expected.

4.4.10. 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 GOM will remain one of the Nation's most important commercial fisheries area.

4.4.11. 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.

Frequent impacts from man-induced debris and litter derived from both offshore and onshore sources are likely to diminish the tourist potential of beaches and to degrade the ambience of shoreline recreational beaches chronically, thereby affecting the enjoyment of recreational beaches throughout the planning area. A ton or more per mile of trash and debris has been removed from recreational beaches cleaned in the WPA each fall since 1986. MARPOL Annex V and the special efforts to generate cooperation and support for reducing marine debris through the Gulf of Mexico Program's Marine Debris Action Plan should lead to a decline in the level of human-generated trash adversely affecting 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.

4.4.12. Archaeological Resources

4.4.12.1. Prehistoric

Grid 4 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. No potential exists to affect prehistoric archaeological resources.

4.4.12.2. Historic

Seven shipwrecks identified in the MMS's database; however, none of these shipwrecks are located within Grid. 4. Seafloor-disturbing activities do hold the potential to affect these resources. In-place mitigating measures should eliminate or minimize potential impacts to these resources. In water depths where anchoring is plausible, these activities may adversely affect historic archaeological resources.

5. CONSULTATION AND COORDINATION

A Notice of Intent to Prepare an Environmental Assessment on the Nansen Project was published in the *Federal Register* on May 9, 2001. The Notice provided the public with a 30-day comment period to provide issues that should be addressed in the PEA. No comments were received.

The State of Texas has an approved Coastal Zone Management (CZM) Program. Therefore, a Certificate of Coastal Zone Consistency was required for the proposed activities. The MMS mailed the plan and other required and necessary information to the State of Texas, Coastal Coordination Council on February 12, 2001. It was received by the Council on February 16, 2001. The plan was assigned Project Number 01-0048-F4. After the required 15-day evaluation interval, no written notice was received from the Council and the plan was deemed to be consistent with the Texas CZM Program.

The MMS coordinated with the USEPA, Region 6, because of the high rate of produced water discharge projected for the Nansen Project. The current NPDES General Permit (GMG 29000) for Region 6 requires that the operator test the produced-water outfall for oil and grease, estimate flow rates once per month, monitor for visual sheens daily, and analyze for toxicity once per quarter when the discharge rate is above 4,600 barrels of produced water per day (BPW/D) until such testing shows compliance for one full year. The permit requires that these monitoring results be summarized and submitted to the USEPA on discharge monitoring reports (DMR's) for the previous 12-month period. Since the plan submitted for the Nansen Project indicates that as much as 40,000 BPW/D could be discharged, the USEPA plans to contact the operator and request that, in addition to the annual submission of monitoring results on the DMR's, the operator must submit all quarterly testing results required by the general permit on a quarterly basis to the USEPA. The USEPA will provide this information to the MMS.

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8. APPENDICES

Appendix A. Accidental Hydrocarbon Discharge Analysis
Appendix B. Meteorological Conditions
Appendix C. Geology
Appendix D. Physical Oceanography
Appendix E. Other Information on Grid 4
Appendix F. Socioeconomic Conditions

APPENDIX A

Accidental Hydrocarbon Discharge Analysis

Appendix A

Accidental Hydrocarbon Discharge Analysis

Prepared for the Kerr-McGee Oil and Gas Corporation's proposal to complete and produce 12 wells either as dry trees or subsea tie backs to a truss spar floating production system located in East Breaks, Block 602, N-7045 (Nansen).

1. Hydrocarbon Spill Accidents

a. Potential Sources of a Spill as a Result of the Proposal

This proposal covers the completion and production of 12 wells either as dry trees or subsea tie backs to a truss spar floating production system (Platform A) located in East Breaks, Block 602, in approximately 3,675 ft of water. The Nansen spar is not drilling capable; however, a smaller workover/completion rig will be installed on the spar to workover or complete the wells as needed. Oil and gas will be exported from the spar by right-of-way pipelines owned and operated by a third party.

Potential sources of hydrocarbon spills from the proposed activity would include

- the loss of hydrocarbons during the proposed operations from

— a storage tank(s) accident on the facility;
— a transfer operation mishap(s) between the supply vessel and the facility; and/or
— a leak from a riser or pipeline; and

- the loss of hydrocarbons as a result of a blowout.

Facility Storage and Transfer Operations (diesel)

Platform A will have a storage capacity totaling 3,526 bbl for liquid oils. Approximately one trip per week will be made to the platform by a supply vessel during which the transfer of hydrocarbon products will occur. The carrying capacity of the fuel supply vessel is approximately 1,425 bbl. Approximately two trips per week will be made to the drill site by crewboats during production. During completion activities or workovers, three trips per week by workboats are expected. The carrying capacity of these workboats are also estimated at approximately 1,425 bbl. Table A-1 lists the storage capacity for the tanks or the completion rig on Platform A that are capable of holding liquid oils by oil type and volume.

Blowouts

Blowouts can occur during any phase of development: exploratory drilling, development drilling, completion, production, or workover operations. Blowouts occur when improperly balanced well pressures result in sudden, uncontrolled releases of fluids from a wellhead or wellbore. Historically (since 1971), most blowouts have resulted in the release of gas; blowouts resulting in the release of oil have been rare.

Although not a new potential source of spills, the likelihood of spills from loss of control (blowouts) in deep water may be different from the risk of spills in shallow water. Further investigation is required before the consequences of blowouts in deep water can be fully evaluated. Of particular concern is the ability to stop well control loss once it begins, thus limiting the size of a spill. Regaining well control in deep water may be a problem, in some instances, since it could require the operator to cap and control well flow at the seabed in great water depths [in this instance, over 1,120 m (3,675 ft)] and could require simultaneous fire-fighting efforts at the surface. Since there are a number of semisubmersibles and drill ships capable of drilling relief wells in these water depths, rig availability is not anticipated to be a problem.

Table A-1

Storage of Liquid Oils

Liquid Hydrocarbons	Type of Facility	No. of Tank(s)	Volume of Tanks (bbl)	Total Capacity (bbl)	Description of Oil/Type
Diesel	Platform A	1	167	167	No. 2 diesel
Diesel	Platform A	1	29	29	No. 2 diesel
Diesel	Completion Rig on Platform A	200	1	200	No. 2 diesel
Crude	Production vessel	25-100	7	305	29 ^{o} crude
Crude	Production vessel	100-300	4	686	29 ^{o} crude
Crude	Production vessel	>300	4	2,139	29 ^{o} crude
Total			18	3,526	N/A

The operator described the formation as being loosely compacted, minimally cemented sand and silt, having a high probability for a well to bridge over with produced sand during a blowout situation, if sand control has not been utilized. If the well has not been gravel packed, it is estimated by the operator that in a blowout situation, the well could sand over within 24 hours. If the well was gravel packed and the well was allowed to flow uncontrolled, the operator estimates that the well could bridge over within 3 days (Kerr-McGee Oil and Gas Corporation, 2001).

At the first indication of a loss of well control, the operator states that he would make every attempt to use surface intervention to stop the blowout. It is anticipated that these wells could be controlled successfully using surface intervention techniques (Kerr-McGee Oil and Gas Corporation, 2001).

In the event that the aforementioned well control measures were ineffective, Kerr-McGee estimates that it could take 45 days to drill an intervention well at the proposed locations once the rig was on site (Kerr-McGee Oil and Gas Corporation, 2001). The actual amount of time required to drill the relief well will depend upon the complexity of the intervention, the location of a suitable rig, the type of operation that must be terminated in order to release the rig (e.g., may need to run casing before releasing the rig), and any problems mobilizing personnel and equipment to the location (Regg, personal communication, 1998; Stauffer, personal communication, 1998; McCarroll, personal communication, 1998). Keeping in mind that it is rare for a well blowout to result in a release of oil, if a blowout in deepwater occurs, the MMS will still most likely require that the operator immediately begin preparations to drill a relief well (McCarrel, 1998).

Pipeline Spills

The installation of pipelines in deep water raises some unique concerns regarding the potential for oil spills. One of these concerns is the ability for surface detection of a leak from a deepwater pipeline. Because natural gas solubilities increase by orders of magnitude in deep water and because of oil densities, surface detection may be almost impossible. Leaks may be detected by pressure drops in the lines and confirmed by ROV inspection. Additional concerns are the ability to timely repair damage to deepwater pipelines and the unknowns regarding the potential effects of the steep terrain prevalent in some deepwater areas on the pipelines.

b. *Historical Spill Information*

Storage and Transfer Operations Spills (diesel)

The MMS's database on diesel spills that occurred from oil and gas operations conducted on the OCS between 1976 and 1985 was analyzed. These years were chosen because they represent the most complete recording of these events over a 10-year period. These data are not routinely captured within the MMS historical database. From 1976 to 1985, there were approximately 139 reported diesel spills of greater than 1 bbl related to OCS activity (includes all OCS areas). There is no information available on diesel spills of less than 1 bbl.

Many of the diesel spills in the MMS database occurred as a result of an accident during transfer operations. The majority of transfer accidents occurred due to human error of some type (personnel falling asleep, unmanned transfer operations, etc.) and, secondly, due to the malfunction or failure of the transfer equipment, which was sometimes due to weather conditions. Requirements now exist that reduce the risk of some of the transfer accidents historically caused by human error. Causes of the spills that were not associated with transfer mishaps were divided between equipment malfunctions/failures involving the fuel tanks on a rig and collisions involving supply vessels. Difficulties with deepwater operations that could cause diesel spill events are not necessarily reflected in these data.

Historically, diesel spill sizes from OCS operations have ranged from less than 1 bbl to 1,500 bbl. A vessel collision was the cause of the only diesel spill of greater than 1,000 bbl to occur during drilling activities. In 1979, an anchor-handling boat collided with a drilling platform in the Main Pass Area and released 1,500 bbl of diesel.

Blowouts and Production Related Spills

In order to enhance the prevention of blowouts, the MMS has identified requirements for well control and blowout prevention equipment, procedures, and inspections as specified in 30 CFR 250.

From 1971 to 1999, a total of only 901 bbl of crude oil and/or condensate were spilled in the 66 blowouts that occurred during nondrilling operations (i.e., completions, workovers, and production) on the Federal OCS (USDOI, MMS, 1997b and 2001c). The reasons for this historic low volume of oil spillage over the past 28 years is that a majority of the historic blowouts were gas blowouts and did not result in an oil spill. Blowouts that did involve oil spillage were typically low-volume events. However, the historical MMS accident database primarily reflects drilling in the shallower shelf waters. Therefore, because of differences in deepwater drilling operations, it cannot yet be determined with any degree of certainty whether this same trend will continue in the deepwater areas of the OCS.

Data maintained since 1964 on spills of 1,000 bbl or greater from offshore platforms and pipelines have documented only 11 spills of 1,000 bbl or more from platforms on the OCS (all OCS areas included). The majority of these spills occurred due to bad weather conditions. These spill event data, in conjunction with the historic production of OCS leases, allow the estimation of a spill rate. This spill rate has not been uniform through time and several revisions have been made (Nakassis, 1982; Lanfear and Amstutz, 1983; Anderson and LaBelle, 1990, 1994, and 2001). The latest revisions in the spill rate found a decrease in the spill rate for platforms (Anderson and LaBelle, 1990, 1994, and 2001). These reductions were attributed to improved safety practices in the oil industry. Based on historical data, the MMS has estimated the rate at which spills occur from platforms for oil spills greater than or equal to 1,000 bbl as 0.13 spills per billion bbl produced.

The probability that an oil spill of 1,000 bbl or greater will occur from the proposed platform is estimated using a Poisson Distribution and using the spill rate of 0.13 spills per billion bbl produced (Anderson and LaBelle, 2001). The other parameter needed to determine this probability would include the amount of oil produced [estimated to be 219 million bbl of oil (MMBO) over the 15-year life of the project] for an estimated 0.03 mean number spills greater than or equal to 1,000 bbl likely to occur from the platform over the 15-year life of the project, with a 3 percent probability of one or more such spills occurring.

The historical record shows that there have only been four large oil spills exceeding 10,000 bbl as a result of OCS activities (all OCS areas included)—of which two resulted from platforms. These two platform spills resulted from blowouts, which along with the Santa Barbara blowout incident, prompted the implementation of new and stringent operating regulations pertaining to drilling procedures, subsurface safety valves, and platform safety devices. Based on historical data, as a subset of spills greater than or equal to 1,000 bbl, the MMS has estimated the rate at which spills occur from platforms for oil spills greater than or equal to 10,000 bbl as 0.05 spills per billion bbl produced.

The probability that an oil spill of 10,000 bbl or greater will occur from the proposed platform is estimated using a Poisson Distribution and using the spill rate of 0.05 spills per billion bbl produced (Anderson and LaBelle, 2001). The other parameter needed to determine this probability would include the amount of oil produced (estimated to be 219 MMBO over the 15-year life of the development) for an estimated 0.01 mean number spills greater than or equal to 10,000 bbl likely to occur from the platform over the 15-year life of the project, with a 1 percent probability of one or more such spills occurring.

The historical database used as the basis for the above discussion reflects drilling in the shallower shelf waters. Because of differences in deepwater drilling operations, it cannot yet be determined with any degree of certainty whether this same trend will continue in the deepwater areas of the OCS.

Pipeline Spills

For spills occurring in Federal waters and greater than or equal to 1,000 bbl, the spill rate is calculated to be 1.38 spills/Bbbl of produced oil for OCS pipelines. This pipeline spill rate is based on the entire OCS production (transportation) record and all historic pipeline spill records. Assuming that all of the oil from this proposal will be transported in the proposed export pipeline at a rate of 40,000 bbl/day and that additional oil will not be added to the pipeline from other sources, the probability for a spill to occur from the pipeline over the 15-year life of the project would be 26 percent.

c. Spill Volume(s) to be Analyzed

To comply with the requirements at 30 CFR 254, the operator has provided an estimated worst-case blowout volume of 8,800 bbl/day for the proposed facility (Kerr-McGee Oil and Gas Corporation, 2001).

Kerr-McGee further determined a “reasonable blowout scenario” to be used in the analysis for this EA. The operator concluded that it could be expected that the blowout scenario could continue for up to three days at a rate of 8,800 bbl/day before it would reasonably be assumed that the well would shut-in on its own without further intervention (Kerr-McGee Oil and Gas Corporation, 2001). Although the operator identified that the blowout volume would be expected to diminish overtime due to the change in reservoir pressure and formation collapse, the diminished rates for the blowout were not provided. Therefore, an 8,800 bbl day blowout scenario over three days will be analyzed in this EA. Since the volume of oil that will be analyzed for this EA as part of the blowout scenario is greater than the total contents of the tanks on the platform and the storage on the supply vessels, this analysis will not consider, as a separate scenario, the loss of the stored or transferred hydrocarbons.

2. Vulnerability of Potentially Affected Resources to Hydrocarbon Spills Subsurface Spills

Since modeling research funded by the MMS to determine oil-spill behavior from subsurface well blowouts in deep water is currently underway, this analysis does not attempt to predict or model the potential movement of a subsurface oil slick.

Surface Spills

Table A-2 is derived from the results of an Oil Spill Risk Analysis (OSRA) as a supplement to the 1997 Gulf of Mexico OSRA (Price et al., 1999), and presents the risk of a spill greater than or equal to 1,000 bbl from the facility, if one occurred, contacting land segments (designated as counties/parishes) within 3, 10, or 30 days after a spill event.

Table A-2

Probabilities (expressed as a percent chance) that a Hypothetical Oil Spill Greater Than 1,000 bbl Resulting from the Proposed Facility in Launch Area 21 will Contact a Land Segment (county/parish) within 3, 10, or 30 Days[1]

Land Segment (segment number)	Probability of Contact (conditional)[2] Percent Chance	
	10 days	30 days
Kenedy, Texas (3)	—	1
Kleberg, Texas (4)	—	1
Neuces, Texas (5)	—	1
San Patricio, Texas (5)	—	1
Aransas, Texas (6)	—	1
Calhoun, Texas (7)	—	3
Matagorda, Texas (8)	—	6
Brazoria, Texas (9)	—	2
Chambers, Texas (10)	—	3
Galveston, Texas (10)	—	3
Jefferson, Texas (11)	—	2
Cameron, Louisiana (12)	—	4

As identified in Table A-2, there is a low probability for a hypothetical spill greater than or equal to 1,000 bbl from the facility to contact any county or parish. These contact estimates assume no weathering or oil-spill response intervention. Weathering and spill-response intervention would be expected to reduce the persistence of the oil and the potential for a slick to contact any of the identified counties/parishes. The next two chapters address the effects of weathering and spill-response intervention.

3. Assumptions about the Characteristics and Fates of Spilled Hydrocarbons Characteristics of Hydrocarbons

Information submitted by Kerr-McGee indicates that the produced crude could have an API gravity of approximately 29.1 degrees. The information submitted by Kerr-McGee regarding the estimated chemical characteristics of the target oil and the diesel fuel projected for use is included in Kerr-McGee's plan (Kerr-McGee Oil and Gas Corporation, 2001).

Subsurface Spills

The chemical behavior, transport, and physics of the rising plume during a subsea blowout under the temperature and pressure conditions encountered in deep water is not fully understood. The 1997 S.L. Ross study indicated that the form that a slick will take if released during a subsea blowout may be very different from oil spilled at the surface and may affect the residence time of the slick (S.L. Ross Environmental Research Ltd., 1997). This modeling effort showed that hydrates might form from some of the gaseous components in a blowout fluid. This deepwater blowout study funded by the MMS modeled the fate of a release of 30,000 bbl of oil per day and 60 million cubic feet of gas per day during a deepwater blowout. One of the scenarios modeled assumed a blowout in water depths greater than 900 m. The results indicated that blowouts at this depth were expected to result in a very fast conversion of all of the gas to hydrate, and the oil was expected to rise to the water surface due only to its buoyancy.

In contrast, field trials and modeling efforts recently completed by IKU Petroleum Research (Rye and Brandvik, 1997) showed that the stratification of the ambient watermasses may prevent the subsurface plume from reaching the sea surface. If the oil were to reach the sea surface, it could be far from the spill's subsea origin. This work indicated that it may consist of oil droplets that form a very thin surface slick spread over a larger area, accelerating the speed at which the slick breaks up and dissipates. The results of this study indicated that not all of the oil originally released would be expected to reach the surface in the form of a surface slick.

In an effort to better understand the behavior of oil released at the seafloor from subsea well blowouts in deep water, the MMS and industry co-funded an experimental deepwater release off the coast of Norway in late summer 2000. Results from this research indicated that, while the current structure of the water column affected the rising plume, the plume still surfaced relatively near the source. These results will also be used to further calibrate models of deepwater blowouts. The final results of this research should provide a more in-depth analysis of oil-spill behavior from subsurface well blowouts in deep water; this analysis can be used to predict the fate of a potential deepwater release.

Surface Spills

For the evaluation of this proposed action, the Sintef Oil Weathering Model, Version 1.8, developed by Sintef Applied Chemistry, was run. The model's calculations essentially predict the material balance of spilled hydrocarbons as a function of time, assuming the spilled oil is not transported subsea. An oil having chemical characteristics as similar as possible to the crude oil that the operator projected they might encounter during completion and production activities was chosen. The representative oil used in the Sintef model run has an API gravity of 27.6 degrees. Since the preliminary information that is available as a result of the field test conducted off Norway in 2000 indicates that any accidentally released oil will surface fairly closely to the spill site, a surface slick was assumed for these scenarios. The Sintef oil-spill scenario assumed the continuous loss of 8,800 bbl of oil/day (over 3 days) during a blowout under conservative spring weather conditions (20°C sea surface temperature and low wind speeds of 6 kn with no frontal passages). The Sintef model results showed that the majority of oil that was lost due to weathering occurred due to evaporation. The results indicate that very little oil was lost due to natural dispersion. Figure A-1 depicts the percentage of oil that evaporated and that naturally dispersed as a result of a spill event involving an 8,800 bbl/day release of oil over 3 days.

The percentage of the hypothetically spilled oil remaining on the water surface per day up to 20 days as calculated by the Sintef Weathering Model run is depicted in Figure A-2. As shown in Figure A-2, the Sintef scenario runs for the 8,800 bbl/day deepwater blowout event lasting 3 days indicate that approximately 63 percent of the 26,400-bbl spill would remain on the water surface up to 20 days after the blowout occurred.

4. Hydrocarbon Spill Containment/Cleanup Capabilities and Effectiveness

Kerr-McGee will be responsible for ensuring that a response to an oil spill of would be in full accordance with the applicable Federal and State laws and regulations as well as with Kerr-McGee's own policy for accidental spill prevention and containment. The proposal is covered by Kerr-McGee's Regional Oil Spill Response Plan (ROSRP), which provides the basis for an oil-spill response for this action. The ROSRP covering Kerr-McGee's facilities is designed to help personnel respond quickly and effectively to environmental incidents and is a guide that will be followed in handling spill-response situations.

The ability to respond to a spill that might occur in the deepwater areas of the OCS will vary dependent upon a number of factors. Among these factors are

- the chemical and physical characteristics of an oil,
- the volume of oil spilled,
- the rate of spillage,
- the weather conditions at the time of a spill,
- the source of the spill (e.g., platform storage spill or surface or subsurface blowout), and
- the amount of time necessary for response equipment or chemical countermeasures to reach a spill site.

Spills in deep water may be larger due to the high production rates associated with deepwater wells and the length of time it could take to stop the source of pollution (e.g., subsea blowout). In addition, response times to the deepwater locations may be longer than elsewhere in the GOM. However, the distance from shore (approximately 118 mi) will generally allow more time for cleanup efforts and natural dissipation of the oil to take place.

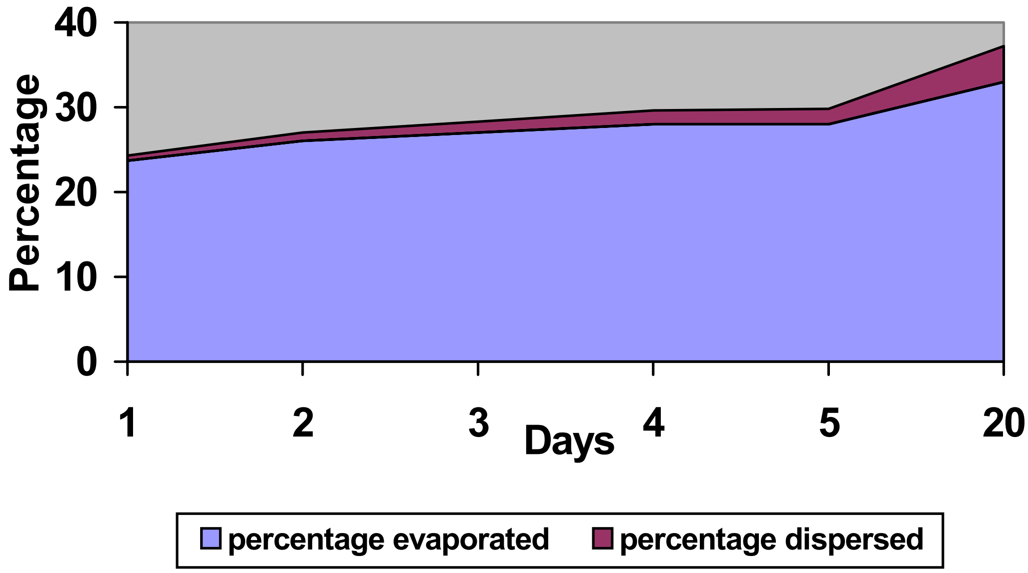

Figure A-1. Percentage of oil lost through evaporation and natural dispersion of an 8,800-bbl/day continuous spill for 3 days.

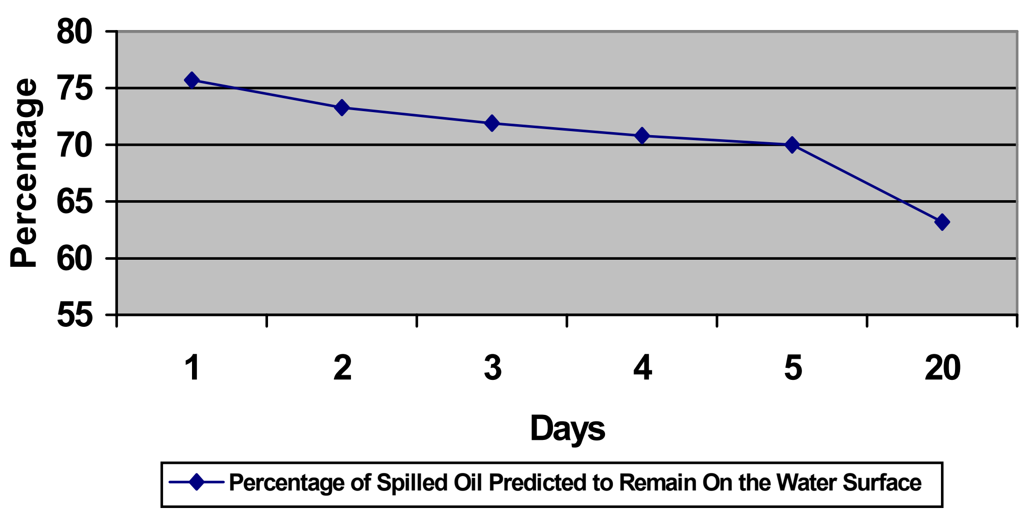

Figure A-2. Percentage of spilled oil predicted to remain on the water surface due to an 8,800-bbl/day blowout over 3 days.

Subsurface Spill

There is a remote possibility that oil released subsea (e.g., subsea blowout) in these deepwater environments could remain submerged for some period of time and travel away from a spill site. There are few practical spill-response options for dealing with submerged oil. It should be expected that it would not be possible to predict the movement of or to detect the submerged oil in a deepwater environment. Containment and recovery would only be possible when the oil is in shallow, clear, sheltered waters where the oil is relatively stationary and restricted in extent (Brown et al., 1998)

The model results of a study conducted by S.L. Ross in 1997 (S.L. Ross Environmental Research Ltd., 1997), which was discussed previously, indicated that slicks formed in those cases where the gas plume does not develop (in water depths greater than 900 m) will be narrower at the source than bubble plume slicks (assumed to occur in water depths ranging from 300 to 750 m) and more patchy. These slicks (where a gas plume does not develop) will be thin and, as a result, are not expected to be successfully contained and/or removed from the water surface through the typical mechanical oil-spill response booming and removal operations. Chemical dispersants may be the only viable spill-response countermeasure that would be effective under these conditions. The 1997 study further concluded that it is possible that natural dispersion of these slicks would alleviate the necessity for any response action for blowouts in some deepwater locations (S.L. Ross Environmetnal Research Ltd., 1997). The MMS and industry co-funded field research off the coastline of Norway in the Summer of 2000 to better understand the behavior of oil released at the seafloor from subsea well blowouts in deep water. Preliminary results from the research indicated that while the current structure of the water column will affect the rising plume, the plume still surfaces relatively near the source. These results will also be used to further calibrate models of deepwater blowouts. Once compiled, the results will be examined to determine whether the findings from the field exercise validate the 1997 S.L. Ross assumptions regarding appropriate spill-response countermeasures to a deepwater spill.

Since the application of dispersants may be the only feasible oil-spill response option to some deepwater spills due to the anticipated slick thickness and due to the potential volume of oil that could be spilled from some deepwater wells, the availability and suitability of dispersant application in the deepwater environment is a concern. At present, the Oil Spill Removal Organizations (OSRO's), with whom Kerr-McGee has contracts, cite contractual access to Airborne Support Inc. (ASI) located in Bourg, Louisiana. ASI has a stockpile of approximately 45,300 gal of the dispersant Corexit 9527 and 9500 available for application by two DC-3 and one DC-4 aircraft. At a 20:1 application ratio, each DC-3 holds enough dispersant to spray a slick of approximately 571 bbl of oil, and the DC-4 can spray a 952-bbl slick. At this same 20:1 ratio, the 45,300-gal stockpile of dispersant available through ASI in Bourg, Louisiana, is sufficient to spray a 22,000-bbl oil spill. However, numerous sorties would be required to apply this volume of dispersant. Additional dispersant stockpiles are also available and additional supplies of Corexit 9500 can be manufactured by Exxon within 2-3 days after a request is made.

Surface Spill

Kerr-McGee would be expected to mount a response strategy to effectively respond to a spill. Equipment that is contractually available to the operator through OSRO membership or contracts to be called out to respond to a spill situation can be obtained through Clean Gulf Associates and the National Response Corporation. Initially, the operator plans to call equipment out from a spill-response equipment stockpile in Ingleside and Galveston, Texas, and from dedicated ID vessel locations offshore Texas. During a spill event, the operator would be expected to cascade in additional equipment as deemed necessary to respond to the spill. Estimated response times for this equipment to arrive onsite utilizing the spill equipment locations and staging areas identified by Kerr-McGee is provided in Table A-3.

Once all of the equipment identified by Kerr-McGee is operational at 20 hours, the total recovery capacity onsite is estimated at 58,708 bbl per day. In the event that other equipment would be needed or in the event that some of the equipment would need replacing in order to support a long-term, a-round-the-clock response effort, Kerr-McGee could obtain additional equipment from other CGA and National Response Corporation equipment bases located throughout the GOM. Response times for this equipment would vary dependent upon its location and the type of equipment transported.

Table A-4 compares the recovery capacity of the identified skimming equipment to the amount of available recovered oil storage capacity during the timeframes required for this equipment to be onsite and operational.

Table A-3

Estimated Response Times for Offshore Skimming/Containment/Storage Equipment Identified by Kerr-McGee for Spill Response

Location of Equipment	Source	Amount/Type	Staging Area	Derated Skimming Capacity (bbl)[1]	Storage Capacity	Total Response Time
Ingleside, Texas	NRC	OSR Barge Valiant	Ingleside, Texas	24,000	20,892	18.5
	CGA	skimmer	Ingleside, Texas	3,400	180	19.5
Galveston, Texas	NRC	OSRV Admiral	Galveston, Texas	24,000	300	18.5
	CGA	skimmer	Galveston, Texas	3,400	180	18.5
	Unknown	Oceangoing barge or tank vessel	Galveston, Texas	N/A	10,000[2]	48
Offshore West Cameron, Block 71	NRC	ID boat "Jill G"	N/A	1,954	101	19.5
Offshore Ingleside, Texas, or Matagorda Island, Block 604	NRC	ID boat "Autry G"	N/A	1,954	101	11
Total Skimming Capacity				58,708		
Total Storage Capacity					31,754	

Note: CGA = Clean Gulf Associates; NRC = National Response Corporation.
[1]The derated skimming capacity was determined using the USCG guidance requiring a reduction of the equipment's nameplate capacity by using a 20 percent efficiency factor in the calculations.
[2]The operator indicated that larger barges can be procured up to 500,000-bbl capacity in the Galveston area.

Table A-4

Offshore Spill Response Recovery Capacity

Hours Since Spill Originated	Estimated Volume in bbl Remaining on Water Surface[1]	Calculated Daily Recovery Capacity Onsite[2] (bbl/day)	Recovered Waste Storage Onsite (bbl)
11	3,149	1,954	101
18.5	5,261	53,354	21,473
19.5	5,511	58,708	21,754
48	12,860	58,708	31,754

[1]The amount of oil remaining on the water surface was estimated by using the results of the Sintef Model runs, assuming that cleanup did not occur. An 8,800 bbl/day crude oil spill scenario was used.
[2]These estimates were determined using the USCG guidance using a 20% efficiency factor in the calculation.

As Table A-4 indicates, approximately 31,754 bbl of recovered oil storage capacity could be onsite within 48 hours. Having sufficient recovered oil storage onsite in a timely manner is important because a lack of storage would limit the amount of oil that could be recovered despite the fact that all the necessary skimming and containment equipment may already be onsite. It is important for the skimming and containment equipment to be deployed and operational with sufficient storage capacity as soon as possible after a spill event occurs, as the slick could get away from a cleanup contractor. Once this occurs, the spill response would require the dedication of additional containment and cleanup equipment because isolated slicks could then need to be "chased down." The lack of sufficient recovered oil storage onsite has historically been one of the factors that reduces the effectiveness of a spill-response operation. If necessary, additional recovered oil-storage equipment could be augmented from additional sources available in the GOM.

Although this chapter has primarily focused on mechanical oil-spill response, and because no single spill-response method is 100 percent effective, it is likely that larger spills in deep waters under the right conditions will require the simultaneous use of all available cleanup methods (e.g., mechanical cleanup, dispersant application, and possibly insitu burning). Historically, during responses to actual spills, mechanical recovery has typically only removed 10-30 percent of the volume spilled offshore. The results of about a dozen field trails conducted to determine dispersant effectiveness indicated dispersant effectiveness ranging from 20 to 30 percent. For example, assuming that 10-15 percent of the oil spilled in this scenario can be picked up mechanically, one can estimate that for a 26,400- bbl spill approximately 2,640-3,960 bbl could be recovered by mechanical means. Likewise, assuming that 20-30 percent of the treated oil in this scenario will be dispersed chemically, 2,513-3,769 bbl could be removed through dispersant application. This assumes that

(1) 4,188 bbl of spilled oil per day is treated with dispersants for 3 days
(2) 6 sorties were flown per day, and
(3) the dispersant supply was available.

Over 20 days, the estimated volume of oil that could be expected to remain on the water surface under this scenario after weathering and cleanup would range from 8,956 to 11,532 bbl out of the originally spilled 26,400 bbl.

The adequacy of Kerr-McGee's proposed equipment and capabilities will be verified through the annual oil-spill drills that the MMS requires Kerr-McGee to conduct. These drills will monitor Kerr-McGee's readiness to deal with potential oil spills of all sizes. If changes in the response strategy are deemed necessary during the conduct of these drills, the MMS could require that Kerr-McGee amend their proposed response strategy and ROSRP, if necessary.

APPENDIX B

Meteorological Conditions

Appendix B

Meteorological Conditions

General Description

The Gulf of Mexico 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. The Bermuda High is a high-pressure cell. The center of the high is usually located at the Atlantic Ocean or sometimes near the Azores Islands off the coast of Spain (Henry et al., 1994). The Gulf of Mexico 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 Gulf of Mexico 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 Gulf of Mexico. 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 Gulf of Mexico. These storms may affect any area of the Gulf of Mexico 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 subtropical maritime 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.

The climatology of the Gulf of Mexico region is primarily governed by two types of air masses. 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 Gulf of Mexico. In the southeastern region of the Gulf of Mexico, 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 Gulf of Mexico 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 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.

Average air temperature at coastal locations vary with latitude and exposure. Winter temperatures depend on the frequency and intensity of penetration by polar air masses from the north. Air temperature 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.

The relative humidity over the Gulf of Mexico 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. Due to the presence of the warm, moist, maritime tropical air mass in the southern Gulf of Mexico, the relative humidity in this region is high for the whole year.

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 generates 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. 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. The annual average precipitation in Lake Charles, Louisiana, is 1.35 m. In the southern portions of the Gulf of Mexico, 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 Gulf of Mexico. Specifically, the F stability class seldom occurs and the G stability 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, 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 Gulf of Mexico 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 Gulf of Mexico 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°N in the Western Gulf of Mexico. 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. 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. During June-August frontal activity decreases to almost zero and fronts seldom reach below 25°N. (USDOI, MMS, 1988).

Tropical cyclones affecting the Gulf originate over the equatorial portions of the Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. 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 Gulf of Mexico (USDOI, MMS, 1988). The Yucatan Channel is the main entrance of Atlantic storms into the Gulf of Mexico, 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 and 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).

APPENDIX C

Geology

Appendix C

Geology

General Description

The present day Gulf of Mexico is a small ocean basin of more than 1.5 million km^2 with its greatest water depth reaching approximately 3,700 m. 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 Gulf of Mexico 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 Gulf of Mexico 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 more than 15 km 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 there was gradual subsidence and shallow seas persisted overtime, marine plants and animals created reefs. Where marine life was abundant, the deposition of limestone was dominant.

The physiographic provinces in the Gulf of Mexico—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 water depth and is characterized by a gentle slope of less than one 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 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 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 one 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.

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 Gulf of Mexico 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 Gulf of Mexico 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 Gulf are Miocene, Pliocene, and Pleistocene in age. Producing horizons become progressively younger in a seaward direction. Recent developments in high-energy, 3D seismic technology has allowed industry to "see" below the regional salt layers and identify potential "subsalt plays" or hydrocarbon traps. Exploration and development in the Gulf of Mexico have resulted in the identification of more than 1,000 fields.

The presence of hydrogen sulfide (H_2S) within formation fluids occurs sporadically throughout the Gulf of Mexico OCS. H_2S-rich oil and gas is called "sour." Approximately 65 operations have encountered H_2S-bearing zones on the Gulf of Mexico 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 H_2S in these wells offshore Texas as they were reported mostly from deep, high-temperature drilling wells using 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 speaking, formations of Lower Cretaceous Age or older (which are deeply buried in the Gulf) are prone to contain H_2S in association with 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. Examination of in-house data suggest that H_2S concentrations vary from as low as fractional 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 CPA.

Geologic Hazards

The major geologic hazards that may affect oil and gas activities within the Gulf of Mexico north of 26°N. latitude can be generally grouped into the following categories: (a) slope instability and mass transport of sediments; (b) gas hydrates; (c) sediment types and characteristics; and (d) 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 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 one 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.

Gas hydrates occur in the upper sediments and are of biogenic in origin rather than petrogenic. Methane is the major and often the only component. Gas hydrates are more prevalent in deeper waters than on the shelf because of the lower temperature and high pressures at greater 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. 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 constraints that can usually be effectively mitigated through existing or new technologies and designs.

APPENDIX D

Physical Oceanography

Appendix D

Physical Oceanography

The Gulf of Mexico is a semienclosed, subtropical sea with an area of approximately 1.5 million km^2. 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 continental shelf width along the Gulf coastline varies from about 350 km offshore West Florida to 16 km off the Mississippi River, then to 156 km off Galveston, Texas, and finally decreasing to 88 km off Port Isabel near the Mexican border. The depth of the central abyss ranges to approximately 3,700 m. The water volume of the Gulf, assuming a mean water depth of 2 km, is 2 million km^3. The shelf's volume, assuming a mean water depth of 50 m, is 25,000 km^3. The Gulf is unique among the world's mediterranean seas, having two entrances: the Yucatan Channel and the Straits of Florida. Both straits restrain communication from the deep Atlantic waters because of the limited sill depths—1,600 m in the Yucatan Channel and about 1,000 m in the Straits of Florida. A portion of the Gulf Stream system, the parent Loop Current, whose presence and influence are described below, is present in the Gulf. Along the 24,800-km Gulf coastline, 21 major estuaries are found on the U.S. coast. The amount of freshwater input to the Gulf Basin from precipitation and a number of rivers—dominated by the Mississippi and Atchafalaya Rivers—is enough to influence the hydrography of most of its northern shelves. The basin's freshwater budget shows a net deficit, however, due to the high rate of evaporation.

Sea-surface temperatures in the Gulf range from nearly isothermal (29-30^{o}C) in August to a sharp horizontal gradient in January, ranging from 25^{o}C in the Loop core to 14-15^{o}C along the shallow northern coastal estuaries. August temperatures at 150 m water depth show a warm Loop Current and an anticyclonic feature in the Western Gulf (both about 18-19^{o}C) grading into surrounding waters of 15-16^{o}C along the slope. The entire pattern is maintained during winter, but warmer by about 1^{o}C. At 1,000 m water depth, the temperature remains close to 5^{o}C year-round. Intimately related with the vertical distribution of temperature is the thermocline, defined as the depth at which the temperature gradient is at maximum. During January, the thermocline depth is about 91-107 m in the Western and Central Gulf and about 30-61 m in the Eastern Gulf. In May, the thermocline depth is about 46 m throughout the entire Gulf (Robinson, 1973). This depth is important because it demarcates the bottom of the mixed layer and acts as a barrier to the vertical transfer of materials and momentum.

Surface salinities along the northern Gulf display seasonal variations because of the seasonality of the freshwater input. During months of low freshwater input, deep Gulf water penetrates into the shelf, and salinities near the coastline range between 29 and 32 parts per thousand (ppt). High, freshwater-input conditions (spring-summer months) are characterized by strong horizontal gradients and inner-shelf salinity values of less than 20 ppt (Wallace, 1980; Cochrane and Kelly, 1986).

Sharp discontinuities of temperature and/or salinity at the sea surface, such as fronts associated with eddies or river plumes or the Loop Current front, are dynamic features that may act to concentrate buoyant material such as spilled oil, detritus, or plankton. These materials are not transported by the front's movements such as the slow westward drift of eddies or Loop Current incursion. The motion consists mainly of lateral movement along the front instead of motion across the front. In addition to open ocean fronts, a coastal front, which separates turbid, lower salinity water from the open-shelf regime, is probably a permanent feature of the northern Gulf shelf. This front lies about 30-50 km offshore. It is not known how strongly this front might affect buoyant material transport.

The Loop Current, a highly variable current feature, enters the Gulf through the Yucatan Channel and exits through the Straits of Florida (as the Gulf Stream) after tracing an arc that may intrude as far north as the Mississippi-Alabama shelf. The Loop consists of ascending and descending 30-km-wide bands of rapidly moving water enclosing a relatively quiescent inner region, and the entire feature may be clearly seen in hydrographic sections down to about 1,000 m. Below that level, there is evidence of a countercurrent. The volumetric flux of the Loop has been estimated at 30 million m^3/sec. This volume flow is enough to replace the water volume of the Gulf shelf in about 10 days.

Major Loop Current eddies move into the Western Gulf along various paths to a region between 25^{o}-28^{o}N and 93^{o}-96^{o}W. Recent analysis of frontal-positions data indicates that the eddy-shedding period varies between 6.5 and 9.5 months with an average of 7.5 months (Hamilton et al., 1989). Major eddies have diameters on the order of 300-400 km and may clearly be seen in hydrographic data to a depth of about 1,000 m. The eddies move at speeds ranging from 2 to 5 km/day, decreasing in size as they mix with resident waters. The life of an individual eddy to its eventual assimilation by regional circulation patterns in the Western Gulf is about 1 year.

Eddy-shedding from the Loop Current is the principal mechanism coupling the circulation patterns of the eastern and western parts of the basin. The heat and salt budgets of the Gulf are dependent on this importation, balanced by seasonal cooling and river input, and probably also by internal, deeper currents that are poorly understood. The eddies are frequently observed to affect local current patterns along the Louisiana/Texas slope, hydrographic properties, and possibly the biota of fixed platforms or hard bottoms. There is some evidence that these large reservoirs of warm water play some role in strengthening tropical cyclones when their paths coincide.

Smaller anticyclonic eddies have been observed to be generated by the Loop Current, although it is not known if the process is merely a scaled-down version of the above cycle. They have diameters on the order of 100 km, but the few data available indicate a shallow hydrographic signature on the order of 200 m. Their observed movements indicate a tendency to translate westward along the Louisiana/Texas slope. Similar in size, cyclonic eddies are observed in the Eastern Gulf, are associated with the eddy-shedding cycle, and occur along the Louisiana/Texas slope. Their genesis and role in the overall Gulf circulation are not well studied. A major cyclonic eddy seems to be resident in the southern part of the Western Gulf, based on older data synthesis; however, some recent evidence points toward a more complex, less homogeneous structure.

Aside from the wind-driven surface layer, current regimes on the outer shelf and slope are the result of balance between the influence of open Gulf circulation features and the shelf circulation proper, which is dominated by long-term wind forcing. A western boundary current, driven both by prevailing winds and the semipermanent anticyclonic eddy, occurs offshore northern Mexico and South Texas. A strong east-northeasterly current along the remaining Texas and Louisiana slope has been explained partly by the effects of the semipermanent, anticyclonic eddy and a partner cyclonic eddy ("modon pair") and partly by the mass-balance requirements of eddy movement. When the Loop Current impinges onto the Florida slope and shelf, it has been observed that the current structure acts to upwell nutrient-rich water from deeper zones, a mechanism that may also take place as eddies move along the Louisiana/Texas slope, accounting for the increased productivity recognized in these areas. West of approximately Cameron, Louisiana (93^{o}W.), current measurements clearly show a strong response of coastal current to the winds, setting up a large-scale, anticyclonic gyre. The inshore limb of the gyre is the westward or southwestward (downcoast) component that prevails along much of the coast, except in July-August. Because the coast is concave, the shoreward prevailing wind results in a convergence of coastal currents at a location where the winds are normal to the shore or at the downcoast extent of the gyre. A prevailing countercurrent toward the northeast along the shelf edge constitutes the outer limb of the gyre. The convergence at the southwestern end of the gyre migrates seasonally with the direction of the prevailing wind, ranging from a point south of the Rio Grande in the fall to the Cameron area by July. The gyre is normally absent in July but reappears in August-September when a downcoast wind component develops (Cochrane and Kelly, 1986). The Mississippi/Alabama shelf circulation is controlled by the Loop Current, winds, tides, and freshwater input. The West Florida shelf circulation is dominated by tides, winds, eddy-like perturbations, and the Loop Current.

Longshore currents, consisting of tidal, wind-driven, and density-gradient components, predominate over across-shelf components within a narrow band close to the coast (on the order of 10-20 km, referred to as the coastal boundary layer). Typical maximum tidal currents within this band would be about 15 cm/sec. These currents will cause a particle displacing, known as the tidal excursion, at 2-3 km. Currents, driven by synoptic-scale winds, range up to 25-50 cm/sec for conditions that are not extreme, with 10- to 100-km excursions expected for a typical 5-day "wind event." Longshore currents due to winter northers, tropical storms, and hurricanes may range up to hundreds of cm/sec, depending on local topography, fetch, and duration. Should an oil spill occur, deviations from results predicted by open-ocean models could happen at coastal fronts, where concentration and lateral translation could occur, and within the longshore-current zone, where significant transport away from the "expected" point of contact could occur, as determined by local tidal phase and predominant winds.

Studies of surface drifters are useful and illustrative in the study of oil movement because, hopefully, surface slicks will respond to currents in a similar way. A summary of drifter studies across the Gulf (Parker et al., 1979) indicated that the Texas coastline and the southern and eastern Florida coastlines receive the most landings. Other coastlines along the Gulf received very small numbers of landings. Strangely, during summer and fall, the Louisiana and Texas coastlines received sizable fractions of the landings. However, these results contain some bias because populated or frequently visited areas would show more landings than desolated areas.

Summer waves in the Western Gulf tend to be smaller than those in the Eastern Gulf. Waves in both regions intensify in winter, with the Western Gulf showing a clear mode at 2-3 m.

APPENDIX E

Other Information on Grid 4

Table E-1

Grid 4 — Exploration and Development Drilling Activities

Area	Well	Operator	Spud Date	Total Depth Date	Water Depth (ft)	Remarks
AC 24	001	Exxon-Mobil	05/30/98	06/25/98	4,851	TA
AC 25	001	Exxon-Mobil	12/23/96	01/30/97	4,795	P&A
AC 25	HA001	Exxon-Mobil	07/05/00	08/10/00	4,808	Completion
AC 25	HA002	Exxon-Mobil	06/27/00	04/02/01	4,804	Sidetrack
AC 25	HA002	Exxon-Mobil	05/01/01	05/04/01	4,808	Drilling
AC 25	HA003	Exxon-Mobil	06/17/00	10/18/00	4,808	Sidetrack
AC 25	HA003	Exxon-Mobil	10/24/00	11/20/00	4,808	Sidetrack
AC 25	HA003	Exxon-Mobil	11/22/00	11/25/00	4,808	Completion
AC 25	HA004	Exxon-Mobil	06/22/00	01/01/01	4,808	Sidetrack
AC 25	HA004	Exxon-Mobil	01/27/01	01/28/01	4,808	Sidetrack
AC 25	HA004	Exxon-Mobil	01/31/01	02/22/01	4,808	Completion
AC 25	HA005	Exxon-Mobil	07/07/00		4,808	Drlg shut-in
AC 25	HA006	Exxon-Mobil	07/01/00		4,808	Drlg shut-in
AC 26	HA002	Exxon-Mobil	06/27/00		4,804	Drilling
AC 26	HA004	Exxon-Mobil	06/22/00	01/01/01	4,804	Sidetrack
AC 65	001	Exxon-Mobil	02/14/97	03/24/97	4,852	Sidetrack
AC 65	001	Exxon-Mobil	04/07/97	04/19/97	4,852	TA
AC 195	001	Amerada Hess	07/22/00	08/20/00	5,256	P&A
AC 200	001	Exxon-Mobil	04/30/98	05/17/98	5,088	P&A
EB 430	001	Amerada Hess	04/11/00	05/03/00	2,285	TA
EB 465	001	Samedan	02/10/01	02/24/01	2,800	Sidetrack
EB 465	001	Samedan	02/24/01	03/09/01	2,800	TA
EB 469	001	Texaco	05/01/84	06/10/84	2,296	P&A
EB 475	001	Mobil	10/07/91	11/17/91	2,633	P&A
EB 556	001	Odeco	02/10/84	04/13/84	2,826	P&A
EB 558	001	Anadarko	01/28/01	02/07/01	3,531	Sidetrack
EB 558	001	Anadarko	02/19/01	03/12/01	3,531	TA
EB 599	001	Burlington	12/08/00	04/02/01	3,154	TA
EB 600	001	Exxon-Mobil	03/25/89	04/21/89	2,976	P&A
EB 602	001	Kerr-McGee	08/27/99	09/25/99	3,678	Sidetrack
EB 602	001	Kerr-McGee	07/10/00	08/29/00	3,680	Sidetrack
EB 602	001	Kerr-McGee	09/02/00	09/05/00	3,680	TA
EB 602	002	Kerr-McGee	10/08/99	11/11/99	3,678	Sidetrack
EB 602	002	Kerr-McGee	11/11/99	11/17/99	3,678	TA
EB 602	002	Kerr-McGee	07/13/00	09/19/00	3,680	Sidetrack
EB 602	002	Kerr-McGee	09/30/00	10/07/00	3,680	Sidetrack
EB 602	002	Kerr-McGee	10/13/00	10/26/00	3,680	Sidetrack
EB 602	002	Kerr-McGee	10/29/00	11/16/00	3,680	Sidetrack
EB 602	002	Kerr-McGee	11/28/00	11/29/00	3,680	TA
EB 602	003	Kerr-McGee	10/11/99	10/13/99	3,678	Sidetrack
EB 602	003	Kerr-McGee	12/05/99	12/24/99	3,678	TA
EB 602	003	Kerr-McGee	12/11/00	01/07/01	3,680	TA
EB 602	004	Kerr-McGee	02/04/00	02/17/00	3,678	Sidetrack
EB 602	004	Kerr-McGee	02/20/00	03/06/00	3,678	TA
EB 602	004	Kerr-McGee	02/13/01	02/25/01	3,678	Sidetrack
EB 602	004	Kerr-McGee	03/12/01	03/15/01	3,678	TA
EB 602	005	Kerr-McGee	07/17/00	08/02/00	3,678	Sidetrack
EB 602	005	Kerr-McGee	08/09/00	08/14/00	3,678	TA
EB 602	005	Kerr-McGee	03/23/01	04/19/01	3,669	TA
EB 602	006	Kerr-McGee	12/06/00	02/05/01	3,680	TA
EB 602	006	Kerr-McGee	12/06/00	02/05/01	3,680	TA
EB 602	007	Kerr-McGee	04/26/01		3,644	Drilling
EB 602	009	Kerr-McGee	05/16/01		3,644	Drilling
EB 642	001	Kerr-McGee	08/19/97	09/18/97	3,668	Sidetrack
EB 642	001	Kerr-McGee	09/29/97	10/16/97	3,668	Sidetrack
EB 642	001	Kerr-McGee	10/30/97	11/11/97	3,668	Sidetrack
EB 642	001	Kerr-McGee	11/25/97	12/13/97	3,668	TA
EB 642	001	Kerr-McGee	09/30/99	10/31/99	3,678	TA
EB 643	002	Kerr-McGee	08/11/99	09/15/99	3,453	TA
EB 643	002	Kerr-McGee	12/29/00	02/04/01	3,450	TA
EB 643	003	Kerr-McGee	11/08/99	11/16/99	3,450	Sidetrack
EB 643	003	Kerr-McGee	11/25/99	01/02/00	3,453	TA

Table E-1

Grid 4 — Exploration and Development Drilling Activities

Area	Well	Operator	Spud Date	Total Depth Date	Water Depth (ft)	Remarks
EB 643	004	Kerr-McGee	12/24/00	03/27/01	3,457	Drilling
EB 643	005	Kerr-McGee	12/27/00	03/06/01	3,450	TA
EB 646	001	Kerr-McGee	07/10/00	08/29/00	3,680	Sidetrack
EB 646	001	Kerr-McGee	09/02/00	09/05/00	3,680	TA
EB 646	002	Kerr-McGee	07/13/00	09/19/00	3,680	Sidetrack
EB 646	002	Kerr-McGee	09/30/00	10/07/00	3,680	Sidetrack
EB 646	002	Kerr-McGee	10/13/00	10/26/00	3,680	Sidetrack
EB 646	002	Kerr-McGee	10/29/00	11/16/00	3,680	Sidetrack
EB 646	003	Kerr-McGee	12/07/00	01/04/01	3,680	TA
EB 646	004	Kerr-McGee	02/17/01	02/26/01	3,678	Sidetrack
EB 646	004	Kerr-McGee	03/13/01	03/15/01	3.678	Drilling
EB 646	005	Kerr-McGee	03/26/01	04/18/01	3.678	Drilling
EB 684	001	Shell	02/25/95	03/13/95	3,820	P&A
EB 686	001	Total Fina Elf	01/05/01	01/31/01	4,050	P&A
EB 688	001	Kerr-McGee	04/19/98	05/23/98	3,767	P&A
EB 688	002	Kerr-McGee	01/19/97	02/17/97	3,752	Sidetrack
EB 688	002	Kerr-McGee	02/28/97	03/03/97	3,752	P&A
EB 688	003	Kerr-McGee	12/30/97	01/06/98	3,753	P&A
EB 688	004	Kerr-McGee	01/17/98	02/02/98	3,751	P&A
EB 688	005	Kerr-McGee	04/09/01	04/24/01	3,589	P&A
EB 688	006	Kerr-McGee	05/02/01	05/08/01	3,792	Sidetrack
EB 688	006	Kerr-McGee	05/10/01		3,788	Drilling
EB 688	007	Kerr-McGee	05/25/01		3,795	Drilling
EB 689	001	Shell	07/20/94	08/17/94	3,789	P&A
EB 832	001	Mariner	12/15/00	12/31/00	3,536	P&A
EB 945	001	Exxon-Mobil	06/16/90	08/03/90	4,645	P&A
EB 945	001	Exxon-Mobil	10/27/98	11/14/98	4,639	Sidetrack
EB 945	002	Exxon-Mobil	01/13/96	02/23/96	4,628	TA
EB 945	005	Exxon-Mobil	08/15/98	08/16/98	4,635	Sidetrack
EB 945	DB001	Exxon-Mobil	08/07/98	08/09/98	4,638	Completion
EB 945	DB002	Exxon-Mobil	08/11/98	08/13/98	4,639	Sidetrack
EB 945	DB002	Exxon-Mobil	11/25/99	11/27/99	4,639	Sidetrack
EB 945	DB002	Exxon-Mobil	01/10/01	01/15/01	4,639	Completion
EB 945	DB003	Exxon-Mobil	09/01/99	09/17/99	4,641	Completion
EB 946	001	Exxon-Mobil	03/06/96	04/02/96	4,628	P&A
EB 946	002	Exxon-Mobil	01/13/96	02/23/96	4,628	TA
EB 946	DA001	Exxon-Mobil	09/13/98	12/07/98	4,651	Completion
EB 946	DA002	Exxon-Mobil	08/19/98	03/20/00	4,657	Completion
EB 948	001	Exxon-Mobil	06/06/00	06/11/00	4,376	TA
EB 949	001	Exxon-Mobil	06/07/98	07/30/98	4,376	Sidetrack
EB 949	001	Exxon-Mobil	06/06/00	04/11/01	4,376	TA
EB 949	002	Exxon-Mobil	05/08/00	05/26/00	4,376	Sidetrack
EB 949	002	Exxon-Mobil	03/10/01	03/12/01	4,376	Completion
EB 989	001	Exxon-Mobil	10/27/98	11/14/98	4,639	Sidetrack
EB 989	B-3	Exxon-Mobil	09/01/99	09/17/99	4,641	Completion
EB 992	001	Exxon-Mobil	10/24/95	11/28/95	4,872	Sidetrack
EB 992	001	Exxon-Mobil	12/07/95	12/23/95	4,872	P&A
EB 994	001	BP	05/01/97	05/13/97	4,585	Sidetrack
EB 994	001	BP	05/17/97	05/22/97	4,585	P&A
GB 840	001	Marathon	11/02/98	11/27/98	3,500	P&A

Remarks: Drlg shut-in = drilling shut-in
P&A = plugged and abandoned
TA = temporarily abandoned

Note: AC is Alaminos Canyon
EB is East Breaks
GB is Garden Banks

Table E-2
Grid 4 — Approved Plan Activities

Area	Operator	Approval (latest)	Water Depth Range (ft)	Type Plan
AC 24	Exxon-Mobil	11/07/97	4,850-4,870	EP
AC 24	Exxon-Mobil	01/30/01	4,850	DOCD
AC 25	Exxon-Mobil	11/27/96	4,786-4,809	EP
AC 25	Exxon-Mobil	09/05/00	4,825	DOCD
AC 26	BP	11/27/96	4,771	EP
AC 65	Exxon-Mobil	12/02/96	4,870-4,915	EP
AC 73	Marathon	07/29/99	4,130-4,192	EP
AC 117	Marathon	07/29/99	4,170-4,207	EP
AC 155	Exxon-Mobil	02/10/98	4,933-4,965	EP
AC 195	Amerada-Hess	06/09/00	5,260-5,270	EP
AC 200	Exxon-Mobil	02/10/98	5,143	EP
KC 96	Amerada-Hess	02/18/00	4, 870-4,960	EP
EB 424	El Paso	01/20/00	2,811-2,821	EP
EB 428	Shell	08/31/89	2,502-2,601	EP
EB 430	Amerada-Hess	03/17/99	2,140-2,285	EP
EB 465	Samedan	02/06/01	2,800-2,805	EP
EB 475	Mobil	02/24/92	2,510-2,890	EP
EB 513	Anadarko	11/29/00	2,727-2,861	EP
EB 514	Anadarko	11/29/00	2,727-2,822	EP
EB 558	Anadarko	11/29/00	3,519-3,540	EP
EB 599	Burlington	09/12/00	3,165-3,250	EP
EB 600	Exxon-Mobil	03/23/89	2,980	EP
EB 602	Kerr-McGee	02/22/01	3,590-3,680	EP
EB 602	Kerr-McGee	Pending	3,590-3,680	DOCD
EB 642	Kerr-McGee	09/21/99	3,625-3,673	EP
EB 642	Kerr-McGee	Pending	3,625-3,673	DOCD
EB 643	Kerr-McGee	03/29/01	3,449-3,548	EP
EB 643	Kerr-McGee	Pending	3,449-3,548	DOCD
EB 646	Kerr-McGee	Pending	3,590-3,680	DOCD
EB 684	Mobil	07/05/94	3,795-3,886	EP
EB 686	Total Fina Elf	08/17/00	3,840-4,085	EP
EB 688	Kerr-McGee	01/11/01	3,594-3,818	EP
EB 688	Kerr-McGee	Pending	3,594-3,818	DOCD
EB 689	Mobil	05/26/94	3,784-3,823	EP
EB 730	Total Fina Elf	08/17/00	4,038-4,040	EP
EB 773	Total Fina Elf	08/17/00	3,775	EP
EB 774	Total Fina Elf	08/17/00	3,925	EP
EB 832	Mariner	11/07/00	3,545-3,565	EP
EB 944	Exxon-Mobil	07/02/98	4,790	DOCD
EB 945	Exxon-Mobil	09/15/95	4,635-4,645	EP
EB 945	Exxon-Mobil	06/29/99	4,790	DOCD
EB 946	Exxon-Mobil	09/15/95	4,675	EP
EB 946	Exxon-Mobil	07/02/98	4,660	DOCD
EB 948	Exxon-Mobil	03/31/98	4,282-4,451	EP
EB 949	Exxon-Mobil	03/31/98	4,356-4,427	EP
EB 949	Exxon-Mobil	01/30/01	4,375	DOCD
EB 988	Exxon-Mobil	08/24/95	4,760-4,785	EP
EB 988	Exxon-Mobil	07/02/98	4,800	DOCD
EB 991	Exxon-Mobil	08/18/95	4,865	EP
EB 992	Exxon-Mobil	08/18/95	4,800	EP
EB 994	BP	02/07/97	4,585-4,674	EP
GB 798	Phillips	12/27/99	3,580-3,680	EP
GB 840	Marathon	09/10/98	3,500-3,775	EP
GB 841	Samedan	09/10/99	4,100	EP
GB 842	Phillips	12/27/99	3,717-3,955	EP
GB 843	Phillips	12/27/99	3,675-3,860	EP

Note: EP = Exploration Plan
DOCD = Development Operations Coordination Document
AC is Alaminos Canyon
EB is East Breaks
GB is Garden Banks
KC is Keathley Canyon

Table E-3

Grid 4 — Surface Structures

Project	Area	Structure	Year Installed	Wells	Remarks
Diana-Hoover	AC 25	Spar	2000	8	8 slots with 3 subsea tiebacks. Also included Diana subsea system, which consist of two 4-well manifolds
Nansen	EB 602	Spar	2001	9	9 slots with 3 subsea tiebacks
Boomvang	EB 688	Spar	2001	6	6 slots with 3 subsea tiebacks

Note: AC is Alaminos Canyon
EB is East Breaks

Table E-4

Grid 4 — Incidents Associated with Oil and Gas Operations

Date	Area and Block	Operator	Incident	Description
11/28/99	AC 25	Exxon-Mobil	Spill	Approximately 1 bbl of hydraulic oil was spilled when a control valve was inadvertently left open.
06/18/00	AC 25	Exxon-Mobil	Injury	Human Error. Riding board shackle became entangled on the elevator top drive service loop. Upon release, rider was propelled into the derrick board racking fingers, resulting in head, neck, and rib injuries.
06/18/00	AC 25	Exxon-Mobil	Fire	Human Error. Tarps hung to isolate an area for hot work were blown onto a hot exhaust stack by a helicopter. The tarps ignited but were quickly extinguished with water.

Note: AC is Alaminos Canyon

Table E-5

"Qualified Wells" in Grid 4

Area	Block	Date Qualified
Alaminos Canyon	24	10/02/98
Alaminos Canyon	25	09/11/97
Alaminos Canyon	65	0924/97
East Breaks	602	11/16/99
East Breaks	642	12/07/99
East Breaks	643	10/01/99
East Breaks	646	10/19/00
East Breaks	688	05/13/92
East Breaks	945	01/24/94
East Breaks	946	04/23/96
East Breaks	949	10/02/98
East Breaks	989	02/23/00
East Breaks	992	07/14/97

Table E-6

Shore Bases in the Gulf of Mexico and Their Distances to Grid 4

Shore Base	Distance to Grid 4 (miles)
Abbeville	203
Amelia	226
Aransas Pass	135
Bayou Boeuf	225
Bayou Labatre	389
Bayside	142
Berwick	223
Cameron	160
Cocodrie	226
Corpus Christi	150
Dulac	230
Empire	284
Erath	206
Fourchon	243
Freeport	100
Freshwater City	200
Galveston	120
Gibson	232
Grand Chenier	165
Grand Isle	261
Harbor Island	131
Harvey	282
Hopedale	298
Houma	240
Ingleside	139
Intracoastal City	192
Kaplan	199
Lake Charles	190
Leeville	248
Louisa	205
Mobile	412
Morgan City	225
New Iberia	216
Paradis	265
Pascagoula	372
Patterson	221
Pelican Island	119
Port Aransas	129
Port Arthur	159
Port Isabel	139
Port Mansfield	150
Port Oconnor	108
Rockport	131
Sabine Pass	149
Surfside	163
Theodore	403
Theriot	232
Venice	293
Weeks Island	206

APPENDIX F

Socioeconomic Conditions

Table F-1

Listing of Counties and Parishes of the Coastal Impact Area

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

Table F-2
Onshore Expenditure Allocation by Subarea
(in percentages)

Impan Number	Sector Description	Subarea									
		TX-1	TX-2	LA-1	LA-2	LA-3	MA-1	FL-1	FL-2	Gulf-Other	US Other
38	Oil & Gas Operations		0.34	0.09	0.06	0.15				0.25	0.12
50	New Gas Utility Facilities				0.06	0.62	0.11			0.13	0.07
53	Misc Natural Resource Facility Construction	0.03	0.21	0.23	0.15	0.30	0.02			0.06	0.03
56	Maintenance and Repair, Other Facilities				0.05	0.52	0.09			0.22	0.11
57	Other Oil & Gas Field Services		0.30	0.26	0.12	0.16				0.11	0.05
160	Office Furniture and Equipment	0.15	0.54			0.08	0.23				
178	Maps and Charts (Msc Publishing)	0.12	0.59	0.02	0.06	0.11	0.10				
206	Explosives	0.50	0.50								
209	Chemicals, NEC	0.03	0.64	0.04	0.10	0.04	0.04			0.08	0.04
210	Petroleum Fuels	0.11	0.50	0.09	0.16	0.09	0.05				
232	Hydraulic Cement		0.10				0.10			0.50	0.30
258	Steel Pipe and Tubes		0.50	0.31	0.05	0.07				0.08	0.04
284	Fabricated Plate Work	0.04	0.63	0.06	0.09	0.05	0.14				
290	Iron and Steel Forgings		0.81			0.05				0.14	
307	Turbines	0.05	0.65		0.10	0.20					
311	Construction Machinery & Equipment	0.06	0.42		0.06	0.19	0.11			0.11	0.06
313	O&G Field Machinery	0.03	0.18	0.27	0.18	0.22				0.08	0.04
331	Special Industrial Machinery				0.38	0.54				0.05	0.03
332	Pumps & Compressors	0.04	0.30	0.17	0.22	0.09				0.12	0.06
354	Industrial Machines, NEC	0.05	0.66	0.06	0.10	0.06	0.06				
356	Switchgear		0.63		0.07	0.11	0.07			0.11	
374	Communication Equipment, NEC	0.13	0.50			0.25				0.13	
392	Shipbuilding and Ship Repair	0.09	0.24	0.05	0.24	0.18	0.19				
399	Transportation Equipment, NEC		0.78	0.06	0.11		0.06				
401	Lab Equipment		1.00								
403	Instrumentation	0.01	0.13	0.39	0.27	0.08				0.08	0.04
435	Demurrage/Warehousing/ Motor Freight				0.07	0.69	0.12			0.12	
436	Water Transport				0.07	0.72	0.13	0.01	*	0.08	
437	Air Transport				0.06	0.61	0.11			0.22	
441	Communications	0.09	0.51	0.07	0.11	0.11	0.11				
443	Electric Services	0.13	0.36	0.06	0.15	0.12	0.18				
444	Gas Production/Distribution	0.10	0.54	0.08	0.07	0.05	0.03			0.08	0.04
445	Water Supply	0.08	0.43	0.08	0.12	0.05	0.11			0.12	0.01
446	Waste Disposal		1.00								
454	Eating/Drinking			0.37	0.11	0.53					
455	Msc Retail	0.09	0.48	0.06	0.10	0.15	0.11				
459	Insurance	0.04	0.47	0.07	0.12	0.09				0.18	0.03
462	Real Estate	0.09	0.47	0.04	0.08	0.11	0.08			0.12	0.01
469	Advertisement	0.06	0.45	0.06	0.08	0.15	0.08			0.12	0.01
470	Other Business Services		0.60	0.11	0.09	0.06				0.10	0.05
473	Msc. Equipment Rental and Leasing				0.06	0.59	0.11	*		0.20	0.03
490	Doctors & Veterinarian Services	0.09	0.53	0.06	0.09	0.14	0.08				
494	Legal Services	0.07	0.48	0.07	0.11	0.19	0.08				
506	Environmental/Engineering Services	0.06	0.38	0.11	0.08	0.08	0.03	0.01		0.21	0.01
507	Acct/Msc Business Services	0.06	0.46	0.05	0.09	0.13	0.07			0.12	0.01
508	Management/Consulting Services	0.04	0.54	0.04	0.09	0.11	0.05			0.12	0.01
509	Testing/Research Facilities		0.38	0.14	0.14	0.05				0.22	0.11
*	= < .01%										

Source: MMS, "Cost Profiles and Cost Functions for Gulf of Mexico Oil and Gas Development Phases for Input-Output Modeling Study," 2000.

Table F-3

Population Projection for Socio-Economic Impact Area

(in thousands)

2000		2001	2002	2005	2010	2015	2020	2025
697.71		702.97	708.32	723.93	749.61	775.93	803.08	830.66
1,054.55		1,068.40	1,082.27	1,123.38	1,191.06	1,259.65	1,329.20	1,399.61
1,197.73		1,202.56	1,207.41	1,221.45	1,235.16	1,267.95	1,292.76	1,318.46
912.11		922.24	932.40	962.52	1,011.98	1,062.37	1,113.54	1,165.51
3,862.10		3,896.17	3,930.40	4,031.28	4,187.81	4,365.90	4,538.58	4,714.24
923.09		933.22	943.46	973.95	1,024.54	1,076.45	1,129.68	1,183.81
5,021.05		5,094.84	5,168.84	5,388.52	5,750.80	6,117.37	6,488.76	6,864.69
5,944.14		6,028.06	6,112.30	6,362.47	6,775.34	7,193.82	7,618.44	8,048.50
772.44		785.47	798.60	837.50	901.81	966.77	1,032.56	1,099.13
FL-2	122.07	124.05	125.98	131.81	141.53	151.29	161.18	171.18
EPA	894.51	909.52	924.58	969.31	1,043.34	1,118.06	1,193.74	1,270.31
Planning Area	10,700.75	10,833.75	10,967.28	11,363.06	12,006.49	12,677.78	13,350.76	14,033.05
Average Annual Percentage Population Increase								
Gulf of Mexico Planning Areas	2000	2001	2002	2005	2010	2015	2020	2025
LA-1	0.60%	0.75%	0.76%	0.73%	0.71%	0.70%	0.70%	0.69%
LA-2	1.02%	1.31%	1.30%	1.27%	1.20%	1.15%	1.10%	1.06%
LA-3	0.11%	0.40%	0.40%	0.39%	0.22%	0.53%	0.39%	0.40%
MA-1	1.06%	1.11%	1.10%	1.08%	1.03%	1.00%	0.96%	0.93%
CPA	0.67%	0.88%	0.88%	0.85%	0.78%	0.85%	0.79%	0.77%
TX-1	0.87%	1.10%	1.10%	1.08%	1.04%	1.01%	0.99%	0.96%
TX-2	1.72%	1.47%	1.45%	1.42%	1.34%	1.27%	1.21%	1.16%
WPA	1.58%	1.41%	1.40%	1.36%	1.30%	1.23%	1.18%	1.13%
FL-1	1.19%	1.69%	1.67%	1.62%	1.53%	1.44%	1.36%	1.29%
FL-2	1.35%	1.62%	1.56%	1.54%	1.47%	1.38%	1.31%	1.24%
EPA	1.21%	1.68%	1.66%	1.61%	1.53%	1.43%	1.35%	1.28%
Planning Areas	1.22%	1.24%	1.23%	1.20%	1.13%	1.12%	1.06%	1.02%

Table F-4

Employment Impacts Projected from Kerr-McGee's
Initial Development Operations Coordinations Document
(peak employment is projected for the year 2001 as shown an additional 40-50 person years
of employment for operations and maintenance is required for each year over the life of the project)

Onshore Subarea	Direct Employment	Indirect Employment	Induced Employment	Total Employment	Baseline Employment	Marathon Plan as a % of Baseline
FL-1	1.5	1.2	0.8	3.5	436,890	0.00%
FL-2	0.2	0.1	0.0	0.3	45,320	0.00%
EGOM	1.6	1.3	0.8	3.8	482,210	0.00%
LA-1	188.5	48.7	71.8	309.0	394,330	0.08%
LA-2	138.9	47.1	54.9	240.9	613,040	0.04%
LA-3	309.6	118.3	124.0	551.8	741,380	0.07%
MA-1	21.4	9.8	9.0	40.3	521,070	0.01%
CGOM	658.5	223.8	259.7	1142.0	2,269,820	0.05%
TX-1	24.3	8.0	9.0	41.3	465,640	0.01%
TX-2	313.5	172.7	180.6	666.8	3,119,840	0.02%
WGOM	337.8	180.7	189.7	708.2	3,585,480	0.02%
Total GOM	997.9	405.9	450.2	1,854	6,337,510	0.03%

Table F-5

Employment by Major Industry Sector

Industry/ Geographic Area	Agricultural Services	Mining	Construction	Manufacturing	Transportation & Public Utilities	Wholesale Trade	Retail Trade	FIRE	Services	Unclassified Establishments	Total
FL-1	1,859	326	18,283	19,777	9,978	9,525	67,525	14,101	94,589	120	236,083
FL-2	529	173	1,722	4,488	849	943	6,074	1,124	4,816	59	20,777
EPA Total Employment	2,388	499	20,005	24,265	10,827	10,468	73,599	15,225	99,405	179	256,860
Percent in Category	0.93%	0.19%	7.79%	9.45%	4.22%	4.08%	28.65%	5.93%	38.70%	0.07%	100.00%
LA-1	1,713	10,742	23,664	37,934	28,534	24,339	79,738	17,725	123,261	161	347,811
LA-2	1,942	10,179	51,562	50,906	25,811	26,955	96,458	23,619	139,126	161	426,719
LA-3	1,092	11,533	12,988	24,470	26,309	12,590	64,256	18,624	131,158	125	303,145
MA-1	1,925	462	22,956	50,430	16,843	15,373	73,302	14,924	117,170	76	313,461
CPA Total Employment	6,672	32,916	111,170	163,740	97,497	79,257	313,754	74,892	510,715	523	1,391,136
Percent in Category	0.48%	2.37%	7.99%	11.77%	7.01%	5.70%	22.55%	5.38%	36.71%	0.04%	100.00%
TX-1	1,649	3,171	15,983	35,054	13,025	12,777	65,689	12,944	91,194	134	251,620
TX-2	13,360	60,314	146,448	251,601	146,088	138,885	377,456	117,826	680,595	514	1,933,087
WPA Total Employment	15,009	63,485	162,431	286,655	159,113	151,662	443,145	130,770	771,789	648	2,184,707
Percent in Category	0.69%	2.91%	7.43%	13.12%	7.28%	6.94%	20.28%	5.99%	35.33%	0.03%	100.00%
Impact Area Total	24,069	96,900	293,606	474,660	267,437	241,387	830,498	220,887	1,381,909	1,350	3,832,703
Percent	0.63%	2.53%	7.66%	12.38%	6.98%	6.30%	21.67%	5.76%	36.06%	0.04%	100.00%

Source: County Business Patterns 1997.

Table F–6

Payroll by Major Industry Sector
(in $000)

Industry/ Geographic Area	Agricultural Services	Mining	Construction	Manufacturing	Transportation & Public Utilities	Wholesale Trade	Retail Trade	FIRE	Services	Unclassified Establishments	Total
FL-1	34,161	10,403	384,460	651,139	313,497	236,691	860,238	341,618	2,020,760	1,450	4,854,417
FL-2	3,175	2,651	29,098	148,215	24,052	15,928	67,255	22,725	75,532	93	388,724
EPA Total Payroll	37,336	13,054	413,558	799,354	337,549	252,619	927,493	364,343	2,096,292	1,543	5,243,141
Percent in Category	0.71%	0.25%	7.89%	15.25%	6.44%	4.82%	17.69%	6.95%	39.98%	0.03%	100.00%
LA-1	19,529	448,701	376,191	905,311	470,500	418,289	584,938	214,040	1,566,438	1,785	5,005,722
LA-2	21,953	382,330	1,363,188	2,084,861	843,256	742,912	1,057,018	655,316	2,883,188	1,837	10,035,859
LA-3	29,550	818,103	709,835	1,293,155	1,276,296	935,861	1,502,870	1,019,239	4,826,503	3,598	12,415,010
MA-1	31,659	18,833	538,004	1,650,816	505,933	429,120	888,117	416,075	2,528,555	1,629	7,008,741
CPA Total Payroll	102,691	1,667,967	2,987,218	5,934,143	3,095,985	2,526,182	4,032,943	2,304,670	11,804,684	8,849	34,465,332
Percent in Category	0.30%	4.84%	8.67%	17.22%	8.98%	7.33%	11.70%	6.69%	34.25%	0.03%	100.00%
TX-1	20,667	104,061	392,197	1,121,882	386,798	335,981	847,264	321,642	1,910,799	2,332	5,443,623
TX-2	242,031	,891,122	4,745,880	11,431,745	5,740,136	5,663,902	5,689,792	4,904,951	20,356,704	17,369	62,683,632
WPA Total Payroll	262,698	3,995,183	5,138,077	12,553,627	6,126,934	5,999,883	6,537,056	5,226,593	22,267,503	19,701	68,127,255
Percent in Category	0.39%	5.86%	7.54%	18.43%	8.99%	8.81%	9.60%	7.67%	32.69%	0.03%	100.00%
Impact Area Total	402,725	5,676,204	8,538,853	19,287,124	9,560,468	8,778,684	11,497,492	7,895,606	36,168,479	30,093	107,835,728
Percent	0.37%	5.26%	7.92%	17.89%	8.87%	8.14%	10.66%	7.32%	33.54%	0.03%	100.00%

Source: County Business Patterns 1997.

Table F-7
Opportunity Cost Employment of a Scenario Oil Spill
(an 8,800-bbl spill a day for 3 days)

	Subarea							
FL-1	MA-1	LA-3	LA-2	LA-1	TX-2	TX-1	Total Employment
Total Employment	2.0	65.4	170.0	104.9	81.4	399.4	77.2
Direct	0.9	35.8	93.3	65.3	47.3	203.7	44.8
Indirect	0.6	7.3	20.3	10.5	9.7	60.6	9.5
Induced	0.5	22.4	56.4	29.1	24.4	135.1	22.9

	Planning Area			Planning Area
	EPA	CPA	WPA	Total
Total Employment	2.0	421.8	476.6	900.4
Direct	0.9	241.7	248.5	491.1
Indirect	0.6	47.9	70.1	118.6
Induced	0.5	132.2	158.0	290.7