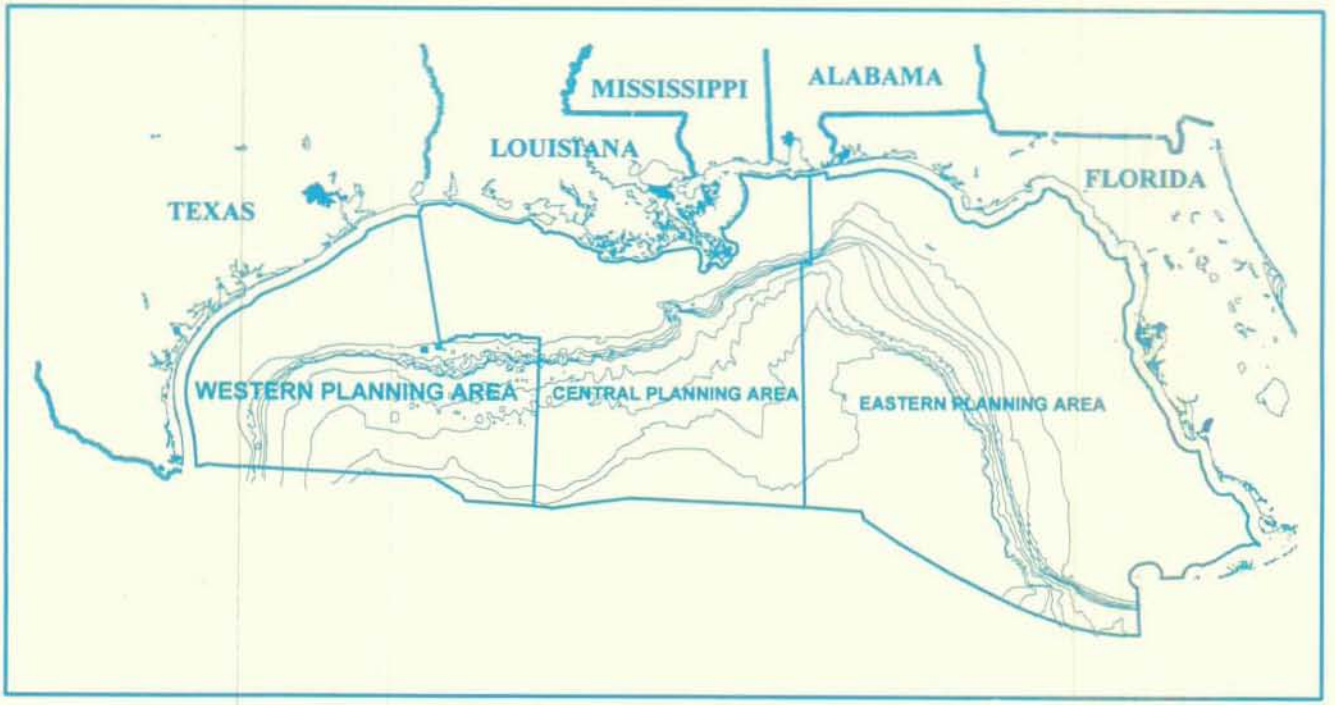
OCS EIS/EA
MMS 98-0008

Gulf of Mexico OCS Oil and Gas Lease Sales 171, 174, 177, and 180

Western Planning Area

Final Environmental Impact Statement



MMS U.S. Department of the Interior
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Gulf of Mexico OCS Region

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REGIONAL DIRECTOR'S NOTE

The Gulf of Mexico Outer Continental Shelf (OCS) Region of the Minerals Management Service (MMS) has been conducting environmental analyses of the effects of OCS oil and gas development since the passage of the National Environmental Policy Act (NEPA) of 1969. Since that time, we have published over 40 draft and final environmental impact statements (EIS). Our goal has always been to provide factual, reliable, and clear analytical statements in order to inform decisionmakers and the public about the environmental effects of proposed OCS activities and their alternatives. We view the EIS process as providing a balanced forum for early identification, avoidance, and resolution of potential conflicts. It is in this spirit that we welcome comments on this document from all concerned parties.

In keeping with the goals of making Government work better and cost less, MMS has streamlined the NEPA compliance process whenever possible and appropriate. Since the sale proposal and projected activities are very similar each year, MMS has decided to prepare a single EIS for the remaining four Western Gulf sales in the current 5-Year Leasing Program. The multisale approach is intended to focus the NEPA/EIS process on differences between these proposed sales and on new issues and information. The multisale EIS will lessen duplication and save resources. This EIS will serve as a base reference for future Western Gulf NEPA compliance documents.

Chris C. Oynes
Regional Director
Minerals Management Service
Gulf of Mexico OCS Region

COVER SHEET

Environmental Impact Statement for Proposed Western Gulf of Mexico OCS Oil and Gas Lease Sales 171, 174, 177, and 180

	Draft ( )	Final (x)
Type of Action:	Administrative (x)	Legislative ( )
Area of Potential Impact:	Offshore Marine Environment and Coastal Counties/Parishes of Texas and Louisiana	

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ABSTRACT

The Minerals Management Service proposes to hold annual oil and gas lease sales in the Western Planning Area (WPA) of the Gulf of Mexico Outer Continental Shelf (OCS). The proposed actions are the Western Gulf sales scheduled in the *Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002* (Sale 171 in 1998, Sale 174 in 1999, Sale 177 in 2000, and Sale 180 in 2001). This environmental impact statement (EIS) serves as a decision document for proposed Sale 171. This document includes the purpose and background of the proposed actions, identification of the alternatives, description of the affected environment, and an analysis of the potential environmental impacts of the proposed actions, alternatives, and associated activities, including proposed mitigating measures and their potential effects. Potential contributions to cumulative impacts resulting from activities associated with the proposed actions are also analyzed.

Each of the proposed actions will offer for lease all unleased blocks in the Western Planning Area of the Gulf of Mexico OCS, with the exclusion of the East and West Flower Garden Banks (Blocks A-375 and A-398 in the High Island Area, East Addition, South Extension) and three blocks used for Naval mine warfare testing and training (Blocks 793, 799, and 816 in the Mustang Island Area). Additionally, discussions between the United States and Mexico regarding tracts beyond the U.S. Exclusive Economic Zone are ongoing and may result in the deferral of those tracts for Sale 171 (approximately 277 tracts) in the "Northern Portion of the Western Gap" (Figure I-1). Decisions whether or not to defer tracts in the northern portion of the Western Gap from Sales 174, 177, and 180 will be made within the context of the prelease decision processes for those sales. The planning area includes about 28.4 million acres located from 14 to 357 kilometers offshore Texas in water depths ranging from 8 to more than 3,000 meters. It is estimated that each proposed sale could result in the production of 0.01-0.09 billion barrels of oil and 0.57-1.93 trillion cubic feet of gas. The alternatives to the proposed areawide sales are exclusion of the blocks near biologically sensitive topographic features and no action.

Hypothetical scenarios were developed indicating the levels of activities, accidental events (such as oil spills), and potential impacts that might result if the proposed action is adopted. The scenarios are on estimated amounts, timing, and general locations for OCS exploration, development, and production activities and facilities.

Additional copies of this EIS and the referenced visuals may be obtained from the MMS, Gulf of Mexico OCS Region, Public Information Office (MS 5034), 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123-2394, or by telephone at 1-800-200-GULF.

SUMMARY

This environmental impact statement (EIS) addresses four proposed Federal actions that offer for lease areas on the Gulf of Mexico Outer Continental Shelf (OCS) that may contain economically recoverable oil and gas resources. Federal regulations allow for several similar proposals to be analyzed in one EIS (40 CFR 1502.4). Since the sale proposal and projected activities are very similar each year, a single EIS is being prepared for all four Western Gulf sales scheduled in the *Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002*. The proposed annual Western Gulf sales are Sale 171 in 1998, Sale 174 in 1999, Sale 177 in 2000, and Sale 180 in 2001. Although this EIS addresses four proposed sale actions, only one sale decision will be made each year. This EIS will serve as a decision document for Sale 171 scheduled for 1998. All unleased blocks in the Western Planning Area (WPA), except two blocks in the Flower Garden Banks National Marine Sanctuary and three blocks for Naval operations, will be available for lease under any proposed actions; only a small percentage is expected to be actually leased. Of the blocks that will be leased, only a portion would be drilled and result in subsequent production. Additionally, discussions between the United States and Mexico regarding tracts beyond the U.S. Exclusive Economic Zone are ongoing and may result in the deferral of those tracts for Sale 171 (approximately 277 tracts) in the "Northern Portion of the Western Gap" (Figure I-1). Decisions whether or not to defer tracts in the northern portion of the Western Gap from Sales 174, 177, and 180 will be made within the context of the prelease decision processes for those sales.

The analytical methods used in this EIS have been formulated over a period of years. The first step of the analysis is the identification of significant environmental and socioeconomic resources through the scoping process. A range of oil and natural gas resource estimates is derived from geologic and economic assumptions. Alternatives to the proposed actions are established. Estimated levels of exploration and development activity are assumed for the purposes of the analysis. An analysis of the potential impacts expected on the significant environmental resources from the projected OCS-related activities is then conducted.

The following are brief descriptions of the proposed actions, alternatives, mitigating measures, and issues addressed in this EIS.

Proposed Actions and Alternatives

Alternative A (Proposed Western Gulf Sales 171, 174, 177, and 180): Each proposed action, scheduled for August of each year, would offer for lease all unleased blocks in the WPA, with the following exceptions. Excluded from the proposed actions are Blocks A-375 and A-398 in the High Island Area, East Addition, South Extension (East and West Flower Garden Banks, respectively). The East and West Flower Garden Banks are designated as a national marine sanctuary. Blocks 793, 799, and 816 in the Mustang Island Area, identified by the Navy as needed for testing equipment and for training mine warfare personnel, have been removed from the proposed actions. The planning area includes about 11.5 million hectares (ha) (28.4 million acres (ac)) located from 14 to 357 km (9 to 220 mi) offshore in water depths ranging from 8 to more than 3,000 m (26 to more than 9,000 ft). The Topographic Features Stipulation establishes "No Activity Zones" around 23 banks in the WPA. The proposed actions include existing regulations and proposed lease stipulations designed to reduce environmental risks. It is estimated that each proposed sale could result in the production of 0.01-0.09 billion barrels of oil (BBO) and 0.57-1.93 trillion cubic feet (tcf) of gas.

Alternative B (The Proposed Actions Excluding the Blocks Near Biologically Sensitive Topographic Features): This alternative would offer for lease all unleased blocks in the WPA to be offered in the proposed actions, with the exception of the approximately 61 unleased blocks of the 200 total blocks on or near biologically sensitive areas of the topographic features.

Alternative C (No Action): This alternative equates to cancellation of a sale. Neither potential oil and gas production nor potential environmental effects resulting from a proposed action would occur.

Mitigating Measures

Three stipulations are included as part of the proposed actions. These stipulations are the Topographic Features, Military Areas, and Naval Mine Warfare Area Stipulations. Application of these stipulations to leases resulting from the proposed actions is an option available to the Secretary of the Interior.

Scenarios Analyzed

Oil and gas resources estimated to be leased, discovered, and developed from a proposed lease sale are the basis of the scenario to be analyzed for potential impacts to environmental resources. The estimated oil and gas resources are based on factors such as geologic structure, economic assumptions, and proximity to existing development. The proposed action analyzed is expected to be "typical" of any of the Western Gulf sales held over the next four years. The scenario analyzed is a range of the amounts of undiscovered, unleased hydrocarbon resources estimated to be leased and discovered as a result of a proposed action. The analyses are based on an assumed range of activities that would be needed to develop and produce the amount of resources estimated to be leased. These activities include the number of platforms, wells, pipelines, and service-vessel trips.

The cumulative analysis considers environmental impacts that result from the incremental impact of the lease sales when added to all past, present, and reasonably foreseeable future human activities, including non-OCS activities such as import tankering and commercial fishing, as well as all OCS activities.

Significant Issues

The major issues that frame the environmental analyses in this EIS are the direct result of concerns raised during years of scoping for Gulf lease sale EIS's. Issues related to OCS exploration, development, production, and transportation activities include oil spills, wetlands loss, air emissions, discharges, water quality degradation, trash and debris, structure and pipeline emplacement activities, platform removal, increase in deepwater activities, increase vessel and helicopter traffic, multiple-use conflicts, support services, population fluctuations, demands on public services, land use planning, tourism, aesthetic interference, cultural impacts, and consistency with State coastal zone management programs. Environmental resources and activities determined through the scoping process to warrant an environmental analysis are sensitive coastal environments, sensitive offshore resources, water and air quality, marine mammals, sea turtles, coastal and marine birds, commercial fisheries, recreational resources and activities, archaeological resources, and socioeconomic conditions.

Impact Conclusions

A summary of the potential impacts on each environmental resource and the conclusions of the analyses can be found in Section II.C.1.b.; the full analyses are presented in Section IV.D.1. Below is a general summary of the potential impacts resulting from a typical proposed action.

Offshore Resources

The proposed action is expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density Bush Hill-type chemosynthetic communities could experience minor impacts from drilling discharges or resuspended sediments, with recovery expected within 2 years. If physical disturbance (such as anchor damage) to high-density Bush Hill-type communities were to occur, impacts could be severe over a limited area, with recovery times as long as 200 years for mature tube worm communities. Such impact could cause incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos. The provisions of NTL 88-11, requiring surveys and avoidance prior to drilling, will greatly reduce the risk of physical disturbance.

Potential impacts on live-bottom communities from bottom-disturbing activities (structure removal and emplacement), operational discharges (drilling muds and cuttings, produced waters), blowouts, and surface and subsurface oil spills should be prevented by the proposed Topographic Features Stipulation. Recovery from impact incidences of operational discharges and blowouts would take place within 10 years. Contact with spilled oil would cause lethal and sublethal effects in benthic organisms. The oiling of benthic organisms is not likely because the proposed Topographic Features Stipulation would keep sources of spills away from the immediate vicinity of topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for adult sessile biota, including

coral colonies in the case of the Flower Garden Banks, and there would be limited incidences of mortality. The recovery of harmed benthic communities could take more than 10 years.

Activities resulting from the proposed action have the potential to cause detrimental effects to marine mammals and sea turtles through degradation of water quality resulting from operational discharges, helicopter and vessel traffic and noise, platform and drillship noise, seismic surveys, explosive platform removals, oil spills, oil-spill response activities, and discarded trash and debris from service vessels and OCS structures. The proposed action is unlikely to have significant long-term adverse effects on the size and productivity of any marine mammal or sea turtle species or population stock in the northern Gulf of Mexico. Lethal effects are most likely to be from chance collisions with OCS service vessels and ingestion by eating indigestible trash, particularly plastic items, lost from drill rigs and service vessels of plastic materials, though few lethal impacts are expected. 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, and result in either acute or gradual population declines.

The proposed action is expected to result in less than a one percent decrease in commercial fishery populations, in essential habitat, or in commercial fishing. It will require less than six months for fishing activity and one generation for fishery resources to recover from 99 percent of the impacts.

OCS discharges and spills associated with the proposed action would contribute less than one percent of the metal and hydrocarbon contaminants that are measurable in regional offshore waters and that may be accumulating in offshore sediments. Regional water quality is not expected to be compromised by discharges related to the proposed action. Toxic effects to the benthos from OCS discharges are expected to be very localized, limited to within 100 m from the discharge, and will be of a relatively small magnitude. Loss of use of marine water resulting from accidental spills will be of short-duration (from a few days to 3 months) and very localized. Water quality changes in the water column are limited to the area around and beneath the surface slick and are expected to last for only a short time following the removal of the slick from the surface of the water. Minimum, short-term changes in water quality conditions due to resuspension of sediments are expected from removal operations and accidental blowout events.

Coastal Resources

The proposed action is not expected to adversely alter barrier beach configurations significantly beyond existing impacts in very localized areas down drift of artificially jettied and maintained channels. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas.

The most significant impacts to wetlands from the proposed action are from the installation, maintenance, continued existence, and the failure of mitigation structures of pipeline and navigation canals. Proposed action-related impacts would not be significant because of their broad and diffuse distribution over coastal Texas, and their minor contribution to the impacts from other ongoing OCS Program-related impacts to wetlands.

Future regional water quality degradation due to proposed action operations would be very small in relation to degradation from all other sources. Maintenance dredging will result in localized impacts (primarily increased turbidity and resuspended contaminants) that will preclude uses of the waters immediately surrounding dredged sites and that could last up to several months. Water clarity within the navigation channels could be compromised as a result of continuous sediment influx from bank erosion, natural widening, and reintroduction of dredged material back into surrounding waters. Spills related to proposed action activities would result in acute, localized, and low-level impacts to coastal waters and are not likely to become major contributors to regional petroleum contamination of Gulf coastal waters. Impacts to coastal waters from a proposed action should not disrupt current uses designated for these waters.

Emissions of pollutants into the atmosphere from the activities associated with the proposed action are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline. Emissions from proposed action activities are not expected to have concentrations that would change onshore air quality classifications. Increases in onshore annual average concentrations of NO_x, SO_x, and TSP are estimated to be less than the maximum increases allowed under the PSD Class II program.

It is expected that most effects from the major impact-producing factors on coastal and marine birds will be sublethal (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris), causing temporary disturbances and displacement of localized groups inshore. Chronic sublethal stress can weaken individuals and expose them to infection and disease. Spills occurring in biologically sensitive areas are expected to kill a number of individuals with a net effect of alteration of the species composition of the affected area(s) and possibly the reduction of the overall carrying capacity of these area(s) in general. Recovery of the affected areas is expected to take up to several years.

The proposed action is expected to result in accidental pollution events, intermittent marine debris washup, nearshore operations, and a slight increase in noise from helicopter and vessel traffic that may adversely affect the enjoyment of some beach uses on Texas and Louisiana beaches; however, these will have little effect on the number of beach users.

Other Resources

The greatest potential impact to a historic archaeological resource as a result of the proposed action would result from a contact between a proposed action-related offshore activity (platform installation, drilling rig emplacement, and a dredging or pipeline project) and a historic shipwreck. Although not probable, such an event would result in the disturbance or destruction of important historic archaeological information. Most other activities associated with the proposed action are not expected to impact historic archaeological resources.

Impact to a prehistoric archaeological resource could result from a contact between a proposed action-related activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric site located on the continental shelf. The proposed action is not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, there would be damage to or loss of significant or unique archaeological information.

The coastal subareas of Texas are projected to provide the greatest support and, hence, incur the greatest potential socioeconomic impacts associated with the proposed action. Peak annual changes in the employment and population of all coastal subareas in the Western and Central Gulf represent less than 1 percent of the levels expected in absence of the proposed action. It is expected that employment demands in support of the proposed action will be met with the existing population and available labor force. Some employment is expected to be met through in-migration due to the shadow effect and a labor force lacking requisite skills for the oil and gas and supporting industries. About 32 percent of the total employment resulting from the proposed action is expected to affect the coastal subareas of the Central Gulf.

Population, employment, and land use impacts that result from a typical proposed action will not result in disruptions to community infrastructure and public services beyond what is anticipated by in-place planning, development, and regulatory agencies. An increasing focus on deepwater activity may result in some stress placed on local infrastructure at or near focal points associated with support of deepwater exploration and development activities. Potential impacts from oil spills include temporary (6 weeks maximum) stresses to local infrastructure, a loss of community cohesion, social disorganization associated with a rapid influx of strangers into a tightly-knit community, and an increased cost of living associated with increased demand for housing. The impact of the proposed action on sociocultural issues is expected to be minimal with some deleterious impacts to family life in a small number of cases resulting from the external work schedule and minimal impacts to educational attainment. Social and cultural problems typically associated with in-migration and out-migration are generally not expected to occur as a result of the proposed action; however, it is possible that some of the communities heavily involved in supporting OCS activity may experience problems associated with in-migration in support of the proposed action. The proposed action is not expected to affect the practice of traditional occupations in the WPA. The proposed action is not expected to cause disproportionately high or adverse human health or environmental effects on minority or low-income populations.

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ABBREVIATIONS AND ACRONYMS

ACAA	Alabama Coastal Area Act
ACAMP	Alabama Coastal Area Management Plan
ADECA	Alabama Department of Economic and Community Affairs
ADEM	Alabama Department of Environmental Management
ANWR	Aransas National Wildlife Refuge
APD	Application for Permit to Drill
API	American Petroleum Institute
ARZ1	Archeological Resource Zone 1
BACT	best available control technology
BAST	best available and safest technology
Bbbl	billion barrels
BBO	billion barrels of oil
Bcf	billion cubic feet
BEA	Bureau of Economic Affairs
BOE	barrels of oil equivalent
BOP	blowout preventer
B.P.	before present
Call	Call for Information and Nominations
CCA	Coastal Coordination Act (Texas)
CD	Consistency Determination
CDP	common depth point
CEI	Coastal Environments, Inc.
CEQ	Council on Environmental Quality
CER	Categorical Exclusion Review
cf.	compare, see
CFDL	Coastal Facilities Designation Line (Texas)
CFR	Code of Federal Regulations
CNRA	Coastal Natural Resources Area
COD	chemical oxygen demand
COE	Corps of Engineers (U.S. Army)
CPA	Central Planning Area
CSA	Continental Shelf Associates
CWA	Clean Water Act
CWPPRA	Coastal Wetlands Protection, Planning & Restoration Act
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
DOCD	Development Operations Coordination Document
DOD	Department of Defense (U.S.)
DOI	Department of the Interior (U.S.) (also: USDOI)
DOT	Department of Transportation (U.S.) (also: USDOT)
DWOP	Deepwater Operations Plan
dwt	dead weight tonnage
EA	environmental assessment
EEZ	Exclusive Economic Zone
EIA	Energy Information Administration (USDOE)
EIS	environmental impact statement
EP	Exploration Plan
EPA	Eastern Planning Area
ESP	Environmental Studies Plan
et al.	and others
et seq.	and the following
EWTA	Eglin Water Test Area
FAA	Federal Aviation Administration
FCF	Fishermen's Contingency Fund
FERC	Federal Energy Regulatory Commission
FMC	Fishery Management Council
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impact
FPS	floating production system
FPSO	floating production, storage, and offloading system
FR	*Federal Register*
FWPCA	Federal Water Pollution Control Act of 1972
FWS	Fish and Wildlife Service
FY	fiscal year
G&G	geological and geophysical
GIS	geographical information system
GIWW	Gulf Intracoastal Waterway
GMAQS	Gulf of Mexico Air Quality Study
GMFMC	Gulf of Mexico Fishery Management Council
GTFP	Green Turtle Fibropapillomatosis
HMWHC	high molecular weight hydrocarbons
IPF	impact-producing factor
ITL	Information to Lessees and Operators
ITM	Information Transfer Meeting
LATEX	Texas-Louisiana Shelf Circulation and Transport Process Program (MMS-funded study)
LCRP	Louisiana Coastal Resources Program
LDNR	Department of Natural Resources (Louisiana)
LLD	lower limit of detection

LOOP	Louisiana Offshore Oil Port
LSU	Louisiana State University
LTL	Letter to Lessees and Operators
MAFLA	Mississippi, Alabama, and Florida
MARPOL	International Convention for the Prevention of Pollution from Ships
MCP	Mississippi Coastal Program
MFCMA	Magnuson Fishery Conservation and Management Act of 1976
Mmbbl	million barrels
MMC	Marine Mammal Commission
MMPA	Marine Mammal Protection Act of 1972
MMS	Minerals Management Service
MSA	Metropolitan Statistical Area
Mta	million metric tons annually
MOU	Memorandum of Understanding
NAAQS	National Ambient Air Quality Standards
NACE	National Association of Corrosion Engineers
NARP	National Artificial Reef Plan
NAS	National Academy of Sciences
n.d.	no date
NEPA	National Environmental Policy Act
NERBC	New England River Basins Commission
NFEA	National Fishing Enhancement Act
NGVD	National Geodetic Vertical Depth
NHAP	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent to Prepare an EIS
NORM	naturally occurring radioactive material
NOW	nonhazardous oil-field waste
NPDES	National Pollutant and Discharge Elimination System
NRC	National Research Council
NST	National Status & Trends Program (NOAA)
NTL	Notice to Lessees and Operators
OCD	Offshore and Coastal Dispersion model
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OPA	Oil Pollution Act of 1990
OPEC	Organization for Petroleum Exporting Countries
OSCP	Oil Spill Contingency Plan
OSIR	Oil Spill Intelligence Report
OSRA	Oil Spill Risk Analysis
P.L.	Public Law
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PINC	Potential Incident of Noncompliance
PINS	Padre Island National Seashore
PM_{10}	particulate matter smaller than 10 microns
ppm	parts per million
ppt	parts per thousand
PSD	Prevention of Significant Deterioration
RCRA	Resource Conservation and Recovery Act
RPA	representative of the proposed action
RD	Regional Director
RTR	Rigs-to-Reef
SEIS	supplemental environmental impact statement
SEFSC	Southeast Fisheries Science Center
SIC	Standard Industrial Classification
sp.	species
spp.	multiple species
SSP	Strategic Studies Plan
Stat.	Statutes
tcf	trillion cubic feet
TCMP	Texas Coastal Management Plan
TED	turtle excluder device
THC	total hydrocarbon content
TLP	tension leg platform
TSP	total suspended particulate matter
TWC	treatment, workover, and completion
U.S.	United States
U.S.C.	United States Code
USCG	U.S. Coast Guard
USCOE	U.S. Corps of Engineers
USDOC	U.S. Department of Commerce
USDOE	U.S. Department of Energy
USDOI	U.S. Department of the Interior (also: DOI)
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compounds
WBNP	Wood Buffalo National Park
WPA	Western Planning Area

CONVERSION CHART

Measurements in this EIS are given in SI metric units (International System of Units) except where U.S. units are the accepted standard (for example, altitudes for aircraft). For the reader's convenience, both SI metric and U.S. customary units are included in the Summary. Factors for converting SI metric to U.S. customary units are provided in the following table.

To convert from	To	Multiply by
millimeter (mm)	inch (in)	0.03937
centimeter (cm)	inch (in)	0.3937
meter (m)	foot (ft)	3.281
kilometer (km)	mile (mi)	0.6214
meter^2 (m^2)	foot^2 (ft^2)	10.76
	yard^2 (yd^2)	1.196
	acre (ac)	0.0002471
hectare (ha)	acre (ac)	2.47
kilometer^2 (km^2)	mile^2 (mi^2)	0.3861
meter^3 (m^3)	foot^3 (ft^3)	35.31
	yard^3 (yd^3)	1.308
liter (l)	gallons (gal)	0.2642
degree Celsius (°C)	degree Fahrenheit (°F)	°F=(1.8 x °C) + 32

1 barrel (bbl) = 42 gal = 158.9 l = approximately 7.36 metric tons

1 nautical mile (nmi) = 6,076 ft or 1.15 mi

THE PROPOSED ACTIONS — I

ALTERNATIVES INCLUDING THE PROPOSED ACTIONS — II

DESCRIPTION OF THE AFFECTED ENVIRONMENT — III

ENVIRONMENTAL CONSEQUENCES — IV

CONSULTATION AND COORDINATION — V

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SECTION I

THE PROPOSED ACTIONS

I. THE PROPOSED ACTIONS

A. PURPOSE OF AND NEED FOR THE PROPOSED ACTIONS

The proposed Federal actions addressed in this environmental impact statement (EIS) are four areawide oil and gas lease sales, one held each year, in the Western Planning Area (WPA) of the Gulf of Mexico Outer Continental Shelf (OCS) (Figure I-1). The purpose of these proposed Federal actions is to offer for lease areas that may contain economically recoverable oil and gas resources. The proposed actions will provide qualified bidders the opportunity to bid upon and lease acreage in the Gulf of Mexico OCS in order to explore, develop, and produce oil and natural gas. This EIS analyzes the potential impacts of the proposed actions on the marine, coastal, and human environments. Although this EIS addresses four proposed sale actions, this EIS serves as a decision document for only proposed Sale 171. Formal consultation with other Federal agencies and the affected States, and a National Environmental Policy Act (NEPA) review will be conducted for each subsequent sale.

The Outer Continental Shelf Lands Act (OCSLA) (43 U.S.C. 1331-1356, as amended) , established Federal jurisdiction over submerged lands on the OCS seaward of the State boundaries. Under the OCSLA, the Secretary of the 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 (Secretary) 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 and fair return for these resources and that free-market competition is maintained. The Act empowers the Secretary to grant leases to the highest qualified responsible bidder(s) on the basis of sealed competitive bids and to formulate such regulations as necessary to carry out the provisions of the Act. The Secretary of the Interior has designated the Minerals Management Service (MMS) as the administrative agency responsible for the mineral leasing of submerged OCS lands and for the supervision of offshore operations after lease issuance.

The Western and Central Gulf of Mexico constitute one of the world's major oil and gas producing areas, and have proved a steady and reliable source of crude oil and natural gas for more than 40 years. Oil from the Gulf of Mexico can help reduce the Nation's need for oil imports and reduce the environmental risks associated with oil tankering. Natural gas is an environmentally preferable alternative to oil, both in terms of the production and consumption.

B. DESCRIPTION OF THE PROPOSED ACTIONS

The proposed annual Western Gulf Sales, as scheduled in the *Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002* (5-Year Program), are Sale 171 in 1998, Sale 174 in 1999, Sale 177 in 2000, and Sale 180 in 2001. The planning area includes about 28.4 million acres (ac) located 14 to 357 kilometers (km) offshore in water depths ranging from 8 to 3,000 meters (m). Each proposed sale would offer for lease all unleased blocks in the WPA, with the following exceptions. Excluded from the proposed actions are Blocks A-375 (East Flower Garden Bank) and A-398 (West Flower Garden Bank) in the High Island Area, East Addition, South Extension. The East and West Flower Garden Banks are designated as a national marine sanctuary. Blocks 793, 799, and 816 in the Mustang Island Area have been removed from the proposed actions. These blocks have been identified by the Navy as needed for testing equipment and for training mine warfare personnel. On December 11, 1997, Secretary Babbitt deferred blocks in the northern portion of the Western Gap from proposed Sale 169 in light of the joint undertaking by the U.S. and Mexico to begin discussions regarding the establishing of a continental shelf boundary in the Western Gap. These discussions are now underway, and the blocks in the northern portion of the Western Gap are proposed to be deferred from Sale 171. The northern portion of the Western Gap is the area in the Western Gulf Planning Area beyond the U.S. Exclusive Economic Zone and includes the following blocks: Keathley Canyon (NG15-05) Blocks 722-724, 764-770, 807-816, 849-861, 892-907, 934-953, and 978-999, and Unnamed (NG15-08) Blocks 11-34, 56-81, 102-128, 148-173, 194-217, 239-261, 284-305, and 336-349. Decisions

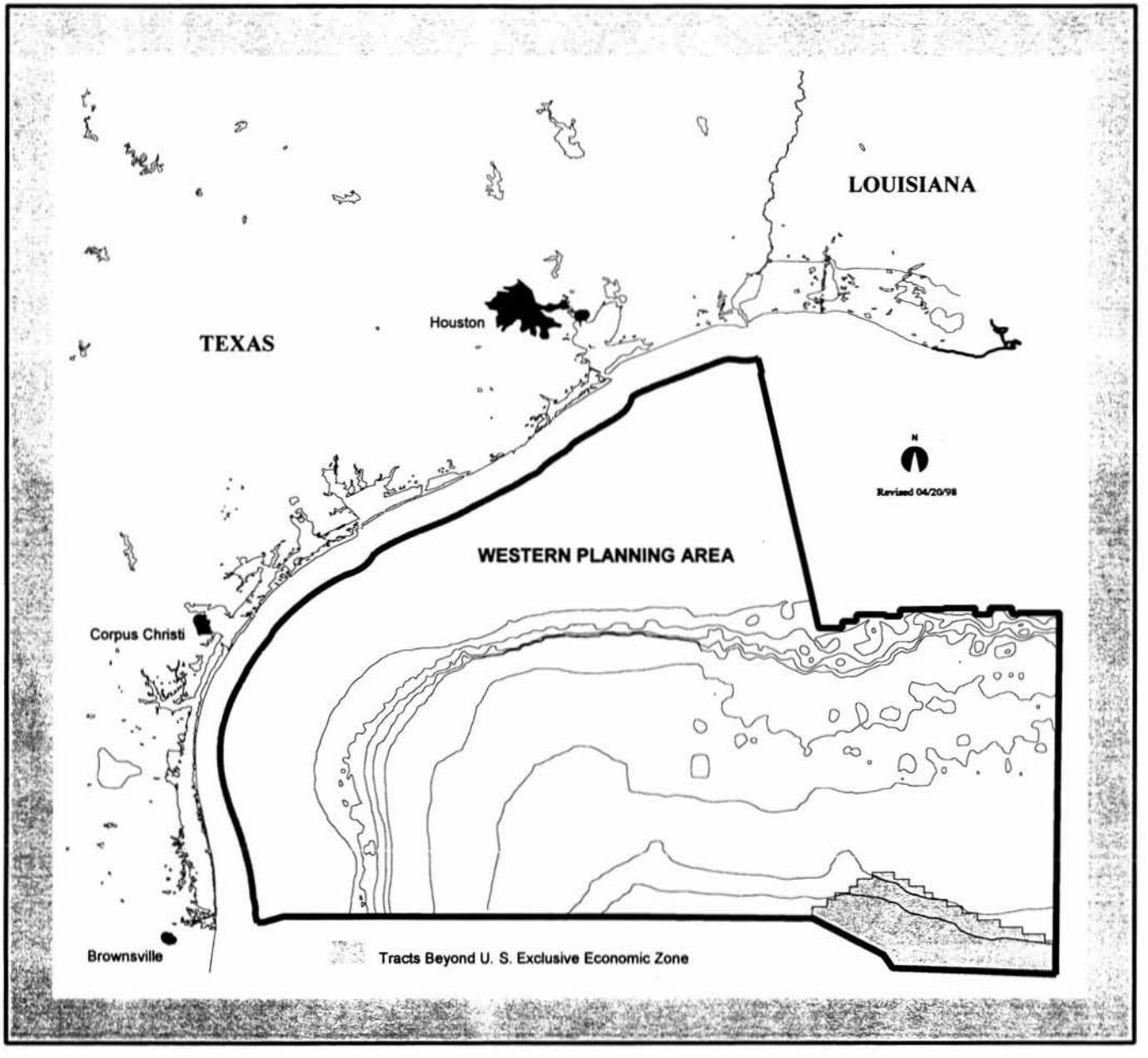


Figure I-1. Gulf of Mexico Outer Continental Shelf Western Planning Area and Locations of Some Major Cities.

whether or not to defer tracts in the northern portion of the Western Gap from Sales 174, 177, and 180 will be made within the context of the prelease decision processes for those sales. The Topographic Features Stipulation establishes "No Activity Zones" around 23 banks in the WPA. The proposed actions include existing regulations and proposed lease stipulations designed to reduce environmental risks. It is estimated that each proposed lease sale could result in the production of 0.01-0.09 billion barrels of oil (BBO) and 0.57-1.93 trillion cubic feet (tcf) of gas.

Federal regulations allow for several similar proposals to be analyzed in one EIS (40 CFR 1502.4). Since the sale proposal and projected activities are very similar each year, the MMS has decided to prepare a single EIS for all four Western Gulf sales in the 5-Year Program. The multisale approach is intended to focus the NEPA/EIS process on differences between the proposed sales and on new issues and information. The multisale EIS will eliminate the repetitive issuance of complete draft and final EIS's for each sale. The multiyear approach will also allow the prelease process to take place within a one-year period, rather than the current two-year process. The two-year schedule can cause confusion as two EIS processes overlap with a final EIS being prepared concurrently with the next draft EIS.

Although this EIS addresses four proposed sale actions, only one sale decision will be made each year. This EIS will serve as a decision document for Sale 171 scheduled for 1998. Formal consultation with other Federal agencies and the affected States, and NEPA review will be conducted for each subsequent sale. An Environmental Assessment (EA) will be conducted to determine whether or not the information and analyses in this original multisale EIS have changed sufficiently for each subsequent sale under consideration to warrant further analysis. The EA will result in either a Finding of No New Significant Impact (FONSI) or the preparation of a Supplemental EIS (SEIS). The EA, and SEIS if deemed necessary, will tier off this initial multisale EIS and incorporate much of the material contained herein by reference.

The proposed action analyzed in this EIS is presented as a set of ranges for resource estimates, projected exploration and development activities, and impact-producing factors. This analyzed proposed action is expected to be "typical" of any of the Western Gulf sales held over the next four years. In other words, each of the proposed sales is expected to be within the ranges used for the analyzed "typical" sale. The sale area is depicted in Figure I-1. All unleased blocks in the WPA, with the exclusions noted above, will be available for lease under each proposed action, but only a small percentage is expected to actually be leased and an even smaller percentage will actually produce oil and gas.

C. REGULATORY AND ADMINISTRATIVE FRAMEWORK

Federal regulations mandate the OCS leasing program and the environmental review process. Several Federal regulations establish specific consultation and coordination processes with Federal, State, and local agencies. In addition, the OCS leasing process and all activities and operations on the OCS must comply with other Federal, State, and local laws and regulations. The following are summaries of applicable laws and regulations.

The Outer Continental Shelf Lands Act

Under the Outer Continental Shelf Lands Act (OCSLA), the Department of the Interior is required to manage the orderly leasing, exploration, development, and production of oil and gas resources on the Federal OCS, while simultaneously ensuring the protection of the human, marine, and coastal environments; that the public receives a fair and equitable return for these resources; and that free-market competition is maintained. The OCSLA requires coordination with the affected States and, to a more limited extent, local governments. At each step of the procedures that lead to lease issuance, participation from the affected States and other interested parties is encouraged and sought.

The National Environmental Policy Act and the Council on Environmental Quality

The National Environmental Policy Act (NEPA) requires that all Federal agencies use a systematic, interdisciplinary approach to protection of the human environment; this approach will ensure the integrated

use of the natural and social sciences in any planning and decisionmaking that may have an impact upon the environment. The NEPA also requires the preparation of a detailed EIS on any major Federal action that may have a significant impact on the environment. This EIS must include any adverse environmental effects that cannot be avoided or mitigated, alternatives to the proposed action, the relationship between short-term uses and long-term productivity of the environment, and any irreversible and irretrievable commitments of resources. In 1979, the Council on Environmental Quality (CEQ) established uniform procedures for implementing the procedural provisions of NEPA. These regulations provide for the use of the NEPA process to identify and assess the reasonable alternatives to proposed actions that avoid or minimize adverse effects of these actions upon the quality of the human environment. "Scoping" is used to identify the scope and significance of important environmental issues associated with a proposed Federal action through coordination with Federal, State, and local agencies; the public; and any interested individual or organization prior to the development of an impact statement. The process also identifies and eliminates from further detailed study issues that are not significant or that have been covered by prior environmental review.

The Marine Mammal Protection Act

Under the Marine Mammal Protection Act (MMPA) of 1972, the Secretary of Commerce is responsible for all cetaceans and pinnipeds, except walruses, and has delegated authority for implementing the Act to the National Marine Fisheries Service (NMFS). The Secretary of the Interior is responsible for walruses, polar bears, sea otters, manatees, and dugongs, and has delegated the responsibility to the Fish and Wildlife Service (FWS). The Act established the Marine Mammal Commission and its Committee of Scientific Advisors on Marine Mammals, which are responsible for overviewing and providing advice to the responsible regulatory agencies on all Federal actions bearing upon the conservation and protection of marine mammals.

The MMPA established a moratorium on the taking of marine mammals in waters under U.S. jurisdiction. The Act defines "take" to mean "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." "Harassment" is defined as any act of pursuit, torment, or annoyance which -- has the potential to injure a marine mammal or marine mammal stock in the wild (level A); or has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption or behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (level B). The moratorium may be waived when the affected species or population stock is within its optimum sustainable population range and will not be disadvantaged by the authorized taking--e.g., be reduced below its maximum net productivity level, which is the lower limit of the optimum sustainable population range. The Act directs that the Secretary, upon request, authorize the unintentional taking of small numbers of marine mammals incidental to activities (other than commercial fishing)--e.g., offshore oil and gas exploration and development--when, after notice and opportunity for public comment, the Secretary finds that the total of such taking during the 5-year (or less) period will have a negligible impact on the affected species.

The Act also specifies that the Secretary shall withdraw, or suspend for a time certain, permission to take marine mammals incidental to oil and gas and other activities if the applicable regulations regarding methods of taking, monitoring, or reporting are not being complied with, or the taking is, or may be, having more than a negligible impact on the affected species or stock.

In 1994, a new subparagraph (D) was added to Section 101(a)(5) to simplify the process for obtaining "small take" exemptions when unintentional taking incidental to activities such as offshore oil and gas development is by harassment only. Specifically, incidental take of small numbers of marine mammals by harassment can now be authorized for periods of up to one year without rulemaking, as required by Section 101(a)(5)(A), which remains in effect for authorizing other types of incidental taking.

In October 1995, NMFS issued regulations authorizing and governing the taking of bottlenose and spotted dolphins incidental to the removal of oil and gas drilling and production structures in State waters and on the Gulf of Mexico OCS for a period of 5 years (*Federal Register*, 1995). Letters of Authorization must be requested from, and issued to, individual applicants (operators) to conduct the activities (platform removals) pursuant to the regulations.

To ensure that OCS activities adhere to MMPA regulations, MMS must actively seek information concerning impacts from OCS activities on local species of marine mammals. Consequently, the MMS Outer Continental Shelf Environmental Studies Program continues to fund a series of studies begun in 1991 through Texas A&M University and NMFS on the distribution and abundance of marine mammals along the continental slope of the north-central and western Gulf of Mexico designed to produce an estimate of the potential effects of deepwater exploration and production on these species.

Since 1986, MMS, the U.S. Army Corp of Engineers, and OCS operators have been following strict NMFS recommendations to prevent adverse impacts to endangered marine turtles and to avoid the incidental taking of marine mammals.

The Magnuson Fishery Conservation and Management Act of 1976

The Magnuson Fishery Conservation and Management Act of 1976 (MFCMA) (16 U.S.C. 1801-1882) established and delineated an area from the States' seaward boundary out 200 nmi as a fisheries conservation zone for the United States and its possessions. The Act created eight Regional Fishery Management Councils (FMC's) and mandated a continuing planning program for marine fisheries management by the Councils. The Act, as amended, requires that a Fishery Management Plan (FMP) based upon the best available scientific and economic data be prepared for each commercial species (or related group of species) of fish that is in need of conservation and management within each respective region.

Reauthorization of the Act was completed by Congress through passage of the Magnuson-Stevens Act of 1996. The reauthorization implements a number of reforms and changes, including some that are specific to the Gulf of Mexico. Three new standards have been added to the existing seven. These new standards consider fishing communities, bycatch, and human safety at sea. Changes specific to the Gulf concern the red snapper fishery--the previously approved individual transfer quota system is repealed; preparation of any information or plan pertaining to an individual transfer quota system is prohibited; and the stock's assessment and associated information will receive a number of independent peer reviews.

The Magnuson-Stevens Act requires that Fishery Management Councils identify essential fisheries habitat for every fishery management plan that they develop, and they must go back and amend all existing plans to include the identification of this habitat. Essential fisheries habitat is defined as water and substrate for fish spawning, breeding, feeding, and growth to maturity. At this time, it is unclear how NMFS and the Gulf of Mexico Fishery Management Council will treat artificial habitats, such as oil and gas platforms, under the new regulations.

To date, nine FMP's have been implemented in the Gulf of Mexico. The FMP for shrimp was implemented in 1981; for stone crab, in 1982; for spiny lobster, in 1982; for coastal pelagic fish, in 1983; for coral, in 1984; for reef fish, in 1984; for swordfish, in 1985; for red drum, in 1987; and for sharks, in 1992 (Justen, 1992). The FMP's are amended and updated as new information from studies and public input is received and assessed.

The Endangered Species Act

The Endangered Species Act of 1973, as amended, establishes protection and conservation of threatened and endangered species and the ecosystem upon which they depend. The Act is administered by FWS and NMFS. Section 7 of the Act governs interagency cooperation and consultation. The MMS formally consults with NMFS and FWS to ensure that activities on the OCS under MMS jurisdiction do not jeopardize the continued existence of a threatened or endangered species and/or result in adverse modification or destruction of their critical habitat.

The FWS and NMFS make recommendations on the modification of oil and gas operations to minimize adverse impacts, although it remains the responsibility of MMS to ensure that proposed actions do not impact threatened and endangered species. In response to FWS/NMFS recommendations, MMS requires adequate oil spill contingency plans for all activities and has requested aircraft supporting offshore facilities to maintain an altitude of 2,000 ft or more above national parks, seashores, and wildlife refuges.

The National Fishing Enhancement Act

The National Fishing Enhancement Act of 1984, also known as the Artificial Reef Act, establishes broad artificial-reef development standards and a national policy to encourage the development of artificial reefs that will enhance fishery resources and commercial and recreational fishing. The national plan identifies oil and gas structures as acceptable materials of opportunity for artificial-reef development. The MMS adopted a Rigs-to-Reefs policy in 1985 in response to this Act and to broaden interest in the use of petroleum platforms as artificial reefs.

The Marine Protection, Research, and Sanctuaries Act

The Marine Protection, Research, and Sanctuaries Act of 1972 established the National Marine Sanctuary Program, which is administered by the National Oceanic and Atmospheric Administration of the Department of Commerce. The Flower Garden Banks National Marine Sanctuary (NMS) was designated in 1992. The Department of the Interior has taken action to protect the biological resources of the Flower Garden Banks NMS from possible damage due to oil and gas exploration and development activities. Two blocks (Blocks A-375 and A-398 in High Island Area, East Addition, South Extension), wholly underlain by the Flower Garden Banks, are excluded from leasing. The MMS has also established a "No Activity Zone" around the Flower Garden Banks and has established other operational restrictions as described in the Topographic Features Stipulation. Stetson Bank was added to the Flower Garden Banks NMS in 1996. Stetson Bank is currently protected by a "No Activity Zone."

The Oil Pollution Act

The Oil Pollution Act (OPA) of 1990 establishes a single uniform Federal system of liability and compensation for damages caused by oil spills in U.S. navigable waters. OPA requires removal of spilled oil and establishes a national system for planning for and responding to oil spill incidents. OPA includes provisions to (1) improve oil-spill prevention, preparedness, and response capability; (2) establish limitations on liability for damages resulting from oil pollution; (3) provide funding for natural resource damage assessment, (4) implement a fund for the payment of compensation for such damages, and (5) establish an oil pollution research and development program. The Secretary of the Interior is given authority over offshore facilities and associated pipelines (except deepwater ports) for all Federal and State waters. These functions include spill prevention, oil-spill contingency plans, oil-spill containment and clean-up equipment, financial responsibility certification, and civil penalties.

The Clean Water Act

The Federal Water Pollution Control Act (FWPCA) of 1972, as amended, commonly called the Clean Water Act (CWA), authorizes the U.S. Environmental Protection Agency (USEPA) to issue National Pollutant Discharge Elimination System (NPDES) permits to regulate discharges into waters of the United States. On March 4, 1993, the USEPA issued revised Effluent Limitations Guidelines and New Source Performance Standards that set more restrictive conditions than were previously applied to OCS discharges. These limitations and standards are now being incorporated into Gulf of Mexico NPDES permits, which in turn, place further conditions on discharges to reduce biological impacts. Offshore wastes can be discharged overboard.

The current general NPDES permit of the USEPA, Region 6 (issued for existing sources on December 3, 1993, and for new sources on August 9, 1996) covers the OCS area west of the Mississippi River. This permit will expire in 1997, prior to the first proposed action covered by this EIS. Region 6 will reissue this permit for another 5-year period; it is unknown what changes are likely to the permit conditions.

The USEPA, Region 4, whose jurisdiction covers the area east of the Mississippi River, has yet to issue a general permit that includes the more restrictive effluent limitation and new source performance guidelines. As of this writing, Region 4 has proposed a general NPDES permit for activities under their jurisdiction in

water depths greater than 200 m. Operations occurring in shallower waters would be covered by individual permits that have yet to be issued. It is not known what the final permit strategy for Region 4 will entail.

The USEPA and DOI signed a Memorandum of Agreement in 1984 to allow coordination of any environmental permits for oil and gas lease activities on the OCS. The MMS's Gulf of Mexico OCS Region and the USEPA's Regions 4 and 6 entered into a Cooperative Agency Agreement concerning either agency's preparation of EIS's related to any OCS oil and gas industry operations in the Gulf of Mexico. The CAA expired on June 1, 1997.

The Clean Air Act

The Clean Air Act (CAA), as amended, delineates jurisdiction of air quality between the USEPA and DOI. For OCS operations in the Gulf of Mexico, those west of 87.5°W longitude are subject to MMS air quality regulations; those operations east of 87.5°W longitude are subject to USEPA air quality regulations.

Under the CAA the Secretary of the Interior is tasked to consult with the Administrator of the USEPA "to assure coordination of air pollution control regulation for OCS emissions and emissions in adjacent onshore areas. The MMS established 30 CFR 250.44, 250.45, and 250.46 to comply with the CAA. The regulated pollutants include carbon monoxide, particulates, sulphur dioxide, nitrogen oxides, and volatile organic compounds (as a precursor to ozone). In areas where hydrogen sulfide may be present, operations are regulated by 30 CFR 250.67. These regulations allow the collection of information about potential sources of pollution for the purpose of determining whether the projected emissions of air pollutants from the facility may result in onshore ambient air concentrations above significance levels provided in the regulations and appropriate emissions controls as deemed necessary to prevent accidents and air quality deterioration.

The Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act (RCRA) provides a framework for the safe disposal and management of hazardous and solid wastes. Most oil-field wastes have been exempted from coverage under RCRA's hazardous waste regulations. If wastes generated on the OCS are not exempt and are hazardous, these wastes must be transported to shore for disposal at a hazardous waste facility. Exempt wastes taken from the Gulf of Mexico OCS for disposal are regulated in Texas, Louisiana, and Mississippi.

The Marine Plastic Pollution Research and Control Act

The Marine Plastic Pollution Research and Control Act of 1987 implements Annex V of the International Convention for the Prevention of Pollution from Ships (MARPOL). The Gulf of Mexico has received "Special Area" status under MARPOL, thereby prohibiting the disposal of all solid waste into the marine environment. Fixed and floating platforms, drilling rigs, manned production platforms, and support vessels operating under a Federal oil and gas lease are required to develop Waste Management Plans and to post placards reflecting discharge limitations and restrictions.

The Coastal Zone Management Act

Pursuant to the Coastal Zone Management Act (CZMA) and the Coastal Zone Reauthorization Amendments of 1990, all Federal activities, including OCS oil and gas lease sales, must be consistent to the maximum extent practicable with the enforceable policies of each affected State's coastal zone management (CZM) program. Each State's CZM program sets forth objectives, policies, and standards relative to public and private use of land and water resources in the coastal zone.

A State with an approved CZM plan reviews plans for OCS Exploration Plans (EP's) and Development Operations Coordination Documents (DOCD's) to determine whether the proposed activities are consistent with the State's CZM plan. The MMS may not issue a permit for activities described in a plan unless the State concurs or is conclusively presumed to have concurred that the plan is consistent with its CZM plan.

The MMS's Gulf of Mexico OCS Region sends copies of an EP and DOCD--including the consistency determination and other necessary information--to the designated State CZM agency. If no State-agency objection is submitted by the end of the review period, MMS shall presume consistency concurrence by the State. If a written consistency concurrence is received from the State, MMS's Gulf Region may then approve any permit for activities described in the plan. If the Gulf Region receives a written objection from the State, the Region will not approve any permit for that activity until consistency of the activity is achieved. The Gulf Region does not impose or enforce additional State conditions when issuing permits, but can require modification of a plan if the operator has agreed to requirements requested by the State.

Executive Order 12898: Environmental Justice

The environmental-justice policy, based on Executive Order 12898, requires agencies to incorporate analysis into NEPA documents of the environmental effects of their proposed programs on minorities and low-income populations and communities. The MMS's existing presale planning process invites participation in the development of its proposed actions, alternatives, and possible mitigation measures by all groups and communities. Scoping and review for the EIS is an open process that provides an opportunity for all participants, including minority and low-income populations, to raise new expressions of concern that can be addressed in the EIS. Since the coastal areas analyzed in this EIS are maturely developed oil and gas production, equipment manufacturing, and product refining areas, the effect of adopting the proposed action or one of the alternatives analyzed in this EIS is largely to maintain levels of activity ongoing in the Gulf coastal region in recent years. The effects of the proposed actions on local populations or resources used by local groups, including minority and low-income groups, are analyzed in Section IV.D. under the analysis of socioeconomic conditions, commercial fisheries, air quality, and water quality.

The Outer Continental Shelf Deep Water Royalty Relief Act

On November 28, 1995, President Clinton signed Public Law 104-58, which included the Outer Continental Shelf Deep Water Royalty Relief Act. This Act authorizes the Secretary of the Interior to offer OCS blocks for lease with suspension of royalties for a volume, value, or period of production. Deepwater royalty relief applies to blocks offered for lease in the Western and Central Gulf of Mexico in water depths of 200 m or more through November 28, 2000. The MMS has developed procedures for suspension of royalty payment on production from eligible leases. The interim rule was published in the *Federal Register* of March 25, 1996 (61 FR 12022). Regulations are incorporated at 30 CFR 260.110(d) and the final rule was published January 16, 1998. To date, five lease sales have been held since the enactment of the Act, specifically Central Gulf Sales 157, 166, and 169, and Western Gulf Sales 161 and 168. For these five sales, bids on blocks in water depths greater than 200 m more than doubled, and in water depths greater than 800 m more than tripled, as compared to bids received in the previous year in the two sales without royalty relief.

D. PRELEASE PROCESS

On May 1, 1996, the Gulf of Mexico Region published a *Federal Register* notice, placed notices in Gulf Coast newspapers, and mailed out notices to governmental agencies and other interested parties requesting comments concerning the proposed multisale leasing process and multisale EIS. A public meeting was held in New Orleans on May 22, 1996, to present the proposed multisale concept. The MMS received written comments from the State of Louisiana, the State of Alabama, the National Ocean Industries Association, POGO Producing Company, Shell Offshore Inc., Texaco Exploration and Production Inc., and The AM Group. A summary of these comments can be found in Section V. In July 1996, two public hearings were conducted in Houston and New Orleans to receive comments on the Draft EIS for Sales 166 and 168. These hearings also served as a formal scoping opportunity for input on the scope and significant issues related to the OCS Program and to the development of the multisale Draft EIS for proposed Western Gulf of Mexico Sales 171, 174, 177, and 180. In general, comments were favorable.

The MMS also conducted early coordination with appropriate Federal and State agencies and other concerned parties to discuss and coordinate the proposed multisale prelease and EIS process. Key agencies and organizations included the National Oceanic and Atmospheric Administration (NOAA), NMFS, FWS, Department of Defense (DOD), U.S. Coast Guard (USCG), USEPA, State Governors' offices, and industry groups.

In accordance with the CEQ procedures for implementing the procedural provisions of NEPA, scoping was conducted to solicit comments on the proposed actions and the multisale EIS and to update the Gulf of Mexico's environmental information base. Scoping provides those with an interest in the OCS Program an early opportunity to participate in the events leading to the publication of the draft EIS. Publication of the Call for Information and Nominations (Call) and the Notice of Intent to Prepare an EIS (NOI) in the *Federal Register* formally initiated the scoping process for these lease sales. Further information on the scoping process is in Section V.

On January 29, 1997, the Call/NOI for the proposed 1998-2001 Western Gulf of Mexico lease sales were published in the *Federal Register.* The required 45-day comment period closed on March 16, 1997. Additional public notices were distributed via newspaper notices, mailouts, and the Internet. Five comments were received in response to the Call/NOI. A summary of these comments can be found in Section V.

The publication of the draft EIS initiates a 60-day public review and comment period. A notice of availability is published in the *Federal Register.* Additionally, a public notice is mailed out and placed on the Internet. Copies of the draft EIS are sent to Federal, State, and local agencies; libraries; industry; special interest groups; and private individuals. Formal public hearings on the draft EIS and the proposed actions were held during the comment period in the affected coastal States. Written comments were accepted until the close of the comment period on December 2, 1997. All comments were responded to in the final EIS.

A Proposed Notice of Sale and the final EIS are published concurrently. The publication of the final EIS initiates a 30-day comment period. At the end of the comment period, the Secretary of the Interior reviews the final EIS and all comments received on both the draft and final EIS's. The Secretary then decides which of the proposed alternatives will be implemented.

Concurrent with the preparation of the final EIS, a consistency review and subsequent Consistency Determination (CD) is done. For presale consistency determinations, MMS reviews each affected State's coastal zone management program, analyzes potential impacts, and makes an assessment of consistency with the enforceable policies of each State's program. If the State disagrees with MMS's CD, it is required to do the following under the CZMA: (1) indicate how the MMS presale proposal is inconsistent with their coastal program; (2) suggest alternative measures to bring the MMS proposal into consistency with their coastal program; or (3) describe the need for additional information that would allow a determination of consistency. The State may request mediation. Mediation is voluntary and may be requested by either MMS or the State. The Department of Commerce would serve as the mediator. There is no procedure for administrative appeal to the Secretary of Commerce for Federal agency consistency determinations. The final consistency determination by the Department of the Interior constitutes final administrative action for presale activities.

A Final Notice of Sale is published in the *Federal Register* at least 30 days prior to the scheduled lease sale. The Final Notice identifies the specific configuration of the proposed sale as decided upon by the Secretary.

E. POSTLEASE ACTIVITIES

The MMS is responsible for regulating and monitoring the oil and gas operations on the Federal OCS. Regulations provide for the MMS to regulate all operations conducted under a lease, right of use and easement, or DOI pipeline right-of-way; to promote orderly exploration, development, and production of mineral resources; and to prevent harm or damage to, or waste of, any natural resource, any life or property, or the marine, coastal, or human environment. Regulations for oil, gas, and sulphur lease operations on the OCS are specified in 30 CFR 250. Regulations for geological and geophysical (G&G) exploration operations on the OCS are specified in 30 CFR 251.

The MMS's Notices to Lessees and Operators (NTL's) are formal documents that provide clarification, description, or interpretation of OCS regulations or standards. The NTL's provide guidelines on the

implementation of a special lease stipulation or regional requirement and provide industry with a better understanding of the scope and meaning of a regulation by explaining MMS's interpretation of a requirement. The NTL's are also used to transmit administrative information such as current telephone listings or changes in MMS personnel. A detailed listing of Gulf of Mexico NTL's was published in the *Federal Register* on May 16, 1991 (56 FR 22735-22737). The MMS also conveys important information by way of Letters to Lessees and Operators (LTL's) and Information to Lessees and Operators (ITL's). These documents further clarify or supplement operational guidelines.

Geological and Geophysical Exploration Permits: A permit must be obtained from MMS prior to conducting geological or geophysical exploration for mineral resources, except exploration by a lessee on a lease. A permit is required also for geological or geophysical scientific research. Upon receiving a complete G&G permit application, MMS prepares a Categorical Exclusion Review (CER), an EA, or an EIS in accordance with NEPA and other applicable MMS policies and guidelines. When required under an approved coastal zone management program, proposed G&G permit activities must receive State concurrence prior to MMS permit approval and issuance. The Gulf Coast States only require review of G&G permit applications for continental offshore stratigraphic tests wells.

Deepwater Operations Plans: In 1992, MMS formed an internal Deepwater Task Force to address technical issues and regulatory concerns relating to deepwater (greater than 1,000 ft or 305 m) operations and projects utilizing subsea technology. Based upon the Deepwater Task Force's recommendation, a Notice to Lessees (NTL 96-4N) was developed, which required operators to submit a Deepwater Operations Plan (DWOP) for all operations in deepwater and all projects using subsea technology. The DWOP was established to address regulatory issues and concerns that were not existing in the current MMS regulatory framework and is intended to initiate an early dialogue between MMS and industry before major capital expenditures on deepwater and subsea projects are committed. DeepStar, an industry-wide cooperative workgroup focused on deepwater regulatory issues and critical technology development issues, worked closely with the MMS Deepwater Task Force to develop the initial guidelines attached to NTL 96-4N. Deepwater technology has been evolving faster than the MMS's ability to revise OCS regulations; the DWOP was established through the NTL process, which provides for a more timely and flexible approach to keep pace with the expanding deepwater operations and subsea technology.

The MMS and DeepStar expanded the guidelines for the DWOP to include floating production systems. The revised DWOP guidelines are currently under review for use as the basis of a new NTL that will supersede NTL 96-4N.

Exploration Plans and Development Plans: Prior to any exploration, development, or production activities being conducted in a lease block (other than preliminary on-lease activities, such as geotechnical investigations), an Exploration Plan (EP) or a Development Operations Coordination Document (DOCD) and supporting information must be submitted to MMS for review and approval. Supporting information includes environmental information, archaeological report, biological report (monitoring and/or live-bottom survey), or other environmental data determined necessary. This information provides an analysis of both offshore and onshore impacts that may occur as a result of the activities. Additional environmental information may also be required for plans/activities in the Western Gulf of Mexico for the following: (1) areas of high seismic risk or seismicity and relatively untested deepwater and remote areas; (2) areas proposed or established as a marine sanctuary and/or near the boundary of a proposed or established wildlife refuge or areas of high ecological sensitivity (e.g., East and West Flower Garden Banks); (3) areas of potentially hazardous natural bottom conditions; or (4) the use of new or unusual technology, when the additional information is required to evaluate impacts.

The MMS prepares a CER, EA, and/or EIS based on available information, which may include the geophysical report (for determining the potential for the presence of deepwater benthic communities); archaeological report; air emissions data; live-bottom survey and report; biological monitoring plan; and recommendations by the affected State(s), DOD, FWS (for selected plans under provisions of a DOI agreement), NMFS, and/or internal MMS offices. As part of the review process, the plan and supporting environmental information, as required, are sent to the affected State(s) having an approved CZM plan for consistency certification review and determination. The MMS evaluates the proposed activity for potential impacts relative to geohazards and manmade hazards (including existing pipelines), archaeological resources,

endangered species, sensitive biological features, water and air quality, oil-spill response, and other uses (e.g., military operations) of the OCS.

Applications for Permits to Drill: Prior to conducting drilling operations, the operator is required to submit and obtain approval for an Application for Permit to Drill (APD). The lessee is required to take precautions to keep all exploratory well drilling under control at all times. The APD requires detailed information about the drilling program to allow evaluation of operational safety and pollution-prevention measures. The lessee must use the best available and safest technology in order to enhance the evaluation of abnormal pressure conditions and to minimize the potential for uncontrolled well flow.

Archaeological Resources Protection: The Archaeological Resource Stipulation has been converted to operational regulations under 30 CFR 250.26. The new regulation grants MMS the authority to require archaeological resource surveys and reports where deemed necessary. The technical requirements of the archaeological resource surveys that may be required are detailed in the Gulf of Mexico OCS Region NTL 91-02.

Best Available and Safest Technology Requirements: To assure that oil and gas exploration, development, and production activities on the OCS are conducted in a safe and pollution-free manner, the OCSLA requires that all OCS technologies and operations use the best available and safest technology (BAST) that the Secretary determines to be economically feasible. These include requirements for state-of-the-art drilling technology, production safety systems, completion of oil and gas wells, oil-spill contingency plans, pollution-control equipment, and specifications for platform/structure designs.

MMS Technical and Safety Review: The lessee must design, fabricate, install, use, inspect, and maintain all platforms and structures on the OCS to assure their structural integrity for the safe conduct of operations at specific locations. Applications for platform design and installation are filed with MMS for review and approval.

Production safety equipment used on the OCS must be designed, installed, used, maintained, and tested in a manner to assure the safety and protection of the human, marine, and coastal environments. All tubing installations open to hydrocarbon-bearing zones below the surface must be equipped with safety devices that will shut off the flow from the well in the event of an emergency, unless the well is incapable of flowing. All surface production facilities must be designed, installed, and maintained in a manner that provides for efficiency, safety of operations, and protection of the environment.

Pipeline Regulations: Regulatory processes and jurisdictional authority concerning pipelines on the OCS and in coastal areas are shared by several Federal agencies, including the DOI, the Department of Transportation (DOT), the U.S. Army Corps of Engineers (COE), the Federal Energy Regulatory Commission (FERC), and the USCG.

Pipeline permit applications to MMS include the pipeline location drawing, profile drawing, safety schematic drawing, pipe design data to scale, a shallow hazard survey report, and an archaeological report. The MMS evaluates the design and fabrication of the pipeline and prepares a CER, EA, and/or EIS in accordance with applicable policies and guidelines. The MMS prepares an EA and/or an EIS on all pipeline rights-of-way that go ashore. The FWS reviews and provides comments on applications for pipelines that are near certain sensitive biological communities. No pipeline route will be approved by MMS if any bottom-disturbing activities (from the pipeline itself or from the anchors of lay barges and support vessels) encroach on any biologically sensitive areas, such as stipulation-established No Activity Zones. The operators are required to inspect periodically their routes by methods prescribed by the MMS Regional Supervisor for any indication of pipeline leakage. Monthly over-flights are conducted to inspect pipeline routes for leakage.

Pipelines may be abandoned in place if they do not constitute a hazard to navigation and commercial fishing or unduly interfere with other uses of the OCS. Procedures for pipeline abandonment and pipeline reporting requirements are outlined at 30 CFR 250.156 and 250.158.

Oil Spill Contingency Plans: In compliance with 30 CFR 254, all owners and operators of oil handling, storage, or transportation facilities located seaward of the coastline must submit an Oil Spill Response Plan (OSRP) to MMS for approval. Owners or operators of offshore pipelines carrying are required to submit a plan for any pipeline that carries oil, condensate that has been injected into the pipeline, or gas and naturally occurring condensate; pipelines carrying essentially dry gas do not require a plan. A response plan

must be submitted before an owner/operator can use a facility. To continue operations, the facility must be operated in compliance with the approved plan.

All MMS-approved OSRP's are required to be reviewed and updated every two years. Revisions to a response plan must be submitted to MMS within 15 days whenever: (1) a change occurs which significantly reduces an owner/operator's response capabilities; (2) a significant change occurs in the worst case discharge scenario or in the type of oil being handled, stored, or transported at the facility; (3) there is a change in the name(s) or capabilities of the oil spill removal organizations cited in the plan; or (4) there is a significant change in the appropriate Area Contingency Plans.

Discharge and Pollution Regulations: The MMS has promulgated regulations to ensure lessees do not create conditions that will pose an unreasonable risk to public health, life, property, aquatic life, wildlife, recreation, navigation, commercial fishing, or other uses of the ocean. Control and removal of pollution is the responsibility and at the expense of the lessee. Operators are required to install curbs, gutters, drip pans, and drains on platform and rig deck areas in a manner necessary to collect all contaminants and debris not authorized for discharge. The rules also explicitly prohibit the disposal of equipment, cables, chains, containers, or other materials into offshore waters. Portable equipment, spools or reels, drums, pallets, and other loose items weighing 18 kg or more must be marked in a durable manner with the owner's name prior to use or transport over offshore waters. Smaller objects must be stored in a marked container when not in use. Operational discharges such as produced water and drilling muds and cuttings are regulated by the USEPA through the NPDES program.

Hydrogen Sulfide Contingency Plans: The operator of a lease must request that MMS make a determination regarding the presence of hydrogen sulfide (H_2S) gas. The MMS classifies an area of proposed operations as (1) a zone known to contain H_2S, (2) a zone where the presence of H_2S is unknown, or (3) a zone where the absence of H_2S has been confirmed. All operators on the OCS involved in production of sour gas or oil are required to file an H_2S contingency plan. This plan must include procedures to ensure the safety of the workers on the production facility and contingencies for simultaneous drilling, well-completion, well-workovers, and production operations. In addition, all operators are required to adhere to National Association of Corrosion Engineers (NACE) Standard Material Requirement MRO175-90 for Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment (NACE, 1990). These engineering standards serve to enhance the integrity of the infrastructure used to produce the sour oil and gas, and further serve to ensure safe operations. The lessee must take all necessary and practicable precautions to protect personnel from the toxic effects of H_2S and to mitigate the adverse effects of H_2S to property and the environment.

The MMS has issued a final rule governing requirements for preventing hydrogen sulfide releases, detecting and monitoring hydrogen sulfide and sulphur dioxide, protecting personnel, providing warning systems, and establishing requirements for hydrogen sulfide flaring. The rule went into effect on March 28, 1997. An associated NTL titled "Hydrogen Sulfide (H_2S) Requirements" was issued on April 7, 1997, to provide clarification, guidance, and information on the revised requirements. The NTL provides guidance on sensor location, sensor calibration, respirator breathing time, measures for protection against sulfur dioxide, requirements for classifying an area for the presence of H_2S, requirements for flaring and venting of gas containing H_2S, and other issues pertaining to H_2S-related operations.

Conservation and Rate Control: The Gulf Region has established requirements for the submission of Conservation Information (NTL 96-6N, effective October 1, 1996) for deepwater production activities. Conservation reviews are performed to ensure that economic reserves are fully developed and produced, and will be more complex and economically sensitive in deepwater areas.

Structure Removal and Site Clearance: Lessees/operators must notify the MMS 30 days before a structure removal and provide information that includes the following: complete identification of the structure; size of the structure (number and size of legs and pilings); removal technique to be employed (if explosives are to be used, the amount and type of explosive per charge); and the number and size of well conductors to be removed and the removal technique. At present, if a structure removal involves the use of explosives, an environmental assessment is prepared and an Endangered Species Section 7 Consultation is initiated with NMFS. The NMFS issued a "standard" Biological Opinion on July 25, 1988, which covers removal operations that meet specified criteria pertaining to the size of explosive charge used, detonation

depth, and number of blasts per structure grouping. The use of explosives to cut offshore oil/gas structure legs/pilings for removal could cause injury or death to protected marine mammals and endangered sea turtles. Although NMFS has the responsibility to enforce protection of the majority of marine mammals in the Gulf, MMS and NMFS have conferred extensively in the development of platform removal precautions and have employed data resulting from equations found in Connor (1991). The MMS, NMFS, and lessees are cooperating in an observer/monitoring program to determine the presence of marine mammals and/or sea turtles in the vicinity of the structure removals. The NMFS sends observers to every structure removal where explosives are used. Since the NMFS protective observer program began in 1986, only one sea turtle is known with certainty to have been harmed. Others have been removed from platforms slated for removal, prior to detonation. If cetaceans are observed in the vicinity of a removal site, detonations are postponed until the animals have vacated the area.

Under MMS operating regulations and lease agreements, all lessees must remove objects and obstructions upon termination of a lease. The MMS requires lessees to submit a procedural plans for site clearance verification. Lessees must ensure all objects related to their activities were removed following termination of their lease. NTL 90-03 established site clearance verification procedures that included trawling the cleared site over 100 percent of the established clearance radii by a licensed shrimper. Lessees are required to file reports on the results of their site clearance activities.

MMS Inspection Program: The MMS inspection program in the Gulf of Mexico is directed by the OCS Regional Office in New Orleans, Louisiana, and four district offices and two subdistrict offices that provide day-to-day review and inspection of oil and gas operations. The MMS conducts onsite inspections to assure compliance with lease terms, NTL's, and approved plans, and to assure that safety and pollution-prevention requirements of regulations are met. These inspections involve items of safety and environmental concern. Further information on the baseline for the inspection of lessee operations and facilities can be found in the National Potential Incident of Noncompliance (PINC) List (USDOI, MMS, 1990a). If an operator is found in violation of a safety or environmental requirement, a citation is issued. Depending on the nature of the violation, actions can range from requiring that the violation be fixed within 14 days (for minor violations) to immediate suspension of production or other operations (for violations that pose a threat of serious or immediate harm or damage to the marine, coastal or human environment).

The primary objective of initial inspections is to assure proper installation of mobile units or structures and associated equipment. After operations begin, additional announced and unannounced inspections are conducted. Unannounced inspections are conducted to foster a climate of safe operations, to maintain an MMS presence, and to focus on operators with a poor performance record. They are also conducted after a critical safety feature has previously been found defective. Annual inspections are conducted on all platforms, but more frequent inspections may be conducted on rigs and platforms. On-board inspections involve the inspection of all safety systems of a production platform. The MMS is cooperating with the USEPA in monitoring compliance with more restrictive water pollution controls, and MMS inspectors have assumed new duties in collecting water samples from offshore platforms and performing more visual inspections for discharged effluents.

Training Requirements for Offshore Personnel: An important factor in ensuring that offshore oil and gas operations are carried out in a manner that emphasizes operational safety and minimizes the risk of environmental damage is the proper training of personnel. All operators must have trained personnel to operate oil-spill cleanup equipment or must have retained a trained contractor(s) that will operate the equipment for them. The Drilling Well-Control Training Program was instituted by MMS in 1979. In 1982 and 1983, an additional training program--the Safety Device Training Program--was developed and put into effect. The Safety Device Training Program ensures that personnel involved in installing, inspecting, testing, and maintaining safety devices are qualified.

SECTION II

ALTERNATIVES INCLUDING THE PROPOSED ACTIONS

II. ALTERNATIVES INCLUDING THE PROPOSED ACTIONS

A. MULTISALE NEPA ANALYSIS

This environmental impact statement (EIS) is substantially different from previous Gulf of Mexico OCS lease sale EIS's. In keeping with the purposes of the National Performance Review and Vice President Gore's initiative to make government work better and cost less, MMS has streamlined the National Environmental Policy Act (NEPA) compliance process whenever possible and appropriate. Federal regulations allow for several similar proposals to be analyzed in one EIS (40 CFR 1502.4). Given the similar and annual nature of the Western Gulf OCS lease sales, multisale EIS's are appropriate. A single EIS is being prepared for the remaining four Western Gulf sales scheduled in the current 5-Year Program. The multisale EIS will lessen duplication and save resources. The multisale EIS is intended to focus the NEPA/EIS process on differences among the proposed sales and on significant environmental issues and recent information. The multisale approach also allows the prelease process to occur within one year, rather than the current two-year process. This EIS will serve as a base reference for future Western Gulf NEPA compliance documents.

Although this EIS addresses four proposed sale actions, only one sale decision will be made each year. This EIS will serve as a decision document for Sale 171, which is scheduled for 1998. One Call for Information and Nominations (Call) and Notice of Intent to Prepare an EIS (NOI) was issued at the beginning of the multisale prelease process to explain the multisale approach. Only one Area Identification (Area ID) will be prepared to cover the 4-year period. The Area ID would describe the sales' geographical area, the proposed actions, and alternatives for the four scheduled Western Gulf sales. Sale-specific notices will be done as usual, except that the proposed notices will be published after completion of the final NEPA document for each sale.

Consultation with the public will be initiated in subsequent years. An Information Request will be issued, specifically requesting input on the scheduled sale under consideration. A NEPA review also will be conducted for each subsequent sale. An Environmental Assessment (EA) will be prepared to determine whether or not the information and analyses in this original multisale EIS are still valid for each subsequent sale under consideration. Consideration of the EA and any comments received in response to the Information Request will result in either a Finding of No Significant Impact (FONSI) or the determination that the preparation of a Supplemental EIS (SEIS) is warranted.

Because the EA will be prepared for a proposal that "is, or is closely similar to, one which normally requires the preparation of an EIS" (40 CFR 1501.4(e)(2)), a FONSI will be made available for public review for 30 days prior to making a decision. The EA/FONSI would be sent to the Governors of the affected States, and its availability announced in the *Federal Register*. The FONSI will become part of the Record of Decision prepared for the decision on the Notice of Sale.

In some cases, it may be necessary to prepare an SEIS (40 CFR 1502.9). Some of the factors that could justify an SEIS are a significant change in resource estimates, legal challenge on the EA/FONSI, significant new information, significant new environmental issue(s), new proposed alternative(s), a significant change in the proposed action, or the previous analysis in the multisale EIS is deemed inadequate.

The SEIS analysis will focus on addressing the new issue(s) or concern(s) that prompted the decision to prepare the SEIS. The SEIS will include a discussion explaining the purpose of the SEIS and incorporating the multisale EIS, a description of the proposed action and alternatives and a comparison of the alternatives, a description of the affected environment for any potentially affected resources that are the focus of the SEIS and were not described in the multisale EIS, an analysis of new impacts or changes in impacts from the multisale EIS because of new information or the new issue(s) analyzed in the SEIS, and a discussion of the consultation and coordination carried out for the new issues or information analyzed in the SEIS.

B. ALTERNATIVES, MITIGATING MEASURES, AND ISSUES

On January 29,1997, the Call and NOI for the proposed 1998-2001 Western Gulf of Mexico lease sales were published in the *Federal Register.* Federal, State, and local agencies, along with other interested parties, were requested to send written comments to the Region on the scope of the EIS, on significant issues that should be addressed, and on alternatives and mitigating measures that should be considered. The required 45-day comment period closed on March 16, 1997. Additional public notices were distributed via newspaper notices, mailouts, and the Internet. Five comments were received in response to the Call/NOI. A summary of these comments can be found in Section V.

In accordance with the Council on Environmental Quality's (CEQ) procedures for implementing the procedural provisions of NEPA, scoping was conducted to solicit comments on the proposed actions and the multisale EIS, and to update the Gulf of Mexico's environmental information base. Scoping provides those with an interest in the OCS Program an early opportunity to participate in the events leading to the publication of the Draft EIS. Although the scoping process is formally initiated by the publication of the Call and NOI, scoping efforts and other coordination meetings are ongoing. Further information on the scoping process is in Section V.

In July 1996, two public hearings were conducted in Houston and New Orleans to receive comments on the Draft EIS for proposed 1997 Gulf of Mexico Sales 166 and 168. These hearings also served as a formal scoping opportunity for input on the scope and significant issues related to the OCS Program and to the development of the multisale Draft EIS for proposed Western Gulf of Mexico Sales 171, 174, 177, and 180. Section V of this EIS contains additional descriptions of scoping and of the consultation and coordination process.

The MMS also conducted early coordination with appropriate Federal and State agencies and other MMS Region customers to discuss the proposed multisale concept and the proposed Western Gulf sales. Key agencies and organizations included the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Fish and Wildlife Service (FWS), Department of Defense (DOD), U.S. Coast Guard (USCG), U.S. Environmental Protection Agency (USEPA), State Governors' offices, and industry groups.

The result of the scoping effort was the identification of the alternatives, mitigating measures, and issues described below.

1. Alternatives

a. Alternatives for Proposed Western Gulf Sales

Alternative A (The Proposed Action(s)): The proposed action(s) offers for lease all unleased blocks within the WPA for oil and gas operations, with the following exclusions. Excluded are Blocks A-375 and A-398 in the High Island Area, East Addition, South Extension (East and West Flower Garden Banks, respectively), and Blocks 793, 799, and 816 in the Mustang Island Area. Additionally, discussions between the United States and Mexico regarding tracts beyond the U.S. Exclusive Economic Zone are ongoing and may result in the deferral of those tracts for Sale 171 (approximately 277 tracts) in the "Northern Portion of the Western Gap" (Figure I-1). Acreage and block counts are subject to change as a result of ongoing activity.

Alternative B (The Proposed Action(s) Excluding the Blocks Near Biologically Sensitive Topographic Features): This alternative would offer for lease all unleased blocks in the WPA as described for the proposed action(s), with the exception of the unleased blocks of the 200 blocks subject to the Topographic Features Stipulation.

Alternative C (No Action): This alternative is equivalent to cancellation of one or more of the proposed sales scheduled for a specific timeframe in the approved *Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002.* The opportunity for development of the estimated oil and gas resources that could have resulted from any of the proposed action(s) would be precluded or postponed, and any potential environmental impacts resulting from any of the proposed action(s) would not occur or would be postponed.

b. Alternatives Considered But Not Analyzed

Consider an Alternative Approach to Areawide Leasing: The Louisiana Department of Natural Resources (LDNR) suggested nomination sales, rather than areawide sales, in order to optimize the royalties generated by leases while moderating the rate of development of the OCS in the Gulf of Mexico. The question of whether we are receiving revenues commensurate with the value of our resources is a complex one. The first consideration is whether revenues and other benefits that the Nation receives sooner are more valuable than the same revenues and benefits received later (as we have consistently assumed in discounting for present value) or whether a more steady stream of revenue and benefits is more desirable. Other considerations are the uncertainty of lease sales, prices, and the need for oil and gas in the coming decades. Another important issue is whether what the MMS offers companies maximizes the value of the Nation's resources. Added flexibility allows companies to produce the resources when they are most valuable. Additionally, the long period between tract selection and sales might preclude annual sales, because intervening (annual) sales and block relinquishments could force dramatic changes in the block lists. In any case, the MMS employs a two-phase bid adequacy approach to ensure that the Federal Government receives fair market value for blocks leased.

The issue of alternatives to areawide leasing has been a subject of analysis by the MMS during the development of last two 5-Year OCS Leasing Programs. An analysis completed for the Proposed Final 5-Year OCS Leasing Program for 1992-1997 indicates that support and replenishment of leases through the areawide program served to dampen the boom-bust cycle of the 1980's. The recent resurgence in drilling in the Gulf of Mexico has been resource and/or technology based rather than price induced and, therefore, supports a gradual resource depletion. In a 1993 *Federal Register* notice, MMS requested comments on alternative leasing policies and subsequently analyzed numerous policy options before deciding, in 1995, to continue with areawide leasing. In the 1996 decision on the 5-Year Program for 1997-2002, the Department adopted the policy of proposing annual areawide lease sales in the Central and Western Gulf. The Program EIS examined an alternative to slow the pace of leasing by proposing sales in the Central and Western Gulf of Mexico in alternate years. Analysis in the EIS led to the conclusion that offering only half as many sales could slow the pace of development to the point that the economies along the Central and Western Gulf Coasts could experience reduced activity in some OCS-related economic sectors.

On October 4, 1996, the Regional Director of the Gulf of Mexico OCS Region met with the Secretary of the LDNR. Several staff members from both offices also participated in the meeting. Alternatives to areawide leasing were among the topics discussed. The Secretary acknowledged that areawide leasing may be advantageous to both industry and the Federal Government, but did not feel that it was necessarily the best approach for the State of Louisiana. The Regional Director recommended that MMS and LDNR hold another meeting with appropriate staff from both agencies to discuss alternatives to areawide leasing in more detail. It was acknowledged that a discussion of the pros and cons of alternative approaches to leasing would benefit both agencies. In November 1996, the MMS Office of Resource Evaluation provided LDNR with data related to historical leasing, drilling, discovery, and production activity on the Gulf of Mexico OCS, along with summary graphs and tables comparing nomination and areawide sales. On February 14, 1997 MMS staff met with LADNR staff. Alternatives to areawide leasing were among the topics of continued discussion. Although the proposals in this EIS are areawide leasing proposals, the EIS does analyze deferral alternatives that may mitigate specific environmental effects or use conflicts and it does analyze the effects of a range of possible exploration and development levels. MMS will continue discussions and information exchange with LADNR staff regarding their concerns about areawide leasing. If they are able to define more specifically how alternative, more restrictive leasing policies may moderate the rate of development in a manner significantly different than that assumed in the range of development analyzed in the EIS, MMS will consider analyzing such alternatives in future EIS's.

2. Mitigating Measures

a. Proposed Mitigating Measures Analyzed

The potential mitigating measures included for analysis in this EIS were developed as the result of the scoping efforts accomplished over recent years for annual lease sales and for the continuing OCS Program in the Gulf of Mexico. These measures are being considered for adoption by the Secretary and are analyzed as part of the proposed action.

Three stipulations that have been applied to appropriate Western Gulf OCS leases for many years have been included for analysis of the proposed actions. These are the Topographic Features, Military Areas, and the Naval Mine Warfare Area Stipulations. The effectiveness of the stipulations is discussed in Section II.C.1.c. The analysis of these stipulations as part of the proposed action does not ensure a decision by the Secretary to apply the stipulations to leases that may result from the proposed action nor does it preclude minor modifications in wording during subsequent steps in the presale process if comments indicate changes are necessary or if conditions change.

Topographic Features Stipulation

The Topographic Features Stipulation minimizes the likelihood of damage to the biota of the designated banks from routine OCS oil and gas activities (Figure I-1). The topographic features of the Western Gulf provide habitat for coral reef community organisms. Coral and associated communities at the crest and on the flanks of these features would be adversely affected if unrestricted OCS oil and gas activities resulting from the proposed actions occurred on or near these features. Since 1973, topographic features stipulations have been adopted on leases for blocks on or near these biotic communities. The proposed Topographic Features Stipulation, developed through close consultation and coordination between various Federal, State, and local agencies, incorporates the results of the latest topographic-features studies and industry monitoring reports. Through avoidance, by establishing "No Activity Zones," many such activities and their associated impacts are minimized. This stipulation may be selected, at the Secretary's discretion, for appropriate leases resulting from the proposed sales.

Military Areas Stipulation

A standard Military Areas Stipulation has been applied to all blocks leased in military areas in the Gulf of Mexico (Figure II-1) since 1977. The stipulation reduces potential impacts, primarily those associated with safety, by curtailing OCS operations and support activities in areas where military operations are being conducted. One of the requirements of the stipulation is that the operator would notify the military prior to conducting oil and gas activities in an area. This stipulation may be selected, at the Secretary's discretion, for leases resulting from the proposed sales.

Naval Mine Warfare Area Stipulation

The Naval Mine Warfare Area Stipulation will apply to Mustang Island Area, East Addition, Blocks 732, 733, and 734. The Navy has identified these blocks as needed for testing equipment and for training mine warfare personnel. The stipulation will eliminate multiple-use conflicts on these blocks. This stipulation may be selected, at the Secretary's discretion, for leases resulting from the proposed sales.

b. Mitigating Measures Considered But Not Analyzed

Numerous potential mitigating measures have been identified through the scoping efforts for many past lease sale EIS's. Studies were funded to provide information to evaluate some of these potential mitigating measures. Some of the potential mitigating measures were adopted, or modified and adopted. Some measures were dropped from further consideration when analysis indicated that the measures were not

warranted or would have been ineffective. No new mitigating measures were identified during the scoping process for the multisale Draft EIS for the proposed Western Gulf sales.

c. Existing Mitigating Measures

Mitigating measures have been proposed, identified, evaluated, or developed through previous MMS lease sale NEPA review and analysis processes. Many of these mitigating measures have been adopted and incorporated into regulations and guidelines governing OCS exploration, development, and production activities. All plans for OCS activities go through MMS review and approval to ensure compliance with established laws and regulations. Mitigating measures must be incorporated and documented in plans submitted to MMS. Operational compliance is enforced through the MMS on-site inspection program.

Mitigating measures that are a standard part of the MMS Program limit the size of charges used for explosive platform removal; require placing explosive charges at least 5 m below the mudline; ensure site clearance procedures to eliminate potential snags to commercial fishing gear; establish No Activity and Modified Activity Zones around topographic features; delete the Flower Garden Banks from areawide lease sales (both prior to and after the establishment of the National Marine Sanctuary); and require surveys to detect and avoid archaeological sites and biologically-sensitive areas including chemosynthetic communities.

Some MMS-identified mitigating measures are incorporated into OCS operations through cooperative agreements or efforts with industry and various State and Federal agencies. These include the NMFS Observer Program to protect marine mammals and sea turtles during explosive removals, regulations on minimum helicopter altitudes to prevent disturbance of wildlife, labeling operational supplies to track possible sources of accidental debris loss, development of methods of pipeline landfall to eliminate impacts to barrier beaches, and semiannual beach cleanup events.

3. Issues

a. Issues Analyzed

The major issues that frame the environmental analyses in this EIS are the result of concerns raised during years of scoping for Gulf lease sale EIS's. Other criteria used to identify issues include the following: issues identified in the CEQ regulations; issues identified by MMS; comments on a draft EIS; or new information. The following issues relate to potential impact-producing factors (IPF's) and the resources and activities that could be affected by OCS exploration, development, production, and transportation activities.

Oil Spills: The most frequent concerns were over the potential impact of oil spills on the marine and coastal environments. Specific concerns were raised regarding the potential effects of oil spills on marine mammals, other endangered and threatened species, commercial fishing, recreation and tourism, water quality, and wetlands. Other concerns were fate and behavior of oil spills, availability and adequacy of oil-spill containment and cleanup technologies, strategies, impacts of cleanup methods, effect of winds and currents, weathering, toxicological effects of fresh and weathered oil, air pollution associated with spilled oil, and short-term and long-term impacts of oil on wetlands.

Wetlands Loss: Wetlands loss and associated saltwater intrusion are ongoing concerns in Texas and Louisiana. The States and other parties have expressed concern over the incremental contribution of the OCS Program to wetlands loss.

Air Emissions: The potential effects of emissions of combustion gases from platforms, drill rigs, and OCS-related service vessels and helicopters have been raised as an issue. Also under consideration are the flaring of produced gases and burning of produced liquids during extended well testing, and the potential impacts of transport of production with associated hydrogen sulfide.

Water Quality Degradation: Issues related to water quality degradation included OCS operational discharges of drilling muds and cuttings, produced waters, and domestic wastes, sediment disturbance, oil spills and blowouts, and discharges from service vessels.

Other Wastes: Other concerns include storage and disposal of trash and debris, OCS-related trash and debris on recreational beaches, and nonhazardous oil-field wastes (NOW), and siting of OCS-related disposal facilities.

Structure and Pipeline Emplacement: Some of the issues related to structure and pipeline emplacement are bottom area disturbances from bottom-founded structures or anchoring, sediment displacement related to pipeline burial, space use conflicts, aesthetic interference, construction of onshore infrastructure, vulnerability of offshore pipelines to damage that could result in oil spills or H_2S leaks, and effects of pipeline landfalls.

Platform Removals: Concerns about the abandonment of operations on a lease include how a platform is removed, potential impacts of explosive removals on marine organisms, remaining operational debris snagging fishing nets, and site clearance procedures.

OCS-Related Support Services, Activities, and Infrastructure: Concerns over activities related to the support of OCS operations include vessel and helicopter traffic and emission, construction or expansion of navigation channels or onshore infrastructure, maintenance and use of navigation channels and ports, deepening of ports, and tankering and barging of OCS production.

Sociocultural and Socioeconomic: Many concerns have focused on the potential impacts to coastal communities. Issues include impacts on employment, population fluctuations, demands on public services, affects on land use, tourism, impacts to low income or minority populations, and cultural impacts.

Coastal Zone Management: Concern has been expressed over potential conflicts with the coastal states' coastal zone management programs and with local county, parish, or community land use plans.

Deepwater Activities: The recent surge in deepwater leasing has generated concern over many issues related to deepwater operations and support activities. Issues include timing and scale of deepwater operations, potential environmental impacts associated with the new technologies for drilling and production in deepwater areas, oil spills due to tankering from deepwater areas, expansion of the pipeline system, wetlands impacts due to increasing numbers of landfalls, air and water pollution from extended well testing, storage of large volumes of oil on deepwater production structures, disposition of produced gas, noise associated with 3D seismic surveying, compatibility of current infrastructure with anticipated larger support vessels, possible deepening of navigation channels and ports to accommodate larger support vessels, increased demand for fresh water, increased economic and industrial activity in the coastal zone, additional service vessel and helicopter traffic, increased traffic on existing roadways, displacement of other port users, and in-migration of workers.

Other Issues: Many other issues related to OCS operations have been identified. Several of these issues are subsets or variations of the issues listed above. All are taken under advisement and are considered in the analyses, if appropriate. Additional issues raised over several years of scoping are noise from platforms, vessels, helicopters, and seismic surveys; turbidity as a result of seafloor disturbance or discharges; mechanical damage to biota and habitats; and multiple-use conflicts.

Resource Topics Analyzed in the EIS: The analyses in Section IV.D. address the issues and concerns identified above under the following resource topics:

Air Quality

Archaeological Resources
- Historic
- Prehistoric

Coastal Barrier Beaches and Associated Dunes

Coastal and Marine Birds

Commercial Fisheries

Deepwater Benthic Communities

Marine Mammals

Recreational Resources and Beach Use

Sea Turtles

Socioeconomic Conditions
- Population
- Employment

- Public Services and Infrastructure
- Land Use Plans
- Sociocultural Issues
- Environmental Justice

Topographic Features

Water Quality
- Coastal
- Marine

Wetlands

b. Issues Considered But Not Analyzed

Numerous issues have been identified through the scoping efforts for many past lease sale EIS's. Studies were funded to address many of the issues. As a result of these studies, some issues were added to the resources analyzed in lease sale EIS's, some issues were addressed through the development of mitigation measures, and some issues were dropped from further consideration because of little or no impact from the OCS Program. No new issues of concern were identified during the scoping process for the multisale Draft EIS for the proposed Western Gulf sales. For this EIS, the issue of naturally occurring radioactive material (NORM) has been dropped from detailed analysis. Radionuclides leached from geologic formations to oil-field production wastes are referred to as NORM.

Starting in the 1980's, the public became aware of the existence of possible NORM contamination in oil-field wastes and equipment. NORM was raised as a significant issue during scoping. Surveys by industry showed that, in the Gulf of Mexico, radionuclides generally occur above background levels in produced water, produced solids, treatment and workover fluids, and as scale deposited on production equipment. The levels of NORM in these wastes varied tremendously. Very little information was available on potential environmental risks associated with the levels of NORM measured. Stringent State and Federal requirements limiting the disposal and discharge of some NORM-contaminated materials were passed. State requirements restricted the recycling and cleaning of production equipment and stopped the existing disposal practices for oil-field wastes and equipment contaminated with NORM.

The USEPA effluent limitations, promulgated March 4, 1993, prohibited the offshore discharge of produced solids. The USEPA continued to allow produced waters to be discharged offshore, but established monitoring of the levels of radionuclides and required that industry conduct a study determining if biota were bioaccumulating NORM (Section IV.A.3.d.).

To understand if biological uptake of radium is occurring and whether it has the potential to harmfully affect resources such as fish, marine mammals, and human health, private industry and public regulatory agencies conducted an extensive data gathering effort. None of the studies completed to date have found evidence that NORM in produced water is causing adverse effects to marine organisms. The likelihood of consuming seafood available for commercial harvest containing higher than normal radium for a sufficient period of time to present a risk is minimal. The prospect that NORM discharged in offshore produced water will affect commercial fishery species and subsequently increase man's intake of radium is virtually zero.

By the end of 1993, with the exception of produced water, all oil-field wastes contaminated with NORM were no longer allowed to be discharged or disposed of using normal methods. How to properly dispose of these wastes became a significant issue. Few options were available to the oil industry for final disposal; only one site in Utah was licensed to receive NORM wastes. Operators temporarily stockpiled large amounts of NORM-contaminated wastes at centralized facilities or at service bases located along the Gulf Coast. Both Texas and Louisiana have developed criteria and approval mechanisms for NORM-contaminated waste commercial disposal sites in their states. In the last two years, one site in Texas in Port Arthur and two in Louisiana have been constructed and are now in operation. As an alternative to onshore disposal, in 1991, MMS began approving the offshore downhole encapsulation or well injection of OCS-generated, NORM-contaminated wastes. In May 1996, a final NTL was published outlining the criteria for downhole disposal. These actions on the part of the States and the Federal Government have eliminated the problem of final disposal. The OCS-generated wastes and oil-field equipment contaminated with NORM brought onshore are expected to be properly stored and disposed of and are not expected to result in any significant adverse environmental effects.

C. PROPOSED WESTERN GULF SALES

1. Alternative A - The Proposed Action

a. Description

The proposed Western Gulf sales are scheduled to be held annually from 1998 to 2001. Each proposed sale will offer all unleased blocks within the WPA, with the following exceptions. Excluded from the proposed actions are Blocks A-375 (East Flower Garden Bank) and A-398 (West Flower Garden Bank) in the High Island Area, East Addition, South Extension, which have been excluded because of their biologically sensitive nature. The East and West Flower Garden Banks are designated as a National Marine Sanctuary. Blocks 793, 799, and 816 in the Mustang Island Area have been removed from the proposed actions. These blocks have been identified by the Navy as needed for testing equipment and for training mine warfare personnel. Additionally, discussions between the United States and Mexico regarding tracts beyond the U.S. Exclusive Economic Zone are ongoing and may result in the deferral of those tracts for Sale 171 (approximately 277 tracts) in the "Northern Portion of the Western Gap" (Figure I-1). It is estimated that each proposed lease sale could result in the discovery and production of 0.01-0.09 billion bbl of oil (BBO) and 0.57-1.93 trillion cubic feet (tcf) of gas.

The proposed action analyzed in this EIS is presented as a set of ranges for resource estimates, projected exploration and development activities, and impact-producing factors. This analyzed proposed action is expected to be "typical" of any of the Western Gulf sales. In other words, each of the proposed sales is expected to be within the ranges used for the analyzed "typical" sale.

The analyses of impacts summarized in this section and presented in detail in Section IV.D.1. are based on a development scenario, which is based on assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in Sections IV.A. and B.

b. Summary of Impacts

The following summarizes the detailed impact analyses found in Section IV.D.1.a. This summary is limited to the impact of a typical proposed action. Cumulative impacts are assessed under the cumulative analysis in Section IV.D.1.d. and are not summarized here.

The impact analysis for the typical proposed action assumes that the Topographic Features Stipulation, the Military Areas Stipulation, and the Naval Mine Warfare Area Stipulation are part of the proposal. Because no final Secretarial decision to apply these stipulations to leases resulting from the proposed lease sales has been made, the impacts of the any of the proposed actions without these stipulations are discussed in the following section under the heading *Effectiveness of the Lease Stipulation*. Additional discussion of the impacts of any of the proposed actions without the Topographic Features Stipulation can also be found in Section IV.D.1.a.(2)(b).

The Federal offshore area is divided into subareas based on water depth in meters (W0-60, W60-200, W200-900, W900-3000, and W3000+), and the coastal region is divided into two coastal subareas (TX-1 and TX-2). These subareas are delineated on Figure IV-1.

In some of the following summaries, reference is made to various size oil spills. The oil-spill sizes are defined as follows:

Spill Size	Symbol
Crude Oil Spills	
1 bbl or less	$\leq$ 1 bbl
greater than 1 bbl and less than or equal to 50 bbl	$>$ 1 bbl and $\leq$ 50 bbl
greater than 50 bbl and less than 1,000 bbl	$>$ 50 bbl and $<$ 1,000 bbl
greater than or equal to 1,000 bbl	$\geq$ 1,000 bbl
Other Oil-Type Spills	
(not broken down into size categories)	

Sensitive Coastal Environments

Coastal Barrier Beaches and Associated Dunes (Section IV.D.1.a.(1)(a))

The proposed action represents 0.5-1.0 percent of the OCS Program, based on BOE. The OCS Program is projected to have 9-38 large spills (≥1,000 bbl) and 65-90 spills between 50 and 1,000 bbl in OCS waters. Depending upon where a spill occurs, the OSRA analysis for conditional probability indicates that OCS spills in the WPA, originally consisting of 1,000 bbl or more of oil, had a less than 0.5-95 percent probability of contacting the U.S. Gulf Coast in 10 days; if the smaller spills persist as a consolidated slick for 10 or 30 days they would have a similar probability for land fall. Otherwise, smaller spills have significantly smaller probabilities of contacting that coast due to their size and dispersion rates. Barrier beaches in Jefferson, Galveston, Chambers, Brazoria, and Madagorda counties of Texas have the highest risk of being contacted by one of these spills. Where a spill contacts barrier beaches, oiling is expected to be light and sand removal will be minimized. Should the spill cleanups proceed as described in Section IV.A.3.h.(2), impacts are projected as moderate to minimal. Cleanup methods will be selected for minimizing removal of beach sediments. Hence, no significant impacts to the physical shape and structure of barrier beaches and associated dunes are projected to occur as a result of the proposed action.

No new coastal infrastructure (navigation channels, service bases, platform yards, petroleum terminals, etc.) is projected to be built on barrier beaches and dunes. Facilities constructed previously in or close behind dune zones where erosion rates are high will have to relocate if erosion threatens the site of the facility. The projected 128-261 new pipeline landfalls for the OCS Program (17-35 in the WPA) are not anticipated to cause significant impacts to barrier beaches as a result of the proposed action, due to the non-intrusive installation methods being used.

Maintenance dredging of barrier inlets and bar channels is expected to occur, which, combined with channel jetties, generally cause very localized impacts on adjacent barrier beaches down drift of the channel due to sediment deprivation. Sediment from maintenance dredging of channels is available for use in mitigating such impacts at an additional cost to the maintenance project. The worst of these situations is found on the sediment-starved coasts of Louisiana, where sediments are largely organic. Deepening the channel to Port Fourchon, Louisiana is expected to accelerate existing and continuing adverse impacts on nearby barrier features. The strategic placement of dredged material from deepening and maintenance of this OCS-related channel is proposed to mitigate the impact by benefitting barrier beaches immediately west of that channel's jetties. The proposed action is responsible for 0.06-0.12 percent of these impacts.

In conclusion, the proposed action is not expected to adversely alter barrier beach configurations significantly as a result of related spills or beyond existing impacts in very localized areas down drift of artificially jettied and maintained channels. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas.

Wetlands (Section IV.D.1.a.(1)(b))

Offshore oil spills resulting from the proposed action are not expected to significantly damage inland wetlands. As related to the proposed action, inland oil spills are expected to cumulatively impact about 9-70 ha of wetlands. These areas will be broadly scattered over the coastal regions, generally northeast of Matagorda County, in the vicinities where WPA oil is handled. After 4 and 10 years, about 2.7-21ha and 7.7-58 ha, respectively, are projected to recover from the oil-spill impacts;1.3-11 ha of wetlands are projected to be converted to open water.

Seagrasses may be contacted by low concentrations of oil, if any, from these spills. No permanent impacts to seagrass are expected, although the epifauna in those beds will be damaged for 1-2 years.

The proposed action is projected to contribute to the construction of 17-35 new onshore pipelines in the WPA. The proposed action is representatively projected to impact about 2.6-10 ha of wetlands. Of that representative area, vegetative productivity on 0.1-0.7 ha will be suppressed; 0.3-1.3 ha would be converted to open water. As a secondary impact, wetlands will be converted to open water by continued widening of

existing pipeline and navigational canals. The proposed action is projected to cause the loss of about 4.2-9.4 ha of the wetlands.

Maintenance dredging of navigation channels related to the proposed action are expected to occur with minimal impacts. Alternative dredged-material disposal methods can be used to enhance and create coastal wetlands.

Deepening an existing channel to accommodate larger service vessels is expected to occur within a saline marsh environment and affords the opportunity for creating 0.1-0.3 ha of wetlands attributable to the proposed action.

In conclusion, adverse impacts of installation, maintenance, continued existence, and the failure of mitigation structures of pipeline and navigation canals are considered the most significant continuing OCS-related and proposed action-related impacts to wetlands. Although these OCS-related impacts are considered locally significant where OCS-related canals pass through wetlands, the proposed action-related impacts would not be considered significant because of their low representative percentages of the OCS program, their broad and diffuse distribution over coastal Texas, and the difficulty in distinguishing them from other ongoing, OCS-related impacts to wetlands.

Sensitive Offshore Resources

Deepwater Benthic Communities (Section IV.D.1.a.(2)(a))

The most serious threat to chemosynthetic communities is physical disturbance of the bottom, which could destroy the organisms comprising these communities. Such disturbance could come from pipelaying, anchoring, structure emplacement, and seafloor blowouts. Drilling discharges and resuspended sediments may cause minor, mostly sublethal, impacts to chemosynthetic communities. Seafloor disturbance is considered to be a threat only to the high-density (Bush Hill-type) communities; the widely distributed low-density communities would not be at risk. The provisions of NTL 88-11 (currently in effect), requiring surveys and avoidance prior to drilling, will greatly reduce the risk of physical disturbance.

The proposed action is expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density Bush Hill-type chemosynthetic communities could experience minor impacts from drilling discharges or resuspended sediments, with recovery expected within 2 years. If physical disturbance (such as anchor damage) to high-density Bush Hill-type communities were to occur, impacts could be severe over a limited area, with recovery times as long as 200 years for mature tube worm communities. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

Topographic Features (Section IV.D.1.a.(2)(b))

The proposed Topographic Features Stipulation could prevent most of the potential impacts on live bottom communities from bottom-disturbing activities (structure removal and emplacement), operational discharges (drilling muds and cuttings, produced waters), blowouts, and surface and subsurface oil spills. Recovery from impact incidences of operational discharges and blowouts would take place within 10 years.

Contact with spilled oil would cause lethal and sublethal effects in benthic organisms. The oiling of benthic organisms is not likely because the proposed Topographic Features Stipulation would keep sources of spills away from the immediate vicinity of topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for adult sessile biota, including coral colonies in the case of the Flower Garden Banks, and there would be limited incidences of mortality. The recovery of harmed benthic communities could take more than 10 years.

Water Quality

Coastal Waters (Section IV.D.1.a.(3)(a))

Future regional water quality degradation due to effluent discharges and runoff from onshore infrastructure and coastal waterway usage supporting proposed action operations would be very small in relation to all other sources. Because so many OCS support facilities are located throughout the coastal zone, the area of potential contamination will be widespread. Maintenance dredging of about 33 million m^3 of sediment annually will result in localized impacts (primarily increased turbidity and resuspended contaminants) that will preclude uses of the waters immediately surrounding dredged sites and that could last up to several months. Water clarity within the navigation channels where the majority of vessel operations occur will be compromised as a result of continuous sediment influx from bank erosion, natural widening, and reintroduction of dredged material back into surrounding waters. Primarily because so few sites are expected to be impacted by spill events and the impacts will be temporary, spills are not likely to become major contributors to regional petroleum contamination of Gulf coastal waters. The number and volume of the spills estimated to occur in the coastal zone or from offshore operations reaching coastal waters from a proposed action would result in no more than acute, localized, and low-level impacts to coastal waters. Excluding the short-term effects of dredging and oil spills, impacts to coastal waters from a proposed action should not disrupt current activity uses designated for these waters, with the exception of Galveston Bay. Discharges, spills, and dredging disturbances that will likely result from use of Galveston Bay are likely to contribute to a minor extent to the water quality problems of the Bay's waters.

Marine Waters (Section IV.D.1.a.(3)(b))

Sediment disturbance from the emplacement and removal of platforms and associated pipelines and from the drilling of wells is expected to result in minor, localized, temporary increases in water-column turbidity in offshore waters. Given the low number and frequency of estimated explosive platform removals and blowouts, minimum, short-term changes in water quality conditions due to resuspension of sediments are expected from removal operations and accidental blowout events.

Oil spills related to the proposed action are assumed to be mostly very small events, and, for spills greater than 50 bbl, to occur very infrequently, if at all. These events are extremely unlikely to occur in the same area or in the same year. Water quality changes in the water column are limited to the area around and beneath the surface slick and is expected to last for only a short time following the removal of the slick from the surface of the water. Based on the above factors, loss of use of marine water from these spills will be of short-duration (from a few days to 3 months) and very localized.

Current and future limits on the levels of contaminants in drilling muds and cuttings and produced-water discharges, discharge-rate restrictions, and monitoring and toxicity testing requirements are expected to eliminate significant biological or ecological effects that were documented in the past. For shallow developments, elevated levels of some contaminants found in the plumes of produced-water discharges and drilling mud discharges are expected to be detected out to a few thousand meters downcurrent from the discharge point; however, no ecological effects to water-column organisms are expected. For deepwater facilities, although levels of discharges per deepwater facility would be higher than shallower water facilities, there would be fewer locations where discharges would take place. Drilling discharges from facilities located in waters deeper than 400 m could reach the seafloor, but would result in extremely low levels of sediment contamination, if any at all, and any cuttings would be distributed in very thin accumulations distributed somewhere within a broader area than they would be in shallower waters.. The plume from produced-water discharges is not expected to reach the seafloor in water depths greater than 100 m. Despite any possible sediment accumulation of discharged chemicals, biological responses in soft-tissue benthic organisms are not expected to be detectable beyond a couple of hundred meters. Toxic effects to the benthos from OCS discharges are expected to be very localized, limited to within 100 m from the discharge, and will be of a relatively small magnitude. Given that the contaminants are exhibiting localized, low-level sediment

retention and biological perturbation, regional water quality is not expected to be compromised by discharges related to the proposed action.

OCS discharges and spills associated with the proposed action could be contributing less than 1 percent of the metal and hydrocarbon contaminants that are measurable in regional offshore waters and may be accumulating in offshore sediments.

Air Quality (Section IV.D.1.a.(4))

Emissions of pollutants into the atmosphere from the activities associated with the proposed action are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline. Emissions from proposed action activities are not expected to have concentrations that would change onshore air quality classifications. Increases in onshore annual average concentrations of NO_x, SO_x, and TSP are estimated to be less than the maximum increases allowed under the PSD Class II program.

Marine Mammals (Section IV.D.1.a.(5))

The proposed action, by itself, is unlikely to have significant long-term adverse effects on the size and productivity of any marine mammal species or population stock in the northern Gulf of Mexico provided (1) previous and on-going exploration and development activities have not increased the sensitivity of any marine mammal species to disturbance from seismic surveys, rig construction, drilling operations, or ship and helicopter support activities; (2) responses to disturbance do not increase as the level of disturbance increases or do not occur until a sensitivity threshold is reached; and (3) if oil spills occur, they occur at times and in places where significant numbers of marine mammals are not present, and individually and collectively do not adversely affect habitats or habitat components (e.g., important prey species) that are essential to the well-being of any marine mammal species or population stock in the northern Gulf. Small numbers of marine mammals could be killed or injured by chance collision with service vessels and by eating indigestible trash, particularly plastic items, lost from drill rigs and service vessels. Deaths due to structure removals are not expected due to mitigation measures (NMFS observer program). Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain biomagnification; there is uncertainty concerning the possible effect.

Sea Turtles (Section IV.D.1.a.(6))

Activities resulting from the proposed action have the potential to cause detrimental effects to sea turtles. These animals could be impacted by the degradation of water quality resulting from operational discharges, helicopter and vessel traffic and noise, platform and drillship noise, seismic surveys, explosive platform removals, oil spills, oil-spill response activities, and discarded trash and debris from service vessels and OCS structures. Lethal effects are most likely to be from chance collisions with OCS service vessels and ingestion of plastic materials; few lethal impacts are expected. Deaths due to structure removals are not expected due to mitigation measures (NMFS observer program). Sale-related oil spills of any size are considered to rarely contact Gulf of Mexico sea turtles. Contact with oil, and consumption of oil and oil-contaminated prey, may seriously impact turtles. There is direct evidence that turtles have been seriously harmed by oil spills. Most OCS activities are estimated to have sublethal effects (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or debris). Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification; there is uncertainty concerning the possible effect. 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, and result in either acute or gradual population declines. The proposed action, by itself, is unlikely to have significant long-term adverse effects on the size and productivity of any sea turtle species or population stock in the northern Gulf of Mexico.

Coastal and Marine Birds (Section IV.D.1.a.(7))

Activities resulting from the proposed action are expected to affect endangered/threatened and nonendangered/nonthreatened coastal and marine birds of the WPA. It is expected that the majority of effects from the major impact-producing factors on coastal and marine birds are sublethal (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris), causing temporary disturbances and displacement of localized groups inshore. Chronic sublethal stress, 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. Lethal effects result primarily from coastal inshore oil spills and associated spill-response activities, and are especially serious for endangered/threatened species as any reductions in population size represents a threat to their existence. Spills occurring in biologically sensitive areas are expected to kill a number of individuals from any or all groups of birds. The net effect will be the alteration of the species composition of the affected area(s) and possibly the reduction of the overall carrying capacity of these area(s) in general. Recovery of affected areas is expected to take up to several years.

Commercial Fisheries (Section IV.D.1.a.(8))

Operations resulting from the proposed action have the potential to cause detrimental effects on WPA commercial fisheries. Activities such as seismic surveys, subsurface blowouts, pipeline trenching, and OCS discharge of drilling muds and produced water will cause negligible impacts and will not deleteriously affect WPA commercial fisheries. Operations such as production platform emplacement, underwater OCS impediments, explosive platform removal, oil spills, and activities that result in coastal environmental degradation will cause greater impacts on WPA commercial fisheries. The proposed action is expected to result in less than a 1 percent decrease in commercial fishery populations, in essential habitat, or in commercial fishing. It will require less than six months for fishing activity and one generation for fishery resources to recover from 99 percent of the impacts.

Recreational Resources and Beach Use (Section IV.D.1.a.(9))

A few small onshore and offshore spills may affect portions of Texas or Louisiana beaches with little disruption of recreational activities. Marine debris will be lost from time to time from OCS operations associated with drilling new wells and producing oil and gas from new production locations throughout the WPA. However, the impact from the resulting intermittent pollution washup on Texas and Louisiana beaches should be minimal. Helicopter and vessel traffic will add very little additional noise pollution likely to affect beach users.

The proposed action is expected to result in pollution events and nearshore operations that may adversely affect the enjoyment of some beach uses on Texas and Louisiana beaches. However, these will have little effect on the number of beach users.

Archaeological Resources

Historic (Section IV.D.1.a.(10)(a))

The greatest potential impact to a historic archaeological resource as a result of the proposed action would result from a contact between an OCS offshore activity (platform installation, drilling rig emplacement, dredging or pipeline project) and a historic shipwreck. An MMS-funded study (Garrison et al., 1989) resulted in the redefinition of the high probability areas for the location of historic period shipwrecks. An in-house review of the historic high probability areas is occurring at the time of this writing. An NTL for archaeological resource surveys in the Gulf of Mexico Region (NTL 91-02) has mandated a 50-m linespacing density for remote-sensing surveys for historic shipwreck surveys.

Most other activities associated with the proposed action are not expected to impact historic archaeological resources. It is conservatively assumed that 0.5-1.0 percent of OCS Program use of projected

onshore facilities will occur as a result of the proposed action (Table IV-12). It is expected that archaeological resources will be protected through the review and approval processes of the various Federal, State, and local agencies involved in permitting onshore activities. Ferromagnetic debris has the potential to mask the magnetic signatures of historic shipwrecks. There is a small chance of contact from an oil spill associated with the proposed action. Furthermore, the major impact from an oil-spill contact on a historic coastal site, such as a fort or lighthouse, would be visual due to oil contamination. These impacts would be temporary and reversible. Maintenance dredging of navigation channels may result in impacts to historic shipwrecks; however, the percentage of OCS use of these channels under the proposed action is less than 1 percent.

OCS activities could contact 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.

Prehistoric (Section IV.D.1.a.(10(b))

Several impact-producing factors may threaten the prehistoric archaeological resources of the Western Gulf. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric site located on the continental shelf. The archaeological survey and archaeological clearance of sites required prior to an operator beginning oil and gas activities on a lease block are estimated to be 90 percent effective at identifying possible prehistoric sites. Since the survey and clearance provide a significant reduction in the potential for a damaging interaction between an impact-producing factor and a prehistoric site, there is a very small possibility of an OCS activity contacting a prehistoric site. Should such contact occur, there would be damage to or loss of significant or unique archaeological information.

Onshore development as a result of the proposed action could result in the direct physical contact from new facility construction, pipeline trenching, and new navigation canal dredging. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes of the Federal, State, and local agencies involved.

Should an oil spill contact a coastal prehistoric site, the potential for dating the site using radiocarbon methods could be destroyed. Oil-spill cleanup operations could physically impact coastal prehistoric sites. Previously unrecorded sites could also experience an impact from oil-spill cleanup operations on beaches. Should a spill contact an archaeological site, damage might include loss of C-14 dating potential, direct impact from oil-spill cleanup equipment, and/or looting. There is a small possibility of onshore oil spills contacting a prehistoric site; should such contact occur, impacts identical to those described for offshore spills could occur.

The proposed action is not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost.

Socioeconomic Conditions

Employment and Population (Section IV.D.1.a.(11)(a))

Peak annual changes in the employment and population of all coastal subareas in the Western and Central Gulf resulting from the proposed action in the Western Gulf represent less than 1 percent of the levels expected in absence of the proposal in the Western Gulf. About 33 percent of the total employment resulting from the proposed action is expected to affect the coastal subareas of the Central Gulf. Employment resulting from oil-spill clean-up activities due to the proposed action is expected to be negligible. For the most part, it is expected that employment demands in support of the proposed action will be met with the existing population and available labor force. Some employment is expected to be met through in-migration due to the shadow effect and a labor force lacking requisite skills for the oil and gas and supporting industries.

Public Services, Infrastructure, and Land Use Plans (Section IV.D.1.a.(11)(b))

Impacts to public services and infrastructure would be related to dramatic increases or decreases in OCS activities resulting in rapid increases or decreases in population, migration, employment, etc., which are not projected in the WPA as a result of a typical proposed action. Specific impact-producing factors examined in this analysis include workforce fluctuations, migration into or out of the coastal subareas, and the relatively high wages made by personnel involved in the oil and gas industry. The greatest population and employment impacts associated with a typical proposed action would fall within western Louisiana and Texas. An analysis of historical trends indicates that population impacts of greater than 1 percent result in positive net migration into a given area. Population impacts are not expected to exceed the peak-year impacts of 0.6 percent. It is expected that most employment needs will be met by those currently employed in the oil and gas industry as well as by the unemployed, underemployed, and new employees already living in the area. In addition, jobs created by the proposal would likely reduce the amount of migration out of the coastal subareas as compared to scenarios without the proposal. The need for some skilled labor may result in some in-migration. The amount of in-migration may be increased by a shadow effect resulting from the previous oil bust. An increasing focus on deepwater activity may result in some stress placed on local infrastructure at or near focal points associated with support of deepwater exploration and development activities. Some use conflicts involving the GIWW near Corpus Christi, Texas, may be exacerbated by activities resulting from the proposed action. Potential impacts of oil spills could include temporary stresses on local infrastructure including housing, recreation, transportation, and water supply. The duration of these possible impacts would be limited to the amount of time necessary to clean up the spill. Projected construction is anticipated to be in accordance with appropriate land use plans, zoning regulations, and other State/regional/local regulatory mechanisms.

Population, employment, and land use impacts that result from a typical proposed action will not result in disruptions to community infrastructure and public services beyond what is anticipated by in-place planning, development, and regulatory agencies. Temporary (6 weeks maximum) stresses to local infrastructure could occur as a result of oil spills.

Sociocultural Issues and Environmental Justice (Section IV.D.1.a.(11)(c))

The employment projected to occur in association with a typical proposed action is expected to be filled primarily by persons already engaged in OCS oil- and gas-related employment, unemployed persons living in the area, and underemployed persons living in the area. The coastal subareas of Texas are projected to provide the greatest support and, hence, incur the greatest potential impacts associated with the proposal. Inasmuch as jobs (including high-paying jobs) will be provided for persons living in the coastal subareas, some positive impact is expected. Given the present amount of OCS-related jobs in the coastal subareas, a typical proposed action is not expected to result in workforce fluctuations. None of the coastal subareas are projected to experience population impacts greater than 0.06 percent as a result of a typical proposed action. Some importation of skilled labor may be required to support a typical proposed action. In addition, the shadow effect may exacerbate the need for importation of skilled labor. It is assumed that employment as a result of a typical proposed action will decrease the amount of out-migration compared to that which would occur without a typical proposed action. Social and cultural problems typically associated with in-migration and out-migration are not expected to generally occur as a result of a typical proposed action. However, it is possible that some of the communities heavily involved in supporting OCS activity may experience problems associated with in-migration in support of the proposed action. The relatively small amount of employment associated with a typical proposed action, in comparison with the total employment in the affected Western and Central Gulf coastal subareas, is expected to result in no deleterious impacts to small businesses. The projected amount of wetlands loss is not sufficient to affect the practice of traditional occupations in the WPA, given the total amount of coastal marsh available for exploitation. Potential offshore oil-spill impacts could include a loss of community cohesion, social disorganization associated with a rapid influx of strangers into a tightly-knit community, and an increased cost of living associated with increased demand for housing. The duration of these possible impacts would be limited to the amount of

time necessary to clean up the spill (6 weeks estimated). Employment requirements for cleanup of onshore spills is expected to be minimal. Impacts to educational attainment are expected to be minimal. It is expected that in a small number of cases, successful adaptation of the family to the extended work schedule will not occur. In these cases, some deleterious impacts to family are expected. Several different possible scenarios may result in the siting of facilities, with their concomitant economic and environmental implications, proximal to low-income or minority communities or populations. The siting of onshore infrastructure is not regulated by the MMS. Economic and logistic considerations, as well as local zoning and permitting requirements, drive the choice of where to locate these facilities. A typical proposed action could be attributed with 0.5-1.0 percent of the impacts associated with the siting of any new onshore facilities proximal to minority or low-income populations or communities. The proposed action is not expected to cause disproportionately high or adverse human health or environmental effects on minority or low-income populations; however, the lack of information on the location of potential construction of onshore infrastructure over the life of the proposed actions makes it impossible to dismiss potential disproportionate impacts.

c. Mitigating Measures

Measures have been developed to mitigate possible impacts of OCS activities on environmental resources and non-OCS activities. The three stipulations presented below have been applied to appropriate OCS leases for years. The stipulations are analyzed as part of the proposed actions in this EIS, i.e., the analysis assumes that the measures will be in place. An evaluation of the effectiveness of the stipulations describes how implementation of the stipulations would mitigate potential adverse impacts.

(1) Topographic Features Stipulation

The topographic features of the Western Gulf provide habitat for coral reef community organisms (Section III.B.2.). These communities could be severely and adversely impacted by oil and gas activities resulting from the proposed actions if such activities took place on or near these communities without the Topographic Features Stipulation and if such activities were not mitigated. The DOI has recognized this problem for some years, and since 1973 stipulations have been made a part of leases on or near these biotic communities so that impacts from nearby oil and gas activities were mitigated to the greatest extent possible. This stipulation would not prevent the recovery of oil and gas resources, but would serve to protect valuable and sensitive biological resources.

The Topographic Features Stipulation was formulated based on consultation with various Federal agencies and comments solicited from the States, industry, environmental organizations, and academic representatives. The stipulation is based on years of scientific information collected since the inception of the stipulation. This information includes various Bureau of Land Management/MMS-funded studies on the topographic highs in the Western Gulf; numerous stipulation-imposed, industry-funded monitoring reports; and the National Research Council (NRC) report entitled *Drilling Discharges in the Marine Environment* (1983). The location and lease status of the blocks affected by the Topographic Features Stipulation are shown on Figures II-2, II-3, and II-4.

The requirements in the stipulation are based on the following facts:

(a) Shunting of the drilling effluent to the nepheloid layer confines the effluent to a level deeper than that of the living reef of a high-relief topographic feature. Shunting is therefore an effective measure for protecting the biota of high-relief topographic features (Bright and Rezak, 1978; Rezak and Bright, 1981; NRC, 1983).

(b) The biological effect on the benthos from the deposition of nonshunted discharge is mostly limited to within 1,000 m of the discharge (NRC, 1983).

(c) The biota of topographic features can be categorized into depth-related zones defined by degree of reef-building activity (Rezak and Bright, 1981; Rezak et al., 1983 and 1985).

The stipulation establishes No Activity Zones at the topographic features. A zone is defined by the 85-m isobath because, generally, the biota shallower than 85 m are more typical of the Caribbean reef biota, while the biota deeper than 85 m are similar to soft-bottom organisms found throughout the Gulf. Where a bank is in water depths less than 85 m, the deepest closing isobath defines the No Activity Zone for that bank. Within the No Activity Zones, no operations, anchoring, or structures are allowed. Outside the No Activity Zones, additional restrictive zones are established within which oil and gas operations could occur, but within which drilling discharges would be shunted.

The stipulation requires that all effluents within 1,000 m of banks containing an antipatharian-transitional zone be shunted to within 10 m of the seafloor. Banks containing the more sensitive and productive algal-sponge zone require a shunt zone extending 1 nautical mile (nmi) and an additional 3-nmi shunt zone for development only.

Exceptions to this general stipulation scheme are made for the Flower Garden Banks, Stetson Bank and the low-relief banks. Because they have received National Marine Sanctuary status, the Flower Garden Banks are protected to a greater degree than the other banks. The added provisions at the Flower Garden Banks require that (a) the No Activity Zone be based on the 100-m isobath instead of the 85-m isobath and be defined by the "1/4 1/4 1/4" system (a method of defining a specific portion of a block) rather than the actual isobath and (b) there be a 4-Mile Zone instead of a 1-Mile Zone in which shunting is required. Although Stetson Bank was made part of the Flower Garden Banks National Marine Sanctuary in 1996, it has not as yet received added protection that would differ from current stipulation requirements. Low-relief banks have only a No Activity Zone. Indeed, a shunting requirement would be counterproductive as it would put the potentially toxic drilling muds in the same water depth range as the bank biota that are being protected. Also, the turbidity potentially caused by the release of drilling effluents in the upper part of the water column would not affect the biota on low-relief banks as they appear to be adapted to high turbidity. Yet, Claypile Bank, which is a low-relief bank that exhibits the *Millepora*-sponge community, has been given the higher priority protection of a 1,000-Meter Zone within which monitoring is required.

The stipulation reads as follows:

Topographic Features Stipulation
(Western Planning Area)

(a) No activity including structures, drilling rigs, pipelines, or anchoring will be allowed within the listed isobath ("No Activity Zone") of the banks as listed below.

(b) Operations within the area shown as "1,000-Meter Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 meters, from the bottom.

(c) Operations within the area shown as "1-Mile Zone" shall be restricted by shunting all drill cuttings and drilling fluids to the bottom through a downpipe that terminates an appropriate distance, but no more than 10 meters, from the bottom. (Where there is a "1-Mile Zone" designated, the "1,000-Meter Zone" in paragraph (b) is not designated.) This restriction on operations also applies to areas surrounding the Flower Garden Banks National Marine Sanctuary, namely the "4-Mile Zone" surrounding the East Flower Garden Bank and the West Flower Garden.

(d) Operations within the area shown as "3-Mile Zone" shall be restricted by shunting all drill cuttings and drilling fluids from development operations to the bottom through a

downpipe that terminates an appropriate distance, but no more than 10 meters, from the bottom.

The banks and corresponding blocks to which this stipulation may be applied in the Western Gulf are as follows:

Bank Name	Isobath (meters)
Shelf Edge Banks	
West Flower Garden Bank (defined by 1/4 1/4 1/4 system)	100
East Flower Garden Bank (defined by 1/4 1/4 1/4 system)	100
MacNeil Bank	82
29 Fathom Bank	64
Rankin Bank	85
Geyer Bank	85
Elvers Bank	85
Bright Bank[1]	85
McGrail Bank[1]	85
Rezak Bank[1]	85
Sidner Bank[1]	85
Parker Bank[1]	85
Stetson Bank	52
Appelbaum Bank	85
Low Relief Banks[2]	
Mysterious Bank (see leasing map)	74, 76, 78, 80, 84
Coffee Lump (see leasing map)	Various
Blackfish Ridge	70
Big Dunn Bar	65
Small Dunn Bar	65
32 Fathom Bank	52
Claypile Bank[3]	50
South Texas Banks[4]	
Dream Bank	78, 82
Southern Bank	80
Hospital Bank	70
North Hospital Bank	68
Aransas Bank	70
South Baker Bank	70
Baker Bank	70

[1]Central Gulf of Mexico bank with a portion of its "1-Mile Zone" and/or "3-Mile Zone" in the Western Gulf of Mexico.
[2]Low-Relief Banks--Only paragraph (a) applies.
[3]Claypile Bank--Paragraphs (a) and (b) apply. In paragraph (b), monitoring of the effluent to determine the effect on the biota of Claypile Bank shall be required rather than shunting.
[4]South Texas Banks--Only paragraphs (a) and (b) apply.

Effectiveness of the Lease Stipulation

The purpose of the stipulation is to protect the biota of the topographic features from adverse effects due to routine oil and gas activities. Such effects include physical damage from anchoring and rig emplacement and potential toxic and smothering effects from muds and cuttings discharges. The Topographic Features Stipulation has been used on leases since 1973 and has effectively prevented damage to the biota of these banks from routine oil and gas activities such as anchoring. Monitoring studies have demonstrated that the shunting requirements of the stipulation are effective in preventing the muds and cuttings from impacting the biota of the banks. The stipulation, if adopted for the proposed action, will continue to protect the biota of the banks, specifically as discussed below.

The stipulation provides different levels of protection for banks in different categories as defined by Rezak and Bright (1981). The categories and their definitions are as follows:

Category A: zone of major reef-building activity; maximum environmental protection recommended;

Category B: zone of minor reef-building activity; environmental protection recommended;

Category C: zone of negligible reef-building activity, but crustose algae present; environmental protection recommended; and

Category D: zone of no reef-building or crustose algae; additional protection not necessary.

The proposed action, without benefit of the Topographic Features Stipulation or comparable mitigation, is expected to have a severe impact on the sensitive offshore habitats of the topographic features. The impact-producing factors resulting from the proposed action would include anchoring of vessels, structure emplacement (long-lasting physical impacts disturbance of the benthic environment--recovery from damage may take 10 or more years), operational discharges (drilling muds and cuttings, produced waters potentially causing turbidity and sedimentation--recovery from such damage may take 10 or more years), blowouts (resuspension of sediments causing turbidity and sedimentation--recovery from such damage may take up to 10 years), oil spills contacting benthic organisms (subsurface blowouts and pipeline leaks), and structure removal using explosives (turbidity, redeposition of sediments, and explosive shock-wave impacts--recovery from such damage could take more than 10 years).

Mechanical damage resulting from drilling and anchoring are probably the most severe sources of impact to benthic communities. Yet, by conforming with the Topographic Features Stipulation, activities resulting from the proposed action should not affect the sensitive biota of WPA topographic features. In fact, the stipulation protects the biota of low-relief banks from mechanical damage impacts by establishing a No Activity Zone. The biota of these banks and the turbidity of the water are such that protective measures to restrain drilling discharges are not warranted.

The stipulation provides an added measure of protection for Claypile Bank, requiring both a No Activity Zone and a 1,000-Meter Zone. Claypile Bank is the only low-relief bank that is known to contain the *Millepora*-sponge community. This assemblage is categorized by Rezak and Bright (1981) as a Category B community (minor reef-building activity) worthy of increased protection. Monitoring will be required within the 1,000-Meter Zone. Any impacts from drilling will thereby be documented so that further protective measures could be taken. Due to the low relief of the bank (only 5 m), shunting would be counterproductive.

The stipulation requires that all drill cuttings and drilling fluids within 1,000 m of high-relief topographic features categorized by Rezak and Bright (1981) as Category C banks (negligible reef-building activity) be shunted into the nepheloid layer; the potentially harmful materials in drilling muds would be trapped in the bottom boundary layer and would not move up the banks where the biota of concern are located. Surface drilling discharge at distances greater than 1,000 m from the bank is not expected to adversely impact the biota.

The stipulation protects the remaining banks (Category A and B banks--major and minor reef building) with even greater restrictions. (Appelbaum Bank is categorized as Category C; however, it contains the algal-sponge community, which is indicative of Category A banks. Therefore, it carries a Category A bank stipulation.) Surface discharge will not be allowed within 1 nmi of these more sensitive banks. Surface discharges outside of 1 nmi are not expected to adversely impact the biota of the banks. However, when multiple wells are drilled from a single platform (surface location), typical during development operations, extremely small amounts of muds discharged more than 1 nmi from the bank may reach the bank. In order to eliminate the possible cumulative effect of muds discharged from numerous wells outside of 1 nmi, the stipulation imposes a 3-Mile Zone within which shunting of development effluent is required. The stipulation results in increased protection to the Flower Garden Banks. Shunting would be required within a 4-Mile Zone.

The surface discharge of drilling muds and cuttings resulting from exploratory wells within the 3-Mile Zone is not expected to reach or affect the biological resources located within the No Activity Zone for three main reasons: (a) the biological effect on the benthos from the deposition of nonshunted discharge is mostly limited to within 1,000 m of the discharge (NRC, 1983); (b) exploration usually requires the drilling of one to four wells per site as opposed to more than five in the case of development; and (c) a significantly lower volume of exploration drilling discharges is expected per site since development usually requires the drilling of several additional wells over greater distances to reach potential reservoirs. The requirement to shunt drilling discharges within the 3-Mile Zone during development is probably not necessary but has been maintained to endorse a strong recommendation made by the U.S. Fish and Wildlife Service.

The stipulation would prevent damage to the biota of the banks from routine oil and gas activities resulting from the proposed action, while allowing the development of nearby oil and gas resources. The stipulation would not protect the banks from the adverse effects of an accident such as a large blowout on a nearby oil or gas operation.

(2) Military Areas Stipulation

The Military Areas Stipulation has been applied to blocks in military warning areas in past lease sales in the Western Gulf and may be included, at the Secretary's option, in all leases resulting from these proposed actions. Figure II-1 shows the military warning areas in the Gulf of Mexico. The stipulation is considered by DOI and DOD to be an effective method of mitigating potential multiple-use conflicts. The stipulation reads as follows:

Military Areas Stipulation

(a) Hold and Save Harmless

Whether compensation for such damage or injury might be due under a theory of strict or absolute liability or otherwise, the lessee assumes all risks of damage or injury to persons or property, which occur in, on, or above the Outer Continental Shelf (OCS), to any persons or to any property of any person or persons who are agents, employees, or invitees of the lessee, its agents, independent contractors, or subcontractors doing business with the lessee in connection with any activities being performed by the lessee in, on, or above the OCS, if such injury or damage to such person or property occurs by reason of the activities of any agency of the United States Government, its contractors or subcontractors, or any of its officers, agents or employees, being conducted as a part of, or in connection with, the programs and activities of the command headquarters listed in Table II-1.

Notwithstanding any limitation of the lessee's liability in Section 14 of the lease, the lessee assumes this risk whether such injury or damage is caused in whole or in part by any act or omission, regardless of negligence or fault, of the United States, its contractors or subcontractors, or any of its officers, agents, or employees. The lessee further agrees to indemnify and save harmless the United States against all claims for loss, damage, or injury sustained by the lessee, or to indemnify and save harmless the United States against all claims for loss, damage, or injury sustained by the agents, employees, or invitees of the lessee, its agents, or any independent contractors or subcontractors doing business with the lessee in connection with the programs and activities of the aforementioned military installation, whether the same be caused in whole or in part by the negligence or fault of the United States, its contractors, or subcontractors, or any of its officers, agents, or employees and whether such claims might be sustained under a theory of strict or absolute liability or otherwise.

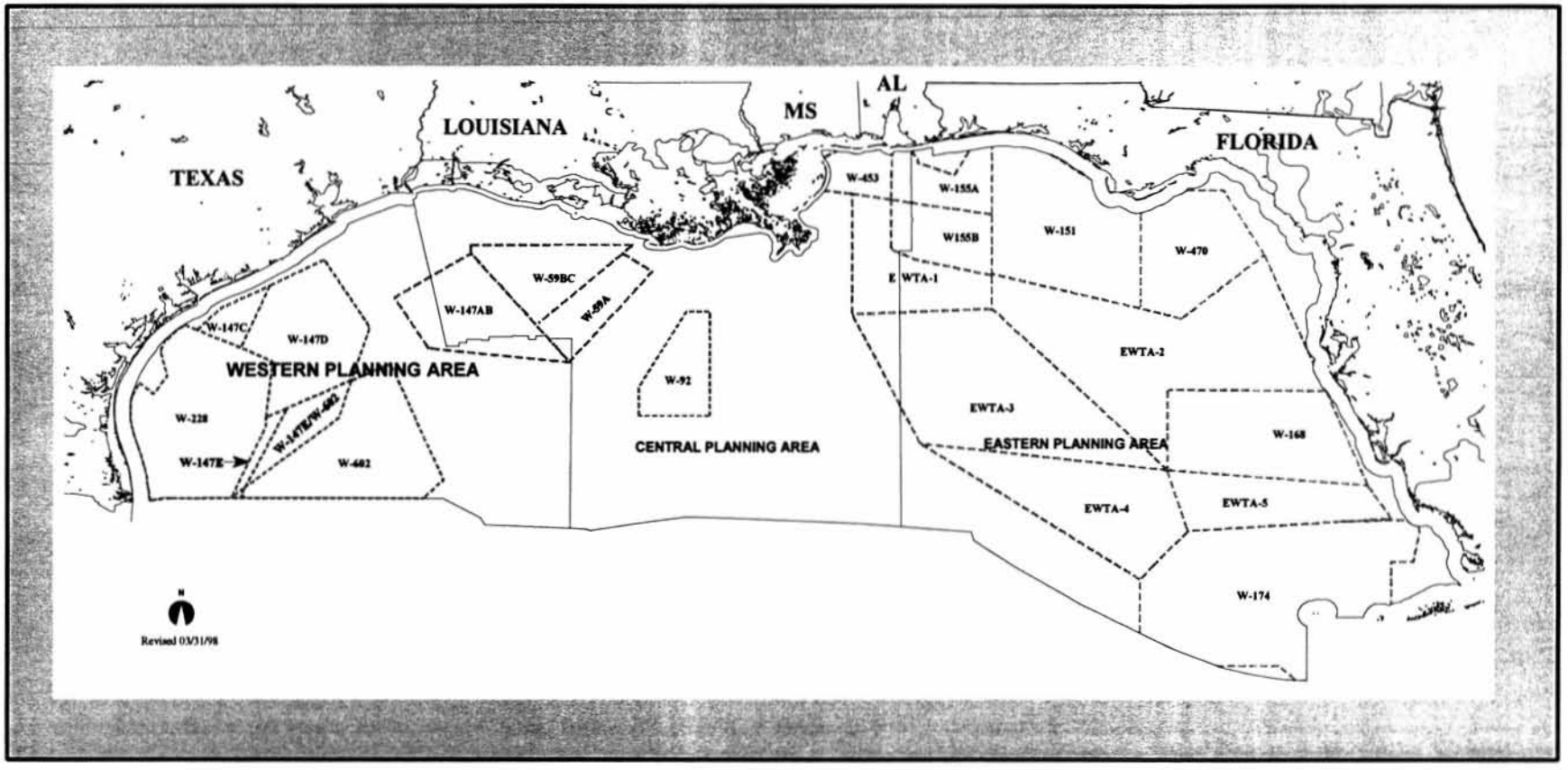


Figure II-1. Military Warning Areas in the Gulf of Mexico.

Table II-1

Military Contacts
(updated March 1998)

Western Gulf of Mexico

Warning Areas	Command Headquarters
W-59	Naval Air Station - JRB 400 Russel Avenue Box 27 New Orleans, Louisiana 70143-0027 Telephone: (504) 391-8696/8687
W-147	147th Fighter Wing 147 OSF/CC 14657 Sneider Street Houston, Texas 77034-5586 Telephone: (281) 929-2716/2683
W-228	Chief, Naval Air Training Naval Air Station Office No. 206 Corpus Christi, Texas 78419-5100 Telephone: (512) 939-3862/3902
W-602	Headquarters ACC/DOR, Detachment 1 Operations Headquarters, Air Combat Command Offutt AFB, Nebraska 68113-5550 Telephone: (402) 294-2334

Central Gulf of Mexico

Warning Areas	Command Headquarters
W-59	Naval Air Station - JRB 400 Russel Avenue Box 27 New Orleans, Louisiana 70143-0027 Telephone: (504) 391-8696/8687
W-92	Naval Air Station Air Operations Department Air Traffic Division/Code 52 New Orleans, Louisiana 70146-5000 Telephone: (504) 678-3100/3101
W-147AB	147th Fighter Wing 147 OSF/CC 14657 Sneider Street Houston, Texas 77034-5586 Telephone: (281) 929-2716/2683
W-155A and W-155B (for agreement)	Chief, Naval Air Training Naval Air Station Office No. 206 Corpus Christi, Texas 78419-5100 Telephone: (512) 939-3862/3902
W-155A and W-155B (for operational control)	Fleet Area Control & Surveillance Facility (FACSFAC), Operations Naval Air Station Pensacola, Florida 32508 Telephone: (904) 452-2735/4671
W-453	Air National Guard - CRTC Gulfport/ACTS 4715 Hewes Ave., Bldg. 1 Gulfport, Mississippi 39507-4324 Telephone: (601) 867-2433
Eglin Water Test Areas (EWTA) 1 and 3	Air Force Development Test Center Strategic Plans Division Directorate of Requirements 101 West "D" Ave., Suite 129 Eglin AFB, Florida 32542-5495 Telephone: (904) 882-3899/4188

(b) Electromagnetic Emissions

The lessee agrees to control its own electromagnetic emissions and those of its agents, employees, invitees, independent contractors or subcontractors emanating from individual designated defense warning areas in accordance with requirements specified by the commander of the command headquarters listed in Table II-1 to the degree necessary to prevent damage to, or unacceptable interference with Department of Defense flight, testing, or operational activities, conducted within individual designated warning areas. Necessary monitoring control, and coordination with the lessee, its agents, employees, invitees, independent contractors or subcontractors, will be effected by the commander of the appropriate onshore military installation conducting operations in the particular warning area; provided, however, that control of such electromagnetic emissions shall in no instance prohibit all manner of electromagnetic communication during any period of time between a lessee, its agents, employees, invitees, independent contractors or subcontractors and onshore facilities.

(c) Operational

The lessee, when operating or causing to be operated on its behalf, boat, ship, or aircraft traffic into the individual designated warning areas, shall enter into an agreement with the commander of the individual command headquarters listed in Table II-1, upon utilizing an individual designated warning area prior to commencing such traffic. Such an agreement will provide for positive control of boats, ships, and aircraft operating into the warning areas at all times.

Effectiveness of the Lease Stipulation

The hold and save harmless section of the Military Areas Stipulation serves to protect the U.S. Government from liability in the event of an accident involving the lessee and military activities. The actual operations of the military and the lessee and its agents will not be affected.

The electromagnetic emissions section of the stipulation requires the lessee and its agents to reduce and curtail the use of radio or other equipment emitting electromagnetic energy within some areas. This serves to reduce the impact of oil and gas activity on the communications of military missions and reduces the possible effects of electromagnetic energy transmissions on missile testing, tracking, and detonation.

The operational section requires notification to the military of oil and gas activity to take place within a military use area. This allows the base commander to plan military missions and maneuvers that may avoid the areas where oil and gas activities are taking place or to schedule around these activities. Prior notification helps reduce the potential impacts associated with vessels and helicopters traveling unannounced through areas where military activities are underway.

The Military Areas Stipulation reduces potential multiple-use impacts, particularly in regards to safety, but does not reduce or eliminate the actual physical presence of oil and gas operations in areas where military operations are conducted. Without the stipulation, some multiple-use conflict is likely. The best indicator of the overall effectiveness of the stipulation may be that there has never been an accident involving a conflict between military operations and oil and gas activities.

(3) Naval Mine Warfare Area Stipulation

This stipulation will apply to Mustang Island Area, East Addition, Blocks 732, 733, and 734. (Mustang Island Area, East Addition, Block 733 was leased in August 1994.) The Navy has identified these blocks as needed for testing equipment and for training mine warfare personnel. The MMS and the Navy have entered into a formal agreement (signed June 20, 1994, by the MMS and July 15, 1994, by the Navy) that these blocks could be offered for lease with a special stipulation.

The stipulation reads as follows:

Naval Mine Warfare Area Stipulation

(a) The placement, location, and planned periods of operation of surface structures on this lease during the exploration stage are subject to approval by the Regional Director (RD), Minerals Management Service, Gulf of Mexico Region, after the review of the operator's Exploration Plan (EP). Prior to approval of the EP, the RD will consult with the Commander, Mine Warfare Command, in order to determine the EP's compatibility with scheduled military operations. No permanent structures nor debris of any kind shall be allowed in the area covered by this lease during exploration operations.

(b) To the extent possible, sub-seafloor development operations for resources subsurface to this area should originate outside the area covered by this lease. Any above-seafloor development operations within the area covered by this lease must be compatible with scheduled military operations as determined by the Commander, Mine Warfare Command. The lessee will consult with and coordinate plans for above-seafloor development activities (including abandonment) with the Commander, Mine Warfare Command. The Development Operations Coordination Document (DOCD) must contain the locations of any permanent structures, fixed platforms, pipelines, or anchors planned to be constructed or placed in the area covered by this lease as part of such development operations. The DOCD must also contain the written comments of the Commander, Mine Warfare Command on the proposed activities. Prior to approval of the DOCD, the RD will consult with the Commander in order to determine the DOCD's compatibility with scheduled military operations.

For more information consultation, and coordination, the lessee must contact: Commander, Mine Warfare Command, 325 Fifth Street, SE, Corpus Christi, Texas 78419-5032, phone (512) 939-4895.

Effectiveness of the Lease Stipulation

The Naval Mine Warfare Area Stipulation will eliminate potential impacts from multiple-use conflicts on these blocks.

For exploration activities, the stipulation requires consultation with the Commander, Mine Warfare Command, prior to approval of any EP. Prior coordination will determine the compatibility of the proposed exploration operations with scheduled military operations and help mitigate potential impacts between surface structures and scheduled military activities.

For development activities, the stipulation requires that both sub-seafloor and above-seafloor development operations must be compatible with scheduled military operations. Consultation and coordination prior to approval of any DOCD will help mitigate potential impacts between development operations and military activities on these blocks.

2. Alternative B - The Proposed Actions Excluding the Blocks Near Biologically Sensitive Topographic Features

Alternative B would protect the biologically sensitive banks (topographic features) of the Western Gulf. The blocks that would be deleted under this alternative are the same blocks that are covered by the Topographic Features Stipulation (discussed in Section II.B.1.c.(1)).

a. Description

This alternative is equivalent to offering any of the proposed actions, except for excluding the 61 unleased blocks (Figures II-2, II-3, and II-4) of the total 200 blocks (these blocks are listed in Appendix A)

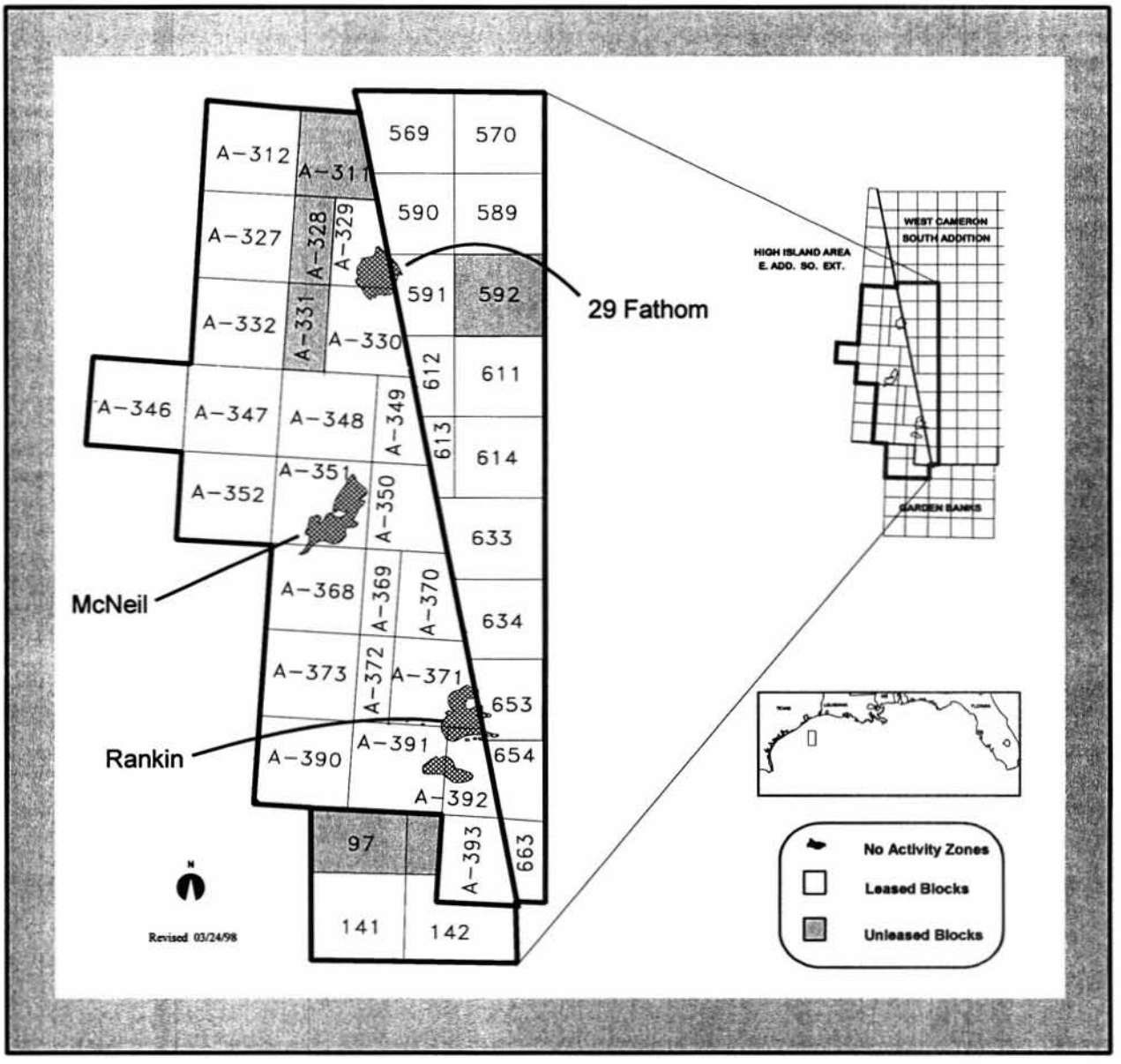


Figure II-2. Location and Lease Status of Blocks Affected by Alternative B (East Texas).

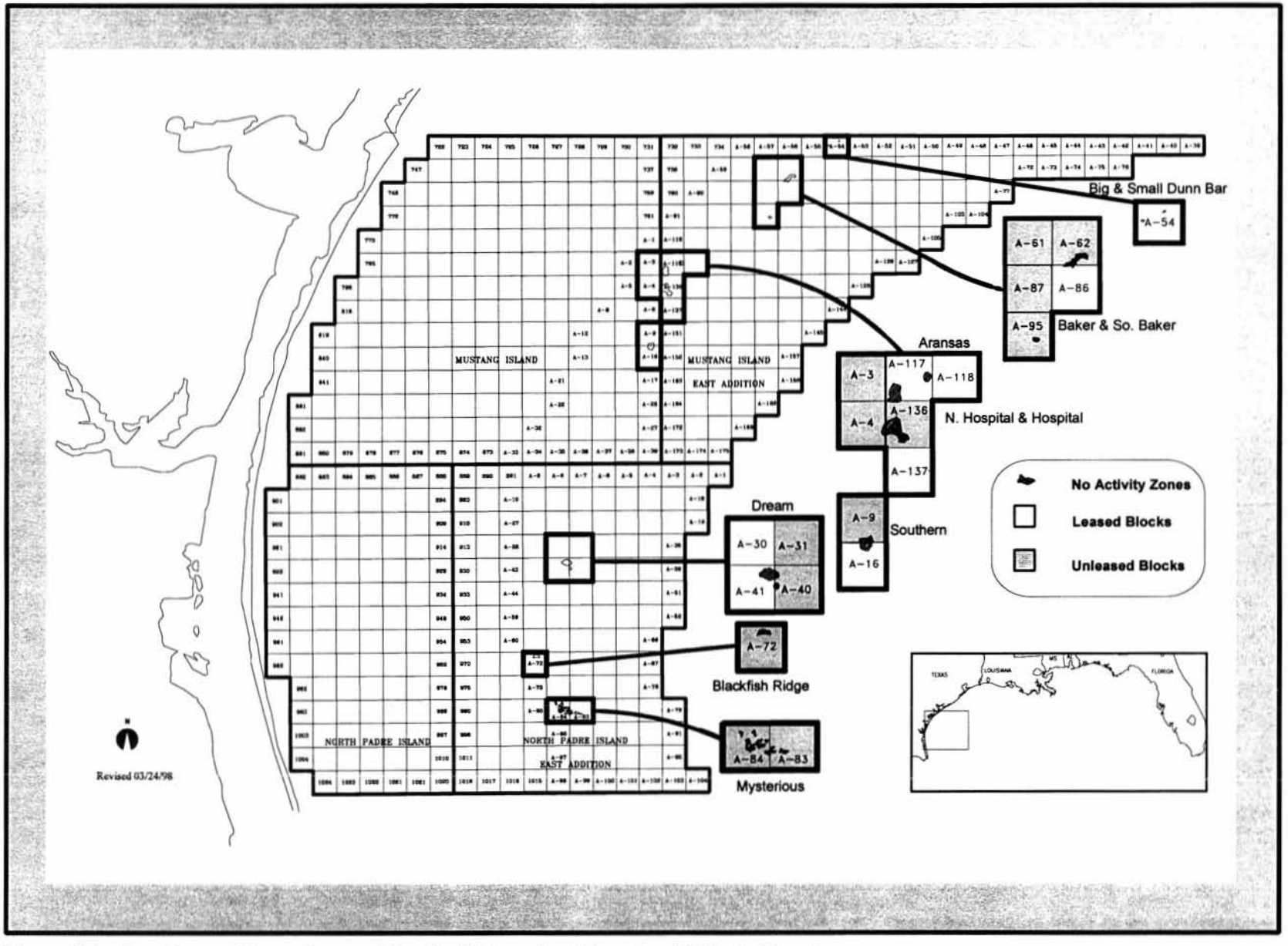


Figure II-3. Location and Lease Status of Blocks Affected by Alternative B (South Texas).

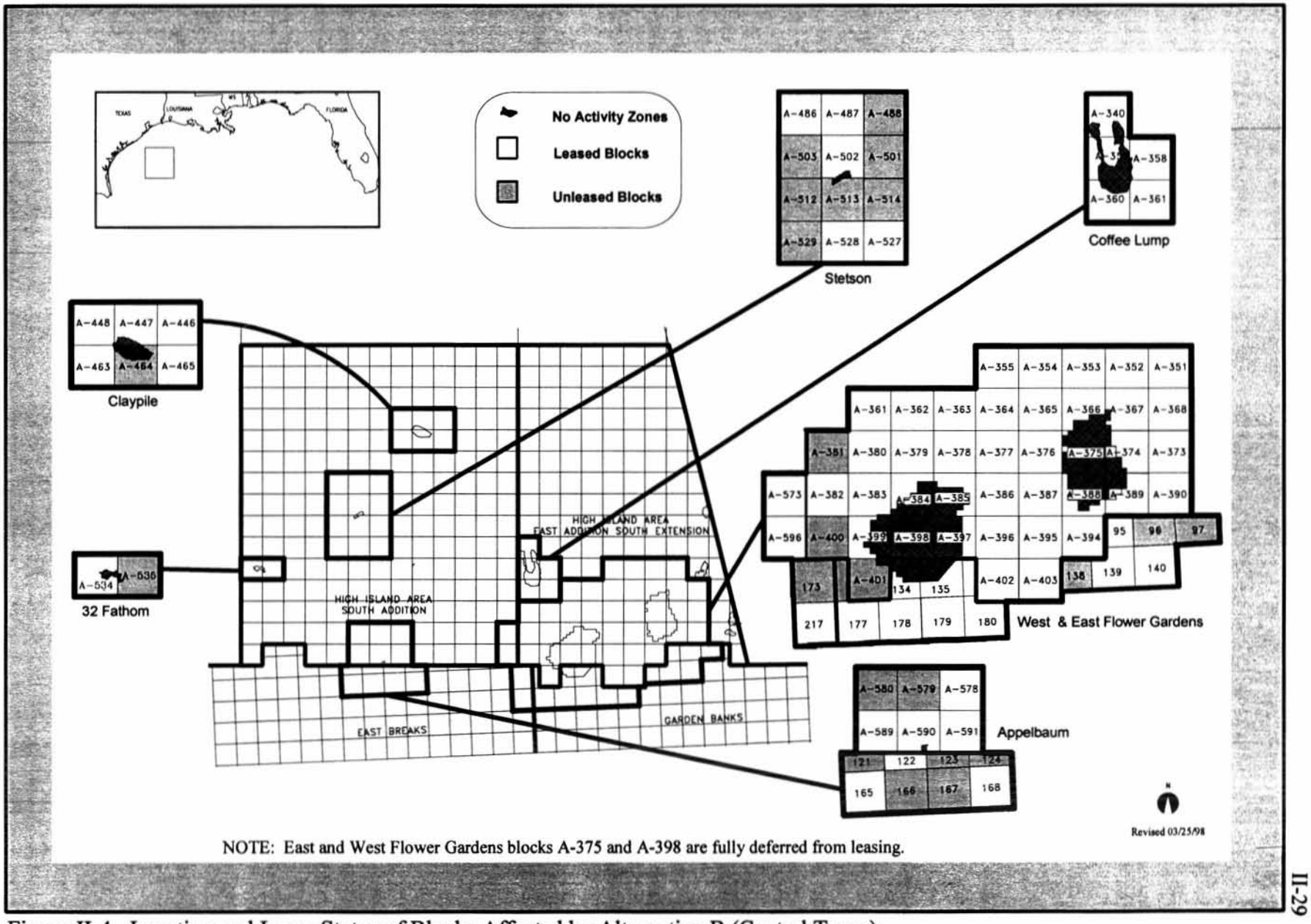


Figure II-4. Location and Lease Status of Blocks Affected by Alternative B (Central Texas).

assumed for the typical proposed action are discussed in Sections IV.A. and B. It is assumed that activity biologically sensitive areas of the topographic features of the WPA so that activities resulting from any of the proposed actions have a high probability of impacting these biota. These blocks represent about two percent of the blocks to be offered in the Western Gulf. It is estimated that each proposed lease sale could result in the production of 0.01-0.09 BBO and 0.57-1.93 tcf of gas; the Alternative B deletion would not change the resource estimate ranges.

The analyses of impacts summarized in this section and presented in detail in Section IV.D.1.b. are based on a development scenario, which is based on assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major related impact-producing factors is included in Sections IV.A. and B. Estimates of the major activities and associated impact-producing factors levels estimated for Alternative B will be the same as those estimated for any of the proposed actions.

b. Summary of Impacts

This alternative is offered for the Secretary's consideration to protect valuable offshore biological resources. It affects the biologically sensitive banks (topographic features) of the Western Gulf.

Given the size of the area available for lease under Alternative A (the proposed actions), it is reasonable to assume that the removal of this 2 percent of the area will not significantly change the projected level of activity (i.e., numbers of wells, platforms, vessel trips, etc.) projected under that alternative. The only difference between the potential impacts under Alternative A and those under Alternative B is that under Alternative B no activity will take place in the excluded areas. The assumption that the levels of activity for Alternative B are virtually identical to those projected for the proposed action(s) leads to the conclusion that the impacts expected to result will be very similar to those described under the proposed action(s) (Section IV.D.1.a.). The small areas that would not be offered under Alternative B contain comparatively small amounts, if any, of the other environmental resources analyzed in this document. Therefore, the regional impact levels for all resources are estimated to be identical to those described under the typical proposed action. However, there are some localized changes in the impacts as described below.

Topographic Features

Essentially, oil and gas operations within certain distance of topographic features are considered potential sources of impact to the biota of those features: blocks that fall within 4 nmi of the 100-m isobath of the East and West Flower Garden Banks; within 3 nmi of the 85-m isobath of the seven high-relief, shelf-edge banks of the Western Gulf (and five banks of the Central Gulf that are within 3 nmi of the Western Gulf); within 1,000 m of the seven low-relief South Texas banks; and within designated areas of the seven other low-relief banks. The biological resources of the topographic features are considered very sensitive to potential impacts due to oil and gas operations; however, topographic features in the Western Gulf are usually the surface expressions of salt domes, which are often associated with oil and gas reserves. The recovery of such reserves, the extent of which is unknown at this time, would be prevented by the adoption of this alternative. It is noted that 139 of the 200 blocks affected are already leased. This deletion alternative is presented in order to offer even greater protection to the biological resources inhabiting the crests of the topographic features.

This alternative, if adopted, would prevent any oil and gas activity whatsoever in the affected blocks (except for pipeline construction, which is regulated through the normal pipeline permitting procedures); thus, it would eliminate any impacts to the biota of the area from oil and gas activities, which otherwise would be conducted within the blocks. However, because of the operation of the proposed Topographic Features Stipulation, the impact to the topographic features will be essentially the same for both the proposed action and Alternative B.

Conclusion: Selection of Alternative B would preclude oil and gas operations in the unleased blocks (61 of 200) affected by the proposed Topographic Features Stipulation. Alternative B is expected to cause little to no damage to the physical integrity, species diversity, or biological productivity of the habitats of the topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for corals (in the case of the Flower Garden

Banks) and for much of the other adult biota. It is anticipated that recovery for such an event would occur within a period of 2 years.

Sea Turtles

Adult loggerhead, green, hawksbill, and Kemp's ridley sea turtles are unlikely to occur in the proposed deletion area because the topographic features in the WPA are at depths in excess of 85 m, which is near the lower limit of the benthic feeding habitat for these species. However, the pelagic stages of all sea turtles could occur in the vicinity of any of these areas. Sea turtles could be impacted by oil and gas activities in this area by contact with or ingestion of oil, collision with vessels, entanglement in or ingestion of debris generated from platforms, or physical/acoustic disturbances (drilling, and structure placement and removal). Not offering this area would eliminate all impacts to sea turtles that would otherwise occur from proposed action-related oil and gas operations within the blocks not offered. If the area is not offered, impacts to sea turtles will not change from those of the proposed actions because of the comparatively low level of oil and gas activity proposed in the area.

Conclusion: Selection of Alternative B would eliminate potential impacts on sea turtles in or near the areas that would not be offered under this alternative. This slightly smaller number of blocks to be offered is not substantial enough to change the regional impacts on these resources as projected under any of the proposed actions. Sea turtles and their habitats are expected to experience some temporary disturbance, but deaths are expected to be rare.

3. Alternative C - No Action

a. Description

Alternative C is equivalent to cancellation of one or more sales scheduled for a specific timeframe in the approved *Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002* (USDOI, MMS, 1996a). Sales in the Western Gulf are scheduled on an annual basis. By canceling a proposed sale, the opportunity is postponed or foregone for development of the estimated 0.01-0.09 BBO and 0.57-1.93 tcf of gas that could have resulted from any of the proposed sales in the Western Gulf.

b. Summary of Impacts

If Alternative C is selected, all impacts, positive and negative, associated with any of the proposed actions would be canceled. This alternative would therefore result in no effect on the sensitive resources and activities discussed in Section IV.D.1.a. The incremental contribution of any of the proposed actions to cumulative effects would also be foregone, but effects from other activities, including other OCS sales, would remain. Oil-spill risk could increase due to the importation of foreign oil to replace the resources lost through cancellation of any of the proposed actions.

Strategies that could provide replacement resources for lost domestic OCS oil and gas production include a combination of energy conservation; onshore domestic oil and gas supplies; alternative energy sources; and imports of oil, natural gas, and liquefied natural gas. Market forces are assumed to be the predominant factor in determining substitutes for OCS oil and gas. Based on this, increased imports of foreign oil are assumed to be the largest replacement source. Much of this imported oil would enter the United States through the Gulf of Mexico, thus increasing the risks due to tanker spills. This is thoroughly analyzed in the Final EIS for the *Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002*.

SECTION III

DESCRIPTION OF THE AFFECTED ENVIRONMENT

III

III. DESCRIPTION OF THE AFFECTED ENVIRONMENT

A. PHYSICAL ELEMENTS OF THE ENVIRONMENT

1. Geology

General Description

The present day Gulf of Mexico is a small ocean basin of more than 1.5 million km^2 with the greatest water depth 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 Florida and 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.

There are two major sedimentary provinces in the Gulf. 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. In the Eastern Gulf carbonate (limestone) province, fewer wells have been drilled and less is known about the subsurface geology.

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, of which 810 were being developed or producing as of 1993.

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. Encounters offshore Mississippi, Alabama, and Florida are from Jurassic Age formations. 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. Potential hazards associated with H_2S are discussed in Section IV.A.3.i.

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.

Non-energy Mineral Resources

Potentially commercially exploitable mineral resources identified in the Gulf of Mexico include phosphate, sulphur, salt, oyster-shell, limestone, sand and gravel, and magnesium. Offshore sand deposits may provide material for coastal restoration, protection against accelerating rates of wetland loss, and beach replenishment.

2. 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 Gulf of Mexico is located to the southwest of this center of circulation. This proximity to the high-pressure system results in a predominantly southeasterly flow in the western Gulf of Mexico region. Two important classes of cyclonic storms are occasionally superimposed on this circulation pattern. During the winter months, 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. Tropical cyclones may develop or migrate into the Gulf of Mexico during the warmer months. 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 very little diurnal or seasonal variation.

Selected climatological data for a few Gulf coastal locations can be found in Table III-1.

Pressure, Temperature, and Relative Humidity

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

Average air temperatures at coastal locations vary with latitude and exposure. Air temperatures range from highs in the summer of 24.7-28.0°C to lows in the winter of 2.1-21.7°C. Winter temperatures depend on the frequency and intensity of penetration by polar air masses from the north. Air temperatures over the open Gulf exhibit narrower limits of variations on a daily and seasonal basis due to the moderating effect of the large bodies of water. The average temperature over the center of the Gulf is about 29°C in the summer and between 17 and 23°C in the winter.

The relative humidity over the Gulf 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 when prevailing southerly winds bring in warm, moist air.

Table III-1

Climatological Data for Selected Gulf Coast Locations

Location	Precipitation (annual average, meters)	Temperature (mean annual, °C)	Wind Speed (average annual mean, m/sec)	Humidity (average percent)	Barometric Pressure (average annual, millibars)	Stability Conditions Annual Percent		
						Unstable	Neutral	Stable
Corpus Christi, Tex.	0.77	21.7	5.4	89	1,014	11.0	61.0	28.0
Galveston, Tex.	1.07	20.9	4.9	83	1,015	16.0	61.4	22.6
Lake Charles, La.	1.35	19.9	3.9	90	1,016	23.0	44.0	33.0
Gulfport, Miss.	1.50	20.0	3.6	85	1,016	17.5	47.4	35.1
Pensacola, Fla.	1.55	19.9	3.7	85	1,013	18.0	22.0	60.0
Key West, Fla.	1.01	25.3	5.0	79	1,014	80.0	18.0	2.0

Sources: USDOC, NOAA, 1961-1986.

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 position of the Bermuda High generates predominantly southeasterly winds, which become more southerly in the northern Gulf. Winter winds usually blow from easterly directions with fewer southerlies but more northerlies.

Precipitation and Visibility

Precipitation is frequent and abundant throughout the year but does show distinct seasonal variation. Stations along the entire coast record the highest precipitation values 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). The month of maximum rainfall for most locations is July. 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. Snowfalls are rare, and when frozen precipitation does occur, it usually melts on contact with the ground. Incidence of frozen precipitation decreases with distance offshore and rapidly reaches zero.

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 due to offshore fog. 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 lowest visibility. Industrial pollution and agricultural burning also impact visibilities.

Atmospheric Stability and Mixing Height

The mixing height is very important because it determines the volume available for dispersing pollutants. Because the mixing height is directly related to vertical mixing in the atmosphere, a mixed layer is expected to occur under neutral and unstable atmospheric conditions. The mixing height does not exist under stable atmospheric conditions. The mixing height tends to be lower in winter, and daily changes are smaller than in summer.

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 near the southern tip of Florida to 4.2 over central Louisiana (USDOI, MMS, 1988). The ongoing MMS LATEX study contains an element to investigate the generation of extratropical storms in the Gulf.

The frequency of cold fronts in the Gulf exhibits similar patterns during the four-month period of December through March. During this time the area of frontal influence reaches 10°N. Frontal frequency is about nine fronts per month (1 front every 3 days on the average) in February 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.

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). The Saffir-Simpson scale definitions and a listing of the most damaging hurricanes in the Gulf can be found in Table III-2.

3. Air Quality

The Clean Air Act established the National Ambient Air Quality Standards (NAAQS); the primary standards are to protect public health and the secondary standards are to protect public welfare. New NAAQS for ozone and particulate matter took effect on September 16, 1997. The current NAAQS (40 CFR 50.12 and 62 FR 138, 7/18/97) are shown in Table III-3. The Clean Air Act Amendments of 1990 established classification designations based on regional monitored levels of ambient air quality. These designations impose mandated time tables and other requirements necessary for attaining and maintaining healthful air quality in the U.S. based on the seriousness of the regional air quality problem.

When measured concentrations of regulated pollutants exceed standards established by the NAAQS, an area may be designated as a nonattainment area for a regulated pollutant. The number of exceedances and the concentrations determine the nonattainment classification of an area. There are five classifications of nonattainment status: marginal, moderate, serious, severe, and extreme (Clean Air Act Amendments, 1990).

Unclassified areas may either be nonattainment or attainment, but cannot be classified due to the lack of representativeness of air quality data in these areas. Figure III-1 presents the air quality status in the Gulf Coast as of September 1, 1997. All air quality nonattainment areas reported in Figure III-1 are for ozone. No graphics depicting the boundaries (projected from historical data) of ozone areas of influence, areas at risk, or areas of violation along the U.S. Gulf of Mexico coast were available at the time of publishing this EIS. It is expected that the areas of violation of the new 8-hour ozone NAAQS will increase from the areas under the old 1-hour standard.

Pollutant levels in coastal areas of Texas are reported in the *Air Monitoring Report, 1991* (Texas Air Control Board, 1994). The pollutants monitored were nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur dioxide (SO_2), particulate matter (PM_{10}), and ozone (O_3). The State of Texas is considered attainment for the pollutants SO_2 and NO_2. Exceedances of the national standards for CO and PM_{10} have only been measured in the interior of the state. Thus, there have been no exceedances of the NAAQS for SO_2, NO_2, CO, and PM_{10} in Texas coastal areas. The following Texas coastal counties are classified as nonattainment for ozone: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Victoria, Jefferson, Hardin, and Orange.

Measurements of pollutant concentrations in Louisiana are presented in the *Air Quality Data Annual Report, 1996* (Louisiana Dept. of Environmental Quality, 1996). Louisiana is considered to be in attainment of the NAAQS for CO, SO_2, NO_2, and PM_{10}. Four Louisiana coastal zone parishes have been tentatively designated nonattainment for ozone: Iberville, Ascension, Lafourche, and Livingston. Ozone measurements (Louisiana Dept. of Environmental Quality, written communication, 1997) between 1989 and 1997 show that the number of days exceeding the national standards are declining.

Air quality data for 1993 was obtained from the Alabama Department of Environmental Management for PM_{10}, NO_2, and O_3. The data shows that Mobile County is in attainment of the NAAQS for all criteria pollutants.

Table III-2

Summary of the Most Damaging Hurricanes in the Gulf of Mexico

Hurricane	Year	Category[1]	Damage[2] (million $)	Deaths
Tex.	1900	4	NA	6,000+
Miss./Ala./Pensacola, Fla.	1906	3	NA	134
Southeast Fla.	1906	2	NA	164
La.	1909	4	NA	350
Tex.	1909	3	NA	41
La.	1915	4	NA	275
North Tex.	1915	4	1,177	275
Southwest La.	1918	3	NA	34
Fla. Keys	1919	4	NA	600-900
Fla.	1926	4	1,315	243
La.	1926	3	NA	25
Tex.	1932	4	NA	40
South Tex.	1933	3	NA	40
Southwest Fla.	1944	3	582	NA
Southeast Fla./La./Miss.	1947	4	707	51
Audrey (La./Tex.)	1957	4	696	390
Carla (Tex.)	1961	4	1,926	46
Hilda (La.)	1964	3	578	38
Betsy (Fla./La.)	1965	3	6,461	75
Beulah (Tex.)	1967	3	844	NA
Camille (Miss./Ala.)	1969	5	5,242	256
Celia (Tex.)	1970	3	1,560	NA
Eloise (Fla.)	1975	3	1,081	NA
Claudette (Tex.)	1979	T.S.	609	NA
Frederic (Ala./Miss.)	1979	3	3,502	NA
Allen (Tex.)	1980	3	410	NA
Alicia (Tex.)	1983	3	2,391	NA
Elena (Miss./Ala./La.)	1985	3	1,392	NA
Juan (La.)	1985	1	1,671	NA
Allison (Tex.)	1989	T.S.	511	NA
Andrew	1992	4	NA	NA

[1] Storm Category represents the Saffir/Simpson Scale
Category 1 = winds of 74-95 mph
Category 2 = winds of 96-110 mph
Category 3 = winds of 111-130 mph
Category 4 = winds of 131-155 mph
Category 5 = winds greater than 155 mph

[2] Damage in adjusted 1990 U.S. dollars.

T.S. = tropical storm.
NA= Data not available.

Source: Modified from Herbert et al., 1992.

Table III-3

National Ambient Air Quality Standards (NAAQS)

Source: 40 CFR 50, 1997

Pollutant	Averaging Period	Primary Standards[a]	Secondary Standards[b]
Ozone	1-hour [c d]	0.12 ppm (235 $\mu g/m^3$)	(same as primary)
	8-hour [e f]	0.08 ppm (157 $\mu g/m3$)	(same as primary)
Sulphur Dioxide	Annual	0.03 ppm (80 $\mu g/m^3$)	NA
	24-hour	0.14 ppm (365 $\mu g/m^3$)	NA
	3-hour [d]	-	1,300 $\mu g/m^3$
Carbon Monoxide	8-hour [d]	9.0 ppm (10 mg/m^3)	NA
	1-hour [d]	35 ppm (40 mg/m^3)	NA
Nitrogen Dioxide	Annual	0.053 ppm (100 $\mu g/m^3$)	(same as primary)
Suspended Particulate Matter (PM_{10})	Annual	50 $\mu g/m^3$	(same as primary)
	24-hour	150 $\mu g/m^3$ [g]	(same as primary)
$PM_{2.5}$[e]	Annual	15 $\mu g/m^3$ [h]	(same as primary)
	24-hour	65 $\mu g/m^3$ [I]	(same as primary)
Lead	Calendar Quarter	1.5 $\mu g/m^3$	(same as primary)

[a] The levels of air quality necessary, with an adequate margin of safety to protect the public health.
[b] The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.
[c] The 1-hour standard for ozone is being phased out after 9/16/97.
[d] Not to be exceeded more than once a year.
[e] New standard effective 9/16/97.
[f] Three-year average of the annual fourth-highest daily maximum 8- hour average for each monitor.
[g] Based on the 99th percentile of 24-hour PM_{10} concentration at each monitor.
[h] Based on 3-year average of annual arithmetic mean concentrations.
[I] Based on 3-year average of 98th percentile of 24-hour concentrations.
Note: mg/m^3 = milligrams per cubic meter = 1,000 $\mu g/m^{-3}$ and $\mu g/m^3$ = micrograms per cubic meter.

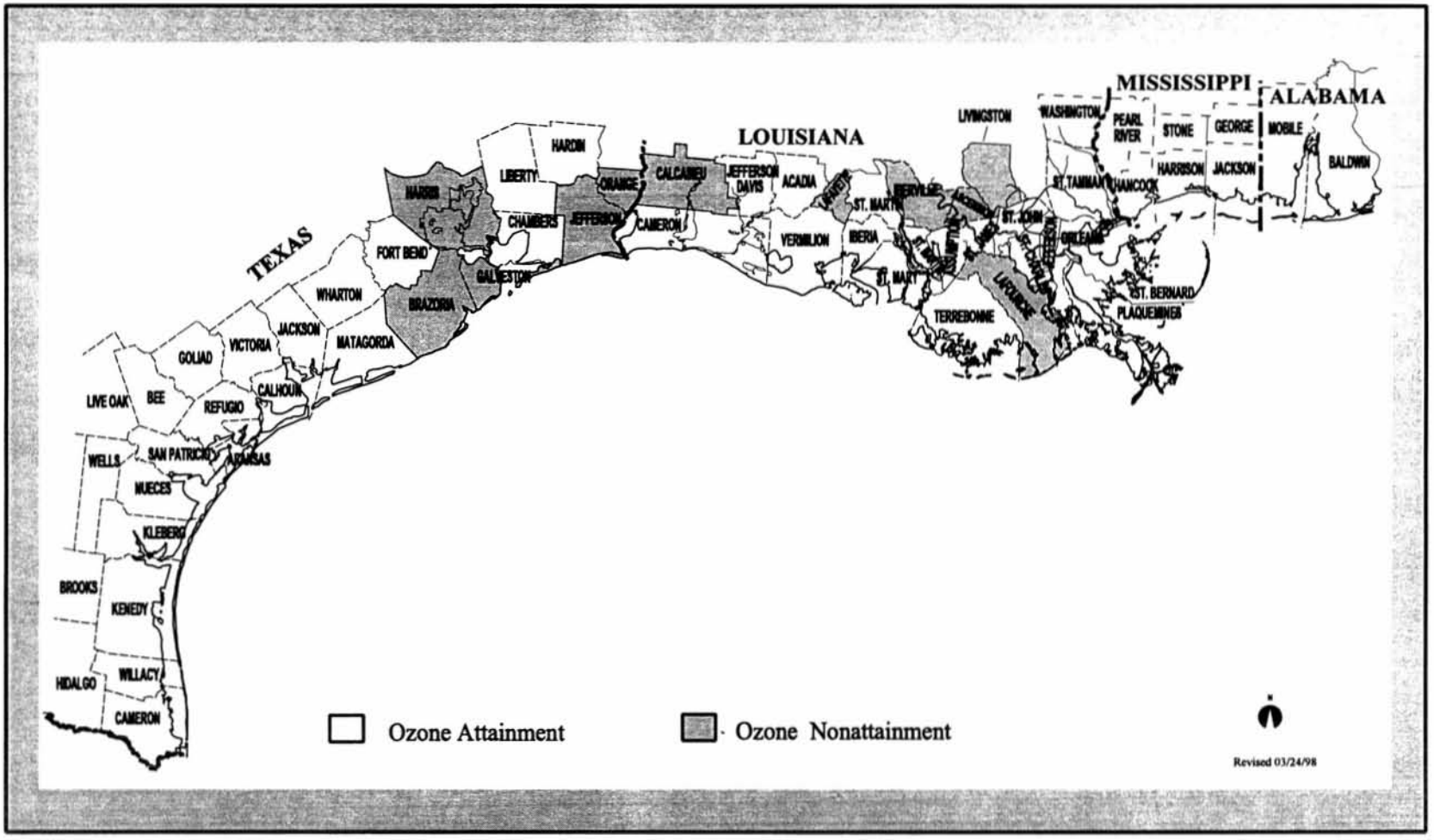


Figure III-1. Status of Ozone Attainment in the Coastal Counties and Parishes of the Gulf of Mexico as of September 1, 1997.

Ambient air quality is a function of the size, distribution, and activities directly related with population in association with the resulting economic development, transportation, and energy policies of the region. Meteorological conditions and topography may confine, disperse, or distribute air pollutants. Assessments of air quality depend on multiple variables such as the quantity of emissions, dispersion rates, distances from receptors, and local meteorology. Due to the variable nature of these independent factors, ambient air quality is an ever-changing dynamic process.

4. 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 U.S. coastline is about 350 km offshore West Florida, 16 km off the Mississippi River, and 156 km off Galveston, Texas, 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°C) in August to a sharp horizontal gradient in January, ranging from 25°C in the Loop core to 14-15°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°C) grading into surrounding waters of 15-16°C along the slope. The entire pattern is maintained during winter, but warmer by about 1°C. At 1,000 m water depth, the temperature remains close to 5°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°-28°N and 93°-96°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°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.

5. Water Quality

a. Coastal Waters

The primary activities occurring along the Gulf Coast that have contributed to or are contributing to the degradation of coastal waters conditions include petrochemical industry operations, hazardous and oil-field wastes disposal operations, agricultural and livestock farming, power plant operations, pulp and paper manufacturing, fish processing, commercial and recreational fisheries, municipal wastewater treatment, maritime shipping, hydrological basin modifications, and urbanization. The petrochemical industry along the Gulf Coast is the largest in the United States. This industry includes extensive onshore and offshore oil and gas development operations, tanker and barge transport of both imported and domestic petroleum into the Gulf region, and petrochemical refining and manufacturing operations.

The Gulf of Mexico coastal area has more point sources of contaminants than any other region in the country--more than 3,700 sites according to one assessment (Weber et al., 1992). Point sources contribute contaminants through discharges and accidental releases. More than half of the 3,700 sites identified were industrial facilities. About 460 of the 3,700 point sources were discharging directly into the waters of the Gulf or its estuaries. Of these 460 sites, 113 were municipalities discharging more than a billion gallons (more than 3.8 billion liters) a day of sewage effluent into Gulf coastal waters (Weber et al., 1992). Of the remaining point-sources discharging directly into Gulf coastal waters, 192 were in Texas, 79 in Louisiana, 30 in Mississippi, 29 in Alabama, and 17 in Florida. Most are petroleum refineries and petrochemical plants. The Houston Ship Channel is heavily impacted by point sources from both municipal and industrial facilities, especially oil, steel, and petrochemical industries, receiving waste waters from approximately 400 point-source discharges (Crocker and Koska, 1996).

Vessel traffic is another major source of contamination to Gulf waters. Ship-generated wastes include episodic bilge and ballast waters, sanitary and domestic wastes, trash and debris, spills, and leaching of tributyltin from ship hulls. Of the 10 busiest ports in the United States, four are located on the Gulf Coast. The Houston Ship Channel is the third leading shipping terminal in the U.S. In 1995, approximately 136,000 vessels came and went through the Houston Channel. Almost as many vessels (126,000 vessel trips) used the Gulf Intracoastal Waterway System from Sabine Pass to the Mexican Border (USCOE, 1996). Besides commercial shipping, the Gulf has the largest commercial fishing industry in the United States and a large recreational boating industry.

Despite such significant point sources, nonpoint sources have had the greatest impact on the Gulf's coastal water quality. Nonpoint pollutant sources include agriculture, forestry, urban runoff, marinas, recreational boating, and hydromodification. Waterways draining into the Gulf transport wastes from 75 percent of U.S. farms and ranches, 80 percent of U.S. cropland, hundreds of cities, and thousands of industries not in the Gulf's coastal zone. Urban and agricultural runoff contribute large quantities of pesticides, nutrients, and fecal coliform bacteria.

More than 10 million pounds (about 4.5 thousand metric tons) of pesticides were applied within the Gulf of Mexico coastal area in 1987, making it the top user of pesticides in the country (USDOC, NOAA, 1992a). The Gulf of Mexico ranked highest in the use of herbicides (6.6 million pounds (3,000 metric tons)) and fungicides, and a close second in the use of insecticides. The Lower Laguna Madre and Matagorda Bay in Texas and the Atchafalaya/Vermilion Bays in Louisiana ranked in the top 10 estuarine drainage areas in the U.S. for carrying pesticides to coastal waters. Although ranking high based on total input volume, when NOAA normalized pesticide use for risk to estuarine organisms (USDOC, NOAA, 1992a), the Gulf fared better; Tampa Bay and the Lower Laguna Madre were the only two drainage basins in the top 10.

Hydrodynamic modification, which includes channelization, wetland dredge and fill modifications, and natural subsidence, is also strongly altering the Gulf's coastal water quality. These activities result in sediment deficit and saltwater intrusion, particularly in the Louisiana coastal area. Saltwater intrusion is the inland movement of offshore saline waters into more brackish and fresh waters. In 1993, about 38.28 million m^3 of material were dredged from navigation channels in Texas. Most material dredged from the extensive navigation channel network is dumped at the 39 dredged-material disposal sites found offshore along the Gulf of Mexico coastline (Visual 1); 13 of these sites are offshore of Texas. An average of 43.6 million m^3 of sediments was disposed of at the 39 sites annually, for the period between 1976 and 1995. Dredged material disposed of in coastal waters results in temporarily increased turbidity and resuspension of released sediment contaminants.

An excess of nutrients, primarily found in river runoff, is one of the greatest sources of contamination to Gulf coastal waters. Nutrient overenrichment can lead to noxious algal blooms, decreased seagrasses, fish kills, and oxygen-depletion events. Nitrogen and phosphorus loadings in the Mississippi River and Gulf coastal waters have risen dramatically over the last three decades (Rabalais, 1992). The Nutrient Enrichment Subcommittee of the Gulf of Mexico Program estimated that more than 379,000 pounds (about 172 metric tons) of phosphorus and more than 1.87 million pounds (about 848 metric tons) of Kjeldahl nitrogen are discharged into the Gulf on an average day, with 90 percent of both elements coming from the Mississippi River system (Lovejoy, 1992). Nutrient overenrichment has been a particular problem for the Lower and Upper Laguna Madre in Texas; Lake Pontchartrain, the Mississippi River, and Barataria Bay in Louisiana; Mississippi Sound, Pascagoula Bay, and Biloxi Bay in Mississippi; and Perdido, Pensacola, Choctawhatchee, and St. Andrews Bays in Florida (Rabalais, 1992). Although Galveston Bay is at least as susceptible to problems as other bay systems suffering from nutrient overenrichment, the open bay experiences few algae blooms, episodes of dissolved oxygen depletion, or fish kills (Shipley, 1995).

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 (three in Galveston County, one in Harris County, and one in Chambers County) (USDOC, NOAA, 1992b). Because oysters are bottom-dwelling filter feeders, they concentrate pollutants and pathogens. The oyster industry is a good indicator of impacts from septic tank runoff pollution. Most of the productive oyster reefs in Gulf estuaries are in conditionally approved areas or areas where shellfish harvesting is affected by predictable levels of pollution. In the late fall of 1993 and again in 1994, outbreaks of viral gastroenteritis in humans associated with the consumption of oysters contaminated with fecal material occurred in every state along the Gulf.

Since its creation in 1984, the National Oceanic and Atmospheric Administration's (NOAA) National Status and Trends Program (NST) has monitored the concentrations of synthetic chlorinated compounds such as DDT, chlordane, polychlorinated biphenyls (PCB's), tributyltin, polynuclear aromatic hydrocarbons (PAH's), and trace metals in bottom-feeding fish, shellfish, and sediments at coastal and estuarine sites along the Gulf of Mexico (USDOC, NOAA, 1992c; O'Connor and Beliaeff, 1995). Other similar monitoring programs have been established in the Gulf, such as the USEPA Environmental Monitoring and Assessment Program and the Galveston National Estuary Program. Sites were randomly selected to represent general conditions of estuaries and nearshore waters away from waste discharge points. Eighty-nine sites were sampled along the Gulf Coast in NOAA's program and were compared with more than 300 sites found throughout the U.S. coastal areas. Chemical concentrations exceeding natural levels are considered contamination. NOAA defines "high" levels of a compound class as when the logarithmic value is more than the mean plus one standard deviation of the logarithm. The following summarizes NOAA's findings for both sediments and shellfish.

Contaminants were measured in mussels and oysters taken from Gulf coastal waters from 1986 to 1993 as part of NOAA's National Mussel Watch Program. Nationally, the highest chemical contamination consistently occurs near urban areas. Fewer sites along the Gulf were contaminated than along other coastlines, probably because urban centers along the Gulf are farther inland than those along other coasts. Of the six U.S. urbanized areas showing highest levels of organic compound contamination in shellfish, Mobile, Alabama, was the only Gulf Coast site in this group. 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 in the Gulf--one in Texas, two in Louisiana, one in Mississippi, one in Alabama, and three in Florida. This implies that the source for the high levels of these compounds are continuing to contaminate these areas. Sites along the Western Gulf having oysters containing at least three compounds with "high" concentrations for at least half the years since 1990 include Galveston Bay, Brazos River, Matagorda, and Corpus Christi, Texas; Lake Pontchartrain, Lake Borgne, and

Breton Sound, Louisiana; Mobile Bay, Alabama; and 3 sites in Florida (O'Connor and Beliaeff, 1995). The highest concentrations of chlorinated hydrocarbons were observed at stations in Galveston, along the coast from Mississippi to northern Florida, and at Tampa Bay. Mercury was found to be very high in Matagorda Bay, Texas, which was probably related to a major discharge of this element in the area in the 1970's (USDOC, NOAA, 1992c).

Sediment data were also collected and examined (O'Connor, 1990). As in benthic samples, higher levels of sediment contamination were associated with highly populated areas, and, in general, sites in the Gulf of Mexico had lower concentrations of toxic contaminants than the rest of the country (sampling period from 1984 to 1988). Again the likely reason for this finding was that sampling sites in the Gulf of Mexico coastal area were away from urban areas, which are characterized as having large numbers of point-source discharges. The distribution of organochlorine loadings in sediments followed those observed in oysters (Texas A&M University, 1988). One study determined for each contaminant the 20 locations where that contaminant concentration were highest (USDOC, NOAA, 1992c). Texas and Mississippi each had 1 site, Louisiana and Alabama had none, and Florida had 17 sites. The Texas site ranked for total DDT. Sediments with chemical concentrations exceeding high levels were identified in Galveston Bay, Texas.

Also, as part of NOAA's Status and Trends Program, petroleum hydrocarbons were measured in Gulf of Mexico oyster and sediment samples. The results showed (1) total hydrocarbon concentrations were lower than hydrocarbon concentrations at east and west U.S. coast locations, probably because the sites in the Gulf are farther removed from large point sources, such as large cities and industrial areas; (2) chronic petroleum contamination is taking place, possibly from oil and gas operations along the Gulf of Mexico coastline, but also due to contamination of the discharge from the Mississippi River; and (3) water quality degradation from oil and gas operations is not taking place to such an extent to show marked increases over U.S. coastal areas that do not have as many oil operations.

Daskalakis and O'Connor (1994) examined data from six different electronic information systems maintained by USEPA and NOAA and evaluated the spatial distribution of sediment contamination. These datasets show that coastal waters of the Gulf of Mexico have more sites with high contaminant concentrations than do other coastal waters of the United States. This conclusion contradicts the findings drawn from the National Oceanic and Atmospheric Administration's NST database. Although the report does not explain this discrepancy, it does state that most of the six databases provide chemical concentrations that were measured near effluent discharge sites while the NST database provides chemical concentrations that were measured at randomly selected points along the Gulf Coast. Given that the Gulf of Mexico has the greatest number of waste discharge point sources, it is not surprising that the Gulf of Mexico would show a larger number of sites with "high" levels of contamination than do other regions.

b. Marine Waters

The chemical oceanography of the Gulf of Mexico is primarily influenced by its configuration and the large volumes of land runoff it receives. The Gulf of Mexico 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. Sea-surface salinities along the northern Gulf vary seasonally. During months of low freshwater input, salinities near the coastline range between 29 and 32 ppt. High freshwater input conditions during the spring and summer months result in strong horizontal salinity gradients with salinities less than 20 ppt on the inner shelf. The mixed layer in the open Gulf, extending to a depth of approximately 100-150 m, is characterized by salinities between 36.0 and 36.5 ppt (Barnard and Froelich, 1981). Dissolved oxygen values in the mixed layer average about 4.6 milliliters/liter (ml/l), with certain seasonal variations, particularly a slight lowering during the summer months, decreasing to about 3.5 ml/l with depth (Barnard and Froelich, 1981). Vertical profiles of temperature, salinity, oxygen, and phosphate identify five major water masses down to 1,000 m. The principal nutrients--phosphate, nitrate, and silicate--generally are depleted in the surface mixed layer. Phosphates range from 0 to 0.25 parts per million (ppm), averaging 0.021 ppm; silicates predominantly range from 0.048 to 1.9 ppm; and nitrates range from 0.0031 to 0.14 ppm, averaging 0.014 ppm.

Two types of unusual water masses can be found in the Gulf of Mexico: hypersaline basins and midshelf freshwater vents. Two basins containing hypersaline waters have been identified. Salinities are as high as 196 ppt at a small pool on the East Flower Garden topographic high and 250 ppt in the Orca Basin (Barnard

and Froelich, 1981; Addy and Behrens, 1980). The southwest Florida shelf contains a number of submarine freshwater springs found in association with extensive karst topography.

A common phenomenon in the Gulf, especially on the shelf, is the local presence of greatly elevated levels of suspended material (greater than one 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 at the promontories of significant topographic highs (Brooks et al., 1981).

The Louisiana-Texas Shelf Physical Oceanography Program (LATEX), funded by MMS, has just completed year three of LATEX A (Texas-Louisiana Shelf Circulation and Transport Processes Study). As part of this program, chemical components measured include salinity, nitrate, nitrite, phosphate, silicate, urea, ammonium, dissolved oxygen, phytoplankton pigments, and surface and bottom particulate matter concentrations. Only preliminary conclusions are available as of this writing.

The Mississippi River outflow has a significant effect on the chemistry and water quality of the Gulf of Mexico. 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 loadings measured on a significant area of the Gulf, there were also increased loadings of agricultural chemicals and sediments (Dowgiallo, 1994). The effects of the freshwater inflow into the Gulf of Mexico were detected not only in the northern Gulf but also in the Florida Keys and along the U.S. East Coast. A recently completed study funded by MMS provides further indications of the significance of the Mississippi River plume (Murray and Donley, 1996). Data collected during research trips in 1993 and 1994 show that the plume's characteristics of temperature and salinity are measurable over a broad area reaching to east of Galveston Bay. East of Galveston Bay, the distributions of these parameters are typical of regions receiving large amounts of freshwater, while westward distributions are typical of areas that receive low freshwater changes.

Degradation of the Gulf's marine waters is associated with coastal runoff and discharges, riverine inputs and, to a smaller extent, effluent discharges from offshore activities, primarily OCS oil and gas development and marine transportation. Not only do the river systems, particularly the Mississippi River, bring freshwater to the Gulf, they carry large volumes of contaminants from the extensive agricultural activities, hundreds of cities, and thousands of industries. The most apparent offshore water quality problems are floating debris, hypoxic or oxygen-depleted conditions, and toxic and pathogen contamination.

As of the end of 1995, approximately 5,000 production platforms have been installed in the Gulf with less than 1,000 subsequently removed, 32,000 wells have been drilled, and 208,350 km of pipeline installed. Although such activity seems extensive, the maritime industry's use of Gulf waters is even greater. Approximately 1.5 billion barrels (Bbbl) of crude oil was imported through Gulf waters by tanker in 1993, about five times the volume piped from domestic production. In addition, about 236 MMbbl of petroleum products was imported in Gulf waters and 175 MMbbl was exported. Although petroleum, both crude oil and petroleum products, is the most common commodity shipped through Gulf waters, vessel traffic associated with other commodities is extensive; the Gulf has four of the top 10 busiest ports in the United States. All of these offshore activities discharge some form of treated waste waters into the Gulf and have resulted in accidental spills of both oil and other chemicals.

Oxygen-depleted waters, or "hypoxic" waters, have been identified in a large area of the northern Gulf near the mouth of the Mississippi River. Often called the "dead zone," the areal extent of the oxygen-depleted waters has reached up to 16,500 km^2 of bottom waters on the inner continental shelf from the Mississippi River delta to the Texas coast, as far south as Freeport (Murray and Donley, 1996). Although primarily a summer phenomenon, the zone off the Mississippi River has been identified as early as February and as late as October and may affect more than the bottom waters. 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. The hypoxic conditions vary spatially and seasonally depending on the flow of the Mississippi River discharge and are affected by physical features such as water circulation patterns, saltwater and freshwater stratification, wind mixing, tropical storms, and thermal fronts (Meier, 1996). Efforts are underway, facilitated by the Gulf of Mexico program, to reduce the runoff and discharge of nutrients coming not only from the lower Mississippi River watershed, but also the upper Mississippi River and Ohio watersheds (Meier, 1996). Impacts to phytoplankton and benthic ecosystems are being documented. Benthic fauna studied within the area

exhibited a reduction in species richness, abundance, and biomass that was much more severe than has been documented in other hypoxia-affected areas (Rabalais et al., 1995).

Red tides are a natural phenomenon in the Gulf, primarily occurring in the Gulf off southwestern Florida and Mexico. However in 1996, there was a particularly widespread outbreak. Starting in May and spreading northwest from southwestern Florida, red tides were reported in Texas as well as Alabama, Mississippi, and Louisiana waters. Beaches were closed and oyster beds were shut down. The first documented case of a red tide in the Gulf occurred in 1972. Red tides are blooms of single-cell algae that produce potent toxins harmful to marine organisms and humans. They can result in severe economic and public health problems and are associated with fish kills and invertebrate mortalities. There are ongoing studies to determine whether human activity that increases nutrient loadings to Gulf waters contributes to the intensity of red tides. A summit of biologists, oceanographers, and marine scientists was held in November 1996 to discuss a research initiative by the NOAA to understand the natural phenomenon.

The Texas Brown Tide, caused by single-celled microalga, appeared during the winter of 1989-90 in the Laguna Madre in south Texas. Since then, the Texas Brown Tide alga has been a consistent and dominant feature in the Laguna Madre. No other algal bloom event on record has lasted as long. The Brown Tide has had negative impacts on the ecosystem of the Laguna Madre. A significant decrease in light penetration caused by the alga resulted in a loss of seagrasses. Both the zooplankton community and larval fish populations have declined (DeYoe, 1995).

Information on elevated levels of organic compounds of environmental concern that have been measured in northern Gulf offshore waters was summarized by Kennicutt et al. (1988). Volatile organic compounds (VOC's) were generally more focused in coastal and nearshore waters, were highest 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 (Section IV.C.4.). The highest levels of HMWHC were measured near point sources in coastal environments and near natural seeps. Large areas of the Gulf appear to be relatively pristine (off Florida and southern Texas) and other areas show significant contamination (northern Texas coast, Louisiana, and Alabama). Organochlorine residues appear to exist in many marine species. Higher concentrations of pollutants were generally found in organisms from the Mississippi Delta in comparison to offshore biota (Kennicutt et al., 1988).

B. BIOLOGICAL RESOURCES

1. Sensitive Coastal Environments

a. Coastal Barrier Beaches and Associated Dunes

Coastal barriers of the Western Planning Area of the Gulf of Mexico consist of relatively low land masses that can be divided into several interrelated environments. The beach consists of the foreshore and backshore. The nonvegetated foreshore slopes up from the ocean to the beach-berm crest. The backshore is found between the beach berm-crest and the dunes and may be sparsely vegetated. The backshore may occasionally be absent due to storm activity. The dune zone of a barrier landform can consist of a single dune ridge, several parallel dune ridges, or a number of curving dune lines that are stabilized by vegetation. These elongated, narrow landforms are composed of sand and other unconsolidated, predominantly coarse sediments that have been transported and deposited by waves, currents, storm surges, and winds.

Gulf waters elevated by storms can overwash a coastal barrier, creating overwash fans or terraces behind and between the dunes. With time, these terraces will be vegetated by opportunistic species. Along more stable barriers, the area behind the dunes consists of broad flats that support scrubby woody vegetation. Saline or freshwater ponds may be found among the dunes or on the landward flats. Landward, these flats may grade into wetlands and intertidal mud flats that fringe the shore of lagoons, islands, and embayments. In areas where no bay or lagoon separates barrier landforms from the mainland, the barrier vegetation grades into scrub or forest habitat of the mainland.

These habitats provide a variety of niches that support many avian, terrestrial, aquatic, and amphibian species, some of which are endangered or threatened. Habitat stability is primarily dependent upon rates of geodynamic change in each coastal vicinity. Changes to barrier landforms are primarily due to storms,

subsidence, delta abandonment, deltaic sedimentation, and human activity. Barrier landform configurations continually adjust in response to prevailing or changing environmental conditions.

Landform changes can be seasonal and cyclical, such as seen with the transitional movement of sand onshore during the summer and offshore during the winter, due to seasonal wave energy differences. Noncyclical changes in landforms can be progressive, causing landform movement landward, seaward, or laterally along the coast. Lateral movement of barrier landforms is of particular importance. As headlands and beaches erode, their sediments are transported offshore or laterally along the shoreline, extending sand spits that may encape marshes or previously open, although shallow Gulf waters. By separating inshore waters from Gulf waters and slowing the dispersal of freshwater to the Gulf, the movement of barrier landforms can contribute to the area and diversity of estuarine habitat available along a coast.

Accumulations and movements of sediments that make up barrier landforms are often described in terms of transgressive and regressive sequences. Although transgressive land forms dominate, both transgressive and regressive barriers occur in the Central Gulf of Mexico.

A transgressive sequence moves the shore landward allowing marine deposits to form on terrestrial sediments. Transgressive coastal landforms have a predominantly low-profile morphology and are characterized by narrow widths; low, sparsely vegetated and discontinuous dunes; and numerous, closely spaced, active washover channels. Transgressive barriers are usually being actively eroded. Landward retreat of a shoreline may be caused by subsidence, sea-level rise, storm erosion, or removal of sediment from the longshore drift by channels, groins, or jetties. The coastal retreat is not a steady process since passage and intensity of cold fronts and tropical storms do not occur at a steady rate (Williams et al., 1992).

A regressive sequence is one in which terrestrial sediments are deposited over marine deposits as the land builds out into the sea. Regressive barriers have high and broad dune morphologies. Such sand dunes are continuous and well-vegetated with few, if any, washover channels. These thick accumulations of sand form parallel accretion ridges. Seaward advance of a shoreline may be caused by geologic uplift or deltaic land-building processes, which transport sediments into coastal waters where they are deposited.

The increase or decrease of open-water areas of bays or sounds and their corresponding tidal prisms, as more fully described below under "Wetlands," also has a significant effect upon the deterioration or growth of barrier islands. While a tidal prism remains somewhat steady over a long period of time, typical tidal passes between the islands maintain a fairly constant cross-sectional area. When circumstances cause enlargement of the back bay areas or the expansion of tidal influence into previously non-tidal areas, the tidal prism correspondingly increases, as has been seen in deltaic Louisiana. In response, the tidal passes enlarge, generally at the expense of the flanking islands, to accommodate the additional flow. Compounding these circumstances, storms flush much greater volumes of water into and out of Western and Central Gulf bays than do tides, causing greater sudden increases in the cross-sectional areas of tidal passes than do astronomical tides.

Typically after a storm, waves and water currents move sand into the tidal inlets, reducing the inlet's cross-sectional area, returning the inlet cross-section to equilibrium with tidal pressures. The speed at which the passes are returned to tidal equilibrium largely depends upon the availability of sediments. Hence, tidal inlets with an inadequate sand supply, increased tidal prism, more frequent storms, or any combination of the three would cause larger, average cross-sectional areas of tidal passes (FitzGerald and FitzGerald, 1977; FitzGerald et al., 1984, 1985; Holder and Lugo-Fernandez, 1993; Howard, 1985; O'Brien, 1969.)

Obstructions to littoral sediment movements compound the problems of inadequate sand supply. Hard obstructions, such as jetties, groins, breakwaters, and bulkheads, cause localized accumulation of sediments and seaward shoreline building on their up-drift sides. Dredged channels obstruct littoral sediment movements by capturing sediments in the channel from where they cannot be easily moved by littoral currents and waves. Because sediments down-drift of the interruption do not stop moving and the accreting sediment is prevented from adequately replacing this departing sediment, interruptions of sediment drift cause or accelerate shoreline retreat down-drift of the obstruction.

From east to west, headlands found on the barrier coasts of the Western Gulf include the Chenier Plain of Louisiana and Texas, the Trinity River Delta, the Brazos-Colorado River Delta and accompanying barrier islands, the barrier islands of Espiritu Santo Bay and Laguna Madre, and the Rio Grande Delta. Headlands are important because they generally supply a significant portion of the sediment to the sediment drift and beaches. The Matagorda Peninsula is accretionary and formed as the Brazos-Colorado River Delta became transgressive and the sediments were reworked to form flanking arcs of barrier sand spits. The westward end of the peninsula was separated to form barrier islands when washover channels deepen to form permanent channels. Matagorda and San Jose Islands are accretionary with ridge and swale topography.

The eastern end of Matagorda Island is eroding as the littoral currents move sediments southwest along the shoreline.

b. Wetlands

Wetland habitat types occurring along the Western Gulf Coast include fresh, brackish, and saline marshes; and forested wetlands, including mangroves in the southern most regions. Coastal wetland habitats occur as narrow bands or broad expanses. They can support sharply delineated botanical zones of monotonous stands of a single species or mixed communities of plants.

The importance of coastal wetlands to the coastal environment has been well documented. 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 resident invertebrates, fish, reptiles, birds, and mammals, and are particularly important nursery grounds for many important fish and shellfish juveniles. The Louisiana coastal wetlands support over two-thirds of the Mississippi Flyway wintering waterfowl population, including 20-25 percent of North America's puddle duck population. The region supports the largest fur harvest in North America, producing 40-65 percent of the nation's total each year (Olds, 1984).

According to the U.S. Dept. of the Interior (Dahl, 1990), 9.4 percent of Texas (16,000,000 ac) was considered wetlands during the 1780's. By the 1980's, 4.4 percent of that state (7,612,000 ac) was considered wetlands. During the mid-1980's, 28 percent of Louisiana (8,784,000 ac), 14 percent of Mississippi (4,365 ac), and 8 percent of Alabama (2,651,000 ac) were considered wetlands.

The northeastern Texas coast, from the Louisiana boundary through the Bolivar Peninsula, is part of the Chenier Plain, which extends eastward to Atchafalaya Bay, Louisiana. The Chenier Plain is a series of shell and sand ridges, oriented parallel or oblique to the Gulf Coast. These ridges are sand dunes that were abandoned as sea level dropped during the last ice age. The ridges are separated by progradational mudflats that were accreted from sediments from the greater Mississippi River when localized hydrologic and sedimentation patterns favored deposition in the Chenier area.

Estuarine marshes in the rest of Texas largely occur as discontinuous bands around bays and lagoons, and on the inshore side of barrier islands. Salt marshes consisting primarily of smooth cordgrass occur at lower elevations and at higher salinities. Brackish marshes occur in less saline areas inland of salt marshes. Broad expanses of emergent wetland vegetation do not commonly occur south of Baffin Bay because of the arid climate and hypersaline waters. Dominant salt-marsh plants there include more salt-tolerant species such as *Batis maritima* and *Salicornia sp.* (White et al., 1986). Freshwater marshes in Texas occur primarily along the major rivers and tributaries. There are also sparse bands of black mangroves.

Subsidence and sea-level rise have caused changes in Texas during the past several decades. Open-water areas are appearing in wetlands along their seaward margins, while new wetlands are encroaching onto previously non-wetland habitat along the landward margin of wetland areas on the mainland, on the back side of barrier islands, and onto spoil banks. In addition, wetlands are being affected by human activities including canal dredging, impoundments, and accelerated subsidence caused by fluid withdrawals. The magnitude of these wetland acreage changes have not been determined at the present time.

Most of the Gulf's coastal wetlands are located in coastal Louisiana. There, they occur in two physiographic settings: the Mississippi River Deltaic Plain and the Chenier Plain. Wetlands on the deltaic plain are situated on a series of overlapping riverain deltas that have extended onto the continental shelf over the past 6,000 years. The alluvial and organically-rich sediments found there are subject to high, natural-subsidence and erosion rates. The effects of subsidence are compounded by sea-level rise (1 cm/yr, van Beek and Meyer-Arendt, 1982), both of which have been occurring during the past several millennia.

The deterioration of coastal wetlands is an issue of concern. Under favorable conditions, sedimentation encourages vertical accretion of wetlands and may offset the effects of subsidence and sea-level rise. Historically, wetlands were built in shallow areas that received flow from rivers. At the same time, areas located near inactive, abandoned channels where sedimentation no longer occurs tend to subside.

Several factors contribute to wetlands loss in coastal regions. The suspended-sediment loads of rivers have been reduced significantly since the 1950's, due to channelization and farmland soil conservation efforts. The primary cause of reduced sedimentation rates is levee construction. Levees exclude river-borne sediment from the flanking deltaic wetlands. Subsidence and sea-level rise have caused submergence of lower wetland areas. Construction of ring levees have allowed drainage and development of extensive wetlands. Development activities in low areas, outside leveed areas, have caused the filling of wetlands. Construction of canals converts wetlands to open water and upland spoilbanks. Canals and subsidence have

also contributed to increased tidal influence and salinities in freshwater and low-salinity wetlands, which in turn increase erosion and sediment export.

Seagrasses

Three million hectares of submerged seagrass beds are estimated to exist in exposed, shallow coastal waters of the northern Gulf of Mexico. An additional 166,000 ha are found in protected, natural embayments and are not considered exposed to OCS impacts. The area off Florida, in the Eastern Planning Area, contains approximately 98.5 percent of all coastal seagrasses in the northern Gulf of Mexico. Texas and Louisiana contain approximately 0.5 percent. Mississippi and Alabama have the remaining 1 percent of seagrass beds. Hence, seagrass beds are not dealt with in detail in this report.

Seagrass beds grow 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. Primarily because of low salinity and high turbidity, robust seagrass beds and the accompanying high diversity of marine species are found only within a few scattered, protected locations in the Central Gulf of Mexico. Inshore seagrasses provide important habitat for immature shrimp, black drum, spotted sea trout, juvenile southern flounder, and several other fish species; and they provide a food source for several species of wintering waterfowl.

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

Submerged vegetation dominates the aquatic floral habitat of low-salinity, inshore estuarine communities along the Texas coast. Dominant species include shoal grass and widgeon grass. The Laguna Madre and Copano-Aransas estuaries account for the major portion of submerged vegetation populations in Texas. Submerged vegetation is less common in Corpus Christi Bay due to greater water depth.

2. Sensitive Offshore Resources

"Sensitive offshore resources" refers to both water-column and seafloor biological resources. Seafloor (benthic) habitats, including live-bottom areas, deepwater benthic communities, and topographic features, are at risk of being adversely affected by offshore oil and gas operations; these sensitive benthic resources are primarily discussed in Sections III.B.2.a. and b. below.

The pelagic offshore water-column biota contains primary producers (phytoplankton and bacteria--90% of the phytoplankton in the northern Gulf of Mexico is constituted by diatoms), secondary producers (zooplankton), and consumers (larger marine species including fish, reptiles, cephalopods, crustaceans, and marine mammals). The zooplankton consists of holoplankton (organisms for which all life stages are spent in the water column, including protozoans, gelatinous zooplankton, copepods, chaetognaths, polychaetes, and euphausids) and meroplankton (mostly invertebrates and vertebrates organisms for which larval stages are spent in the water column, including polychaetes, echinoderms, gastropods, bivalves, and fish larvae and eggs). Planktonic primary producers drift with currents, whereas zooplankters move by swimming. The species diversity, standing crop, and primary productivity of offshore phytoplankton are known to fluctuate much less than their coastal counterparts as the offshore phytoplankton are less subject to changes of salinity, nutrient availability, vertical mixing, and zooplankton predation. In general, the diversity of pelagic planktonic species generally decreases with decreased salinity, and biomass decreases with distance from shore. The geographical and vertical ranges of plankters and consumers are limited by temperature, salinity, and nutrient availability. The fish species of the Gulf are temperate, with incursions of subtropical Caribbean faunas. Gulf fish species exhibit seasonal distribution and abundance fluctuations that are probably largely related to oceanographic conditions.

Another essential component of the offshore environment is the neuston, which is composed of organisms living at the air-seawater interface. Significant components of the neuston are copepods, floating *Sargassum* algae (also known as "*Sargassum* rafts"), and the organisms associated with the *Sargassum*. As many as 100 different animal species can be found in the floating *Sargassum* in the Gulf. These species include mostly hydroids and copepods, but also contain fish, crabs, gastropods, polychaetes, bryozoans, anemones, and sea-spiders. The majority of these organisms depend on the presence of the *Sargassum* algae.

Sargassum rafts potentially constitute long-term havens for young sea turtles, which drift with these floating ecosystems as they feed off their living organisms, possibly for several years.

Endangered and threatened species are described in Sections III.B.3.-6. below (marine mammals in Section III.B.3. and birds in Section III.B.6.), and fishes and fisheries are described in Sections III.B.7. and 8., and III.C.2. and 3.

Continental Shelf

Shelf phyto- and zooplankton are more abundant, more productive, and seasonally more variable than the deep Gulf plankton. This is related to salinity changes, greater nutrient availability, increased vertical mixing, and different zooplankton predation in the shelf environment.

The benthos of the shelf has both floral and faunal components; floral representatives include bacteria, algae, and seagrasses. The abundance of benthic algae is limited by the scarcity of suitable substrates and light penetration. In exceptionally clear waters, benthic algae, especially coralline red algae, are known to grow in water depths to at least 180 m. Rezak et al. (1983) recorded algae from submarine banks off Louisiana and Texas. Offshore seagrasses are not conspicuous in the Central and Western Gulf; however, fairly extensive beds may be found in estuarine areas behind the barrier islands throughout the Gulf. Seagrasses would be continuous around the entire periphery of the Gulf if it were not for the adverse effects of turbidity and low salinity of the Mississippi River effluent, which extends from the delta to Galveston (Humm, 1973).

Benthic fauna include infauna (animals that live in the substrate, including mostly burrowing worms, crustaceans, and mollusks) and epifauna (animals that live on or are attached to the substrate; mostly crustaceans, as well as echinoderms, mollusks, hydroids, sponges, and soft and hard corals. Shrimp and demersal fish are closely associated with the benthic community. Substrate is the single most important factor in the distribution of benthic fauna (densities of infaunal organisms increase with sediment particle size) (Defenbaugh, 1976), although temperature and salinity are also important in determining the extent of faunal distribution. Depth and distance from shore also influence the benthic faunal distribution (Defenbaugh, 1976). Lesser important factors include illumination, food availability, currents, tides, and wave shock. Indeed, the density of offshore infaunal organisms has been found to be greater during the spring and summer as compared to during the winter (Brooks, 1991).

In general, the vast majority of bottom substrate available to benthic communities in the Western and Central Gulf consists of soft, muddy bottoms; the benthos here is dominated by polychaetes. Topographic features are the benthic habitats on the continental shelf at most risk to potential impacts from oil and gas operations (Section III.B.2.b. below).

Continental Slope and Deep Sea

The continental slope is a transitional environment influenced by processes of both the shelf and the abyssal Gulf (> 975 m). This transitional character applies to both the pelagic and the benthic realms.

The deep-sea area (> 800 m) of the northern Gulf of Mexico is much less known than the shelf (< 150 m). Observed biotal differences in the deep ecosystem of the Gulf justify referring to the Western Gulf (which includes both the WPA and CPA) as the "true" Gulf and to the Eastern Gulf (which includes the EPA) as a divergence of the "Tropical Western Atlantic" (Pequegnat, 1983; LGL Ecological Research Associates, Inc. and Texas A&M University, 1986).

The highest values of surface primary production are found in the upwelling area north of the Yucatan Channel and in the DeSoto Canyon region. In general, the Western Gulf is more productive in the oceanic region than is the Eastern Gulf. It is generally assumed that all the phytoplankton is consumed by the zooplankton, except for brief periods during major plankton blooms. The zooplankton then egest a high percentage of their food intake as feces that sink toward the bottom. Most of the herbivorous zooplankters are copepods, calanoids being the dominant group (Pequegnat, 1983).

Compared to the shelf, there is less plankton on the slope and in deep Gulf. In addition, some of the planktonic species are specifically associated with either the slope or the deep sea. The biomass of plankton does not appear to be affected by seasonal changes. Some east-west variations noted among diatom species have been attributed to the effects of different water masses, i.e., normal Gulf waters versus those influenced by the Mississippi River (Pequegnat, 1983).

The topographic and physical oceanographic conditions at East Breaks in the Western Gulf support nutrient-rich upwelling, which may contribute to significant recreational billfishing in this area, as reported by the NMFS.

The 450-m isobath defines the truly deep-sea fauna. The aphotic zone at and beyond these depths (below the euphotic zone and extending to within a meter off the bottom) represents a huge mass of water. In these sunlight-deprived waters, photosynthesis cannot occur, and processes of food consumption, biological decomposition, and nutrient regeneration occur in cold and dark waters. The lowermost layer containing the last meter of water off the bottom and the bottom itself constitute the benthic zone. This zone is a repository of sediments where nutrient storage and regeneration take place in association with the solid and semisolid substrate (Pequegnat, 1983).

Most of the benthic fauna found on the deep slope and abyssal plain are endemic to those depths and have been grouped into seven faunal assemblages by Pequegnat (1983) and confirmed by LGL Ecological Research Associates, Inc. and Texas A&M University (1986):

> The Shelf/Slope Transition Zone (150-450 m) is a very productive part of the benthic environment. Demersal fish are dominant, many reaching their maximum populations in this zone. Asteroids, gastropods, and polychaetes are common.
>
> The Archibenthal Zone has two subzones. The Horizon A Assemblage is located between 475 and 750 m. Although less abundant, the demersal fish are a major constituent of the fauna, as are gastropods and polychaetes. Sea cucumbers are more numerous. The Horizon B Assemblage, located at 775-950 m, represents a major change in the number of species of demersal fish, asteroids, and echinoids, which reach maximum populations here. Gastropods and polychaetes are still numerous.
>
> The Upper Abyssal Zone is located between 975 and 2,250 m. Although the number of species of demersal fish drops, the number that reach maximum populations dramatically increases. This indicates a group uniquely adapted to the environment. Sea cucumbers exhibit a major increase, and gastropods and sponges reach their highest species numbers here.
>
> The Mesoabyssal Zone, Horizon C (2,275-2,700 m) exhibits a sharp faunal break. The number of species reaching maximum populations in the zone drops dramatically for all taxonomic groups.
>
> The Mesoabyssal Zone, Horizon D Assemblage, (2,725-3,200 m) coincides with the lower part of the steep continental slope in the Western Gulf. Since the Central Gulf is dominated at these depths by the Mississippi Trough and Mississippi Fan, the separation of Horizon C and D assemblages is not as distinct in the Central Gulf. The assemblages differ in species constitution.
>
> The Lower Abyssal Zone (3,225-3,850 m) is the deepest of the assemblages. Megafauna is depauperate. The zone contains an assemblage of benthic species not found elsewhere.

a. Deepwater Benthic 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 Gulf of Mexico. Initial discoveries of cold-water seep communities indicated that they are primarily associated with hydrocarbon and H_2S seep areas (Kennicutt and Gallaway, 1985; Brooks et al., 1986a). Although these communities are widespread across the northern Gulf of Mexico slope, they are sometimes found in very sparse concentrations of less than one animal per m^2 (Brooks et al., 1986b). The occurrence of chemosynthetic organisms dependent on hydrocarbon seepage has been documented in water depths as shallow as 290 m (Roberts et al., 1990), but the most dense aggregations of these organisms have been found at water depths of around 500 m and deeper. The best known of the dense communities was

named Bush Hill by the investigators who first described it. It is a surprisingly large and dense community of chemosynthetic tube worms and mussels at a site of natural petroleum and gas seepage over a salt diapir in Green Canyon Block 185. The seep site is a small knoll that rises about 40 m above the surrounding seafloor of about 540-m water depth.

Since the initial discovery in 1986 of chemosynthetic communities dependent on hydrocarbon seepage in the Gulf of Mexico, 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 (MacDonald, 1992). Four general community types have been described by MacDonald et al. (1990). These are communities dominated by vestimentiferan tube worms (*Lamellibrachia c.f. barhami* and *Escarpia* n.sp.), mytilid mussels (Seep Mytilid Ia, Ib, and III), vesicomyid clams (*Vesicomya cordata* and *Calyptogena ponderosa*), and infaunal lucinid or thyasirid clams (*Lucinoma* sp. and *Thyasira* sp.). 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.

In addition to higher organisms that support symbiotic bacteria, large mats of free-living bacteria are evident at hydrocarbon seep sites. Preliminary studies suggest that these white and orange mats on the seafloor are primarily *Beggiatoa* spp. in both pigmented and nonpigmented forms (MacDonald and Schroeder, 1993).

Chemosynthetic communities are distributed across a wide range of environmental conditions, but in all cases, their presence strongly indicates active localized seepage (MacDonald, 1992). Seepage from hydrocarbon seeps tends to be diffused through the overlying sediment, so the corresponding hydrocarbon seep communities tend to be larger than chemosynthetic communities found around the hydrothermal vents of the Eastern Pacific (MacDonald, 1992). Although precipitation of authigenic carbonates and other geologic events will undoubtedly alter surface seepage patterns, all preliminary evidence indicates that hydrocarbon seeps and the associated chemosynthetic communities persist in the same locations for long time periods (Powell, 1993). Through taphonomic studies and interpretation of seep assemblage composition from cores, Powell has estimated mussel communities persisting in the same sites for 2,000-4,000 years. A lucinid clam community was estimated persisting at a seep location for more than 3,500 years and a thyasirid clam bed was found to persist in a seep location for 500-1,000 years. Powell also found that both species' composition and trophic tiering of hydrocarbon seep communities tend to be fairly constant across time, with temporal variations only in numerical abundance. He found few cases in which the community type changed (from mussel to clam communities, for example) or had disappeared completely. He found one example of a catastrophic burial event (a mussel community in Green Canyon Block 234).

Initial evidence indicates that tube worm communities are relatively slow growing, with larger tube worms estimated to be over 200 years old (MacDonald, 1993). MacDonald found that juvenile mussels at hydrocarbon seeps initially grow rapidly, but the growth rate drops markedly in adults. Attempts to measure the growth rates in clams have been unsuccessful to date. Recolonization experiments of denuded seep communities indicate no visible recolonization of tube worm communities over the three-year period of the study, and no visible larval recruitment or adult immigration in disturbed mussel areas. MacDonald acknowledges that it would be difficult to rule out the possibility that the process of denuding the tube worm and mussel communities had altered the chemical environment at that location to the point of inhibiting recolonization.

Preliminary information has been presented by Carney (1993) concerning the nonchemosynthetic animals (heterotrophs) found in the vicinity of hydrocarbon seeps. Heterotrophic species at seep sites are a mixture of species unique to seeps and those that are a normal component from the surrounding environment.

To date, there are 43 sites (in 40 blocks) across the northern Gulf of Mexico continental slope where the presence of chemosynthetic metazoans (dependent on hydrocarbon seepage) have been definitively documented (MacDonald, 1992) (Figure III-2 and Table III-4). The locations of all chemosynthetic communities in the Gulf are not known and there is reason to believe that there are many more--perhaps hundreds. The depth limits of discoveries probably reflects the limits of exploraton (submersible diving to date). MacDonald (MacDonald and Schroeder, 1993) has analyzed remote-sensing images from space to reveal the presence of oil slicks across the northern Gulf of Mexico. Preliminary results indicate extensive natural oil seepage in the Gulf, especially in water depths greater than 1,000 m. This preliminary evidence considerably increases the area where chemosynthetic communities dependent on hydrocarbon seepage may be expected.

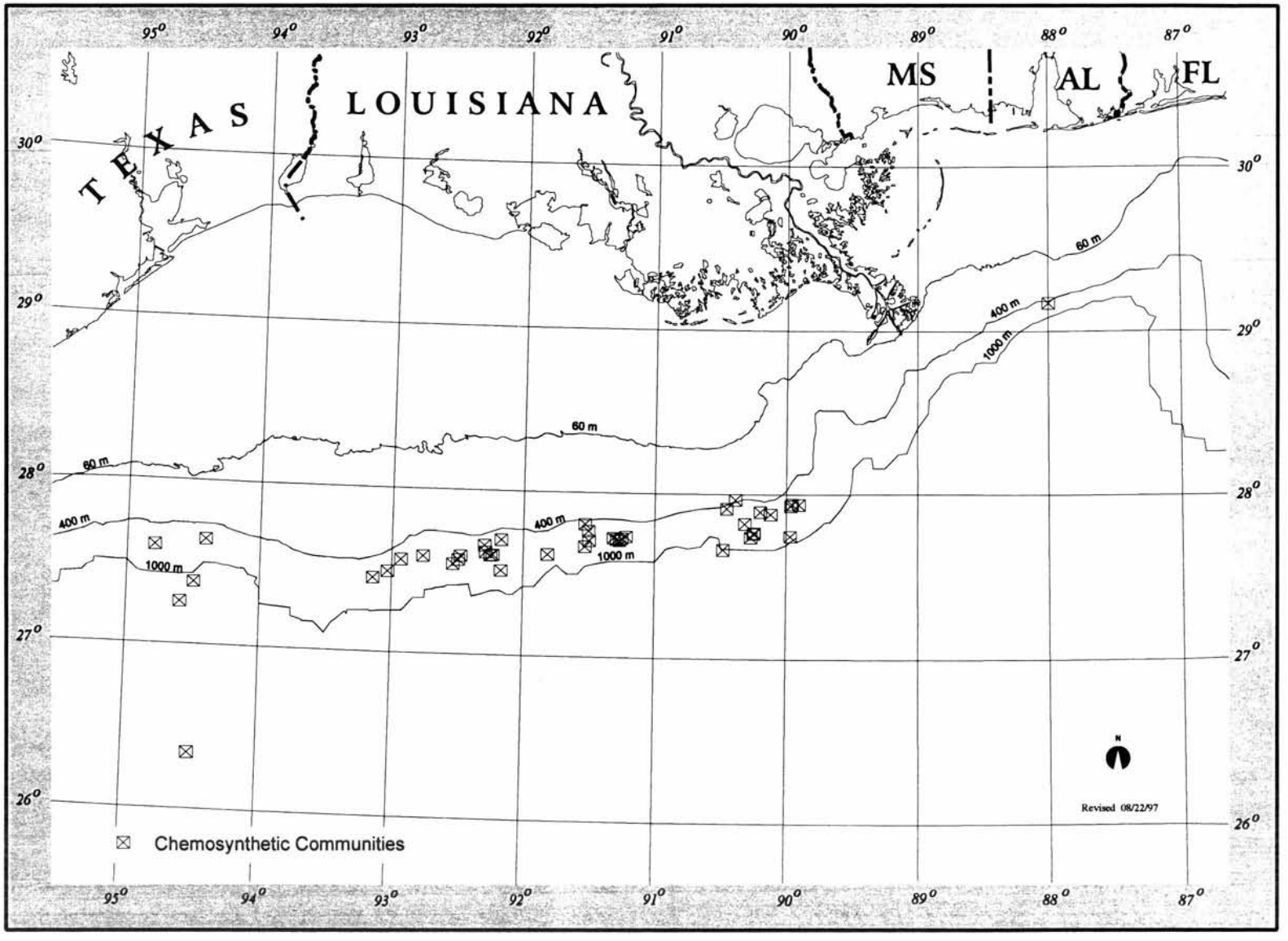


Figure III-2. Location of Known Chemosynthetic Communities in the Gulf of Mexico.

Table III-4

Location of Significant Chemosynthetic Communities in the Gulf of Mexico

Lease Area	Block Numbers
Alaminos Canyon	645
Ewing Bank	339, 375, 602, 731, 1001, 1010
Garden Banks	297, 300, 342, 376, 382, 386, 387, 416, 424, 425, 458, 476, 500
Green Canyon	30, 40, 79, 81, 121, 140, 166, 185, 210, 216, 229, 232-234, 272, 287, 293, 310
Mississippi Canyon	969
Viosca Knoll	826

Source: USDOI, MMS, 1996. Internal MMS databases, December 1996.

Chemosynthetic communities have been a source of controversy over the past few years, in part because of the unusual environmental requirements and the hypothesized sensitivity of the communities to oil and gas activities. Industry does not normally target the low-pressure zones that sustain chemosynthetic organisms. If industry did produce from reservoirs supporting chemosynthetic organisms, MMS believes it is unlikely that an operator could withdraw hydrocarbons to the extent that it would deplete the food supply of chemosynthetic organisms. One of the objectives of a study beginning in late 1997 will be to test the validity of this hypothesis. In addition, this multiyear study will examine the fragility of existing communities and ground-truth remote sensing to determine the existence of new communities. The MMS requires site-specific surveys (NTL 88-11) for proposed bottom-disturbing actions in water depths greater than 400 m in order to judge the potential of the region for supporting chemosynthetic organisms. These areas are subsequently protected from physical disturbance from anchors, pipelines, chains, and templates.

b. Topographic Features

The shelf and shelf edge of the Western and Central Gulf are characterized by topographic features that are inhabited by hard-bottom benthic communities (Figure III-3). The habitat created by the topographic features is important in several respects: they support hard-bottom communities of high biomass, high diversity, and high numbers of plant and animal species; they support, either as shelter or food, or both, large numbers of commercially and recreationally important fishes; they are unique to the extent that they are small, isolated areas of such communities in vast areas of much lower diversity; they provide a relatively pristine area suitable for scientific research (especially the East and West Flower Garden Banks); and they have an aesthetically attractive intrinsic value.

The benthic organisms on these features are mainly limited by temperature and light. Extreme water temperature and light intensity are known to stress corals. Temperatures lower than 16°C reduce coral growth, while temperatures in excess of 32°C will impede coral growth and induce coral bleaching (loss of symbiotic zooxanthellae). While intertidal corals are adapted to high light intensity, most corals become stressed when exposed to unusually high light levels. Furthermore, although corals will grow or survive under low light level conditions, they will do best while submerged in clear, nutrient-poor waters. Light penetration in the Gulf is limited by several factors including depth and events of prolonged turbidity. Hard substrates favorable to colonization by coral communities in the northern Gulf are found on outer shelf, high-relief features. These substrates are found above the nepheloid layer, are off the muddy seafloor, and are bathed most of the year in nutrient-poor waters. The Flower Garden Banks are examples of such suitable substrates. Horizontal Secchi disk water transparency over the coral reef has been estimated at 46 m during

Figure III-3. Location of Topographic Features in the Gulf of Mexico.

the summer, and water temperature ranged from 19 to 30°C, from 1990 to 1995, at a 20-m depth (Gittings, personal communication, 1996).

Rezak et al. (1983 and 1985) identified seven distinct biotic zones on the banks of the Gulf. None of the banks contain all of the seven zones. The zones are divided into the following four categories dependent upon the degree of reef-building activity in each zone.

Zones of Major Reef Building and Primary Production

Diploria-Montastraea-Porites Zone

This zone is characterized by 18 hermatypic coral species. The dominant species of the zone in order of dominance are *Montastraea franksi*, *Diploria strigosa*, *Montastraea cavernosa*, *Colpophyllia* spp., and *Porites asteroides*. Coralline algae are abundant, adding substantial amounts of calcium carbonate to the substrate. Leafy algae are sparse, probably due to grazing. Typical sport and commercial fish include grouper, hind, amberjack, barracuda, red and vermilion snapper, cottonwick, porgy, and creole fish. This high-diversity coral-reef zone is found only at the East and West Flower Garden Banks in water depths less than 36 m. Coral cover in this zone is estimated at 46 percent (Gittings et al., 1992a).

Madracis Zone and Leafy Algae Zone

The *Madracis* Zone is dominated by the small branching coral *Madracis mirabilis*, which produces large amounts of carbonate sediment. In places, large (possibly ephemeral) populations of leafy algae dominate the *Madracis* gravel substratum (Leafy Algae Zone). The *Madracis* Zone appears to have a successional relationship with the *Diploria-Montastraea-Porites* Zone. *Madracis* colony remains build up the substrate and allow the successional species to grow. The zone occurs at the Flower Gardens on peripheral parts of the main reefal structure between 28 and 46 m.

Stephanocoenia-Millepora Zone

The *Stephanocoenia-Millepora* Zone is inhabited by a low-diversity coral assemblage of 12 hermatypic corals and can be found at the Flower Gardens, McGrail Bank, and Bright Bank. The eight most conspicuous corals in order of dominance are *Stephanocoenia michelinii, Millepora* sp., *Montastraea cavernosa*, *Colpophyllia* spp., *Diploria* sp., *Agaricia* spp., *Mussa angulosa*, and *Scolymia* sp. The assemblages associated with this zone are not well known. Coralline algae are most conspicuous in this zone. Reef fish populations are less diverse. The spiny oyster (*Spondylus americanus*) appears numerous. The depth range of this zone is between 36 and 52 m.

Algal-Sponge Zone

The Algal-Sponge Zone covers the largest area among the reef-building zones. The dominant organisms of the zone are the coralline algae, which are the most important carbonate-nodule producers. The algae nodules range from 1 to 10 cm in size, cover 50-80 percent of the bottom, and generally occur between 55 and 85 m. The habitat created by the algae nodules supports communities that are probably as diverse as the coral-reef communities. Most of the leafy algae found on the banks occur in this zone and contribute large amounts of food to the surrounding communities. Calcareous green algae (*Halimeda* and *Udotea)* and several species of hermatypic corals are major contributors to the substrate. Deepwater alcyonarians are abundant in the lower Algal-Sponge Zone. Sponges, especially *Neofibularia nolitangere,* are conspicuous. Echinoderms are abundant and also add to the carbonate substrate. Small gastropods and pelecypods are also abundant. Gastropod shells are known to form the center of some of the algal nodules. Characteristic fish of the zone are yellowtail reef fish, sand tilefish, cherubfish, and orangeback bass.

Partly drowned reefs are a major biotope of the Algal-Sponge Zone. They are defined as those reefal structures covered with living crusts of coralline algae with occasional heads of hermatypic corals. In addition to the organisms typical to the rest of the Algal-Sponge Zone, the partly drowned reefs are also inhabited by large anemones, large comatulid crinoids, basket stars, limited crusts of *Millepora*, and infrequent small colonies of other hermatypic species.

Zone of Minor Reef Building

Millepora-Sponge Zone

The *Millepora*-Sponge Zone occupies depths comparable to the *Diploria-Montastraea-Porites* Zone on the claystone-siltstone substrate of the Texas-Louisiana midshelf banks. One shelf-edge carbonate bank, Geyer Bank, also exhibits the zone but only on a bedrock prominence. Crusts of the hydrozoan coral, *Millepora*, sponges, and other epifauna occupy the tops of siltstone, claystone, or sandstone outcrops in this zone. Scleractinian coral heads and coralline algae are rare.

Transitional Zone of Minor to Negligible Reef-Building

Antipatharian Zone

This transitional zone is not distinct but blends in with the lower Algal-Sponge Zone. It is characterized by an abundance of antipatharian whips growing with the algal-sponge assemblage. With increased water depth, the assemblages of the zone become less diverse, characterized by antipatharians, comatulid crinoids, few leafy or coralline algae, and limited fish (yellowtail redfish, queen angelfish, blue angelfish, and spotfin hogfish). Again, the depth of this zone varies at the various banks but extends generally to 90 m.

Zone of No Reef Building

Nepheloid Zone

High turbidity, sedimentation, and resuspension occur in this zone. Rocks or drowned reefs are covered with a thin veneer of sediment. Epifauna are scarce. The most noticeable are comatulid crinoids, octocoral whips and fans, antipatharians, encrusting sponges, and solitary ahermatypic corals. The fish fauna are different and less diverse than those of the coral reefs or partly drowned reefs. These fish species include red snapper, Spanish flag, snowy grouper, bank butterflyfish, scorpionfishes, and roughtongue bass. This zone occurs on all banks, but its depth differs at each bank. Generally, the Nepheloid Zone begins at the limit of the Antipatharian Zone and extends to the surrounding soft bottom.

Figure III-3 depicts the location of the topographic features in the Gulf of Mexico. Table III-5 describes the biotic zones found or expected at each bank and gives the depths of the bank crest and surrounding seafloor.

Twenty-three of the topographic features are located in the Western Gulf (Figure III-3). Rankin and 29 Fathom Banks are located along the dividing line between the Central and Western Gulf and, therefore, are included here.

Shelf-Edge Banks

East Flower Garden Bank
West Flower Garden Bank
Geyer Bank
Rankin Bank
Elvers Bank
MacNeil Bank
Appelbaum Bank

Midshelf Banks

Claypile Lump
32 Fathom Bank
Coffee Lump
Stetson Bank
29 Fathom Bank

South Texas Banks

Big Dunn Bar
Small Dunn Bar
Blackfish Ridge
Mysterious Bank
Baker Bank
Aransas Bank
Southern Bank
North Hospital Bank
Hospital Bank
South Baker Bank
Dream Bank

Table III-5

Biotic Zones of Topographic Features
with Bank Crest and Seafloor Depth in Meters

	Millepora-Sponge	Diplora Montastrea-Porites	Madracis	Stephanocoenia	Algal-Sponge	Transitional	Antipatharian-Nepheloid	Seafloor
Shelf-Edge Banks								
East Flower Garden		15	x	x	x	x	x	100-120
West Flower Garden		20	x	x	x	x	x	110-130
Bright				37	x	x	x	110
McGrail				45	x	x	x	110-130
Gever	37				x	x	x	190-210
Rankin					52	x	x	110-140
Alderdice					55	x	x	84-90
Rezak					60	x	x	120
Sidner					55	x	x	150
Ewing					56	x	x	85-100
Jakkula					59	x	x	120-140
Bouma					60	x	x	90-100
Elvers					60	x	x	180
Parker					60	x	x	100
MacNeil					62	x	x	86-94
Sackett					67	x	x	100
Diaphus						73	x	110-130
Sweet					75	x	x	130-200
Appelbaum					76	x	x	100-120
Phleger							122	200
Low-Relief								
Midshelf Banks								
Claypile	40						x	50
32 Fathom						52	x	55
Coffee Lump						62	x	70
Midshelf Banks								
Sonnier	18						x	50
Stetson	20						x	60
29 Fathom						52	x	72
Fishnet						66	x	78
Low-Relief								
South Texas Banks								
Sebree							31	37
Big Dunn Bar						61	x	67
Small Dunn Bar						63	x	67
Big Adam						60	x	64
Small Adam						60	x	66
Blackfish						60	x	70-74
Mysterious						70	x	74-86
South Texas Banks								
Baker						56	x	70-74
Aransas						57	x	70-72
Southern						58	x	80
North Hospital						58	x	68-70
Hospital						59	x	70-78
South Baker						59	x	80-84
Dream						62	x	80

Sources: Rezak and Bright, 1981; Rezak et al., 1983.

The shelf-edge banks generally exhibit the *Diploria-Montastraea-Porites* zonation that is exhibited at the Flower Garden Banks at comparable depths. Of interest is Geyer Bank, which crests at 37 m, within the depth that the high-diversity, coral-reef zone is expected. Figure III-4 shows the 1-Mile and 3-Mile Zones around Geyer Bank as an example of the protective zonation that would be established by the Topographic Features Stipulation proposed for these lease sales. The *Millepora*-Sponge Zone is evident at this shelf-edge bank. The *Millepora*-Sponge Zone is found elsewhere in the Gulf only at the midshelf banks.

Three of the midshelf banks contain the *Millepora*-Sponge Zone: Sonnier Bank in the Central Gulf and Stetson and Claypile Banks in the Western Gulf. Claypile Bank, with only 10 m of relief, is considered a low-relief bank and is often enveloped by the nepheloid layer. Thus, the level of development of the *Millepora*-sponge community is lowest at Claypile Bank. Two other midshelf banks in the Western Gulf (32 Fathom Bank and Coffee Lump) are also low-relief banks with less than 10 m of relief.

The South Texas banks are geographically/geologically distinct from the shelf-edge banks. Several of the South Texas banks are also low-relief banks. These banks exhibit a reduced biota and have relatively low relief, few hard-substrate outcrops, and a thicker sediment cover than the other banks.

It has been suggested that four other features in the Western Gulf be considered as sensitive offshore topographic features: Phleger, Sebree, and Big and Small Adam Banks. Phleger Bank (a shelf-edge bank) crests at 122 m, deeper than the lower limit of the No Activity Zones (85 m [100 m in the case of the Flower Gardens]). The depth of the bank precludes the establishment of the Antipatharian Zone so that even though the bank is in clear water, the biota are typical of the nepheloid zone. The bank appears to be predominantly covered with sand, with scattered rock outcrops of approximately 1-2 m in diameter and 1 m in height. The sand substrate is devoid of sessile benthic organisms, although the rock outcrops support a number of epifaunal species such as cup-shaped and encrusting sponges, octocorals, and crinoids. Roughtongue bass was observed in video surveys to be the dominant fish species on this bank.

Sebree Bank, located in 36.5 m of water, is a low-relief feature of approximately 3 m in relief and is subject to high sedimentation. Clusters of the scleractinian coral, *Oculina diffusa*, have been observed on the rocky outcrops of this bank. This species tends to thrive in habitats exhibiting low light and high sedimentation. It forms twisted, rather low-relief colonies, and does not create reefs or distinctive assemblages of reefal species. The bank attracts abundant nektonic species, including red snapper and other commercially and recreationally important finfish (Tunnell, 1981). Findings in the August 1993 cooperative dive effort on Sebree Bank by MMS, the State of Texas, and Texas A&M University at Corpus Christi (Dokken et al., 1993) were generally consistent with those reported by Tunnell (1981).

Dokken et al. (1993) compared the nepheloid dominated, low-diversity community of Sebree Bank with the nepheloid zone community described by Rezak et al. (1985).

Rezak and Bright (1981) categorized similar features containing nepheloid zone communities as Class D banks, where protection is not recommended. Since Sebree Bank is located within a shipping fairway, it is relatively well protected from physical impacts (anchoring or drilling disturbance). Rezak and Bright (1981) devised an environmental priority index to rate the sensitivity of topographic features in the northern Gulf of Mexico. While Sebree Bank was not specifically discussed by Rezak and Bright (1981), based on five ranking criterion, similar nepheloid zone communities were given the lowest rating of all the topographic features.

Big and Small Adam Banks are also low-relief features subject to sedimentation. Rezak and Bright (1981) categorized these features as Class D banks, where protection is not recommended. Although the banks may contain the Antipatharian Zone, this designation is speculative (Rezak et al., 1983). Big and Small Adam Banks were given the lowest ratings of those topographic features discussed by Rezak and Bright (1981), based on their criterion for environmental priority rankings.

3. Marine Mammals

Twenty-eight species of cetaceans, one sirenian, and one exotic pinniped (California sea lion) have been confirmed to occur in the Gulf of Mexico (Table III-6). Cetaceans are divided into two major suborders: Mysticeti (baleen whales) and Odontoceti (toothed whales). Seven baleen and 21 toothed whale species have been reported for the Gulf. The only member of the Order Sirenia found in the northern Gulf is the West Indian manatee. California sea lions exist in the northern Gulf of Mexico as feral individuals that probably were released or escaped from marine parks.

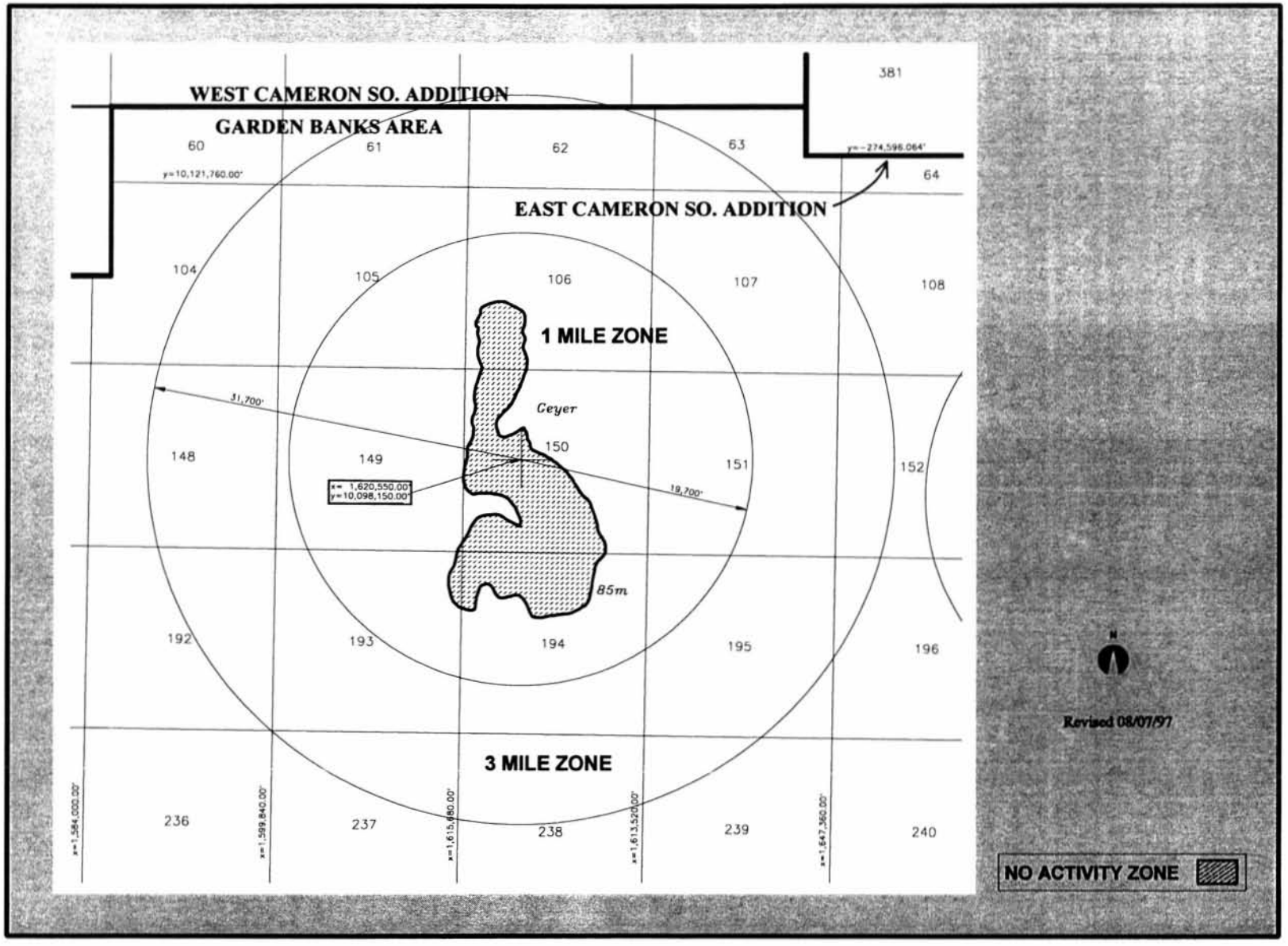


Figure III-4. Geyer Bank and Protective Zones as Proposed by the Biological Lease Stipulation.

Table III-6

Marine Mammals of the Gulf of Mexico

Order Cetacea		
Suborder Mysticeti (baleen whales)		
Family Balaenidae		
Eubalaena glacialis	northern right whale	*
Family Balaenopteridae		
Balaenoptera musculus	blue whale	*
Balaenoptera physalus	fin whale	*
Balaenoptera borealis	sei whale	*
Balaenoptera edeni	Bryde's whale	
Balaenoptera acutorostrata	minke whale	
Megaptera novaeangliae	humpback whale	*
Suborder Odontoceti (toothed whales)		
Family Physeteridae		
Physeter macrocephalus	sperm whale	*
Kogia breviceps	pygmy sperm whale	
Kogia simus	dwarf sperm whale	
Family Ziphiidae		
Mesoplodon bidens	Sowerby's beaked whale	
Mesoplodon densirostris	Blainville's beaked whale	
Mesoplodon europaeus	Gervais' beaked whale	
Ziphius cavirostris	Cuvier's beaked whale	
Family Delphinidae		
Orcinus orca	killer whale	
Pseudorca crassidens	false killer whale	
Feresa attenuata	pygmy killer whale	
Globicephala macrorhynchus	short-finned pilot whale	
Grampus griseus	Risso's dolphin	
Peponocephala electra	melon-headed whale	
Tursiops truncatus	Atlantic bottlenose dolphin	
Steno bredanensis	rough-toothed dolphin	
Stenella coeruleoalba	striped dolphin	
Stenella attenuata	pantropical spotted dolphin	
Stenella clymene	Clymene dolphin	
Stenella frontalis	Atlantic spotted dolphin	
Stenella longirostris	spinner dolphin	
Lagenodelphis hosei	Fraser's dolphin	
Order Carnivora		
Suborder Pinnipedia (seals, sea lions)		
Family Otariidae		
Zalophus californianus	California sea lion	I
Family Phocidae		
Monachus tropicalis	Caribbean monk seal	Ex
Order Sirenia		
Family Trichechidae		
Trichechus manatus	West Indian manatee	*

Source: Davis and Fargion, 1996.

I = introduced, Ex = extinct, * = endangered

a. Nonendangered and Nonthreatened Species

Only two of the seven baleen whales occurring in the Gulf are not listed as endangered or threatened. The Bryde's whale is the second smallest of the balaenopterid whales. Bryde's whales are found in tropical and warm temperate waters (Cummings, 1985). This species feeds on small pelagic fishes and cephalopods (Cummings, 1985). There are more records of Bryde's whale than of any other species of baleen whale in the Gulf of Mexico. It is likely that the Gulf represents at least a portion of the range of a dispersed, resident population of Bryde's whale (Jefferson and Schiro, 1997). This species is concentrated in the extreme northeastern Gulf (Mullin and Hansen, in press). The minke whale is the smallest of the rorquals; it feeds on zooplankton and fish (Stewart and Leatherwood, 1985). The minke whale is widely distributed in tropical, temperate, and polar waters. At least three geographically isolated populations are recognized: North Pacific, North Atlantic, and Southern Hemisphere. The North Atlantic population migrates southward during winter months to the Florida Keys and the Caribbean Sea. Although there are 10 reliable records of minke whales in the Gulf of Mexico, all are strandings (Jefferson and Schiro, 1997). These records may represent strays from low-latitude breeding grounds elsewhere in the western North Atlantic (Mitchell, 1991).

With the exception of the sperm whale, none of the toothed whales occurring in the Gulf are listed as endangered or threatened. Dwarf and pygmy sperm whales (*Kogia*) are typically found in deeper waters (the continental shelf edge and beyond) and congregate in small herd sizes (2-10 individuals) (Ross, 1978). *Kogia* feeds in deep water on cephalopods and, less often, on deep-sea fishes and shrimps. *Kogia* has been found throughout the range of water depths and topographies in the Gulf (Mullin et al., 1991); the GulfCet study found these animals at a mean depth ranging from 950 to 1,100 m (Davis and Fargion, 1996). *Kogia* is uniformly distributed over the upper continental slope; data suggested that *Kogia* may associate with frontal regions along the shelf break and upper continental slope, areas with high plankton biomass (Baumgartner, 1995). There are four species of beaked whales known to occur in the Gulf, including Cuvier's beaked whale and three members of the genus *Mesoplodon* (Gervais' beaked whale, Blainville's beaked whale, and Sowerby's beaked whale). Morphological similarities among species in the genus *Mesoplodon* make identification of free-ranging animals difficult. Life history data on these species are extremely limited. Observed herd sizes of beaked whales are, in most cases, small (1-2 individuals) (Mullin et al., 1991). Beaked whales in the Gulf have been sighted in water depths of deeper than 1,200 m (Davis and Fargion, 1996). An analysis of stomach contents from captured and stranded individuals suggest that they are deep-diving animals, feeding predominantly on mesopelagic fish and squid or deepwater benthic invertebrates (Heyning, 1989; Mead, 1989).

All remaining species of nonendangered whales and dolphins found in the Gulf are members of the family Delphinidae. Most delphinids, with the exception of the bottlenose dolphin and the Atlantic spotted dolphin, inhabit deeper waters of the Gulf. Bottlenose dolphins are the most common delphinid in the nearshore waters and outer edge of the continental shelf. There appear to be two ecotypes of bottlenose dolphins, a coastal form and an offshore form (Mead and Potter, 1990). There is evidence to support the assumption that inshore/offshore populations are genetically discrete (Curry et al., 1995). Inspection of bottlenose dolphin sighting rate distribution with depth reveals an almost bimodal distribution in the Gulf: a shallow water (16-67 m) and a shelf break (about 250 m) region; these regions may represent the individual depth preferences for the inshore and offshore stocks (Baumgartner, 1995). During 1992-1993 GulfCet surveys, an estimated 451 (coefficient of variance (CV)= 36.5%) bottlenose dolphins occurred over the continental shelf in the northwestern Gulf, and 520 (CV=56.3%) over the continental slope (Jefferson, 1996). Bottlenose dolphins are opportunistic feeders, taking a wide variety of fishes, cephalopods, and shrimp.

The Atlantic spotted dolphin is the only species, other than the bottlenose dolphin, that commonly occurs over the continental shelf (Mullin et al., 1991 and 1994a; Davis and Fargion, 1996). This species appears to prefer shallow water with a gently sloping bottom typical of the continental shelf, although it may also occur along the shelf break and upper continental slope (Davis and Fargion, 1996). A satellite-tagged Atlantic spotted dolphin was found to prefer shallow water habitat and make short dives (Davis et al., 1996). This species feeds on small cephalopods, fish, and benthic invertebrates.

Risso's dolphins also have been frequently sighted along the shelf edge, along the upper slope (less than 860 m), where they mostly prey on squid. Baumgartner (1995) found a strong correlation between Risso's dolphin distribution and the steeper portions of the upper continental slope, which is most likely the result of cephalopod distribution along the continental slope. All other delphinids appear to prefer deeper slope waters (Risso's dolphins and short-finned pilot whales inhabit areas with water depths less than 860 m; pantropical spotted and Clymene dolphins in areas with waters deeper than 1,200 m; spinner and rough-

toothed dolphins in waters from 950-1,100 m in depth) and feed on fish and/or squid (Mullin et al., 1991 and 1994a). The pantropical spotted dolphin is the most common cetacean in the oceanic northern Gulf (Davis and Fargion, 1996) and comprises 46 percent of the individuals of all cetacean species estimated to occur here (Mullin and Hansen, in press). Baumgartner (1995) did not find that pantropical spotted dolphins had a preference for any one habitat, and he suggested that this species might be able to utilize prey species in each distinct habitat (e.g., within the Loop Current, inside a cold core eddy, or along the continental slope), an ability which very well may contribute to this species' success and abundance in the northern Gulf. Distribution of the striped, spinner, and Clymene dolphins was shown to have a relationship with the depth of the 15 °C isotherm, suggesting a preference for waters where this isotherm shoals (most probably relating to productivity) (Baumgartner, 1995). Clymene and rough-toothed dolphins, and melon-headed and short-finned pilot whales were sighted almost exclusively west of the Mississippi River (Mullin and Hansen, in press). Although sample sizes are small, most spinner dolphin and false killer whale sightings were east of the Mississippi River (Mullin and Hansen, in press). Most killer whale sightings have been in offshore waters greater than 200 m deep, although there are other sightings from over the continental shelf (Davis and Fargion, 1996); killer whales were found almost exclusively in a broad area of the north-central Gulf (Mullin and Hansen, in press). Thirty-two individual killer whales have been photo-identified so far in the Gulf; some individuals have a wide temporal and spatial distribution (some with a linear distance of over 1,100 km) (O'Sullivan and Mullin, 1997).

Oceanographic features affect the distribution of prey species, and ultimately, cetacean diversity, abundance, and distribution. Information on the spatial abundance and distribution of deepwater cetaceans in the Gulf has been, until recently, sparse and limited to a few survey areas. In July 1989, the National Marine Fisheries Service, Southeast Fisheries Science Center (NMFS/SEFSC), funded by the MMS, began aerial surveys of cetaceans on the upper continental slope in the north-central Gulf (Mullin et al., 1991 and 1994a). The first at-sea identifications of Bryde's whale, pygmy and dwarf sperm whales, spinner dolphins, and Cuvier's beaked whales in the Gulf were recorded during this study.

During 1991-1994, MMS funded the GulfCet study, which was jointly conducted by Texas Institute of Oceanography, Texas A&M University, and NMFS/SEFSC using aerial and shipboard surveys to determine the seasonal and geographic distribution of cetaceans along the continental slope in the north-central and Western Gulf. Additionally, acoustic recordings of shelf edge and deepwater species were made (Davis and Fargion, 1996). The GulfCet study showed that several poorly known species are moderately common (beaked whales, pygmy and dwarf sperm whales, melon-headed whale, and Fraser's and Clymene dolphins). Ship-based surveys led to sightings of two large herds (greater than 100 individuals) of Fraser's dolphins (previously known to the Gulf from only a mass stranding in the Florida Keys (Hersh and Odell, 1986)), and first-time recordings of sounds produced by these animals (Leatherwood et al., 1993). GulfCet surveys also made many sightings of melon-headed whales (previously unknown to the Gulf before strandings in 1990 and 1991 (Barron and Jefferson, 1993)), suggesting that this species is a regular inhabitant of the Gulf of Mexico (Mullin et al., 1994b). Additionally, the Clymene dolphin was previously only known by strandings in the Gulf of Mexico. Mullin et al. (1994c) presented the first sighting records for the Gulf and found the Clymene dolphin to represent a significant component of the northern Gulf of Mexico cetacean population. During 1992-1993 GulfCet surveys, an estimated 2,285 (CV=60.8%) Clymene dolphins occurred in the northwestern Gulf (Jefferson, 1996). Based on historical records (mostly strandings), the short-finned pilot whale would be considered to be one of the most common offshore cetaceans in the Gulf (Jefferson and Schiro, 1997). However, the short-finned pilot whales have only occasionally been sighted during recent surveys in the northern Gulf. The GulfCet II Program is continuing work on patterns of distribution and abundance of Gulf cetaceans, and to identify possible associations between cetacean high-use habitats and the ocean environment. It is hypothesized that cetacean distribution is positively correlated with spatial and temporal variations in regional food stocks of zooplankton and micronekton. These food stocks are concentrated in nutrient-rich areas offshore from the Mississippi River, within cold-core eddies, or along the edge of warm-core eddies.

b. Endangered and Threatened Species

There are five baleen (northern right, blue, fin, sei, and humpback) whale species, one toothed (sperm) whale species, and one sirenian (West Indian manatee) occurring in the Gulf of Mexico that are endangered. The sperm whale is common in the Gulf, while the baleen whales are considered uncommon (Davis and Fargion, 1996). Two families of baleen whales occur in the Gulf: balaenids (northern right) and

balaenopterids, or rorquals (blue, fin, sei, and humpback). Two subspecies of the West Indian manatee are recognized: the Florida manatee and the Antillean manatee (Domning and Hayek, 1986).

The northern right whale is one of the stockiest of all whales; it has a massive head that can be up to one-third of its body length (Jefferson et al., 1993). Right whales forage primarily on subsurface concentrations of calanoid copepods by skim feeding with their mouths agape (Watkins and Schevill, 1976). The northern right whale is the world's most endangered whale. The western North Atlantic population (numbering 300-350 individuals) ranges primarily between Nova Scotia and Florida (USDOC, NMFS, 1991a). Confirmed historical records of northern right whales in the Gulf of Mexico consist of a single stranding in Texas (Schmidly et al., 1972) and a sighting off Florida (Moore and Clark, 1963; Schmidly, 1981). The northern right whale is not a normal inhabitant of the Gulf of Mexico; existing records probably represent extralimital strays from the wintering grounds of this species off the southeastern United States, from Georgia to northeastern Florida (Jefferson and Schiro, 1997). The coastal nature and slow swimming speed of the northern right whale makes it vulnerable to human activities (USDOC, NMFS, 1991a).

The blue whale is the largest animal known. Like all rorquals, the blue whale is slender and streamlined. The blue whale feeds almost exclusively on zooplankton via a combination of gulping and lunge-feeding in areas of heavy prey concentration (Yochem and Leatherwood, 1985). The blue whale occurs in all major oceans of the world; some blue whales are resident, some are migratory (Jefferson et al., 1993). Those that migrate move poleward to feeding grounds in spring and summer after wintering in subtropical and tropical waters (Yochem and Leatherwood, 1985). It is believed that the entire surviving blue whale population in the North Atlantic consists of only a few hundred individuals (Leatherwood and Reeves, 1983). Records of the blue whale in the Gulf consist of two strandings on the Texas coast (Lowery, 1974). There appears to be little justification for considering the blue whale to be a regular inhabitant of the Gulf of Mexico (Jefferson and Schiro, 1997).

The fin whale is the second largest rorqual. The fin whale has unusual head coloration; it is markedly asymmetric with the right lower jaw being largely white in contrast to the rest of the head which is dark. Fin whales are active lunge feeders, taking small invertebrates, schooling fishes, and squid (Jefferson et al., 1993). Fin whales have a worldwide distribution and are most commonly sighted where deep water approaches the coast (Jefferson et al., 1993). The fin whale makes regular seasonal migrations between temperate waters, where it mates and calves, and the more polar feeding grounds occupied in the summer months. Sightings in the Gulf have typically been made in deeper waters, more commonly in the north-central area (Mullin et al., 1991). There are seven reliable reports of fin whales in the Gulf, indicating that fin whales are not abundant in the Gulf of Mexico (Jefferson and Schiro, 1997). It is possible that the Gulf represents a portion of the range of a low latitude western Atlantic population; however, it is more likely that fin whales are extralimital to this area (Jefferson and Schiro, 1997).

The sei whale is a medium-sized rorqual. Sei whales skim copepods and other small prey types, rather than lunging and gulping like other rorquals (Gambell, 1985). Sei whales are open ocean whales, not often seen close to shore (Jefferson et al., 1993). They occur from the tropics to polar zones, but are more restricted to mid-latitude temperate zones than are other rorquals (Jefferson et al., 1993). The sei whale is represented in the Gulf by only four reliable records (Jefferson and Schiro, 1997). This species should be considered most likely to be of accidental occurrence in the Gulf, although it is worth noting that three of the four reliable records were from strandings in eastern Louisiana (Jefferson and Schiro, 1997).

The humpback whale is more robust in body than other balaenopterids. They have rounded heads and extremely long flippers that are often all or partly white. They occur in all oceans, feeding in higher latitudes during spring, summer, and autumn, and migrating to a winter range over shallow tropical banks, where they calve and presumably conceive (Leatherwood and Reeves, 1983). Humpbacks are adaptable lunge feeders, using a variety of techniques to help concentrate krill and small schooling fish for easier feeding (Winn and Reichley, 1985). There are seven reliable sighting records for humpbacks in the Gulf (Weller et al., 1996). It seems likely that some humpbacks stray into the Gulf of Mexico during the breeding season on their return migration northward. The time of the year (winter and spring) and the small size of the animals involved in many sightings points to the likelihood of these records being of inexperienced yearlings on their first return migration (Weller et al., 1996).

The sperm whale is the largest toothed whale. Large mesopelagic squid are the primary diet of sperm whales, though other cephalopods, demersal fishes, and occasionally benthic invertebrates are eaten (Rice, 1989). Sperm whales are distributed from the tropics to the pack-ice edges in both hemispheres, although generally only large males venture to the extreme northern and southern portions of their range (Jefferson et al., 1993). As a group, they seem to prefer certain areas within each major ocean basin, which historically have been termed "grounds" (Rice, 1989). Deep divers, sperm whales tend to inhabit oceanic waters, but

they do come close to shore where submarine canyons or other physical features bring deep water near the coast (Jefferson et al., 1993). The sperm whale is the most abundant large cetacean in the Gulf of Mexico and has been sighted on most surveys conducted in deeper waters (Fritts et al., 1983; Mullin et al., 1991; Davis and Fargion, 1996). Sperm whales in the Gulf were observed to occur most frequently in areas with mean depths of 950-1,100 m (Davis and Fargion, 1996). Congregations of sperm whales are commonly seen off the shelf edge in the vicinity of the Mississippi River Delta (Mullin et al., 1991 and 1994a; Davis and Fargion, 1996). Baumgartner (1995) noted that sperm whales were seldom observed in warm features characterized by a depressed 15°C isotherm and warm water at 100 m; the highest sighting rates occurred in a cooler water mass characterized by intermediate to cool temperatures at 100 m and a moderately shallow 15°C isotherm. Sperm whales may use the peripheries of cold eddies, but as Baumgartner noted, there is an insufficient number of concurrent sightings and plankton biomass measurements to draw conclusions. During the 1992-1993 GulfCet surveys, an estimated 442 (CV=35.7%) sperm whales occurred in the northwestern Gulf (Jefferson, 1996).

The manatee normally ranges no farther north along the west coast of Florida than the Suwannee River. Manatees are uncommon along the Florida Panhandle and are infrequently found (strandings and sightings) as far west as the Central and Western Gulf Planning Areas (Powell and Rathbun, 1984; Rathbun et al., 1990; Schiro and Fertl, 1995). It is unlikely that manatees will be affected adversely by OCS activities in the Central and Western Planning Areas; however, the loss of even a few individual manatees could cause further population declines. The Florida manatee subspecies is found from Louisiana (and possibly eastern Texas) east to Florida and north seasonally to the Carolinas and Chesapeake Bay, generally inhabiting the coastal and inland waters of the southeastern United States (Domning and Hayek, 1986). There are approximately 1,300 manatees on the Gulf Coast of Florida (Ackerman, personal communication, 1996). The manatees occasionally appearing in Texas waters are most likely strays from Mexico rather than Florida (Powell and Rathbun, 1984). Few manatees are known on the east coast of Mexico close to Texas (Lazcano-Barrero and Packard, 1989); manatees in south Texas and northern Mexico are probably stragglers from central Mexico (Ackerman, personal communication, 1996). Antillean manatees in Mexico occur along much of the southeastern coast from Nautla, Veracruz, to the Belize border, but they are still reasonably abundant in only three principal areas in Mexico: vast wetland systems in the states of Tabasco and Chiapas, the bays and coastal springs along the northern and eastern coasts of the state of Quintana Roo, and the rivers near Alvarado in the state of Veracruz (Lefebvre et al., 1989). A study of manatees at the Belize border in Quintana Roo estimates about 200 animals (Ackerman, personal communication, 1996). There are no population estimates for manatees on the west side of the Yucatan Peninsula (Campeche) and near the Texas border (Ackerman, personal communication, 1996). There is also no evidence of manatees traveling between Cuba and Florida; it is has been assumed that travel across the Florida Straits would be too difficult for the animals (Ackerman, personal communication, 1996). Manatee behavior and distribution are influenced by two important aspects of their physiology: nutrition and metabolism. Manatees are herbivores that feed opportunistically on a wide variety of submerged, floating, and emergent vegetation (USDOI, FWS, 1995). Distribution of the manatee is limited to low-energy, inshore habitats supporting the growth of seagrasses (Hartman, 1979). Manatees have an unusually low metabolic rate and a high thermal conductance that leads to energetic stresses in winters, ameliorated by migrations and aggregations in warm water refugia (Hartman, 1979). Shallow grass beds with ready access to deep channels are preferred feeding areas in coastal and riverine habitats (USDOI, FWS, 1995). Manatees often use secluded canals, creeks, embayments, and lagoons, particularly near the mouths of coastal rivers and sloughs, for feeding, resting, mating, and calving (USDOI, FWS, 1995). In estuarine and brackish areas, natural and artificial freshwater sources are sought by manatees (USDOI, FWS, 1995).

4. Sea Turtles

Five species of sea turtle are found in the waters of the Gulf of Mexico: Kemp's ridley, loggerhead, green, leatherback, and hawksbill. All are protected by the Endangered Species Act. Commercial fishing has had a devastating impact on both U.S. and world populations of sea turtles (Witzell, 1994).

Sea turtles spend nearly all of their lives in the water. The females must emerge periodically from the ocean to nest on beaches. Sea turtles are long-lived, slow-reproducing organisms. It is generally believed that all sea turtle species spend the first few years of their lives in pelagic waters, occurring in driftlines and convergence zones (in sargassum rafts) where they find refuge and food in items that accumulate in surface circulation features (Carr, 1986; 1987). Genetic analysis of sea turtles has revealed in recent years that

discrete, non-interbreeding stocks of sea turtles make up "worldwide extensive ranges" of the various species. Adult turtles in the Gulf are apparently less abundant in the deeper waters of the Gulf of Mexico than in waters less than 27-50 m deep (NRC, 1990).

The green turtle (*Chelonia mydas*) is the largest hard-shelled sea turtle. Adults commonly reach 100 cm in carapace length and 150 kg in weight (USDOC, NMFS, 1990a). The green turtle has a circumglobal distribution in tropical and subtropical waters. In U.S. Atlantic waters, green turtles are found around the U.S. Virgin Islands, Puerto Rico, and the continental U.S. from Texas to Massachusetts. Areas in Texas and Florida figured heavily in the commercial fishery for green turtles at the end of the last century (Hildebrand, 1982). Reports of nesting in the northern Gulf are isolated and infrequent, except on Santa Rosa Island, Walton County, Florida. The closest significant nesting aggregations are on the Florida east coast and the Yucatan Peninsula. Green turtles primarily occur in coastal waters, where they forage on seagrasses, algae, and associated organisms (Carr and Caldwell, 1956; Hendrickson, 1980). Areas that are known as important feeding areas for green turtles in Florida include Indian River, Florida Bay, Homosassa, Crystal River, and Cedar Key (USDOC, NMFS, 1990a). In coastal Texas, green turtles have demonstrated site fidelity, remaining in one location for several months (NMFS Newsbreaker, 1993).

The leatherback (*Dermochelys coriacea*) is the largest of the sea turtles, with average curved carapace length for adult turtles of 155 cm and weight ranging from 200 to 700 kg (USDOC, NMFS, 1992a). This species is also the most pelagic and most wide-ranging of sea turtles, undertaking extensive migrations following depth contours for hundreds, even thousands, of kilometers (Morreale et al., 1993). Using satellite telemetry, it was recently determined that female leatherback turtles migrating through the Pacific Ocean are using similar and in some cases virtually identical pathways or ocean corridors through which to travel (Morreale et al., 1993). Leatherbacks' nesting is concentrated on coarse-grain beaches in the tropical latitudes (Pritchard, 1971), though there are rare occurrences on the Panhandle and Flagler County coasts in Florida (Ogren et al., 1989). Leatherbacks have unique deep diving abilities (Eckert et al., 1986), a specialized jellyfish diet (Brongersma, 1972), and unique physiological properties that distinguish them from other sea turtles (Lutcavage et al., 1990; Paladino et al., 1990). Leatherbacks were the most abundant turtle sighted during the GulfCet study (Davis and Fargion, 1996); though sighted throughout the study area, concentrations were found from Mississippi Canyon east to DeSoto Canyon.

The hawksbill (*Eretmochelys imbricata*) is a small to medium-sized sea turtle. Nesting females average about 87 cm in curved carapace length and can weigh up to 80 kg in the Caribbean (USDOC, NMFS, 1993). This turtle is a solitary nester. The six-month nesting season of the hawksbill is longer than that of other sea turtles; nesting occurs between July and October (USDOC, NMFS, 1993). Nesting within the southeastern United States occurs principally in Puerto Rico and the U.S. Virgin Islands. Within the continental U.S., nesting is restricted to the southeast coast of Florida and the Florida Keys. Post-hatchlings occupy the pelagic environment, taking shelter in weedlines. Hawksbill turtles are generally associated with coral reefs or other hard substrate areas, where they forage primarily on sponges (Carr and Stancyk, 1975; Meylan, 1988). This species feeds in the photic zone and prefers warm water temperatures. The hawksbill occurs in tropical and subtropical seas of the Atlantic, Pacific, and Indian Oceans. The species is widely distributed in the Caribbean Sea and western Atlantic Ocean, with representatives of at least some life history stages occurring in southern Florida and the northern Gulf of Mexico (especially Texas); in the Greater and Lesser Antilles; and along the Central American mainland south to Brazil. In the continental U.S., the species is recorded from all the Gulf States and from along the eastern seaboard as far north as Massachusetts, with the exception of Connecticut; however, sightings north of Florida are rare (USDOC, NMFS, 1993). The hawksbill is the least commonly reported sea turtle in the Gulf (Hildebrand, 1982). Stranded hawksbills have been reported in Texas (Hildebrand, 1982; Ogren et al., 1989) and recently in Louisiana (Choromanski, personal communication, 1992); these tend to be either hatchlings or yearlings. Northerly currents may carry them away from their natal beaches in Mexico northward into Texas (Amos, 1989; Collard and Ogren, 1989). Texas and Florida are the only states where hawksbills are sighted with any regularity (USDOI, FWS, 1995). Commercial exploitation is the major cause of the continued decline of the hawksbill sea turtle (USDOC, NMFS, 1993).

The Kemp's ridley (*Lepidochelys kempi*) is the smallest of all living sea turtles. The weight of an adult is generally less than 45 kg and the straight carapace length is around 65 cm; adult Kemp's ridley shells are almost as wide as they are long (USDOC, NMFS, 1992a). The Kemp's ridley sea turtle is the most imperiled of the world's sea turtles. The Gulf of Mexico's population of nesting females has dwindled from an estimated 47,000 in 1947 (Hildebrand, 1963) to a current nesting population of less than 1,000 (Pritchard, 1990). The population crash that occurred between 1947 and the early 1970's may have been the result of both intensive annual harvest of the eggs and mortality of juveniles and adults in trawl fisheries (NRC,

1990). The recovery of the species has been forestalled primarily by incidental morality in commercial shrimping, preventing adequate recruitment into the breeding population (USDOC, NMFS, 1992a). Eggs are laid annually, primarily in Rancho Nuevo, Tamaulipas, Mexico (USDOC, NMFS, 1992a). Nesting in the United States occurs infrequently on Padre and Mustang Islands in south Texas from May to August (Thompson, 1988). Natural nesting was supplemented by a NMFS hatchling and rearing program on Padre Island National Seashore (PINS) (Klima and McVey, 1982). Only 11 Kemp's ridley nests were found in Texas from 1979 to 1995 (Shaver, 1995). As of June 30, 1996, there were six confirmed Kemp's ridley nests on the Texas coast; five were laid at PINS and one at Boca Chica Beach (Shaver, 1996a). The sightings of the living tagged turtles are the first documentation of any sea turtle nesting at an experimental imprinting site and outside of captivity after being headstarted (Shaver, 1996a and b). Kemp's ridley turtles have occasionally nested in Florida; twice reported for the west coast of Florida and once on the Atlantic coast of Florida (Johnson, personal communication, 1996). Hatchlings appear to disperse offshore and are sometimes found in sargassum mats (Collard and Ogren, 1990). The Kemp's ridley feeds on portunids and other crabs (Ogren, 1989; Shaver, 1991), and has an associated distribution with seagrass ecosystems (Carr and Caldwell, 1956; Lutcavage and Musick, 1985). The range of Kemp's ridleys includes the Gulf Coasts of Mexico and the U.S., and the Atlantic Coast of North America as far north as Nova Scotia and Newfoundland (Byles et al., 1996). In the Gulf, Kemp's ridleys inhabit nearshore areas, being most abundant in coastal waters from Texas to Florida.

The loggerhead sea turtle (*Caretta caretta*) occurs worldwide in habitats ranging from estuaries to the continental shelf (Dodd, 1988). The mean straight carapace length of adult southeastern U.S. loggerheads is approximately 92 cm; the corresponding mean body mass is approximately 113 kg (USDOC, NMFS, 1990b). In the western North Atlantic, there are at least four loggerhead nesting subpopulations separated by nesting beach: the Northern Nesting Subpopulation (North Carolina to northeast Florida, about 29° N. latitude), the South Florida Nesting Subpopulation (29° N. latitude to Naples), the Florida Panhandle Nesting Subpopulation (Eglin Air Force Base and the beaches near Panama City), and the Yucatán Nesting Subpopulation (northern and eastern Yucatán Peninsula, Mexico) (Byles et al., 1996). The largest nesting concentration in the United States is on the southeast Florida coast from Volusia to Broward Counties (Hopkins and Richardson, 1984). In the Gulf of Mexico, recent surveys indicate that the Florida Panhandle accounts for approximately one-third of the nesting on the Florida Gulf Coast. In the Central Gulf, loggerhead nesting has been reported on Gulf Shores and Dauphin Island, Alabama; Ship Island, Mississippi; and the Chandeleur Islands, Louisiana (Fuller et al., 1987). Nesting in Texas occurs primarily on North and South Padre Islands, although occurrences are recorded throughout coastal Texas (Hildebrand, 1982). Based on aerial survey results, western North Atlantic loggerheads are distributed about 54 percent in the southeast U.S. Atlantic, 29 percent in the northeast U.S. Atlantic, 12 percent in the Eastern Gulf of Mexico, and 5 percent in the Western Gulf of Mexico (Byles et al., 1996). Aerial surveys indicate that loggerheads are common in less than 50 m depth, but they are also found in deep water (Shoop et al., 1981; Fritts et al., 1983). Juvenile and subadult loggerheads are omnivorous, foraging on pelagic crabs, molluscs, jellyfish, and vegetation captured at or near the surface. Adult loggerheads are generalist carnivores that forage on nearshore benthic invertebrates (Dodd, 1988). The banks off the central Louisiana coast and near the Mississippi Delta are also important marine turtle feeding areas (Hildebrand, 1982).

5. Coastal and Marine Birds

a. Nonendangered and Nonthreatened Species

The offshore waters, coastal beaches, and contiguous wetlands of the northern Gulf of Mexico are populated by both resident and migratory species of coastal and marine birds. They are herein separated into five major groups: seabirds, shorebirds, marsh birds, wading birds, and waterfowl. Many species are mostly pelagic and, therefore, rarely sighted nearshore. The remaining species are found within coastal and inshore habitats and are more susceptible to potential deleterious effects resulting from OCS-related activities (Clapp et al., 1982). 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). Fidelity to these nesting sites varies from year to year along the Gulf Coast. Site abandonment along the northern Gulf Coast has often been attributed to habitat alteration and excessive human disturbance (Martin and Lester, 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). There are four main groups of seabirds; three are represented in the Gulf--the orders Procellariiformes (petrels, albatrosses, and shearwaters), Pelecaniformes (pelicans, gannets and boobies, cormorants, tropicbirds, and frigatebirds), and Charadriiformes (phalaropes, gulls, terns, noddies, and skimmers) (Clapp et al., 1982; Harrison, 1983). In addition to these three mainstream orders, the two orders Gaviiformes (loons) and Podicipediformes (grebes) are also found in the Gulf. Seabirds typically aggregate in social groups called colonies; the degree of coloniality varies between species (Parnell et al., 1988). Nesting seabirds on the Gulf include pelicans, cormorants, laughing gulls, eight species of terns, and black skimmers (Martin and Lester, 1991; Pashley, 1991). Seabirds obtain their food from the sea with a variety of behaviors including piracy, scavenging, dipping, plunging, and surface seizing.

Shorebirds are those members of the order Charadriiformes generally restricted to coastline margins (beaches, mudflats, etc.). Gulf of Mexico shorebirds comprise five taxonomic families--Jacanidae (jacanas), Haematopodidae (oystercatchers), Recurvirostridae (stilts and avocets), Charadriidae (plovers), and Scolopacidae (sandpipers, snipes, and allies) (Hayman et al., 1986). An important characteristic of almost all shorebird species is their strongly developed migratory behavior, with some shorebirds migrating from nesting places in the far north to the southern part of South America (Terres, 1991). The central and western Gulf of Mexico coastline serves as the southern terminus of the Mississippi Flyway (Alabama, Mississippi, and Louisiana) and the Central Flyway (Texas), respectively. Migrating birds spend the majority of summer months in areas as far north as the coastal tundra of Canada and Alaska. Some species only pass through the Gulf area and overwinter in a variety of habitats in the Caribbean Sea, Central America, and South America. Generally, the migrational trend within the Gulf region is north-south. Both spring and fall migrations take place in a series of "hops" to staging areas where birds spend time feeding heavily to store up fat for the sustained flight to the next staging area (Terborgh, 1989); many coastal habitats along the Gulf of Mexico are critical for such purposes. Along the central Gulf Coast, 44 species of shorebirds have been recorded; only 6 nest in the area, the remaining are wintering residents and/or "staging" transients (Pashley, 1991). Although variations occur between species, most shorebirds begin breeding at one to two years of age and generally lay 3-4 eggs per year. They feed on a variety of marine and freshwater invertebrates and fish, and small amounts of plant life.

The term "marsh bird" is a general term for a bird that lives in or around marshes and swamps. Collectively, the following families have representatives in the northern Gulf: Ardeidae (herons and egrets), Ciconiidae (storks), Threskiornithidae (ibises and spoonbills), Gruidae (crane), and Rallidae (rails, moorhens, gallinules, and coots). Wading birds are those birds that have adapted to living in marshes. They have long legs that allow them to forage by wading into shallow water, while their long necks and bills are used to probe under water or to make long swift strokes to seize fish, frogs, aquatic insects, crustaceans, and other prey (Terres, 1991). Seventeen species of wading birds in the Order Ciconiiformes are currently known to nest in the U.S., and all except the wood stork nest in the northern Gulf coastal region (Martin, 1991). Within the central Gulf Coast region, Louisiana supports the majority of nesting wading birds. Great egrets are the most widespread nesting species in the central Gulf region (Martin, 1991), while little blue herons, snowy egrets, and tricolored herons constitute the greatest number of coastal nesting pairs in the western Gulf Coast (Texas Parks and Wildlife Department, 1990). Members of the Rallidae family have compact bodies; therefore, they are not labeled wading birds. They are also elusive and rarely seen within the low vegetation of fresh and saline marshes, swamps, and rice fields (Bent, 1926; National Geographic Society, 1983; Ripley and Beehler, 1985).

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

b. Endangered and Threatened Species

The following coastal and marine birds species that inhabit or frequent the north-central and western Gulf of Mexico coastal areas are recognized by FWS as either endangered or threatened: peregrine falcon, piping plover, whooping crane, eskimo curlew, bald eagle, brown pelican, and least tern.

The peregrine falcon (*Falco peregrinus*) of North America is separated into three subspecies: Arctic, American, and Peale's. The Arctic peregrine, which originates in the Arctic and sub-Arctic regions from western Alaska to western Greenland, accounts for 99 percent of the fall migrants on the Gulf of Mexico coast (*Federal Register*, 1983). The Arctic peregrine falcon was delisted on October 5, 1994. Other peregrine subspecies protection (Federal) has been proposed for removal. 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 (*Charadrius melodus*) is a migratory shorebird that is endemic to North America. The piping plover breeds on the northern Great Plains, in the Great Lakes, and along the Atlantic Coast (Newfoundland to North Carolina); and winters on the Atlantic and Gulf of Mexico coasts from North Carolina to Mexico and in the Bahamas West Indies. Along the U.S. Gulf Coast, the highest number of wintering plovers occur along the Texas coast (Haig and Plissner, 1993). It has been hypothesized that specific wintering habitat, which includes coastal sand flats and mud flats in close proximity to large inlets or passes, may attract the largest concentrations of piping plovers because of a preferred prey base and/or because the substrate coloration provides protection from aerial predators due to chromatic matching, or camouflage (Nicholls and Baldassarre, 1990).

The whooping crane (*Grus americana*) is an omnivorous, wading bird. The whooping crane formerly ranged from summer breeding grounds within the central Canadian provinces and northern prairie states to southern coastal wintering grounds from central Mexico to the Carolinas (Bent, 1926). Whooping cranes currently exist in three wild populations and at five captive locations (USDOI, FWS, 1994). The only self-sustaining wild population nests in the Northwest Territories and adjacent areas of Alberta, Canada, primarily within the boundaries of Wood Buffalo National Park (WBNP). These birds winter in coastal marshes and estuarine habitats along the Gulf of Mexico coast at Aransas National Wildlife Refuge, Texas, and represent the majority of the world's population of free-ranging whooping cranes. Another wild flock was created with the transfer of wild whooping crane eggs from nests in the WBNP to be reared by wild sandhill cranes in an effort to establish a migratory, Rocky Mountains Population (USDOI, FWS, 1994). This population summers in Idaho, western Wyoming, and southwestern Montana and winter in the middle Rio Grande Valley, New Mexico. The third wild population is the first step in an effort to establish a nonmigratory population in Florida (USDOI, FWS, 1994). The December 1993 wild population was estimated at 160; the captive population contained 101 birds (USDOI, FWS, 1994).

The eskimo curlew (*Numenius borealis*) 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. In 1929, the eskimo curlew was thought be extinct; however, occasional records persist (Collar et al., 1994). Census efforts are underway to ascertain whether this species is extinct (Ambrose, personal communication, 1992). Because of the uncertainty as to the status of this species, it has been omitted from the analyses for this EIS.

The bald eagle (*Haliaeetus leucocephalus*) is the only species of sea eagle that regularly occurs on the North American continent (USDOI, FWS, 1984). Its range extends from central Alaska and Canada to northern Mexico. The bulk of the bald eagle's diet is fish, though bald eagles will opportunistically take birds, reptiles, and mammals (USDOI, FWS, 1984). The historical nesting range of the bald eagle within the Southeast United States included the entire coastal plain and shores of major rivers and lakes. The current range is limited, with most breeding pairs occurring 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 (*Pelicanus occidentalis*) is one of two pelican species in North America. It feeds entirely upon fishes captured by plunge diving in coastal waters. Organochlorine pesticide pollution apparently contributed to the endangerment of the brown pelican. In recent years, there has been a marked increase in brown pelican populations along its entire former range. The population of brown pelicans and

their habitat in Alabama, Florida, Georgia, North and South Carolina, and points northward along the Atlantic Coast were removed from the endangered species list in 1985; 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 Louisiana Department of Wildlife and Fisheries submitted a request in March 1994 to the FWS to officially remove the eastern brown pelican from the endangered species list in Louisiana (Louisiana Dept. of Wildlife and Fisheries, 1994a).

The least tern (*Sterna antillarum*) is the smallest North American tern. Least terns are listed as endangered, except within 50 mi of the coast. Least terns prefer inshore habitats. They breed on the Atlantic coast from southern Maine to the Florida Keys and on the coasts of all states bordering the Gulf of Mexico. They also breed along rivers in the interior of the United States from Nebraska and Ohio south to New Mexico and the Gulf of Mexico. Least terns feed largely on small fish by plunge diving and by dipping. Least terns usually nest in small colonies on bare or sparsely vegetated sand and shell substrates, and will use human-made and managed spoil sites as well.

6. Fish Resources

The Gulf of Mexico supports a great diversity of fish resources that are related to variable ecological factors, including salinity, primary productivity, and bottom type. These factors differ widely across the Gulf of Mexico and 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 Gulf of Mexico (Mager and Ruebsamen, 1988). Consequently, estuary-dependent species of finfish and shellfish dominate the fisheries.

The life history of estuary-dependent species involves spawning on the continental shelf; transporting eggs, larvae, or juveniles to the estuarine nursery grounds; growing and maturing in the estuary; and migrating of the young adults back to the shelf for spawning. After spawning, the adult individuals generally remain on the continental shelf. Movement of adult estuary-dependent species is essentially onshore-offshore with no extensive east-west or west-east migration.

Estuary-related species of importance include menhaden, shrimps, oyster, crabs, and sciaenids. Estuary communities are found from east Texas through Louisiana, Mississippi, Alabama, and northwestern Florida. Darnell et al. (1983) and Darnell and Kleypas (1987) found that the density distribution of fish resources in the Gulf was highest nearshore off the central coast. For all seasons, the greatest abundance occurred between Galveston Bay and the Mississippi River. The abundance of fish resources in the far Western and Eastern Gulf of Mexico is patchy. The high salinity bays of the Western Gulf contain no distinctive species, only a greatly reduced component of the general estuary community found in lower salinities (Darnell et al., 1983). High salinity bays and sounds in the Eastern Gulf contain species amenable to shell, coral sand, and coral silt bottoms. These include pink shrimp, rock shrimp, and stone crab (Darnell and Kleypas, 1987).

Estuaries and rivers of the Gulf of Mexico export considerable quantities of organic material, thereby enriching the adjacent continental shelf areas (Grimes and Finucane, 1991; Darnell and Soniat, 1979). Populations from the inshore shelf zone (7-14 m) are dominated seasonally by Atlantic croaker, spot, drum, silver seatrout, southern kingfish, and Atlantic threadfin. Populations from the middle shelf zone (27-46 m) include sciaenids, but are dominated by longspine porgies. The blackfin searobin, Mexican searobin, and shoal flounder are dominant on the outer shelf zone (64-110 m).

Natural reefs and banks, located mainly between the middle and outer shelf zones, support large numbers of grouper, snapper, gag, scamp, and seabass. Reef fish occur on the continental shelf wherever hard/live bottoms with rocks, holes, or crevices are available (USDOC, NOAA, 1986). In the Western and Central Gulf, natural reefs are scattered along the 200-m isobath. Numerous offshore petroleum platforms act as artificial reefs and augment the hard substrate of natural reefs in this area (Linton, 1988). Hard substrates with some vertical relief act as important landmarks for pelagic species. Coastal pelagics such as mackerels, cobia, bluefish, amberjack, and dolphin move seasonally.

Recruitment is by far the most important, yet the least understood, factor contributing to changes in the numbers of harvestable Gulf fish (Sports Fishing Institute, 1992). Natural phenomena such as weather, hypoxia, and red tides may reduce standing populations.

The degradation of inshore water quality and loss of Gulf wetlands as nursery areas are considered significant threats to fish resources in the Gulf of Mexico (Christmas et al., 1988; Horst, 1992a). Loss of wetland nursery areas in the north-central Gulf is believed to be the result of channelization, river control,

and subsidence of wetlands (Turner and Cahoon, 1988). Loss of wetland nursery areas in the far Western and Eastern Gulf is believed to be the result of urbanization and poor water management practices (USEPA, 1989).

Many of the commercially important fish species in the Gulf of Mexico are believed to be in decline due to overfishing (USDOC, NMFS, 1992b). Continued fishing at the present levels are likely to result in eventual failure of certain fisheries. Competition between large numbers of fishermen, between fishing operations employing different methods, and between commercial and recreational fishermen for a given resource may reduce standing populations. Fishing techniques such as trawling, gill netting, or purse seining, when practiced nonselectively, may reduce the standing stocks of the desired target species as well as substantially affect fish resources other than the target. Standing stocks of traditional fisheries, such as shrimp and red snapper, and of recent fisheries, such as black drum, shark, and tuna, have declined and are thought to be in danger of collapse (Angelovic, written communication, 1989; Goodyear and Phares, 1990; USDOC, NOAA, 1986).

Finally, hurricanes may affect fish resources by destroying oyster reefs and changing physical characteristics of inshore and offshore ecosystems (Horst, 1992a).

Finfish

Finfish resources are linked both directly and indirectly to the vast estuaries that ring the Gulf of Mexico. Finfish are directly estuary dependent when the population relies on low salinity brackish wetlands for most of their life history, such as during the maturation and development of larvae and juveniles. 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).

Gulf menhaden and members of the Sciaenidae family such as croaker, red and black drum, and spotted sea trout are directly dependent on estuaries during various phases of their life history.

The occurrence of dense schools, generally by members of fairly uniform size, is an outstanding characteristic that facilitates mass production methods of harvesting menhaden. The seasonal appearance of large schools of menhaden in the inshore Gulf waters from April to November dictates the menhaden fishery (Nelson and Ahrenholz, 1986).

Larval menhaden feed on pelagic zooplankton in marine and estuarine waters. Juvenile and adult Gulf menhaden become filter-feeding omnivores that primarily consume phytoplankton, but also ingest zooplankton, detritus, and bacteria. As filter-feeders, menhaden form a basal link in estuarine and marine food webs and, in turn, are prey for many species of larger fish (Vaughan et al., 1988).

Sciaenids are opportunistic carnivores whose food habits change with size. Larval sciaenids feed selectively on pelagic zooplankton, especially copepods. Juveniles feed upon invertebrates, changing to a more piscivorous diet as they mature (Perret et al., 1980; Sutter and McIlwain, 1987; USDOC, NOAA, 1986).

About 10 percent of finfish in the Gulf of Mexico are not directly dependent on estuaries during their life history. This group can be divided into demersal and pelagic species. Demersal species are associated with live bottoms, reef complexes, hard-bottom banks, and patch reefs. Pelagic species are associated with high-salinity open water beyond the direct influence of coastal systems.

Snappers are non-estuary-dependent demersal fish associated with natural reefs, hard bottom, and artificial reefs of the mid-outer continental shelf. Called reef fish, snappers remain close to underwater structures and exhibit little or no movement. Snappers feed along the bottom on fishes and benthic organisms such as tunicates, crustaceans, and mollusks. Juveniles feed on zooplankton, small fish, crustaceans, and mollusks (Bortone and Williams, 1986; USDOC, NOAA, 1986).

Coastal pelagics are open-water fish widely distributed throughout the Gulf of Mexico. Pelagic species such as king and Spanish mackerel move seasonally in response to water temperature and oceanographic conditions. Mackerels are found from the shore to 200-m depths. Spanish mackerel frequent the coastal areas, while king mackerel stay farther offshore. Mackerels spawn offshore over the continental shelf during the spring and summer. Mackerel feed throughout the water column on other fishes, especially herrings, and on shrimp and squid.

Additional information on finfish and their life histories can be found in Section III.B.7. of the Final EIS for Sales 157 and 161 (USDOI, MMS, 1995).

Shellfish

To a greater degree, estuaries determine the shellfish resources of the Gulf of Mexico. Life history strategies are influenced by tides, lunar cycles, maturation state, and estuarine temperature changes. Very few individuals live more than a year, and the majority are less than six months old when they enter the extensive inshore and nearshore fishery. Year-to-year variations in shellfish populations are frequently as high as 100 percent and are most often a result of extremes in salinity and temperature during the period of larval development. Shellfish resources in the Gulf range from those located only in brackish wetlands to those found mainly in saline marsh and inshore coastal areas. Life history strategies reflect estuary relationships, ranging from total dependence on primary productivity to opportunistic dependence on benthic organisms. Gulf shellfish resources are an important link in the estuary food chain between benthic and pelagic organisms (Darnell et al., 1983; Darnell and Kleypas, 1987; Turner and Brody, 1983).

Up to 15 species of penaeid shrimp can be expected to use the coastal and estuarine areas in the Gulf of Mexico. Brown, white, and pink shrimp are the most numerous. Pink shrimp have an almost continuous distribution throughout the Gulf but are most numerous on the shell, coral sand, and coral silt bottoms off southern Florida. Brown and white shrimp occur in both marine and estuarine habitats. Adult shrimp spawn offshore in high salinity waters; the fertilized eggs become free-swimming larvae. After several molts they enter estuarine waters as postlarvae. Wetlands within the estuary offer both a concentrated food source and a refuge from predators. After growing into juveniles the shrimp larvae leave the saline marsh to move offshore where they become adults. The timing of immigration and emigration, spatial use of a food-rich habitat, and physiological and evolutionary adaptations to tides, temperature, and salinity differ between the two species (Muncy, 1984; Turner and Brody, 1983; USDOC, NOAA, 1986).

About eight species of portunid (swimming) crabs use the coastal and estuarine areas in the Gulf of Mexico. Blue crabs (*Callinectes sapidus*) are the only species, however, that is located throughout the Gulf and comprises a substantial fishery. They occur on a variety of bottom types in fresh, estuarine and shallow offshore waters. Spawning grounds are areas of high salinity such as saline marshes and nearshore waters.

Vast intertidal reefs constructed by sedentary oysters are prominent biologically and physically in estuaries of the Gulf of Mexico. Finfishes, crabs, and shrimp are among the animals using the intertidal reefs for refuge and also as a source of food, foraging on the many reef-dwelling species. Reefs, as they become established, modify tidal currents and this, in turn, affects sedimentary patterns. Further, the reefs contribute to the stability of bordering marsh (Kilgen and Dugas, 1989).

Additional information on shellfish and their life histories can be found in Section III.B.7. of the Final EIS for Sales 157 and 161 (USDOI, MMS, 1995).

C. OTHER RELEVANT ACTIVITIES AND RESOURCES

1. Socioeconomic Conditions

a. OCS Oil and Gas Industry

Factors affecting the oil and gas industry include the structure and dynamics of international finance, the international state system, and consumer demand for gasoline. Restructuring of the oil industry has featured centralization of management, finance, and business services, and the use of computer technology to reduce the number of field operating units (Baxter, 1990).

Figures III-5 through III-7 illustrate the trends in Federal offshore mobile rig utilization, leased Federal OCS acreage, and U.S. hydrocarbon wellhead prices, respectively. These graphs, which cover the period from 1974 through the third quarter of 1996, reflect the volatility of the offshore industry from 1981 to mid-1996.

Immediately following the institution of the areawide Federal offshore leasing program in mid-1983, the declining oil and gas industry experienced some improvement. The total amount of leased OCS acreage jumped significantly in 1984, the year after the first offering of all available blocks of the Western and Central Planning Areas for lease.

The Gulf of Mexico OCS is once again the scene of a relatively intense search for new oil and gas fields. This resurgence in leasing, exploration, and development is due largely to a combination of favorable economics, recent discoveries in the deepwater regions of the Gulf, new technologies for deepwater exploration and development, deepwater royalty relief, and the use of new 3D seismic surveying technology

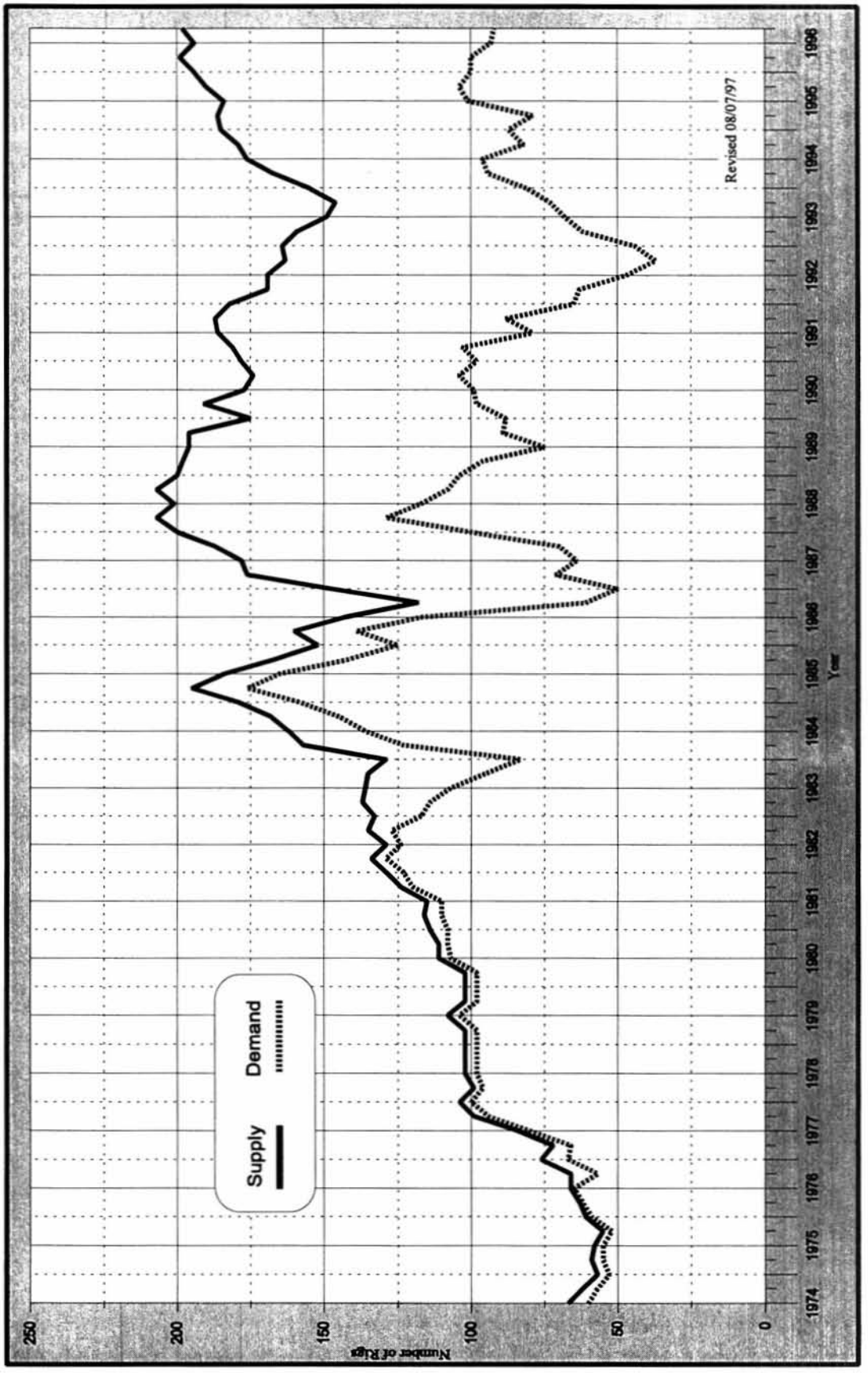


Figure III-5. Mobile Rig Utilization (USDOI, MMS, 1974-1996).

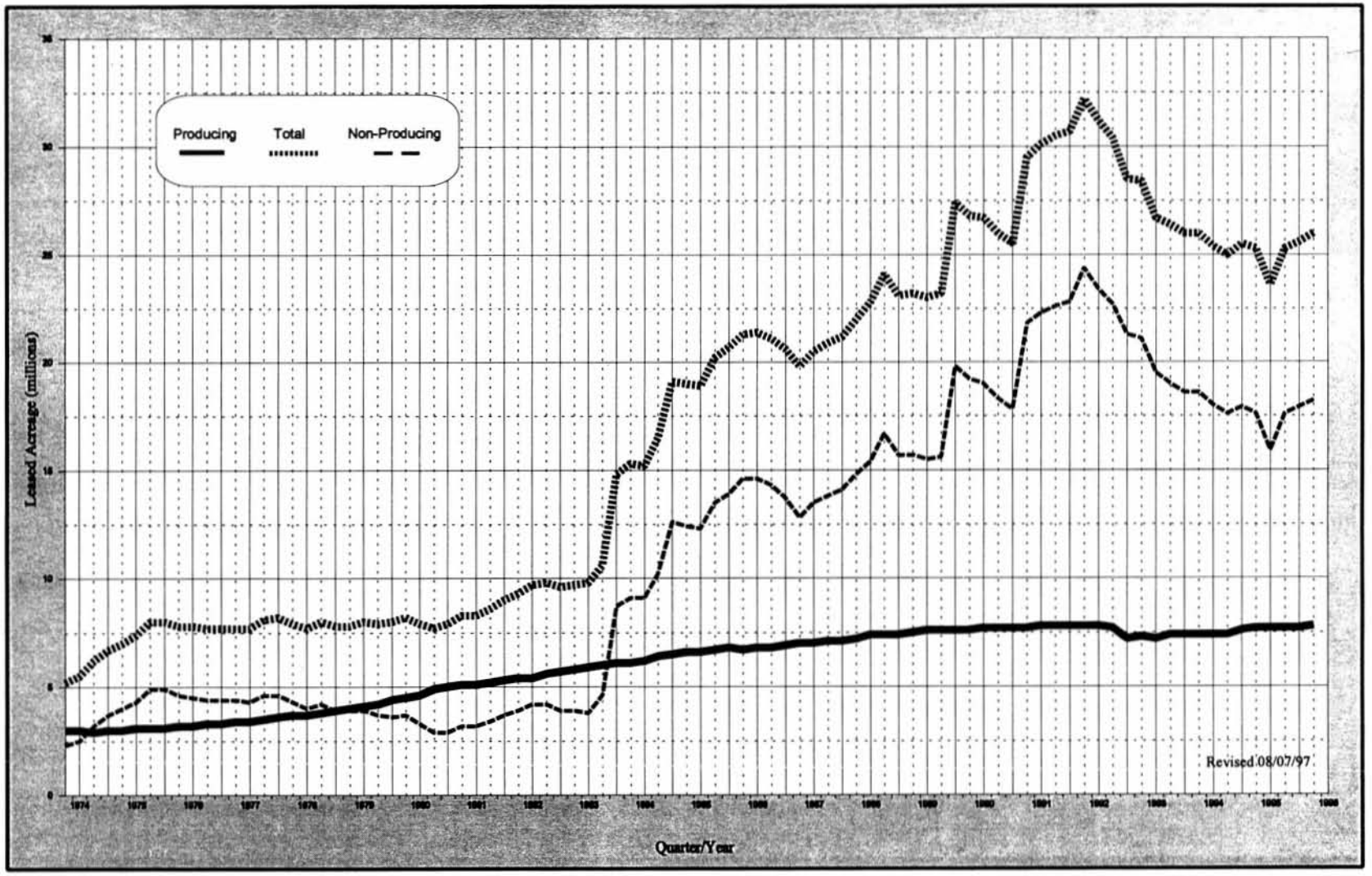


Figure III-6. Leased Acreage (USDOI, MMS, 1974 to the third quarter of 1995).

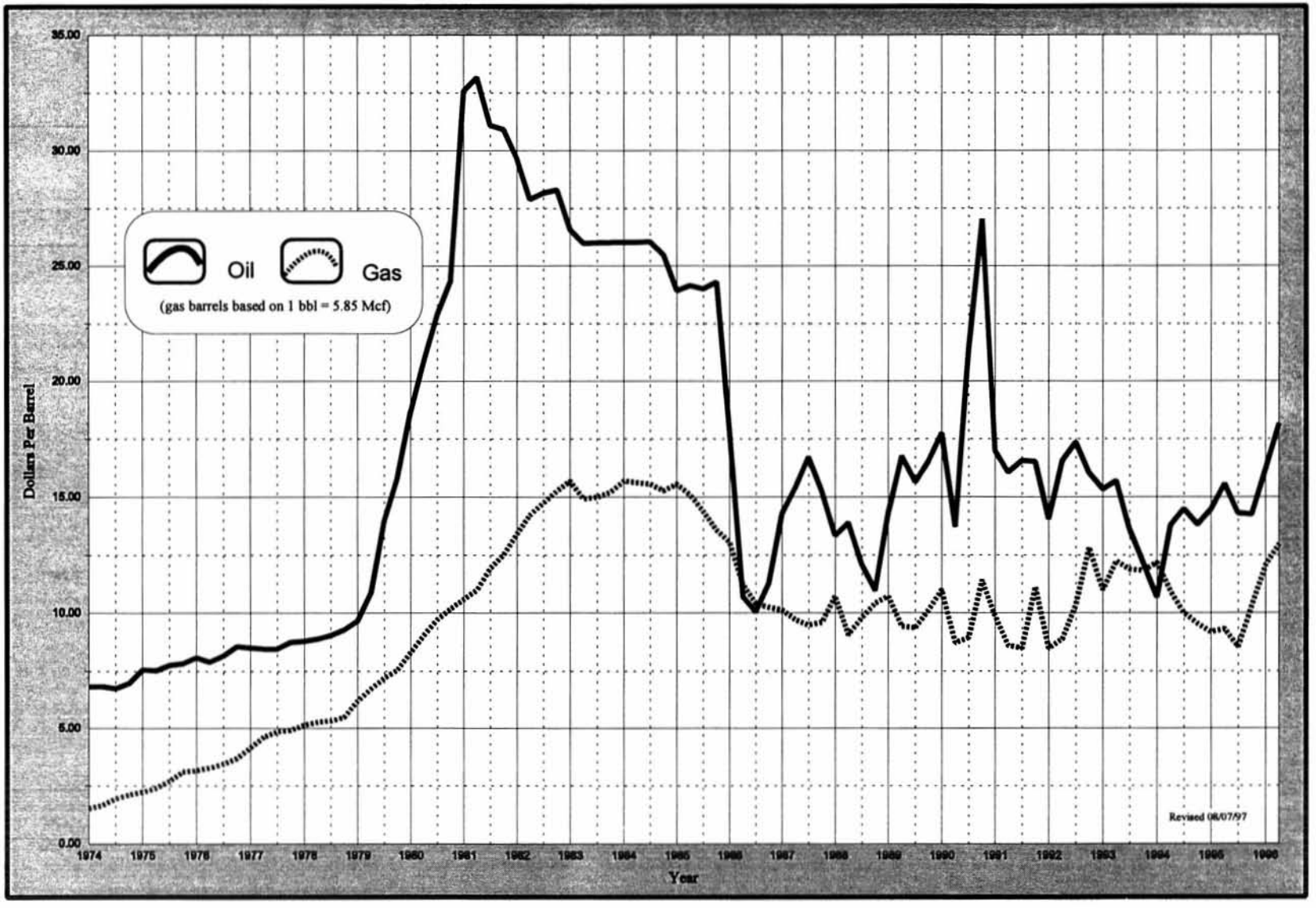


Figure III-7. Oil and Gas Wellhead Prices (U.S. Dept. of Energy, Environmental Information Administration, 1997).

to extend the life of known fields and to more accurately identify new ones. The increase in OCS activities is concentrated in the Central and Western Planning Areas. Production from the Gulf of Mexico OCS is expected to increase dramatically over the next few years.

In Figure III-5, Mobile Rig Use, the supply curve represents the total number of mobile drilling rigs available in the Gulf of Mexico. The demand curve represents only those rigs working in OCS waters. The demand for mobile rig use mirrors the incremental changes in leased OCS acreage over the years. Figures III-8 and III-9 graphically illustrate the production and production value of oil and natural gas offshore Louisiana and Texas.

b. Employment and Population

The Gulf of Mexico impact area for population, labor, and employment is defined 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. For this analysis, the coastal impact area consists of 48 counties and parishes in the Western and Central Gulf of Mexico. Inland counties and parishes are included where offshore oil and gas support 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. This coastal impact area is displayed on Visual 2.

There are 12 MSA's in the impact area of the Western and Central Gulf Region:

		<u>Western Gulf of Mexico</u>
Texas	-	Beaumont-Port Arthur, Corpus Christi, Houston-Galveston-Brazoria, Victoria, Brownsville-Harlingen
		<u>Central Gulf of Mexico</u>
Alabama	-	Mobile
Mississippi	-	Pascagoula, Biloxi-Gulfport
Louisiana	-	New Orleans, Baton Rouge, Lafayette, Lake Charles

The most populated MSA's are Houston-Galveston-Brazoria in Texas and New Orleans in Louisiana. The least populated MSA's are Victoria in Texas and Pascagoula in Mississippi.

The counties and parishes in the impact area are classified in two planning areas: the Western Planning Area (WPA) and the Central Planning Area (CPA). Each planning area is subdivided into coastal subareas: TX-1 and TX-2 in the WPA, and LA-1, LA-2, LA-3, and MA-1 in the CPA. The counties and parishes within the planning areas and coastal subareas are listed in Figure IV-1.

A Historical Perspective

Drilling rig use is a widely used measure of economic activity in the oil and gas industry. As Figure III-5 shows, drilling rig activity in the Gulf of Mexico took a sharp downturn between the end of 1981 and mid-1983. An even greater decline in the demand for mobile drilling rigs was experienced in 1985 and 1986. The population and net migration (Table III-7) parallel these fluctuations in mobile drilling rig activity. Population growth rates for all coastal subareas were relatively high prior to 1983, as families moved to the Gulf looking for work in the booming oil and gas industry. As oil and gas activity began its decline in 1982, drilling rig use also declined. Lower rates of population growth accompanied the decline in drilling activity as workers were laid off and left the area in search of work elsewhere. After 1983 all subareas experienced several years of net migration outflow. The impact on population continued as the demand for mobile rigs declined from 1984 through 1986, to its lowest level in over a decade. Significant net migration out of the region began during the three years leading to the 1986 collapse in oil prices.

Table III-8 depicts the historic indicators for the labor force and unemployment in the coastal impact area of the Gulf region over the last 30 years. In 1970, the CPA unemployment rate was about 1.5 percentage points higher than the unemployment rate for the United States. By 1980, the unemployment rate for both the Western and Central Gulf of Mexico was below the national average. With the downturn in oil prices

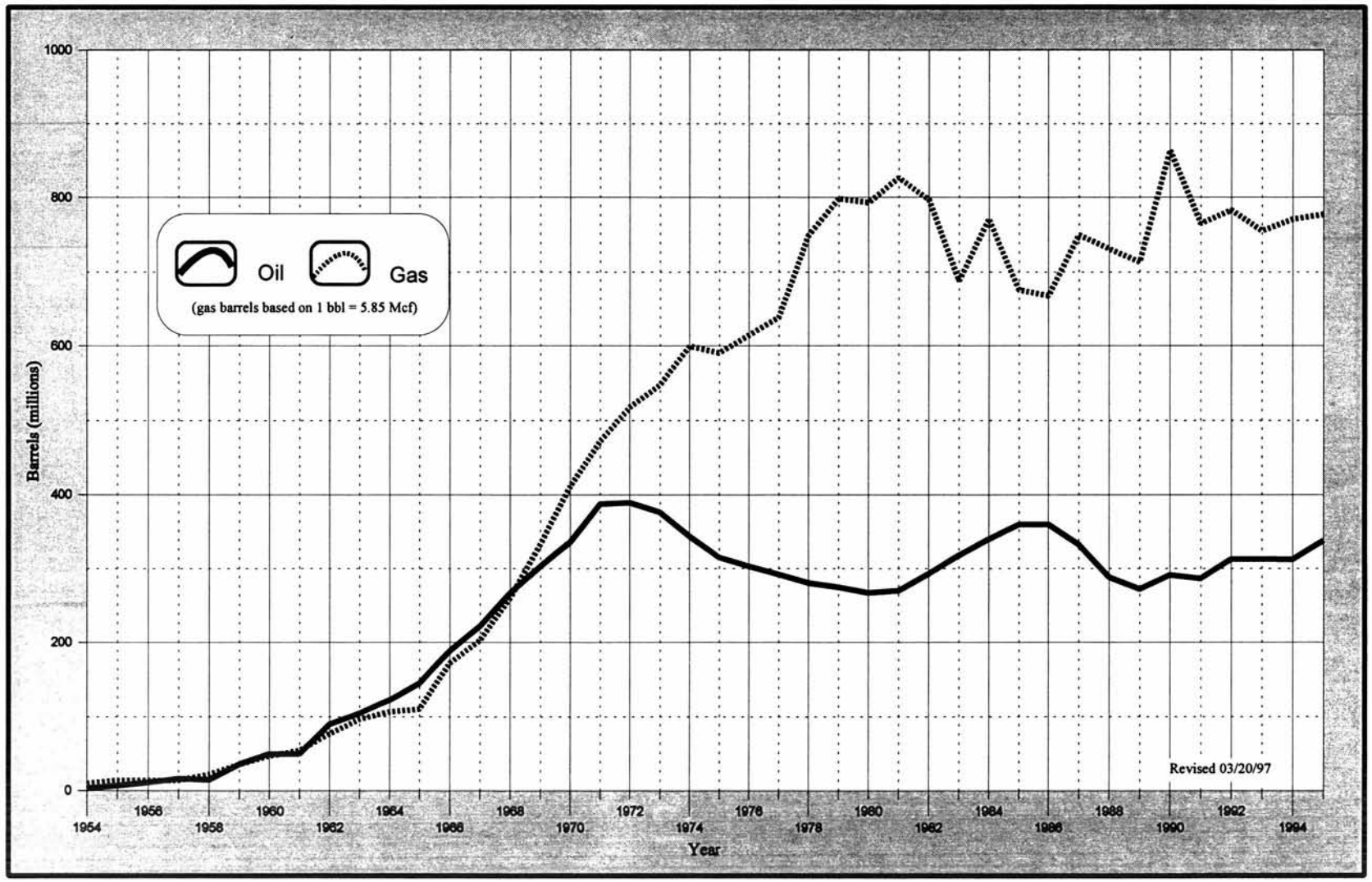


Figure III-8. OCS Oil and Gas Production Offshore Louisiana and Texas, 1954 to 1995 (USDOI, MMS, 1996b).

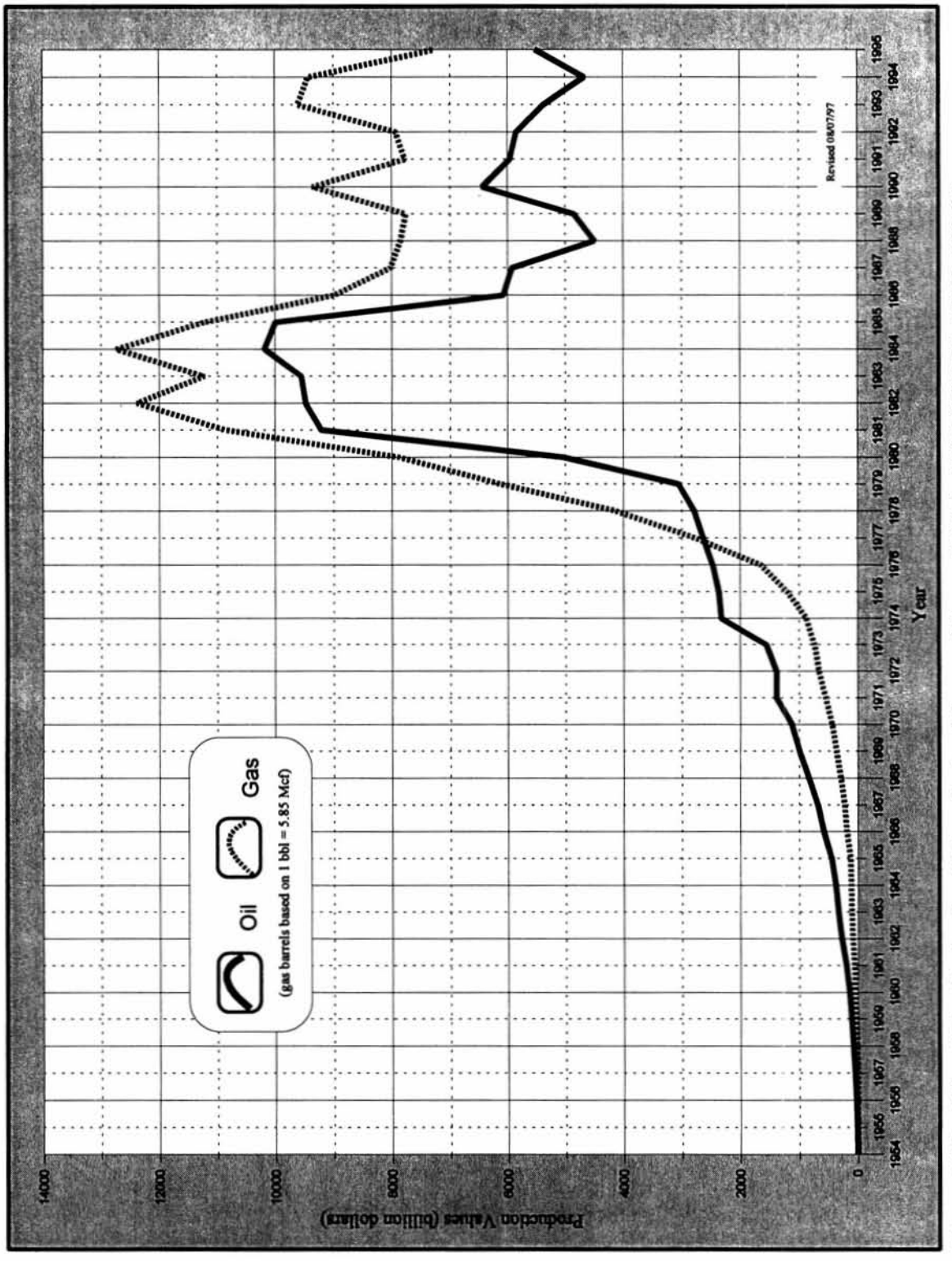


Figure III-9. Oil and Gas Production Values for Louisiana and Texas, 1954 to 1995 (USDOI, MMS, 1996b).

Table III-7

Population Statistics by Onshore Subarea

	1970	1980	1982	1983	1984	1986	1988	1990	1991	1992
Western Planning Area										
TX-1										
Population	577,582	712,633	767,000	787,700	794,300	812,300	806,700	790,800	762,500	762,000
% Change		2.3%	7.6%	2.7%	0.8%	2.3%	-0.7%	-2.0%	-3.7%	-0.1%
Net Migration	(9,727)	3,930	18,206	9,184	(4,224)	1,319	(14,635)			
TX-2										
Population	2,591,869	3,573,398	3,960,200	4,064,600	4,087,400	4,120,900	4,102,200	4,169,200	4,248,900	4,326,200
% Change		3.8%	10.8%	2.6%	0.6%	0.8%	-0.5%	1.6%	1.9%	1.8%
Net Migration	29,448	64,468	153,276	49,530	(30,549)	(31,987)	(34,358)			
Central Planning Area										
LA-1										
Population	363,793	438,786	468,700	476,200	475,100	476,700	465,000	461,900	462,900	465,900
% Change		2.1%	6.8%	1.6%	-0.2%	0.3%	-2.5%	-0.7%	0.2%	0.6%
Net Migration	(2,425)	3,058	8,627	1,018	(7,084)	(5,861)	(11,375)			
LA-2										
Population	720,341	906,656	959,600	977,500	984,700	993,800	977,100	961,100	966,300	977,600
% Change		2.6%	5.8%	1.9%	0.7%	0.9%	-1.7%	-1.6%	0.5%	1.2%
Net Migration	2,081	8,849	10,651	4,804	(5,657)	(11,233)	(18,363)			
LA-3										
Population	1,071,034	1,213,122	1,254,700	1,267,700	1,269,600	1,275,200	1,248,100	1,185,600	1,183,000	1,186,400
% Change		1.3%	3.4%	1.0%	0.1%	0.4%	-2.1%	-5.0%	-0.2%	0.3%
Net Migration	749	4,014	8,052	1,097	(9,764)	(9,220)	(21,149)			
MA-1										
Population	624,735	753,469	782,000	788,900	792,700	822,700	829,100	800,000	793,500	797,600
% Change		2.1%	3.8%	0.9%	0.5%	3.8%	0.8%	-3.5%	-0.8%	0.5%
Net Migration	(3,099)	5,333	11,547	(656)	(3,264)	13,209				

Notes: Net migration for 1970 is the annual average over the period 1960-1970.
Net migration and % population change for 1980 are annual averages over the period 1970-1980.
Net migration for subareas MA-1, TX-1, and TX-2 for 1988 are the annual averages using the change between 1986-1990.

Sources: Applied Technology Research Corporation, 1994.
USDOC, Bureau of the Census, 1990.
University of Alabama, Center for Business and Economic Research, 1992.
University of New Orleans, 1992.
Mississippi State Institutions of Higher Learning, 1991.
Texas Dept. of Commerce, 1992.

Table III-8

Labor Force and Unemployment Statistics for the Western and Central Gulf Coastal Subareas
(average annual data--thousands)

	1970	1980	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Western Gulf												
TX-1:												
Unemployment	n/a	21.1	45.0	41.6	35.2	31.4	28.0	32.2	38.8	36.0	37.6	38.5
Labor Force	n/a	302.9	347.4	344.9	344.8	347.6	345.1	354.3	369.3	376.5	388.9	390.5
Unemployment Rate	n/a	7.0	13.0	12.0	10.2	9.0	8.1	9.1	10.5	9.6	9.7	9.9
TX-2:												
Unemployment	n/a	81.0	215.5	190.1	148.9	131.6	119.3	133.2	171.5	194.4	165.0	152.9
Labor Force	n/a	1,846.2	2,017.4	2,016.3	2,043.2	2,085.1	2,228.3	2,285.3	2,349.7	2,371.2	2,409.0	2,436.8
Unemployment Rate	n/a	4.4	10.7	9.8	7.3	6.3	5.7	5.8	7.3	8.2	6.9	6.3
Total:												
Unemployment	n/a	102.1	260.5	231.7	184.1	163.0	147.3	165.4	210.3	230.4	202.6	191.4
Labor Force	n/a	2,149.1	2,364.8	2,361.2	2,388.0	2,432.7	2,573.4	2,639.6	2,719.0	2,747.7	2,797.9	2,827.3
Unemployment Rate	n/a	4.8	11.0	9.8	7.7	6.7	5.7	6.3	7.7	8.4	7.2	6.8
Central Gulf												
LA-1:												
Unemployment	8.8	11.3	33.5	29.6	23.0	15.4	12.3	14.8	19.7	15.2	14.4	13.9
Labor Force	133.1	199.5	219.8	210.8	206.6	206.5	206.2	223.6	225.2	216.0	208.1	229.6
Unemployment Rate	6.6	5.7	15.2	14.0	11.1	7.5	6.0	6.6	8.7	7.0	6.9	6.0
LA-2:												
Unemployment	16.2	24.7	61.3	55.0	47.0	33.1	27.8	31.4	35.9	34.0	37.8	31.6
Labor Force	260.8	401.2	457.0	447.8	448.1	447.2	446.5	460.6	465.0	454.6	470.3	475.2
Unemployment Rate	6.2	6.2	13.4	12.3	10.5	7.4	6.2	6.8	7.7	7.5	8.0	6.6
LA-3:												
Unemployment	24.3	31.1	63.0	57.7	54.0	40.0	33.5	33.4	37.6	35.3	48.7	34.9
Labor Force	410.9	538.7	584.4	574.0	567.4	566.1	558.1	558.7	555.8	538.0	552.7	556.3
Unemployment Rate	5.9	5.8	10.8	10.0	9.5	7.1	6.0	6.0	6.8	6.6	8.8	6.3
MA-1:												
Unemployment	11.1	22.7	35.9	34.7	31.0	30.0	25.0	25.5	28.6	27.7	25.4	27.8
Labor Force	216.9	310.6	359.6	359.8	353.7	356.1	355.2	363.8	377.0	400.6	415.3	421.5
Unemployment Rate	5.1	7.3	10.0	9.7	8.8	8.4	7.0	7.0	7.6	6.9	6.1	6.6
Total:												
Unemployment	60.4	89.9	193.7	177.0	154.9	118.4	98.6	105.1	127.7	112.2	126.3	108.1
Labor Force	1,021.7	1,449.9	1,620.8	1,592.4	1,575.8	1,575.9	1,565.9	1,606.6	1,697.3	1,609.1	1,646.4	1,682.7
Unemployment Rate	5.9	6.2	12.0	11.1	9.8	7.5	6.3	6.5	7.5	7.0	7.7	6.4
Central and Western Gulf												
Unemployment	n/a	192.0	454.2	408.6	339.0	281.4	245.9	270.4	332.1	342.6	329.0	299.5
Labor Force	n/a	3,598.9	3,985.6	3,953.6	3,963.8	4,008.5	4,139.3	4,246.1	4,342.1	4,356.9	4,444.2	4,510.0
Unemployment Rate	n/a	5.3	11.4	10.3	8.6	7.0	5.9	6.4	7.6	7.5	7.4	6.6
United States:												
Unemployment	3,640.0	7,585.0	8,237.0	7,245.0	6,700.0	6,520.0	6,799.0	8,426.0	9,384.0	8,734.0	7,996.0	7,404.0
Labor Force	82,700.0	106,821.0	117,835.0	119,865.0	121,668.0	123,846.0	124,775.0	125,303.0	126,982.0	128,040.0	131,056.0	132,304.0
Unemployment Rate	4.4	7.1	7.0	6.2	5.5	5.3	5.4	6.7	7.4	6.8	6.1	5.6

*See Figure IV-1.

Sources: Alabama Dept. of Industrial Relations, Research and Statistics, 1996.
Louisiana Dept. of Labor, 1996.
Mississippi State Employment Service, 1996.
Texas Employment Commission, 1996.

from 1986 to the early 1990's, the unemployment rate for the Gulf region surpassed national levels and the labor force growth rate dropped significantly from previous times. The impact area has experienced a decline in unemployment in the mid-1990's concurrent with the resurgence of oil and gas drilling in the Gulf of Mexico. Gulf Region population levels experienced similar trends over this time period.

The coastal subareas of the Western Gulf experienced peak unemployment levels in 1986; however, labor force estimates for the area indicate only a modest decline in 1987. By 1988, the labor force of the Western Gulf impact area was once again on the rise. In fact, the Western Gulf of Mexico experienced an overall increase in labor force from 1986 to the present, in part due to the diversification efforts pursued by the State of Texas. The Western Gulf's unemployment rate has also decreased from its 1986 peak level. Coastal Subarea TX-1, consisting of the southern Texas coastal counties, experienced a fairly stable civilian labor force and a strong decrease in unemployment during that time. Coastal Subarea TX-2, dominated by the Houston metropolitan area, experienced a significant growth in labor force and a decrease in unemployment since the 1986 downturn in the oil and gas industry. The unemployment rate of the Western Gulf impact area also increased during 1991 and 1992, mirroring the downward trend in hydrocarbon prices and mobile rig activity in those years. The Western Gulf impact area experienced a decline in the unemployment rate in 1993. The unemployment rate of the United States also fluctuated in those years (1991-1993), nearly proportionate to the fluctuation in the unemployment rate experienced in the Western and Central Gulf impact areas. Since 1993, however, the unemployment rate in the Gulf Region has declined. With the exceptions of coastal subareas MA-1 and TX-2, the Gulf of Mexico impact area has experienced a decline in the unemployment rate in 1995. All coastal subareas in the Gulf of Mexico impact area experienced a decline in the unemployment rate in 1996. Of particular note is Harris County, which experienced a decline in the unemployment rate from 7.2 percent in 1992 to 5.5 percent in 1996.

All coastal subareas of the Central Gulf also experienced peak levels of unemployment in 1986, followed by a slight decline in the labor force between 1986 and 1990. Coastal Subarea LA-1, with parishes whose industrial make-up is more directly dependent on offshore oil and gas extraction than those of all other coastal subareas, experienced the most noticeable decline in labor force, particularly between 1986 and 1988. Coastal Subarea LA-2, with parishes whose industrial composition is highly dependent on activity indirectly associated with oil and gas extraction (e.g., refining and gas processing) and has a high blue-collar involvement, experienced a small decline in labor force during the same time period. The urban and suburban New Orleans composition of coastal Subarea LA-3, which has a strong tie to offshore oil and gas development but also has a somewhat more diversified economy, experienced a moderate decline in labor forces since the downturn in oil prices of 1986. Coastal Subarea MA-1, consisting of the Mississippi and Alabama coastal counties, experienced the smallest impact, with only a modest decline in labor force since 1986. The decline observed in the labor force of the Central Gulf coastal subareas is consistent with the net migration experienced in the area over the same time period, particularly from 1986 to 1988. Thus, the unemployment rate of the Central Gulf impact area declined steadily from 1986 to 1990. However, the unemployment rate of the Central Gulf impact area increased during 1991 and 1992, coincident with the decline in hydrocarbon prices and mobile rig activity in those years. As in the Western Gulf, the unemployment rate of the Central Gulf impact area in 1993 declined from the 1992 level. All Central Gulf coastal subareas, with the exception of MA-1, display lower levels of labor force in 1993. All Central Gulf coastal subareas, with the exception of MA-1, experienced a decline in the unemployment rate in 1995. The unemployment rate for all Central Gulf coastal subareas (Louisiana, Mississippi, and Alabama) declined in 1996. Testimony presented at a public hearing on the Central Gulf Multisale Draft EIS in Houma, Louisiana, on June 23, 1997, highlighted South Lafourche as an area currently undergoing a strong resurgence of oil- and gas-related employment. Indeed, Lafourche Parish has experienced a decline in the unemployment rate from 7.4 percent in 1992 to 4.3 percent in 1996. Preliminary statistics for 1997 (through April) reveal a 3.2 percent unemployment rate for Lafourche Parish. Lafayette Parish, an administrative center for the oil and gas industry, has undergone similar trends in unemployment. The unemployment rate decreased from 7 percent in 1992 to 4.5 percent in 1996. Other counties in the Central Gulf coastal subareas (Baldwin County in Alabama and Harrison County in Mississippi) have also undergone similar declines in unemployment, although these economies are only peripherally related to the oil and gas industry.

Current Statistics

The Western and Central Gulf vary substantially in socioeconomic patterns, ranging from low-density, undeveloped rural areas to high-density, highly developed urban centers. Current population statistics for the coastal impact area are shown in Table III-7.

According to 1990 United States Census Bureau statistics, the New Orleans urbanized area ranks 7th in population density with 3,852 people per square mile; the Houston urbanized area ranks 25th in population density with 2,466 people per square mile. The Houston urbanized area grew by 314 percent from 1950 to 1990 and the New Orleans urbanized area grew by 58 percent in the same time period.

Table III-9 reflects the 1994 industrial composition of the coastal subareas. The 1994 industrial composition for the Western Gulf coastal subareas--TX-1 and TX-2--and that of the Central Gulf are similar. In both Texas coastal subareas, the largest employer industries for 1994 were services and retail trade, followed closely by the government sector. The industries providing the largest payroll were services, government, and manufacturing.

Services was the largest employer industry for coastal Subareas TX-1 and TX-2, accounting for the highest percentage payroll as well. The manufacturing and government sectors also contributed significantly percentage-wise to employment and payroll in 1994. Mining played a relatively minor role for the Texas coastal subareas, contributing less than 4 percent to employment. The mining sector contributed over 7 percent to payroll for coastal Subarea TX-2, however.

The Gulf area in 1990 reflected a modest to significant recovery from the high unemployment levels experienced after the 1986 downturn of the oil and gas industry. Ironically, the Gulf Coast is experiencing a shortage of skilled labor in the oil and gas industry due to "the restructuring of the oil industry to centralize management, finance, and business services, and the use of computer technology" (Baxter, 1990). Of all coastal subareas in the Gulf, coastal Subarea TX-1 experienced the highest unemployment rate through July 1990, but that rate still exhibited a marked improvement from earlier 1986 levels. Coastal Subarea TX-2 exhibited the lowest unemployment rate for 1990, only 0.1 percentage points higher than the national average. The Central Gulf of Mexico's unemployment rate of 6.3 percent in 1990 was somewhat over the national average. Unemployment in the Western and Central Gulf impact areas climbed moderately during 1991 and 1992. In recent years (including 1996), unemployment has declined.

At present, the impact area is experiencing a major resurgence in oil exploration and drilling. Advances in technology (especially the 3D and 4D seismic technology and horizontal drilling) and stable energy demand, along with enactment of the Deep Water Royalty Relief Act, have served to renew interest in oil and gas exploration and development in the Gulf of Mexico. The most recent sale (Central Gulf Sale 169) continued the trend towards renewed leasing in the Gulf with a total of 794 blocks receiving bids. This followed on the heels of Western Gulf Sale 168 and Central Gulf Sale 166, which had a total of 804 and 1,032 blocks, respectively, receiving bids. Sale 169 represented the third largest number of blocks receiving bids of any Gulf of Mexico lease sale. Recent OCS sales highlight industry's long-term committment to the Gulf. This resurgence has spurred predictions of steady increases in the coastal area's job market over the next few years. According to the Louisiana Economic Outlook (Scott et al., 1996), during 1995, Louisiana was dramatically recovering from the recession of the late 1980's and adding over 100,000 non-farm jobs a year. Recently, Louisiana's unemployment rate was less than the Nation's for the first time in about a decade. Mining employment is hard to quantify, however, in light of the restructuring that the oil industry underwent in the late 1980's. Many services (such as accounting and engineering) previously provided by oil companies are now outsourced and reclassified. Additionally, both oil companies and employees are being cautious. Rather than new hiring, reassignment or transfer of existing employees has become common practice for big oil companies' corporate offices. However, the bulk of the job growth is for welders, fitters, and other craftsmen in the coastal communities of the Gulf of Mexico. Also, potential mining employees are experiencing the "shadow effect" such that workers who previously lost high-paying jobs in the oil industry (or oil service industry) are reluctant to return until stability in the industry is felt. Some workers have been retrained in other promising industries (such as health care) and some have left the Gulf coastal area. This has presented a unique dilemma for the local economy. The shadow effect, coupled with a shortage of skilled labor where the core problem is lack of education and/or training for the requisite skills, has created a situation where temporary communities of workers from out of the area (some from out of the country) have been established. Furthermore, deepwater development drilling requires a higher skill level that may not be met with the existing labor force in the impact area. So while the coastal area's job market has been steadily increasing, some employment is being met through in-migration.

The exploration and production of crude oil and gas is classified as a primary industry. Secondary industries are activities associated with the processing of crude oil and gas in refineries, natural gas plants, and petrochemical plants. While detailed employment information strictly related to offshore activity in the Gulf of Mexico is not readily available, data for selected Standard Industrial Classification (SIC) codes from

Table III-9

Industrial Composition of Western and Central Gulf Coastal Subareas for 1994

	Mining	Ag, For, & Fish	Construct	Manufact	Wholesale Trade	Retail Trade	Transportation & Public Util	FIRE	Services	Government	Total
TX-1											
Employment	9,262	9,155	24,578	37,926	14,335	74,726	16,320	23,335	109,112	73,906	392,655
Percent:	2.36%	2.33%	6.26%	9.66%	3.65%	19.03%	4.16%	5.94%	27.79%	18.82%	100.00%
Payroll	288,659	93,179	547,102	1,480,719	394,716	1,048,861	540,194	352,599	2,235,000	1,984,204	8,965,233
Percent:	3.22%	1.04%	6.10%	16.52%	4.40%	11.70%	6.03%	3.93%	24.93%	22.13%	100.00%
TX-2											
Employment	89,382	25,682	190,153	245,850	136,957	416,905	155,490	184,560	779,734	317,441	2,542,154
Percent:	3.52%	1.01%	7.48%	9.67%	5.39%	16.40%	6.12%	7.26%	30.67%	12.49%	100.00%
Payroll	5,761,877	354,422	6,080,422	12,666,184	5,762,306	6,575,956	7,567,832	4,717,835	22,965,599	9,181,871	81,634,304
Percent:	7.06%	0.43%	7.45%	15.52%	7.06%	8.06%	9.27%	5.78%	28.13%	11.25%	100.00%
WGOM											
Employment	98,644	34,837	214,731	283,776	151,292	491,631	171,810	207,895	888,846	391,347	2,934,809
Percent:	3.36%	1.19%	7.32%	9.67%	5.16%	16.75%	5.85%	7.08%	30.29%	13.33%	100.00%
Payroll	6,050,536	447,601	6,627,524	14,146,903	6,157,022	7,624,817	8,108,026	5,070,434	25,200,599	11,166,075	90,599,537
Percent:	6.68%	0.49%	7.32%	15.61%	6.80%	8.42%	8.95%	5.60%	27.82%	12.32%	100.00%
LA-1											
Employment	18,181	2,569	18,203	25,181	12,325	46,797	16,543	11,927	72,916	34,338	258,9
Percent:	7.02%	0.99%	7.03%	9.72%	4.76%	18.07%	6.39%	4.61%	28.16%	13.26%	100.00%
Payroll	772,163	31,952	450,956	1,044,695	351,412	633,912	529,557	229,777	1,692,705	799,286	6,536,415
Percent:	11.81%	0.49%	6.90%	15.98%	5.38%	9.70%	8.10%	3.52%	25.90%	12.23%	100.00%
LA-2											
Employment	10,868	6,780	50,264	47,355	24,018	84,472	31,397	29,689	129,712	95,304	509,859
Percent:	2.13%	1.33%	9.86%	9.29%	4.71%	16.57%	6.16%	5.82%	25.44%	18.69%	100.00%
Payroll	461,610	62,608	1,383,443	2,251,222	765,338	1,153,034	1,025,193	655,751	2,951,381	2,190,892	12,900,472
Percent:	3.58%	0.49%	10.72%	17.45%	5.93%	8.94%	7.95%	5.08%	22.88%	16.98%	100.00%
LA-3											
Employment	15,254	5,622	30,686	39,675	34,343	119,150	44,938	42,918	221,520	110,171	664,277
Percent:	2.30%	0.85%	4.62%	5.97%	5.17%	17.94%	6.76%	6.46%	33.35%	16.59%	100.00%
Payroll	901,010	68,067	833,451	1,542,368	1,154,083	1,847,858	1,623,911	1,152,449	5,825,536	2,955,408	17,904,141
Percent:	5.03%	0.38%	4.66%	8.61%	6.45%	10.32%	9.07%	6.44%	32.54%	16.51%	100.00%
MA-1											
Employment	1,255	6,262	29,180	58,753	16,579	78,100	20,999	21,445	123,631	84,890	441,094
Percent:	0.28%	1.42%	6.62%	13.32%	3.76%	17.71%	4.76%	4.86%	28.03%	19.25%	100.00%
Payroll	30,697	55,626	701,347	2,140,130	478,581	1,100,164	660,023	419,526	2,773,357	2,204,164	10,563,615
Percent:	0.29%	0.53%	6.64%	20.26%	4.53%	10.41%	6.25%	3.97%	26.25%	20.87%	100.00%
CGOM											
Employment	45,558	21,233	128,333	170,964	87,265	328,519	113,877	105,979	547,779	324,703	1,874,210
Percent:	2.43%	1.13%	6.85%	9.12%	4.66%	17.53%	6.08%	5.65%	29.23%	17.32%	100.00%
Payroll	2,165,480	218,253	3,369,197	6,978,415	2,749,414	4,734,968	3,838,684	2,457,503	13,242,979	8,149,750	47,904,643
Percent:	4.52%	0.46%	7.03%	14.57%	5.74%	9.88%	8.01%	5.13%	27.64%	17.01%	100.00%
GOM											
Employment	144,202	56,070	343,064	454,740	238,557	820,150	285,687	313,874	1,436,625	716,050	4,809,019
Percent:	3.00%	1.17%	7.13%	9.46%	4.96%	17.05%	5.94%	6.53%	29.87%	14.89%	100.00%
Payroll	8,216,016	665,854	9,996,721	21,125,318	8,906,436	12,359,785	11,946,710	7,527,93	38,443,578	19,315,825	138,504,180
Percent:	5.93%	0.48%	7.22%	15.25%	6.43%	8.92%	8.63%	5.44%	27.76%	13.95%	100.00%

the annual U.S. Bureau of the Census County Business Patterns can be used to estimate such employment and related economic effects on the coastal region. The specific SIC codes used in the analysis include the following:

13	-	oil and gas extraction
29	-	petroleum and coal products
3533	-	oil-field machinery
46	-	petroleum pipelines
492	-	gas production distribution
517	-	petroleum and petroleum products
3731	-	shipbuilding

These SIC codes can be used to further identify the extent of direct and indirect employment in the oil and gas industry. SIC 13 is the primary industry from which direct-employment estimates are obtained. The other codes listed identify secondary industries that form the base for estimating indirect employment. Partially excluded from this analysis are some SIC codes that include OCS-related industries within broader categories of data (e.g., SIC 3731 includes shipbuilding and mobile rig fabrication, which is historically considered to be 65% OCS related). Finally, numerous tertiary industries are affected by both direct and secondary industry employment. Induced employment resulting from tertiary industry activity is included in the calculation of OCS Program employment.

The production of oil and gas has been a major source of revenue in the Gulf area since 1954. Data from the Bureau of Economic Analysis's Regional Measurement Division for 1994 show that the average annual payroll associated with all oil and gas activities amounts to approximately $8.2 billion for the Gulf of Mexico Region. Average annual tax dollars generated in the offshore oil and gas program are estimated at 8 percent of payroll revenues. Thus, State and local taxes generated annually by the development of oil and gas in the Gulf of Mexico coastal region are estimated at approximately $660 million.

Job estimates as of February 1997 show that about 35,500 jobs are directly dependent on the offshore program. Nearly all offshore-related employment in the Central Gulf is due to activity offshore Louisiana. In addition, offshore activity in other areas of the Gulf generates employment in Louisiana.

Projections

Table III-10 contains population and employment projections for the coastal subareas of the Western and Central Gulf impact area. Projections through 2045 are based on a population forecast made by the Bureau of Economic Analysis (BEA) Projections to 2045. Regionally, growth is expected to continue to be relatively stronger in the Mideast and Great Lakes areas of the United States based on the BEA regional projections. The population of the Gulf of Mexico Region is projected to grow at a lower rate than the U.S. average. The population of counties and parishes in the Western and Central Gulf impact area is expected to increase approximately 56 percent from 1993 population levels by the year 2045.

Table III-10 also provides employment projections for the coastal subareas of the Western and Central Gulf. Actual employment is shown for the years 1990 through 1995. 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 leasing activity.

c. Public Services, Infrastructure, and Land Use Plans

Public services and infrastructure, as used here, include commonly provided public, semi-public, and private services and facilities, such as education, police and fire protection, sewage treatment, solid-waste disposal, water supply, recreation, transportation, health care, other utilities, and housing. The geographic area that could be directly affected by the proposed actions include coastal parishes and counties in Louisiana, Mississippi, Alabama, and Texas. The greatest effects of the proposed actions would be in Texas and Louisiana.

Table III-10

Population and Employment Projections for the Western and Central Gulf Coastal Subareas*
(thousands)

		1990	1991	1992	1995	2000	2010	2027
Western Planning Area								
TX-1								
	Population	790,774	762,526	762,016	760,489	791,144	848,677	956,247
	% Growth		-3.57%	-0.07%	-0.07%	0.79%	0.70%	0.70%
	Employment	322,200	328,770	337,286	355,334	380,543	421,569	501,718
	% Growth		2.04%	2.59%	1.75%	1.38%	1.03%	1.03%
TX-2								
	Population	4,169,240	4,249,055	4,326,284	4,566,494	4,892,609	5,464,097	6,592,965
	% Growth		1.91%	1.82%	1.82%	1.39%	1.11%	1.11%
	Employment	1,985,000	2,051,847	2,074,654	2,235,204	2,472,857	2,866,982	3,686,458
	% Growth		3.37%	1.11%	2.52%	2.04%	1.49%	1.49%
Total								
	Population	4,960,014	5,011,581	5,088,300	5,326,983	5,683,752	6,312,774	7,549,212
	% Growth		1.04%	1.53%	1.54%	1.30%	1.06%	1.06%
	Employment	2,307,200	2,380,617	2,411,940	2,590,538	2,853,399	3,288,551	4,188,176
	% Growth		3.18%	1.32%	2.41%	1.95%	1.43%	1.43%
Central Planning Area								
LA-1								
	Population	461,908	462,861	465,856	474,956	489,544	516,207	564,909
	% Growth		0.21%	0.65%	0.65%	0.61%	0.53%	0.53%
	Employment	193,900	208,800	205,140	216,714	232,600	256,564	303,102
	% Growth		7.68%	-1.75%	1.85%	1.42%	0.99%	0.99%
LA-2								
	Population	961,127	966,286	977,572	1,012,229	1,059,780	1,142,073	1,296,901
	% Growth		0.54%	1.17%	1.17%	0.92%	0.75%	0.75%
	Employment	418,700	429,150	425,675	452,172	486,752	538,542	639,544
	% Growth		2.50%	-0.81%	2.03%	1.48%	1.02%	1.02%
LA-3								
	Population	1,185,552	1,182,956	1,186,429	1,196,909	1,220,673	1,282,000	1,393,410
	% Growth		-0.22%	0.29%	0.29%	0.39%	0.49%	0.49%
	Employment	524,600	525,300	505,700	526,507	559,862	620,694	739,658
	% Growth		0.13%	-3.73%	1.35%	1.24%	1.04%	1.04%
MA-1								
	Population	800,041	793,516	797,658	810,214	838,134	885,644	972,672
	% Growth		-0.82%	0.52%	0.52%	0.68%	0.55%	0.55%
	Employment	330,200	340,990	349,400	365,504	387,585	422,332	488,701
	% Growth		3.27%	2.47%	1.51%	1.18%	0.86%	0.86%
Total								
	Population	3,408,628	3,405,619	3,427,515	3,494,308	3,608,131	3,825,924	4,227,892
	% Growth		-0.09%	0.64%	0.65%	0.64%	0.59%	0.59%
	Employment	1,467,400	1,504,240	1,485,915	1,560,897	1,666,799	1,838,132	2,171,005
	% Growth		2.51%	-1.22%	1.65%	1.32%	0.98%	0.98%

*See Figure IV-1.

Source: U.S. Dept. of Commerce, Bureau of Economic Analysis, 1995.

Infrastructure and public service development in the area of consideration have tracked population growth and community development. The Gulf Coast physiography has strongly influenced population distribution and community growth. The Texas coastal area includes a broad coastal plain dissected by large estuarine bays. A nearly continuous string of barrier islands serves to protect the mainland areas from the greatest impacts of tropical storms. The Louisiana coastal area includes broad expanses of coastal marshes and swamps interspersed with ridges of higher well-drained land along the courses of modern and extinct river systems. Many of the larger urban centers in coastal Texas are located at the head of navigable estuaries (e.g., Houston and Beaumont). In coastal Louisiana, most large urban centers are located along major navigable rivers and/or along the landward edge of the coastal zone (e.g., Lafayette and Lake Charles). In Mississippi and Alabama, much of the population resides along the immediate coastal fringe and along the shores of navigable estuaries between Gulfport, Mississippi, and Mobile, Alabama.

Public services and infrastructure depend heavily on levels of population, migration patterns, and employment. The most important factor in the Gulf Coastal area has been the oil and gas industry, particularly in Texas and Louisiana.

The characteristics of the regional landscape throughout the Gulf of Mexico region have promoted the growth of population centers keyed to the development of natural resources that occur in the area (oil and gas and other minerals) or to agricultural, forestry, and fisheries resources suited to the regional land and climatic conditions. Rice and sugar cane have become primary crops planted along the coast, sometimes associated with crawfish aquaculture. Cattle farming has been practiced in Texas since early historic times. Forestry has long been an important activity along the Central Gulf coast, in earlier days using swamp and riparian hardwoods, and today mainly pine plantations. The abundant fisheries resources of the open Gulf and nearshore waters have promoted a large fishing fleet and associated seafood processing facilities. The most important resource that has affected community infrastructure changes in the Gulf area, however, has been oil and gas development, both within State jurisdiction and on the Federal OCS.

The area's history and natural resource-based economy have influenced the development of the particulars of the infrastructure distribution in the area. One interstate highway (I-10) traverses the area along the inner margin of the coastal zone in Alabama, Mississippi, Louisiana, and the eastern part of Texas. The central and western part of Texas has a four-lane highway (U.S. 77) that parallels the coast. For the most part, only secondary highways penetrate longitudinally into the coastal areas (Visual 2, Multiple Use Map, 1994). A similar pattern applies to railroads. The agricultural, forestry, and mineral products exported from the area could be largely shipped in bulk by water transport, pipeline, or spur rail line, and an elaborate network of improved highways was not needed. Similarly, communities are scattered throughout the region and are based on extracting, growing, or processing area resources.

Offshore development began off the coast of Louisiana in the 1940's. Initially, it was confined to the coastal waters; however, by the late 1940's, development had moved onto what is presently recognized as the Federal OCS. Offshore development off the coast of Texas occurred at approximately the same time (i.e., late 1940's). Since 1974, the hydrocarbon production from the Gulf of Mexico OCS has surpassed onshore and nearshore coastal production. As of 1994, the Federal OCS accounted for about 80 percent of offshore crude oil and 88 percent of offshore natural gas production (USDOI, MMS, 1997).

Since 1971, OCS crude oil as a percentage of total U.S. production remained stable between 8.8 and 12.9 percent before reaching an all-time high of 15.3 percent in 1994. Production of OCS natural gas as a percentage of total U.S. production has continued to rise since 1971, reaching an all-time high in 1990 of 27.4 percent before dropping to 23.7 percent in 1994 (USDOI, MMS, 1997).

Following years of relatively stable prices, the average annual price of oil began to rise in 1973, initially in response to the Arab Oil Embargo and later as a result of the increasing marketing effectiveness of the Organization for Petroleum Exporting Countries (OPEC) (cf. Laska et al., 1993). The price increase stimulated oil and gas exploration on the OCS, and with the increase in OCS oil and gas exploration and development came a concomitant increase in jobs. The population in the coastal counties and parishes of the Western and Central Gulf of Mexico rose, due, in part, to in-migration of persons seeking employment in the OCS oil and gas industry. Therefore, it is assumed that the in-migration to the area was due, in large part, to the increase in oil and gas activity resulting from the increase in the world oil price. It has been postulated that, by 1981, the northern Gulf of Mexico was the most developed offshore area in the world (Gramling and Freudenburg, 1990).

According to Table III-7, the average annual percent of population change in the Western Gulf from 1970 to 1980 was between 2.3 and 3.8 percent, with an average annual net migration between 3,900 and 64,500. The population increase in the Central Gulf mirrored those of the Western Gulf. The average annual

percent of population change in the Western Gulf from 1970 to 1980 was between 1.3 and 2.6 percent, with an average annual net migration between 3,000 and 8,900.

The period of positive net migration and population growth in the different subareas of the Western and Central Gulf correlate to the period of rising world oil prices and increasing OCS activity, as well as increased oil and gas activity in the respective State controlled areas. In the Western Gulf, population continued to increase from 1980 to 1983 with the percent change in population ranging from 2.3 to 10.8 percent. In 1982 and 1983, most of the Central Gulf experienced population increases caused, in part, by in-migration. The sole exception to this was coastal Subarea MA-1, which experienced net out-migration in 1983. Percent change in population over these years varied from 0.9 percent to 6.8 percent. Recent testimony presented at a public hearing in Houma, Louisiana, on June 23, 1997, reports importation of foreign workers in southern Lafourche and Jefferson Parishes, Louisiana, in response to heavy demand for labor.

Cyclic fluctuation as it relates to oil and gas development in the Gulf of Mexico has been commented on by several authors (cf. Seydlitz and Laska (1994), Laska et al. (1993), Gramling and Freudenburg (1990), Gramling and Brabant (1986), and Gramling (1984)). The rural and relatively isolated nature of the coastal parishes in Louisiana meant that increases in population resulted in greater responsibilities for public service agencies and a need for improved infrastructure in these parishes. Also, the OCS oil and gas industry required some infrastructure improvements to gain access to staging points, water, etc. Increases in expenditures from 1960 to 1980 among several categories of infrastructure included a 184 percent increase in education; a 186 percent increase in fire protection; a 67 percent increase in expenditures for highways; an 86 percent increase in housing; a 200 percent increase in public welfare; a 404 percent increase in health and hospitals; and a 267 percent increase in police protection. The three coastal subareas that experienced the highest increase in outstanding indebtedness when compared from 1960 to 1980 were Subarea LA-1 (170%), Subarea LA-2 (154%), and Subarea TX-2 (146%) (McKenzie et al., 1993). Direct general expenditures by local government in the coastal subareas of the Western and Central Gulf of Mexico amounted to $7.4 billion in 1980.

The rapid increase in population was associated with an increase in the demand for housing and public services. There was also a strain on transportation networks caused by the population increase and by the need for offshore workers and supplies to reach offshore activity staging areas. The recent upsurge in OCS activity, particularly activity serviced through Port Fourchon, Louisiana, has been attributed with an increased need to provide English as a second language class and to expand vocational programs at high schools in Lafourche Parish, Louisiana (Duplantis, written communication, 1997). Seydlitz and Laska (1994; pp. 7-8) state that there was an increase in the high school completion rate and a decrease in the percentage of high school graduates enrolling in institutions of higher learning when petroleum activity increased. They also state that there was an association between increases in petroleum activity and increased educational strain; however, this effect was short term.

The downturn in world oil prices that characterized the mid-1980's was reflected in a decreasing amount of oil and gas activity in the Western and Central Gulf, which, in turn, resulted in greater unemployment and underemployment in the coastal parishes and counties. A comparison of 1980 and 1990 employment shares in oil and gas shows that almost all parishes in Louisiana experienced a decline in the percent of total employment (Greene and Morin, 1997). During the downturn, public and private public service agencies were called upon to provide families and individuals with food, shelter, and other forms of assistance. This resulted in strain on the various public and private service agencies as they attempted to meet rising public service needs (cf. Laska et al., 1993). High unemployment rates and net out-migration from the area during much of the 1980's resulted in falling real estate values and financial problems for individuals and financial institutions. State and local agencies also experienced difficulties in supporting and continuing those programs for upgrading infrastructure that had been started or planned during the earlier days of oil and gas industry expansion. During the period from 1982 to 1986, local government expenditures increased by 30 percent. Texas coastal subareas experienced significantly greater increases than Louisiana coastal areas. This difference reflects the greater economic diversity that is found in coastal Texas as compared to that of coastal Louisiana. While the coastal areas of Texas were impacted by the downturn in the oil and gas industry, the degree of impact was ameliorated to some extent by the greater economic diversity found in Texas. Coastal subareas LA-1 and LA-2 saw expenditure cuts in education, public welfare, and housing. Subarea LA-2 also saw cuts in health and hospitals and police protection. Other decreases reported were in Subareas LA-4 (fire protection); TX-2 (public welfare); and LA-3 (housing). At the same time, all six coastal subareas experienced an increase in local government expenditures for interest on debt, highways, and financial administration (McKenzie et al., 1993).

An apparent shift in industry characteristics occurred following the downturn in industry levels. Independent companies (more specifically, nonintegrated companies) increased their presence in the Gulf between 1986 and 1994, whereas large- and small-integrated companies either reduced their presence or maintained a steady presence (Seydlitz et al., 1995). The complex melange of reasons leading to this increase in the presence of independent companies in the Gulf include the downsizing of larger companies, creating opportunities for entrepreneurs; the lowering of the minimum bid per acre for leased OCS lands; and the implementation of areawide leasing. Preliminary results of recent research suggest a decline in the offshore industry's accident rate through time (when comparing 1987-1994 to 1980-1986), and also suggest that there was not a great difference between major and independent operators' environmental and safety records over the same period (Pulsipher, 1996).

The early 1990's witnessed a stabilization of OCS activity from that witnessed during the downturn of the mid-1980's. This, in turn, has been followed by a major resurgence in OCS activity over the period from 1994 through the present. The most recent Western Gulf of Mexico Sale (Sale 168) continued the trend towards renewed leasing in the Gulf with a total of 804 blocks receiving bids (777 leases were let in Sale 168). The most recent Central Gulf of Mexico Sale (Sale 169), which received 1,188 bids on 794 blocks despite falling oil prices, indicates the resurgence in OCS development is demand driven. The strengthening U.S. economy has triggered higher demand for petrochemicals, the building blocks for many manufactured goods. Global demand for crude is estimated to increase by more than 30 percent by the year 2010. Sale 169 represented the third largest number of blocks receiving bids of any Gulf of Mexico OCS lease sale and highlights the degree of industry commitment to the Gulf. Concurrent with this increase in leasing activity is an increase in the percentage of deepwater blocks that are leased. Western Gulf Sale 168 had about 75 percent of total leased blocks in water depths greater than 800 m. Since the enactment of the Deep Water Royalty Relief Act in 1995, 65 percent of the leases let have been in water depths greater than 200 m; 62 percent in water depths greater than 400 m; and 55 percent in water depths greater than 800 m. [These results exclude Sale 169 because lease awards have not yet been made.] The increase in deepwater activity is due, in large part, to the enactment of the Deep Water Royalty Relief Act in 1995. Other factors contributing to the increase in OCS activities relate to technological advancements occurring in the industry and steadily rising energy demand.

As discussed above, mining employment is hard to quantify in light of the restructuring that the oil industry has undergone. Many services (such as accounting and engineering) previously provided by oil companies are now outsourced and reclassified. Additionally, both oil companies and employees are being cautious. Rather than new hiring, reassignment or transfer of existing employees is the norm for big oil companies' corporate offices. Recently, temporary communities of workers from out of the area (some from out of the country) have been established to fill some skilled positions. Furthermore, deepwater development drilling requires a higher skill level that may not be met with the existing labor force in the impact area. So while the coastal area's job market has been steadily increasing, some employment is being met through in-migration. In the vast majority of areas, the stresses placed on local infrastructure are not as great as those placed on it during the boom times of the late 1970's and early 1980's. However, the specialized needs of deepwater exploration and development have resulted in the focusing of stresses (particularly at Port Fourchon, Louisiana, as a direct outgrowth of deepwater activity) to a level that is as great as, if not greater than, the stresses found during the boom of the late 1970's and early 1980's. If the trend of increased activity continues and the need for skilled workers results in greater amounts of in-migration, increased stress on local infrastructure in other locales is likely.

In summary, as a response to fluctuations in the world oil price, the Gulf of Mexico experienced an extended period of high oil and gas activity followed by a period of diminished activity. By the early 1990's, activities appeared to stabilize at lower levels than those achieved during the boom of the late 1970's and early 1980's, but higher than the levels of activity seen in the bust of the mid- to late-1980's. More recently, levels of oil and gas activity have increased. At present, the greatest increase in activity is in the leasing of blocks on the OCS, although examination of in-house data on plans submitted indicates some increase in operations has also been noted. In addition, the recent onset of royalty relief legislation has resulted in an increased number of deepwater tracts being leased. Correspondingly, some importation of skilled labor has occurred, most notably in southern Lafourche and Jefferson Parishes, Louisiana. In addition, the specialized needs of deepwater activity has resulted in the focusing of stresses to local infrastructure (primarily La. Highway 1) in southern Lafourche Parish.

Oil and gas activity occurs within both Federal- and State-regulated areas and the effects of non-OCS and OCS oil and gas activity are intermingled. In-migration of persons seeking employment occurred in the coastal counties and parishes of the Western and Central Gulf during the period of high oil and gas activity;

out-migration occurred from most of the same areas during the downturn. The changes in population and employment initially caused an increase in the need and extent of public services and infrastructure. The downturn in the oil and gas industry that occurred during the mid- to late-1980's increased the stresses placed on public services and made support of the previously supported infrastucture problematic.

Land use plans at the State, regional, and/or local level provide for planned, orderly growth and development of those areas. Comprehensive planning serves as a tool for a set of long-range community (or larger entity) goals. Since the Standard City Planning Enabling Act was prepared by the U.S. Department of Commerce in 1928, planning has evolved from a process that depicted future land use as static to a more dynamic process that continuously adjusts to meet the needs of the changing community (Emmer et al., 1992). Tools used to implement land use plans are zoning ordinances, subdivision regulations, building codes, and other regulatory mechanisms.

All areas of the Gulf Coast have been involved to various degrees in State, regional, and/or local planning efforts. These planning efforts vary across the Gulf from mandated planning with associated sanctions to planning enabling legislation with no sanctions (Becker and Moore, 1994). Recent budgetary constraints have, in some areas, affected State-level planning agencies (cf. Moore, 1994; page 14). At the county/parish or municipal level, there exists varying degrees of participation in comprehensive plans (cf. Emmer et al., 1992). This varying degree of participation in detailed, comprehensive land use plans at the smaller political level is ameliorated by two factors. Texas. Louisiana, Mississippi, and Alabama all have approved coastal zone management (CZM) programs. Land use plans at all levels are considered in the States' CZM Programs and all offshore activities must receive concurrence with the appropriate State's CZM Program prior to MMS approval. Siting of onshore facilities or other OCS-related uses must undergo a permitting process controlled by Federal, State, regional, and/or local governmental agencies.

d. Sociocultural Issues and Environmental Justice

The coastal zone of the northern Gulf of Mexico is not a physically, culturally, or economically homogenous unit (cf. Gramling, 1984). Communities range in size from small communities with minimal populations to large metropolitan areas containing more than 1 million inhabitants. Some of these communities experienced extensive growth during the period of increased OCS oil and gas activity, which occurred in the late 1970's and early 1980's (Gramling, 1984; Laska et al., 1993). Following the drop of world oil prices, many communities that were heavily involved in OCS oil and gas activities experienced a loss of population. Both the influx of large numbers of in-migrants during boom periods and the exodus of workers during periods of decline have been associated with increases in social complexity (cf. Murray and Weber, 1982; Gramling and Brabant, 1986; England and Albrecht, 1984).

The Gulf of Mexico region is unique in the scope of offshore oil and gas activity that has occurred during the last 50 years. The Central Gulf has witnessed the greatest part of development in the region. Twentieth-century history of coastal Texas and Louisiana is intricately linked to the oil and gas industry, both onshore and offshore. Onshore and coastal oil and gas development in Texas, like in Louisiana, has occurred for several generations. Recent examination of OCS oil and gas activity impact along the coastal counties and parishes found that most exhibit socioeconomic characteristics closely associated with the oil and gas industry; in some areas, however, this association is more closely aligned with non-OCS oil and gas activity (McKenzie et al., 1993).

Executive Order 12898 stated that Federal actions requiring NEPA analysis must consider the impact of the proposed action(s) on environmental justice issues. This requires the assessment of impacts of the proposal on low-income and/or minority communities. Several different possible scenarios may result in the siting of facilities, with their concomitant economic and environmental implications, proximal to low-income or minority communities or populations. Most facilities that support OCS exploration and production activity require multiple acres of contiguous land. Economic and logistic decisions drive the choice of where to locate these facilities. In most cases, the facilities will be located some distance away from populated areas. In some cases, through time, the land adjacent to the facility may be purchased and a community may grow up around the facility. In many cases, the land adjacent to such a facility will be deflated in value with respect to land farther from an OCS-support facility. Conversely, if an OCS-support facility is to be built in a populated area, there is the likelihood that it would be built in a low-income/low-property-value community based on economic factors. There may be subsequent impacts to these communities' environment based on the type of facility constructed. Low-income communities, which can be found across the Gulf Coastal Plain, would include multiethnic as well as homogenous communities and neighborhoods. Minority communities subject to Executive Order 12898 would include primarily Hispanic

communities and neighborhoods found in Texas, African-American communities and neighborhoods found across the northern Gulf rim, and Asian-American communities and neighborhoods found primarily in Texas, Louisiana, and Alabama.

The MMS requires all offshore lessees and operators to have a policy of nondiscrimination in their hiring practices. It is assumed for this EIS that the nondiscrimination policies practiced by offshore lessees and operators are effective.

The rise in world oil prices, which began during the mid-1970's, resulted in an increase in the rate of development on the OCS. Increasingly depleted resources in the coastal plain furthered this shift in focus towards the OCS. The downturn in world oil prices, which occurred in the mid-1980's, slowed the rate of exploration extensively. The resource extraction that had occurred in the nearshore OCS waters resulted in depletion of many reservoirs in these areas and pushed exploration for new resources out into the deeper waters of the Gulf. Extraction of these deeper water resources presented technological problems for resource identification, exploration, and production. These resources were more expensive to extract at a time when the world price of oil was declining or at a steady, low price. An MMS-funded study examined the changes in business characteristics and possible impacts of this industry restructuring in the Gulf (Seydlitz et al., 1995). In general, the study found that during the industry downturn, which occurred in the late 1980's, major, integrated companies tended to reduce operations and employment, and close offices in the Gulf region. At the same time, smaller, nonintegrated companies were increasing their share of Gulf operations, hiring more personnel and opening offices in the Gulf region. The amount of increased activity by the smaller, nonintegrated companies did not, however, offset the decline resulting from the larger, integrated companies' decrease in activity.

The present state of OCS oil and gas activity in the Gulf of Mexico is robust, albeit without the extremes encountered during the "boom" period of the 1970's and early 1980's (cf. Slidell Sentry-News, 1997). Interest in the OCS has been steady since 1994 despite recent falling oil prices. Indeed, the most recent Central Gulf of Mexico sale (Sale 169) received a total of 1,188 bids on 794 blocks, with total high bids of more than $810 million, confirming a long-term committment to development in the Gulf of Mexico. Factors contributing to the increased interest in oil and gas leasing in the Gulf include technological improvements (e.g., 3D and 4D seismic surveying, and horizontal drilling), stable energy demand, and recently enacted royalty relief legislation.

There is a differentiation across the northern Gulf of Mexico between the involvement of the states in the OCS oil and gas industry. Texas has participated to a great extent in both onshore and offshore oil and gas activity. Louisiana has historically been most dependent on oil and gas activity, both onshore and offshore. Mississippi and Alabama have, historically, been much less involved in oil and gas extractive activities. In Alabama, however, oil and gas (primarily gas) production activity has been increasing over the last decade (cf. Wade, 1996). Florida is minimally involved in offshore extractive activities. Texas may be considered to be analogous to Louisiana in that there is a long history of both onshore and offshore oil and gas activity. In a very real sense, it may be said that familial economic involvement in the oil and gas industry has become a traditional occupation in coastal Louisiana and in portions of Texas. The translation of this traditional involvement from onshore activities to the OCS is apparently more pronounced in Louisiana than in Texas. This is likely reflective of the earlier and more intensive OCS activity in the CPA. Individual and familial patterns, world views, perceptions, etc. may reflect this long-term involvement (Freudenburg and Gramling, 1993).

Migration, both in-migration and out-migration, has occurred over the years in various communities with close ties to OCS activity. During the boom years of the mid- to late 1970's and the early 1980's, migration of persons seeking employment in the OCS oil and gas industry into coastal communities occurred. Rapid population growth, particularly in small communities, has been identified as a factor that increases social disruption. Out-migration during the downturn of the mid- to late 1980's resulted in impacts to families and communities as persons employed in the oil and gas industry left the area. Most recently, there has been in-migration of persons to fill positions created by the upsurge in industry activity. This in-migration has been reported most prominently in southern Lafourche Parish, Louisiana. Other occupations in the Gulf coastal counties and parishes may be considered traditional. The trapping of fur-bearing mammals in the extensive coastal marshes of Louisiana has historically been a traditional occupation of many coastal residents (cf. Hallowell, 1979). Trapping was usually practiced in association with other resource gathering activities, such as shrimping and fishing. These activities occurred as a seasonal round, with the trapper or shrimper sometimes spending time away from the family in pursuit of the resource.

The value of Gulf of Mexico commercial fisheries landings for 1994 was $810.5 million (USDOI, MMS, 1996c). Species that are commonly harvested in the Western and Central Gulf include menhaden, shrimps,

snapper, oyster, and blue crab. Traditional fisheries occupations may involve exploitation of species of the coastal marshes and bays as well as of offshore species. The fisherman frequently spends days or weeks at a time in pursuit of the resource, coming back to the dock only to unload and take on fuel and provisions.

Farming of sugarcane, rice, and other crops has also been a traditional occupation in the coastal areas of the Gulf. Major crops produced in southwestern Louisiana include rice and soybeans. South-central Louisiana is the leading producer of sugarcane in the United States. In recent years, rice farming has frequently been combined with crawfish aquaculture. Other aquaculture ventures include alligator, catfish, and some saltwater species (red drum). The gathering of Spanish moss in the coastal swamps of Louisiana and sponge diving off the coast of Florida have diminished or disappeared as resources were diminished or depleted, and preferred alternatives were developed. Cattle raising is an important traditional occupation in Texas and some areas of Louisiana.

Native American cultures, with few notable exceptions (cf. Peterson, 1987), were absorbed or destroyed by the early 20th century. Remnants of the earlier, European cultures were found primarily in isolated areas along the Gulf margin. The Acadians (or Cajuns), located in southwest Louisiana, are the descendants of French-speaking immigrants displaced from the East Coast of Canada in 1755. A roughly triangular area in Louisiana, with the Mississippi Delta to the east, Alexandria to the north, and Lake Charles to the west, is now known as the French Triangle (Rushton, 1979). Other isolated remnant cultures, such as the Isleños from the Canary Islands in St. Bernard Parish, Louisiana (cf. Guillot, 1980); Greeks in Tarpon Springs, Florida; Dalmatian Coast Yugoslavs in the delta of the Mississippi River; and Oriental immigrants in the southeastern portion of Louisiana existed along the Gulf rim margin (Cohen, 1984). The large Mexican-American population found in Texas is reflective of both the historical development of the region and the proximity of the United States' southern neighbor. With the exception of the Orientals in southeast Louisiana, all of the above cultural enclaves are recognizable today; they exist as subcultures within the broader, American culture that is predominant throughout the analysis area.

The work schedule associated with OCS oil and gas activity usually involves the employee's absence from home for an extended period. This may be for one week, two weeks, or even longer periods of time. An extended work schedule places a burden on the remaining spouse (usually the wife) to assume roles more traditionally held by the absent family member.

Jobs associated with the OCS oil and gas industry in the Gulf of Mexico have generally been viewed as higher paying jobs. This is true at both the professional and blue-collar levels. It has been postulated that during the period of increased OCS oil and gas activity, it was more difficult for smaller businesses not involved in the economic sphere of resource extraction activities in the area to compete with the better paying jobs associated with OCS oil and gas activity (Gramling, personal communication, 1992). A corollary postulate was the specialization of businesses to the OCS oil and gas industry, with a greater emphasis on speed and performance than on economy. Findings by Tolbert (1995a) in a study on income inequality in coastal Louisiana parishes suggest that there was a significant decline in family income inequality in these parishes between 1970 and 1980. During the period from 1980 to 1990, however, these parishes experienced increases in overall inequality. There is a suspicion that the lower income inequality quotients between 1970 and 1980 are related to greater opportunities for earnings during the period of the greater OCS activity (i.e., the boom). Correspondingly, the higher income inequality quotients reported between 1980 and 1990 may relate to the diminished job opportunities associated with the downturn on OCS activity. More recent research on income inequality by Tolbert (1996) suggests that there is variability within parishes and counties at the community level. This suggests a differing degree of dependence by communities on OCS activity.

Seydlitz and Laska (1994; pp. 7-8) state that the effects of petroleum activity on social problems were not clear, consistent, or strong. Data indicated that social problems tend to increase when petroleum activity increases, but that this impact is transitory.

Other factors descriptive of the social and cultural environment in the counties and parishes of the northern Gulf of Mexico would include marriage patterns, health, religion, political organizations, aesthetics, etc. These should all be included under the broad "Social Issues" category. Very little quantitative study and analysis of these factors has been conducted in the Gulf of Mexico Region (cf. NRC, 1992); however, a recently funded MMS socioeconomic baseline study will examine some of these factors over the period of 1930-1990.

In September 1992, the MMS's Gulf of Mexico Region sponsored a socioeconomic workshop in New Orleans, Louisiana. A total of 18 studies on the impact of OCS oil and gas activities on broad areas of the social and economic environment were designed by participants. The workshop and resulting products defined gaps in the understanding of social and economic impacts of the OCS oil and gas industry in the

Region and provided a mechanism (the proposed studies) to provide this information to decisionmakers. As of April 1997, eight socioeconomic studies were underway, including a study examining the historical impacts of OCS activity on communities; an examination of employment and commuting patterns of OCS workers; a case study of income inequality at Abbeville, Louisiana; issues analysis studies in the Western and Eastern Gulf of Mexico Planning Areas; baseline and modeling studies for coastal Alabama communities; a study of port and infrastructural needs associated with OCS activity at Port Fourchon; and a baseline and modeling study of selected Florida Panhandle communities.

2. Commercial Fisheries

The Gulf of Mexico provides nearly 20 percent of the commercial fish landings in the continental United States. The Gulf of Mexico yielded the nation's second largest regional commercial fishery by both weight and value in 1995 (Tables III-11 and III-12).

Most commercial species harvested from Federal waters of the Gulf of Mexico are considered to be at or near an overfished condition. Continued fishing at the present levels may result in rapid declines in commercial landings and eventual failure of certain fisheries. Commercial landings of traditional fisheries, such as shrimp, red snapper, spiny lobster, and mackerel, have declined over the past decade despite substantial increases in fishing effort. Commercial landings of recent fisheries, such as shark, black drum, and tuna, have increased exponentially over the past five years, and those fisheries are thought to be in need of conservation (Angelovic, written communication, 1989; Grimes et al., 1992; USDOC, NOAA, 1991).

Nearly all species significantly contributing to the Gulf of Mexico'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). Conflicts between fishermen using fixed gear (traps) and mobile gear (trawls) continue to be a problem in some parts of the Gulf (Anon., 1991a; Federal Fisheries News Bulletin, 1989a and b). Natural catastrophes may change the physical characteristics of offshore, nearshore, and inshore ecosystems and destroy gear and shore facilities.

Fishery Management Plans (FMP's) are developed by the Gulf of Mexico Fishery Management Council (GMFMC) to assess and manage commercial species of fish that are harvested from Federal waters and in need of conservation. Since 1981, nine FMP's have been implemented for the following species in the Gulf of Mexico: shrimp, stone crab, spiny lobster, coastal pelagics, coral, reef fish, swordfish, red drum, and sharks. The GMFMC has initiated development of additional management plans for butterfish, swordfish, and black drum (Gulf of Mexico Fishery Management Council, 1989; Horst, 1989).

The Gulf of Mexico shrimp fishery is the most valuable in the United States accounting for 71.5 percent of the total domestic production (USDOC, NMFS, 1996). Three species of shrimp--brown, white, and pink--dominate the landings. The status of the stocks are as follows: (a) brown shrimp yields are at or near the maximum sustainable levels; (b) white shrimp yields are beyond maximum sustainable levels with signs of overfishing occurring; and (c) pink shrimp yields are at or beyond maximum sustainable levels.

Table III-11

Landings and Value of 1995 Gulf of Mexico Fisheries

	Landings (million pounds)	Value (million dollars)
Total--All Fisheries	1,490	787
Menhaden	1,040	52
Shrimp	234	468
Oyster	24	44
Blue Crab	54	42

Source: USDOC, NMFS, 1996.

Table III-12

Landings and Value of 1995 Gulf of Mexico State Fisheries

	Landings (million pounds)	Value (million dollars)
Texas	88	193
Louisiana	1,129	316
Mississippi	145	42
Alabama	28	50

Source: USDOC, NMFS, 1996.

The shrimp fishery is facing a number of problems: an excessive number of vessels given available yields of shrimp; imports of less expensive shrimp from foreign countries accounting for 33 percent of the value of total edible imports; continued decline in ex-vessel price of domestic shrimp; increases in interest rates to finance acquisition of equipment, vessels, and other related fishing needs; increases in fuel prices; excessive costs of marine casualty insurance; regulations regarding the use of turtle excluder devices; excessive bycatch of finfish; and conflicts with other targeted fisheries (Angelovic, written communication, 1989; Gulf States Marine Fisheries Commission, 1988; Louisiana Dept. of Wildlife and Fisheries, 1994b).

It has been estimated that for every kilogram of shrimp landed more than 8 kg of valuable finfish are killed and discarded as bycatch (Anon., 1991b; Sports Fishing Institute, 1989a). In an attempt to lessen anticipated conflicts between commercial fishing for shrimp, spiny lobster, and stone crab, the GMFMC has closed areas in the Eastern Gulf to shrimp trawling during the traditional trap fishing seasons for lobster and stone crab.

The major concern of the stone crab fishery is whether harvest has reached or exceeded maximum sustainable yield. Until recently, the fishery has been expanding in terms of increasing catch within traditional fishing areas and previously unfished or underfished regions. However, the total harvest has declined steadily over the past several years. The GMFMC is considering limitations on the number of fishermen and traps in the stone crab fishery.

Spiny lobster fishing is practiced exclusively in the Eastern Gulf of Mexico. It is believed that the stock is showing signs of overfishing. Mortality of spiny lobster is high due to the large number of undersized lobsters used to bait lobster fishing traps and the number of traps in the fishery exceed by far the number required to harvest the present yield. Fishermen contend that the present fishery practices are the most optimal for their objectives. The GMFMC is considering limitations on the number of fishermen and traps in the spiny lobster fishery.

The coastal pelagic FMP addresses a number of species. Two of the more important species are king and Spanish mackerel. Both species have been extensively overfished and are now under a managed rebuilding program. Spawning stock biomass for king mackerel has exhibited some gains and recruitment is stable at low levels (Grimes et al., 1990). Spanish mackerel stocks are showing positive signs of recovery. Spawning stock biomass and recruitment appear to be increasing.

The taking of stony corals or gorgonian sea fans is prohibited. Fishing for soft coral is presently below the limits of maximum yield. There is significant concern that butterfish trawlers allegedly destroy coral reef habitat and take a large number of snappers and groupers as bycatch. In addition, a newly formed fishery of "live rock" for the ornamental trade is receiving attention due to the allegation that "live rock" fishing may purposefully or inadvertently include the harvest of stony coral. Amendment 2 to the FMP for coral and coral reefs specifically addresses the concerns of "live rock" harvest in the Gulf of Mexico (Gulf of Mexico Fishery Management Council, 1994).

Red snapper resources in the Gulf of Mexico are believed to be severely overfished from both directed and bycatch fisheries. Red snapper is the most important species in the reef fish complex managed under a FMP in terms of value and historical landings. The species is presently considered to be in worse condition than was red drum when that fishery was closed to all further harvest in Federal waters (Goodyear and Phares, 1990; Horst, 1992b).

Commercial landings of swordfish have increased steadily over the past several years. The percentage of older fish and spawning biomass has declined significantly. The GMFMC is developing a number of alternatives to better manage this resource.

The red drum fishery was closed to all harvest in Federal waters of the Gulf of Mexico on January 1, 1988. Stock assessment concluded that red drum were heavily fished prior to moving offshore to spawn and that those fish less than 12 years of age were poorly represented in the offshore spawning population. Continued harvest of adults from Federal waters would further reduce spawning stock and increase the risk of a collapse of the red drum fishery (USDOC, NMFS, 1989a).

A strong market for shark has resulted in soaring catches over the past several years. Shark stocks are unable to sustain the present heavy fishing pressure, and without management, the fishery is expected to collapse in the near future. The GMFMC requested that Gulf States consider management measures within State waters and issued a FMP for both coastal and pelagic sharks (Justen, 1992).

Blue marlin and white marlin are believed to be at or near the point of full exploitation. There is concern about the increasing mortality of marlin as bycatch associated with the escalating yellowfin tuna longline fishery (Sports Fishing Institute, 1989b). The tuna fishing industry has expanded at an alarming rate in the Gulf of Mexico over the past five years. Tuna are now included under the Magnuson Fishery Conservation and Management Act of 1976 (MFCMA), and the GMFMC can begin to manage the tuna fishing industry and address the marlin bycatch issue (Anon., 1992).

The present concern with the condition of the black drum fishery stems directly from the closure of the red drum fishery. Almost immediately after closure, black drum were accepted as a substitute for red drum within the commercial market. The intensive fishing effort for red drum was switched to black drum without need to change fishing gear or technique. As a result, stocks of black drum are believed to be fast approaching a seriously depleted condition. Several Gulf States have instituted interim management measures in State waters to reduce black drum catches while an FMP is developed and implemented (Horst, 1989).

As issues and potential problems from OCS development arise, MMS, NMFS, and GMFMC coordinate on all aspects of fishery management and conservation. For example, the GMFMC is concerned over declining stocks of reef fish in the Gulf and in 1991, expressed a need to critically examine sources of mortality on reef fish species. In June 1992, MMS and NMFS formally entered into an Interagency Agreement (IA 17912) to study the comparative severity of the effect of explosive platform removals on targeted fish stocks in the Gulf of Mexico. Results from the investigation of several explosive platform removals in 1994 and 1995 and the status of the study were presented to the GMFMC during its Habitat Advisory Panels Meeting held in September 1994 in New Orleans and at the MMS's Fifteenth Information Transfer Meeting held in December 1995 in New Orleans.

3. Recreational Resources and Beach Use

The northern Gulf of Mexico 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. Gulf Coast residents and tourists from throughout the nation, as well as from foreign countries, use these resources extensively and intensively for recreational activity. Commercial and private recreational facilities and establishments, such as resorts, marinas, amusement parks, and ornamental gardens, also serve as primary-interest areas. Visual 2 provides a synoptic view of the location, extent, and components of all the designated recreational areas and major recreational beaches within the marine and coastal areas from Texas to Florida.

Predominant among public recreation areas abutting the Gulf of Mexico in the WPA are Padre Island National Seashore, which extends along the South Texas coast for approximately 80 mi (annual visitation averages 900,000), and Galveston Island, Mustang Island, and Sea Rim State Parks. 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. Likewise, young affluent Texans from Houston have a major impact on the Galveston economy with their main attraction being the Gulf beaches (Texas General Land Office, 1996).

Marine recreational fishing in the Gulf Region from Texas to Alabama is a major industry important to these States' economies. The marine recreational fishing industry accounts for an estimated $769 million in sales (equipment, transportation, food, lodging, insurance, and services) and employment for over 15,000 people, earning more than $158 million annually in the CPA and WPA (Sports Fishing Institute, 1988). According to NMFS, over 40 percent of the nation's marine recreational fishing catch comes from the Gulf of Mexico, and marine anglers in the Gulf made over 15 million fishing trips in 1991, exclusive of Texas. According to the 1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, there were an estimated 828,000 resident and nonresident marine anglers from Texas over 16 years old that fish almost 7 million days a year (USDOI/USDOC, 1993). Texas marine anglers using private boats expended over 4.5 million man-hours to land about 1.5 million saltwater fish during the 1990-1991 fishing years (USDOC, NMFS, 1992b). Speckled trout are the most sought sport fish in coastal marine waters, whereas snapper and mackerel are some of the more popular offshore sport fish. The Texas legislature created an offshore artificial reef development program about 10 years ago. Since then, the Texas Parks and Wildlife Department, in cooperation with oil companies, has sponsored the construction of more than 35 Rigs-to-Reefs projects in order to maintain excellent recreational fishing in Texas offshore waters.

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.

The coastal shorelines of the CPA and WPA contain extensive public park and recreation areas, private resorts, and commercial lodging. Most of the outdoor recreational activity focused on the Gulf shorefront is associated with accessible beach areas. Beaches are a major inducement for coastal tourism, as well as a primary resource for resident recreational activity. Recreational resources, activities, and expenditures are not constant along the Gulf of Mexico shorefront, but are focused where public beaches are close to major urban centers. Beach use is a major economic factor for many Gulf coastal communities, especially during peak-use seasons in the spring and summer. Tourism in the coastal zone of the five Gulf Coast States has been valued at an estimated $20 billion/year (USEPA, 1991).

Bird watching, or public enjoyment of locating and observing coastal and marine birds, is a recreational activity of growing interest and importance all along the Gulf Coast. Of major national and international concern is the documented decline in populations of neotropical migratory birds, some of which are known transmigrants of the Gulf of Mexico. These birds make annual trips between breeding and wintering grounds in North, Central, and South America (Vermillion, 1994). Dedicated bird watchers plan annual meetings and trip excursions to coincide with the arrival of Gulf migrants on the forested shorefront ridges along the coast of Louisiana and Texas. Southwick Associates (1991) estimated $155.3 million in retail sales were generated by nonconsumptive bird use in Texas during 1991.

4. Archaeological Resources

Archaeological resources are any prehistoric or historic site, building, structure, object, or feature that is manmade or modified by human activity. The Archaeological Resources Regulation at 30 CFR 250.26 grants specific authority to each MMS Regional Director to require archaeological resource surveys and reports. Surveys are required prior to any drilling or development activities on leases within the archaeological high-probability areas (NTL 91-02). Support for Western Gulf Sale 171 will come primarily from shore bases in Texas and the western portion of the CPA (Louisiana).

a. Historic

With the exception of the Ship Shoal Lighthouse, historic archaeological resources on the OCS consist of shipwrecks. A 1977 MMS archaeological resource baseline study for the northern Gulf of Mexico indicated that 2 percent of the pre-20th century shipwrecks and 10 percent of all wrecks reported lost between 1500 and 1945 have known and/or verified locations (CEI, 1977). An MMS-funded study by Texas A&M University (Garrison et al., 1989) updated the shipwreck database. Statistical analysis of over 4,000 potential shipwrecks in the northern Gulf indicated that many of the OCS shipwrecks occur in clustered patterns related mainly to navigation hazards and port entrances.

Management of historical archaeological resources has been accomplished by establishing a high-probability zone (ARZ1) for the occurrence of historic shipwrecks. The high-probability zone consists of three subzones--(1) shoreline to 10 km from shore; (2) 21 half-degree-square high-probability quadrats

associated with cultural and geographic features (including historic ports, barrier islands, and reefs); and (3) specific high-probability search polygons associated with shipwrecks located outside of the two aforementioned zones. The zone was delineated by using geographic and cultural factors as indicators of high shipwreck potential. An MMS evaluation of the high-probability zones for historic shipwrecks is underway as of January 1997.

The Texas A&M University study also examined variables affecting the site formation process and shipwreck preservation potential. The study concluded that, in a general sense, shipwrecks located in the western portion of the CPA would have a moderate to high preservation potential, those in the eastern portion of the WPA would have a low to moderate preservation potential, and those in the western portion of the WPA would have a low to high preservation potential contingent on location (cf. Garrison et al., 1989; Figure II-50). The recent discovery of the *Belle* (with associated artifacts) in Matagorda Bay highlights the shipwreck preservation potential found in the area.

b. Prehistoric

The advent of mankind in the Gulf of Mexico region is currently accepted to be around 12,000 years before present (B.P.) (Aten, 1983). According to the sea-level curve for the northern Gulf proposed by Coastal Environments, Inc. (CEI, 1982), sea level at 12,000 B.P. would have been approximately 45 m below the present sea level. On this basis, the continental shelf shoreward of the 45-m bathymetric contour would have potential for prehistoric sites dating subsequent to 12,000 B.P. Therefore, the prehistoric archaeological high-probability zone is roughly contiguous to the area between the Federal/State boundary and the 45-m bathymetric contour. Activities occurring within this zone are subject to archaeological clearance.

Based on their 1977 baseline study, CEI (1977) proposed that sites analogous to the types of sites frequented by Paleo Indians can be identified on the now-submerged shelf. Geomorphic features that have a high probability for associated prehistoric sites include barrier islands and back-barrier embayments, river channels and associated floodplains and terraces, and salt-dome features. Recent investigations in Louisiana and Florida indicate that mound building activity by prehistoric inhabitants may have occurred as early as 6,200 B.P. (cf. Haag, 1992; Saunders et al., 1992; Russo, 1992). Therefore, manmade features, such as mounds, may also exist in the shallow inundated portions of the OCS. Remote-sensing surveys have been very successful in identifying the geographic features that have a high probability for associated prehistoric sites.

Regional geological mapping studies by MMS allow interpretations of specific geomorphic features and assessments of archaeological potential in terms of age, the type of system the geomorphic features belong to, and geologic processes that formed and modified them. The potential for site preservation must also be considered as an integral part of the predictive model. In general, sites protected by sediment overburden have a high probability for preservation from the destructive effects of marine transgression. The same holds true for sites submerged in areas subjected to low wave energy and for sites on relatively steep shelves during periods of rapid rise in sea level.

Though lease-block surveys have identified many specific areas in the Gulf as having a high potential for prehistoric sites, oil and gas development has generally avoided rather than investigated these high-probability areas for archaeological content.

Holocene sediments form a thin veneer or are absent over the majority of the continental shelf off western Louisiana and eastern Texas (USDOI, MMS, 1984b). Many large, late Pleistocene fluvial systems (e.g., the Sabine-Calcasieu River Valley) are within a few meters of the seafloor in this area. Further to the south and west, a blanket of Holocene sediments overlays the Pleistocene horizon. In the Western Gulf, prehistoric sites representing the Paleo-Indian culture period through European contact have been reported. The McFaddin Beach site, east of Galveston in the McFaddin National Wildlife Refuge, has produced late Pleistocene megafaunal remains and lithics from all archaeological periods, including a large percentage of Paleo-Indian artifacts (Stright, personal communication, 1997). A study funded by MMS to locate prehistoric archaeological sites in association with the buried Sabine-Calcasieu River Valley was completed in 1986 (CEI, 1986). Five types of relict landforms were identified and evaluated for archaeological potential. Coring of selected features was performed, and sedimentary analyses suggested the presence of at least two archaeological sites.

Surveys from other areas of the western part of the CPA have produced evidence of floodplains, terracing, and point-bar deposits in association with relict late Pleistocene fluvial systems. Prehistoric sites associated with these features would have a high probability for preservation. Salt diapirs with bathymetric expression have also been recorded during lease-block surveys in this area. Solution features at the crest of

these domes would have a high probability for preservation of associated prehistoric sites. The Salt Mine Valley site on Avery Island is a Paleo-Indian site associated with a salt-dome solution feature (CEI, 1977). The proximity of most of these relict landforms to the seafloor facilitates further investigation and data recovery.

5. Coastal Zone Management Plans

State Coastal Zone Management Programs

Each State's coastal zone management (CZM) program or plan is a comprehensive statement setting forth objectives, policies, and standards for public and private use of land and water resources in that State's coastal zone. The plan provides direct State land and water use planning and regulations. The plan also includes a definition of what constitutes permissible land uses and water uses.

The CZM plan provides for State administrative review of all development plans, projects, or land or water use regulations proposed by any Federal, State or local authority, or private developer. Proposed actions are reviewed for consistency with the State's CZM program. The CZM plan should provide for coordination and simplification of procedures in order to ensure expedited government decisionmaking for the management of coastal resources. Affected Federal agencies should be involved in continued consultation and coordination as well as receive adequate consideration to their views.

Another important component of CZM programs is the development of the Coastal Nonpoint Pollution Control Program. Authorized by Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990, this amendment requires States and territories with approved CZM programs to develop and implement coastal nonpoint programs. These programs will be implemented through changes to the State nonpoint source program approved by USEPA under Section 319 of the Clean Water Act and through changes to the State CZM program.

Federal agencies are involved in the development and implementation of State CZM programs. Once a State's program is federally approved, Federal agencies must ensure that their actions are consistent to the maximum extent practicable with the enforceable polices of the approved State program. State and Federal agencies work together on joint planning and permitting, which reduces the regulatory burden on the public (USDOC, NOAA, 1989). Federal agencies provide feedback to the States through each Section 312 evaluation conducted by NOAA. At the State level, a lead State agency oversees implementation of the CZM program and administers the Federal grant funds. Local governments are involved in the implementation of State CZM programs, either formally or informally. Each State's CZM plan is a statement of plans and goals for land use in the coastal zone. Each federally approved CZM plan takes into consideration and is consistent with local (county/parish and community) land use plans. The State office designated as the CZM lead agency requests input from other State and local agencies with local land use responsibilities or concerns. Through their designated CZM agencies, local land use entities are provided numerous opportunities to comment on the OCS Program. Local land use agencies also have the opportunity to comment directly to MMS at any time, as well as during formal public comments periods related to Draft 5-Year Program announcements, Call for Information and Notice of Intent to Prepare an EIS, EIS scoping, Draft EIS review, EIS public hearings, and Proposed Notice of Sale. To ensure conformance with State CZM and local land use plans, the MMS prepares a federal consistency determination for each proposed OCS lease sale. A State with an approved CZM plan also reviews certain OCS activities to determine whether they will be conducted in a manner consistent with the State's approved CZM plan. This review authority is applicable to activities in any plan for the exploration or development of any area that has been leased under the OCSLA and that affects any land or water use or natural resource within the State's coastal zone (16 U.S.C. 1456(c)(3)(B)).

State of Texas Coastal Management Program

The Texas Coastal Management Program (TCMP)/Final EIS was published in August 1996. On December 23, 1996, the TCMP was approved by NOAA, and requirements therein were made operational as of January 10, 1997. The TCMP is based primarily on the Coastal Coordination Act (CCA) of 1991 (33 Tex. Nat. Res. Code Ann. Ch. 201, *et seq.*), as amended by HB 3226 (1995), which calls for the development of a comprehensive coastal program based on existing statutes and regulations. The CCA established the geographic scope of the program by identifying the program's inland, interstate, and seaward boundaries.

The program's seaward boundary is the State's territorial seaward limit (3 leagues or 10.3 mi). The State's inland boundary is based on the State's Coastal Facilities Designation Line (CFDL). The CFDL was developed in response to the Oil Spill Act of 1990 and basically delineates those areas within which oil spills could affect coastal waters or resources. For the purposes of the TCMP, the CFDL has been modified to capture wetlands in upper reaches of tidal waters. The geographic scope also extends upstream 200 mi from the mouths of rivers draining into coastal bays and estuaries in order to manage water appropriations on those rivers. The program's boundaries encompass all or portions of 19 coastal counties (including Cameron, Willacy, Kenedy, Kleberg, Nueces, San Patricio, Aransas, Refugio, Calhoun, Victoria, Jackson, Matagorda, Brazoria, Galveston, Harris, Chambers, Liberty, Jefferson, and Orange Counties); roughly 8.9 million acres of land and water.

Within this coastal zone boundary, the scope of the TCMP's regulatory program is focused on the direct management of 14 generic "Areas of Particular Concern," called coastal natural resource areas (CNRA's). These CNRA's are associated with valuable coastal resources or vulnerable or unique coastal areas and include the following: waters of the open Gulf of Mexico; waters under tidal influence; submerged lands; coastal wetlands; seagrasses; tidal sand and mud flats; oyster reefs; hard substrate reefs; coastal barriers; coastal shore areas; Gulf beaches; critical dune areas; special hazard areas; critical erosion areas; coastal historic areas; and coastal preserves.

The State has designated the WPA as the geographical area in which Federal consistency shall apply outside of the coastal boundary. The TCMP also identifies Federal lands excluded from the State's coastal zone, such as Department of Defense Facilities.

Land and water uses subject to the program generally include the siting, construction, and maintenance of electric generating and transmission facilities; oil and gas exploration and production; and the siting, construction, and maintenance of residential, commercial, and industrial development on beaches, critical dune areas, shorelines, and within or adjacent to critical areas and other CNRA's. Associated activities also subject to the program include canal dredging; filling; placement of structures for shoreline access and shoreline protection; on-site sewage disposal, stormwater control, and waste management for local governments and municipalities; the siting, construction, and maintenance of public buildings and public works such as dams, reservoirs, flood control projects and associated activities; the siting, construction, and maintenance of roads, highways, bridges, causeways, airports, railroads, and nonenergy transmission lines and associated activities; certain agricultural and silvicultural activities; water impoundments and diversions; and the siting, construction, and maintenance of marinas, State-owned fishing cabins, artificial reefs, public recreational facilities, structures for shoreline access and shoreline protection, and boat ramps.

The TCMP is a networked program that will be implemented primarily through 8 State agencies, 18 local governments, and the Coastal Coordination Council. The program will rely primarily on direct State control of land and water uses, although local governments will implement State guidelines related to beach and dune management. Implementation and enforcement of the coastal policies is primarily the responsibility of the networked agencies and local governments through their existing statutes, regulatory programs, or other authorizations. Networked agencies include the General Land Office/School Land Board, Texas Natural Resource Conservation Commission, Railroad Commission, Texas Parks and Wildlife Department, Texas Transportation Commission, Texas Historical Commission, the Public Utility Commission, the Texas State Soil and Water Conservation Board, and the Texas Water Development Board. Similarly, 18 county and municipal governments, in those counties with barrier islands, are also networked entities with responsibilities for program implementation vis-a-vis beaches and dunes.

Local land uses and government entities are linked to the management of Texas CNRA's in the TCMP. Local governments are notified of relevant TCMP decisions, including those that may conflict with local land use plans or zoning ordinances. The Coastal Coordination Council includes a local government representative as a full-voting member. An additional local government representative can be added to the Council as a nonvoting member for special local matters under review. The Council will establish a permanent advisory committee to ensure effective communication for local governments with land use authority.

In 1994, MMS entered into a Memorandum of Understanding (MOU) with the Texas General Land Office to address similar mineral resource management responsibilities between the two entities and to encourage cooperative efforts and promote consistent regulatory practices. This MOU, which encompasses a broad range of issues and processes, outlines the responsibilities and cooperative efforts, including leasing and CZMA review processes, agreed to by the respective agencies. The MMS is developing coordination procedures with the State for submittal of offshore lease sale consistency determinations and plans of operation. Western Gulf Sale 168 was the first MMS Federal action subject to State consistency review.

For plans of operation, the State has agreed that the information requirements of NTL 86-09 constitute the information needed for their consistency certification review. Effective January 10, 1997, all operators are required to submit to MMS certificates of consistency with the TCMP, as required by NTL 97-03, for proposed operations in the WPA.

State of Louisiana Coastal Zone Management Program

The basis for Louisiana's coastal zone management program is the Louisiana Coastal Resources Program (LCRP) created by the State and Local Coastal Resources Management Act of 1978. The Act puts into effect a set of State coastal policies and coastal use guidelines that apply to coastal land and water use decisionmaking. A number of existing State regulations are also incorporated into the program including those concerning oil and gas and other mineral operations; leasing of State lands for mineral operations and other purposes; hazardous waste and radioactive materials; management of wildlife, fish, other aquatic life, and oyster beds; endangered species; air and water quality; and the Louisiana Superport.

The Act also authorized establishment of Special Management Areas. Included or planned to be included as Special Management Areas are the Louisiana Superport (LOOP), Marsh Island, artificial barrier islands to protect deteriorating coastal areas, and freshwater and sediment diversion projects to offset land loss and saltwater encroachment. For purposes of the CZMA, only that portion of LOOP within Louisiana's coastal zone is part of the Special Management Area. In April 1989, the Louisiana Legislature created the Wetlands Conservation and Restoration Authority and established a Wetlands Conservation and Restoration Trust Fund to underwrite restoration projects. The Legislature also reorganized part of the Louisiana Department of Natural Resources (LDNR) by creating the Office of Coastal Restoration and Management. Local governments (parishes) may assume management of uses of local concern by developing a local coastal program consistent with the State CZM plan.

The State of Louisiana has eight approved local coastal management programs (Calcasieu, Cameron, Jefferson, Lafourche, Orleans, St. Bernard, St. James, and St. Tammany Parishes). Eleven others (Assumption, Iberia, Livingston, Plaquemines, St. Charles, St. John, St. Martin, St. Mary, Tangipahoa, Terrebonne, and Vermilion Parishes) have not formally been approved by NOAA. The parish police jury often serves as the permitting agency for projects limited to local concern. Parish-level programs function in an advisory capacity to Louisiana's CZM agency, the Coastal Management Division.

Appendix C2 of the LCRP outlines the rules and procedures for the State's local coastal management programs. Under the LCRP, parishes are authorized, though not required, to develop local coastal management programs. Approval of these programs gives parishes greater authority in regulating coastal development projects that entail uses of local concern. Priorities, objectives, and policies of local land use plans must be consistent with the policies and objectives of Act 361 and the State guidelines, except for a variance adopted in Section IV.D. of Appendix C2 of the LCRP. The Secretaries of the Departments of Natural Resources, and Wildlife and Fisheries may jointly rule on an inconsistent local program based on local environmental conditions or user practices. State and Federal agencies review parish programs before they are adopted.

The coastal use guidelines are based on seven general policies. They are implemented through Consistency Determinations, coastal use permits, and in-lieu permits. Consistency Determinations are required for any activity, by Federal agencies or private entities, which may have an effect on the air, water, or natural resources of the Louisiana Coastal Zone. Coastal use permits serve as Consistency Determinations for companies and individuals unless the proposed activity occurs on Federal lands or waters, including the OCS. In-lieu permits provide for the use of permit requirements existing before the Act took effect to fulfill the role of coastal use permits, thereby avoiding duplicated permitting procedures.

State concerns that could be relevant to an OCS lease sale and its possible direct effects or associated facilities and nonassociated facilities are (a) any dredge and fill activity that intersects more than one water body, (b) projects involving the use of State-owned lands or water bottoms, (c) national interest projects, (d) pipelines, and (e) energy facility siting and development. Other coastal activities of concern that could be relevant to a lease sale include wetland loss due to channel erosion from OCS traffic; activities near reefs and topographic highs; activities that might affect endangered, threatened, or commercially valuable wildlife; and potential socioeconomic impacts due to offshore development.

Effective August 1993, the DNR Coastal Management Division requires that any entity applying for permits to conduct activities along the coast must notify the landowner of the proposed activity. An affidavit must also accompany any permit application. Through this regulation, the State will strive to minimize coastal zone conflicts.

State of Mississippi Coastal Program

The Mississippi Coastal Program (MCP) is administered by the Mississippi Department of Marine Resources. The MCP is built around 10 enforceable goals that promote comprehensive management of coastal resources and encourage a balance between environmental protection/preservation and development in the coastal zone. The primary coastal management statute is the Coastal Wetlands Protection Law. Other major features of the MCP include statutes related to fisheries, air and water pollution control, surface and groundwater, cultural resources, and the disposal of solid waste in marine waters. The Department of Marine Resources, the Bureau of Pollution Control, the Bureau of Land and Water Resources, and the Department of Archives and History are identified collectively as the "coastal program agencies." Mississippi manages coastal resources by regulation and by promoting activities that use resources in compliance with the MCP. The State developed a coastal wetlands use plan, which includes designated use districts in coastal wetlands and Special Management Area Plans that steer development away from fragile coastal resources and help to resolve user conflicts.

For the purposes of the coastal program, the coastal zone encompasses the three coastal counties of Hancock, Harrison, and Jackson and all coastal waters. The Mississippi coast has 594 km of shoreline, including the coastlines of offshore barrier islands (Cat, Ship, Horn, and Petit Bois Islands). According to NOAA, there are no approved local coastal management plans for the State of Mississippi. The Southern Mississippi Planning and Development District serves in an advisory capacity to the State coastal agencies.

State of Alabama Coastal Area Management Program

The Alabama Coastal Area Act (ACAA) provides statutory authority to review all coastal resource uses and activities that have a direct and significant effect on the coastal area. The Alabama Department of Economic and Community Affairs (ADECA), the lead coastal management agency, has overall responsibility for plan development, improvements, policy development and refinements, planning, research, and general oversight and all other nonpermit-related activities under the Alabama Coastal Area Management Program (ACAMP). The Alabama Department of Environmental Management (ADEM) has the responsibility of all permit, enforcement, regulatory, and monitoring activities, and the adoption of rules and regulations to carry out ADECA. The ADEM must identify specific uses or activities that require a State permit to be consistent with the coastal policies noted above and the more detailed rules and regulations promulgated as part of the ACAMP. Under the ACAA, State agency activities must be consistent with ACAMP policies and ADEM findings. Further, ADEM must make a direct permit-type review for uses that are not otherwise regulated at the State level. The ADEM also has authority to review local government actions and to assure that local governments do not unreasonably restrict or exclude uses of regional benefit. Ports and major energy facilities are designated as uses of regional benefit.

Local governments have the option to participate in the ACAMP by developing local codes, regulations, rules, ordinances, plans, maps, or any other device used to issue permits or licenses. If these instruments are certified to be consistent with ACAMP, ADEM may allow the local government to administer them by delegating its permit authority, thereby eliminating the need for ADEM's case-by-case review.

According to NOAA, there are no local coastal management plans approved for the State of Alabama. However, local authorities such as municipal and county planning commissions serve in an advisory capacity to local government and, in certain instances, have authority to make development decisions that impact the coastal area. The South Alabama Regional Planning Commission provides ongoing technical assistance to the ADECA to assure consistency with the ACAMP guidelines and objectives when the ADECA lacks sufficient personnel locally to coordinate the coastal area program with local planning commissions.

Uses subject to the Alabama's CZM program are divided into regulated and nonregulated categories. Regulated uses are those that have a direct and significant impact on the coastal areas. These uses either require a State permit or are required by Federal law to be consistent with the management program. Uses that require a State permit must receive a certificate of compliance. Nonregulated uses are those activities that have a direct and significant impact on the coastal areas that do not require a State permit or Federal consistency certification. Nonregulated uses must be consistent with ACAMP and require local permits to be administered by ADEM.

SECTION IV

ENVIRONMENTAL CONSEQUENCES

IV

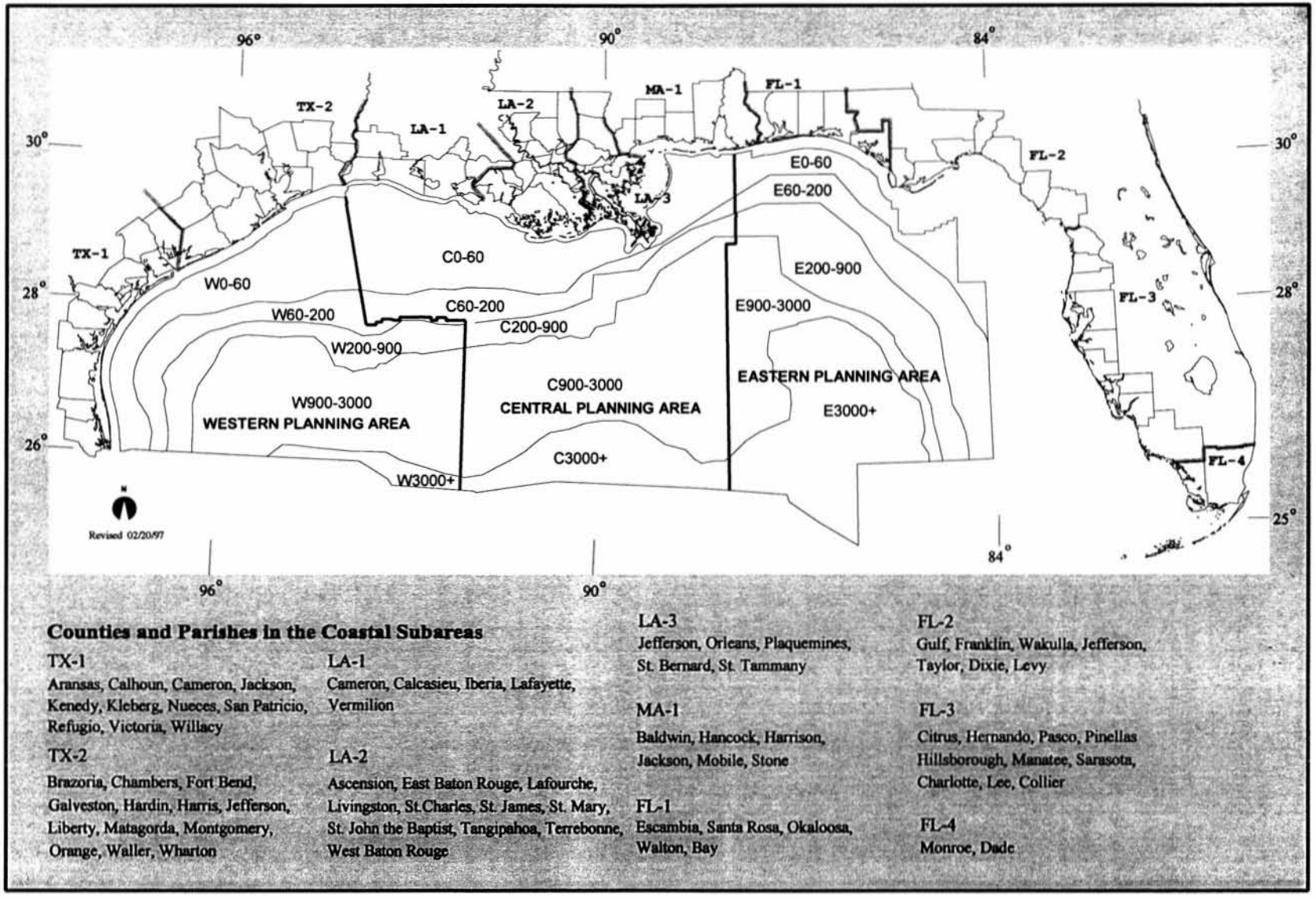
IV. ENVIRONMENTAL CONSEQUENCES

A. OFFSHORE SCENARIO FOR FUTURE OCS OPERATIONS

This section describes the offshore infrastructure, activities, and disturbances associated with both a typical proposed sale and the OCS Program that could potentially affect the biological, physical, and socioeconomic resources of the Gulf of Mexico area. Offshore is defined here as the OCS portion of the Gulf of Mexico that begins 3 leagues offshore Texas; 3 mi offshore Louisiana, Mississippi, and Alabama; and 10 mi offshore Florida; and extends seaward to the limits of the Exclusive Economic Zone (EEZ) (Figure IV-1). Coastal infrastructure, activities, and disturbances associated with the proposed action and the OCS Program are described in Section IV.B.

Offshore activities and disturbances are described in the context of a proposed action scenario and an OCS Program scenario. The MMS, Gulf of Mexico OCS Region, developed these scenarios to provide a framework for detailed analyses of potential impacts of the proposed sales. Each scenario is a hypothetical framework of assumptions based on estimated amounts, timing, and general locations of OCS exploration, development, and production activities and facilities, both offshore and onshore. The proposed action analyzed in this EIS is presented as a set of ranges for resource estimates, projected exploration and development activities, and impact-producing factors. This analyzed proposed action is expected to be "typical" of any of the Western Gulf sales held in 1998-2001. The scenarios do not predict future oil and gas activities with absolute certainty, even though they were formulated using historical information and current trends in the oil and gas industry. Indeed, these scenarios are only approximate since future factors such as the contemporary economic marketplace, the availability of support facilities, and pipeline capacities are all unknown. Notwithstanding these unpredictable factors, the scenarios used in this EIS represent the best assumptions and estimates on a set of future conditions that are considered reasonably foreseeable and suitable for presale impact analyses.

In general, a proposed action represents 0.5-1.0 percent of the Gulfwide OCS Program based on barrels of oil equivalent (BOE) resource estimates. Activities associated with a proposed action are assumed to represent 0.5-1.0 percent of Gulfwide OCS Program activities unless otherwise indicated. The assumed life of the leases resulting from the proposed sale is 35 years. This is based on averages for time required for exploration, development, production life, and abandonment for leases in the Gulf of Mexico. The OCS Program for the cumulative analysis is discussed in terms of current activities, current trends, and projections of these trends into the reasonably foreseeable future. The time period discussed varies by impact-producing factor and by resource. For modeling purposes and quantified OCS Program activities, the time period 1998-2036 (year of the first proposed lease sale through 35 years after the last proposed sale) is used. Activity projections become increasingly uncertain as the length of time projections are made for and the number of influencing factors increases. The projections used to develop the proposed action and OCS Program scenarios are based on resource and reserves estimates as presented in the *Summary of the 1995 Assessment of Conventionally Recoverable Hydrocarbon Resources of the Gulf of Mexico and Atlantic Outer Continental Shelf* (Lore et al., 1996), current industry information, and historical trends. The statistics used for the historic trends exhibit a lag time of about two years; therefore, the models using the trends also reflect two-year-old statistics. In addition, the overall trends average out the "boom and bust" nature of Gulf of Mexico OCS operations. The models cannot fully adjust for short-term changes in the rates of activities. In fact, these short-term changes should not be projected into the long term. An example of a short-term change is the current resurgence of OCS activities in the Gulf as a result of technological advancements in seismic surveying and the enactment of deepwater royalty relief. The short-term effects are "boom"-level activities, which are greater than the activity levels predicted by the resources and socioeconomic models. The acceleration of leasing and exploration cannot be expected to continue indefinitely. The MMS believes that the models, with continuing adjustments and refinements, adequately project Gulf OCS activities in the long term for the EIS analyses. The development scenarios do not represent an MMS recommendation, preference, or endorsement of any level of leasing or offshore operations, or of the types, numbers, and/or locations of any onshore operations or facilities.



Counties and Parishes in the Coastal Subareas

TX-1
Aransas, Calhoun, Cameron, Jackson, Kenedy, Kleberg, Nueces, San Patricio, Refugio, Victoria, Willacy

TX-2
Brazoria, Chambers, Fort Bend, Galveston, Hardin, Harris, Jefferson, Liberty, Matagorda, Montgomery, Orange, Waller, Wharton

LA-1
Cameron, Calcasieu, Iberia, Lafayette, Vermilion

LA-2
Ascension, East Baton Rouge, Lafourche, Livingston, St.Charles, St. James, St. Mary, St. John the Baptist, Tangipahoa, Terrebonne, West Baton Rouge

LA-3
Jefferson, Orleans, Plaquemines, St. Bernard, St. Tammany

MA-1
Baldwin, Hancock, Harrison, Jackson, Mobile, Stone

FL-1
Escambia, Santa Rosa, Okaloosa, Walton, Bay

FL-2
Gulf, Franklin, Wakulla, Jefferson, Taylor, Dixie, Levy

FL-3
Citrus, Hernando, Pasco, Pinellas Hillsborough, Manatee, Sarasota, Charlotte, Lee, Collier

FL-4
Monroe, Dade

Figure IV-1. Gulf of Mexico OCS Planning Areas, Offshore Subareas, and Coastal Subareas.

The proposed action and the OCS Program scenarios are based on the following factors:

- recent trends in the amount and location of leasing, exploration, and development activity;
- estimates of undiscovered, unleased, conventionally recoverable oil and gas resources in the planning area;
- existing offshore and onshore oil and/or gas infrastructure;
- industry information; and
- oil and gas technologies, and the economic considerations and environmental constraints of these technologies.

The proposed actions are the proposed annual Western Gulf sales as scheduled in the *Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002* (Sale 171 in 1998, Sale 174 in 1999, Sale 177 in 2000, and Sale 180 in 2001). Specific projections for activities associated with the typical proposed action are discussed in the following scenario sections. For activities and impacts that are not projected quantitatively, each proposed action is assumed to account for 0.5-1.0 percent of the projected Gulfwide OCS Program activities and impacts. The impacts of the activities and disturbances associated with a typical proposed action are considered in the environmental analysis section (Section IV.D.1.).

The OCS Program includes all activities occurring during the 39-year analysis period that are associated with past, proposed, and future lease sales. Activities that take place beyond the 39-year timeframe as a result of future sales are not included in this analysis. The impacts of activities and disturbances associated with the OCS Program on biological, physical, and socioeconomic resources are analyzed in the major cumulative action analyses (Section IV.D.1.d.).

1. Resource Estimates and Timetables

Proposed Action

The proposed action scenario is used to assess the sale-specific impacts of a proposed lease sale. The resource estimates for a proposed action are based on two factors: (a) the conditional estimates of undiscovered, unleased, conventionally recoverable oil and gas resources in the planning area; and (b) estimates of the portion or percentage of these resources assumed to be leased, discovered, developed, and produced as a result of the proposed actions. The estimates of undiscovered, unleased, conventionally recoverable oil and gas resources are based upon a comprehensive appraisal of the conventionally recoverable petroleum resources of the Nation as of January 1, 1995. Due to the inherent uncertainties associated with an assessment of undiscovered resources, probabilistic techniques were employed and the results were reported as a range of values corresponding to different probabilities of occurrence. A thorough discussion of the methodologies employed and the results obtained in the assessment are presented in the MMS report *Summary of the 1995 Assessment of Conventionally Recoverable Hydrocarbon Resources of the Gulf of Mexico and Atlantic Outer Continental Shelf* (Lore et al., 1996). The estimates of the portion of the resources assumed to be leased, discovered, developed, and produced as a result of a proposed action are based upon logical sequences of events that incorporate past experience, current conditions, and foreseeable development strategies. A profusion of historical databases and information derived from oil and gas exploration and development activities are available to MMS and were used extensively. The undiscovered, unleased, conventionally recoverable resource estimates for a proposed action are expressed as ranges, from low to high. The low end of the range is the 95-percent value, which corresponds to a 95-percent chance of that amount of resource or more occurring. The high end of the range is the 5-percent value, which corresponds to only a 5-percent chance of that amount or more occurring.

Table IV-1 presents the projected oil and gas production in the Gulf of Mexico. Table IV-2 provides a summary of major elements of the proposed action scenario and some of the related impact-producing factors.

Table IV-1

Projected Oil and Gas Production in the Gulf of Mexico OCS

	Proposed Action	OCS Program (1998-2036)
	Total	
Western Gulf of Mexico		
Reserve/Resource Production		
Oil (BBO)	0.010 - 0.090	1.485 - 2.735
Gas (tcf)	0.570 - 1.930	37.780 - 54.225
Central Gulf of Mexico		
Reserve/Resource Production		
Oil (BBO)	-	9.250 - 12.350
Gas (tcf)	-	82.650 - 113.475
Eastern Gulf of Mexico		
Reserve/Resource Production		
Oil (BBO)	-	0.075 - 0.140
Gas (tcf)	-	1.800 - 2.710

Table IV-2

OCS Offshore Scenario Information Related to a Proposed Action in the Western Planning Area

	Offshore Subareas*				Total WPA**
	W0-60	W60-200	W200-900	W900-3000	
Wells Drilled					
Exploration and Delineation Wells	16 - 46	4 - 13	4 - 11	11 - 45	35 - 115
Development Wells	23 - 76	6 - 21	5 - 18	16 - 75	50 - 190
Oil Wells	1 - 8	1 - 5	1 - 5	2 - 27	5 - 45
Gas Wells	22 - 68	5 - 16	4 - 13	14 - 48	45 - 145
Workovers and Other Well Activities	91 - 299	24 - 83	20 - 71	63 - 295	197 - 748
Production Structures					
Number Installed	5 - 19	1 - 3	1 - 2	1 - 3	8 - 27
Structure Removals Using Explosives	4 - 13	1 - 2	0 - 1	0	5 - 16
Method of Oil Transportation***					
Percent Piped	92%	100%	100%	100%	98% - 99%
Percent Barged	8%	0%	0%	0%	1% - 2%
Percent Tankered	0%	0%	0%	0%	0%
Pipelines					
Length of Installed Pipelines (km)#	104 - 300	NA	NA	NA	130 - 420
Length of Installed Oil Pipelines (km)#	NA	NA	NA	NA	25 - 120
Length of Abandoned Pipelines (km)#	NA	NA	NA	NA	18 - 75
Length of Removed Pipelines (km)#	NA	NA	NA	NA	0 - 5
Accidents					
Crude Oil Spills					
Size < or = 1 bbl	NA	NA	NA	NA	45 - 500
Size > 1 and < or = 50 bbl	NA	NA	NA	NA	2 - 15
Size > 50 and < 1,000 bbl	NA	NA	NA	NA	0 - 1
Size > or = 1,000 bbl	NA	NA	NA	NA	0 - 1
Diesel and Other Oil Spills	NA	NA	NA	NA	0 - 5
Blowouts	0 - 1	0	0	0 - 1	1 - 2
Service-Vessel Trips (1,000 trips)	11 - 41	2 - 7	2 - 5	3 - 9	18 - 62

* See Figure IV-1.

** Subarea totals may not add up to the planning area total because of rounding.

*** 100% of gas is assumed to be piped.

Projected length of OCS pipelines does not include length in State waters.

NA means that information is not available.

In order to properly analyze impact-producing factors for a proposed action and the OCS Program, the planning area was divided into offshore subareas based upon ranges in water depth. These water depth ranges reflect the technological requirements and related physical and economic impacts as a consequence of the oil and gas potential, exploration and development activities, and lease terms unique to each water depth range. No resources or development scenario are projected for water depths greater than 3,000 m. Figure IV-1 depicts the location of the offshore subareas. Estimates of resources and facilities are distributed into each of the subareas.

The estimated amounts of resources projected to be developed in each of the proposed actions are 0.01-0.09 BBO and 0.57-1.93 tcf of gas. Table IV-2 includes estimates of the major impact-producing factors or agents related to the estimated levels of exploration, development, and production activity. The number of exploration and delineation wells, production platforms, and development wells estimated to be needed to develop and produce the estimated resources for a proposed action are given in Table IV-2. The table also shows the distribution of these factors by offshore subareas in the WPA.

For purposes of analysis, the life of the leases resulting from a typical proposed action is assumed to be 35 years. Exploratory activity takes place over a 21-year period, beginning in the year immediately after the sale. Development activity takes place over a 28-year period, beginning with the installation of the first production platform and ending with the drilling of the last development wells. Production of oil and gas begins by the third year after a proposed action and continues through the 34th year. Final abandonment and removal activities occur in the last year of the life of a typical sale.

OCS Program

Total OCS Program: Estimates of total reserve/resource production related to the proposed actions plus prior and future sales (OCS Program) over the period 1998-2036 are 10.810-15.225 BBO and 122.23-170.41 tcf of gas. Table IV-3 presents estimates of the major activities and impact-producing factors related to future Gulfwide OCS Program operations in the Gulf of Mexico.

Western Planning Area: Estimates of total reserve/resource production related to the proposed action plus prior and future sales (OCS Program) in the planning area over the period 1998-2036 are 1.485-2.735 BBO and 37.780-54.225 tcf of gas. This represents approximately 13-18 percent of the oil and 31 percent of the gas of the total OCS Program. Table IV-4 presents estimates of the major activities and impact-producing factors related to future WPA operations in the Gulf of Mexico.

Central Planning Area: Estimates of total reserve/resource production related to the proposed actions plus prior and future sales (OCS Program) in the planning area over the period 1998-2036 are 9.25-12.35 BBO and 82.65-113.475 tcf of gas. This represents approximately 83 percent of the oil and 67 percent of the gas of the total OCS Program. Table IV-5 presents estimates of the major activities and impact-producing factors related to future CPA operations in the Gulf of Mexico.

Eastern Planning Area: Estimates of total reserve/resource production related to prior and future sales (OCS Program) in the planning area over the period 1998-2036 are 0.075-0.140 BBO and 1.80-2.71 tcf of gas. This represents less than 1 percent of the oil and less than 2 percent of the gas of the total OCS Program. Table IV-6 presents estimates of the major activities and impact-producing factors related to future EPA operations in the Gulf of Mexico.

2. Offshore Activities

Exploring for, producing, and transporting the hydrocarbon resources that are developed as a result of the proposed actions and the OCS Program require a complex and interrelated series of operations that begins with prelease geological and geophysical exploration under MMS permits; continues through leasing of offshore blocks, postlease seismic surveying operations, drilling of exploration wells, installation of production facilities, drilling of development wells, and movement of hydrocarbons via pipeline or barges; and ends with the removal of production facilities. Transport of personnel and supplies needed to maintain these operations are also part of the process. These diverse activities have associated potential impacts to offshore and onshore resources of the Gulf. This section describes the various kinds of offshore operations and activities that could affect the environmental and socioeconomic resources of the Gulf of Mexico area. The potential impacts associated with these activities are described in Section IV.A.3.

Table IV-3

OCS Offshore Scenario Information Related to Gulfwide OCS Program Activities for the Years 1998-2036

	Offshore Subareas*				Total**
	0-60	60-200	200-900	900-3000	
Wells Drilled					
Exploration and Delineation Wells	2,213 - 3,150	1,010 - 1,393	891 - 1,412	1,311 - 2,535	5,425 - 8,490
Development Wells	2,635 - 4,791	1,245 - 2,267	1,076 - 2,262	1,604 - 3,820	6,560 - 13,140
Oil Wells	816 - 1,650	669 - 1,232	703 - 1,471	872 - 2,072	3,060 - 6,425
Gas Wells	1,819 - 3,141	576 - 1,035	373 - 791	732 - 1,748	3,500 - 6,715
Workovers and Other Well Activities	82,500 - 87,500	39,300 - 41,600	6,600 - 10,000	5,400 - 12,800	133,800 - 151,900
Production Structures					
Number Installed	656 - 1,202	155 - 285	91 - 190	83 - 188	985 - 1,865
Structure Removals Using Explosives	373 - 538	46 - 72	4 - 10	0	424 - 619
Total Structure Removals	532 - 769	66 - 102	12 - 27	10 - 27	620 - 925
Method of Oil Transportation***					
Percent Piped	< 97%	100%	100%	< 91%	< 97%
Percent Barged	> 3%	0%	0%	0%	< 1%
Percent Tankered	0%	0%	0%	> 9%	> 2% - > 3%
Pipelines					
Length of Installed Pipelines (km)#	20,925 - 29,700	NA	NA	NA	29,450 - 41,140
Length of Installed Oil Pipelines (km)#	NA	NA	NA	NA	6,070 - 11,500
Length of Abandoned Pipelines (km)#	NA	NA	NA	NA	3,990 - 7,120
Length of Removed Pipelines (km)#	NA	NA	NA	NA	30 - 440
Accidents					
Crude Oil Spills					
Size < or = 1bbl	NA	NA	NA	NA	55,300 - 79,300
Size > 1 and < or = 50 bbl	NA	NA	NA	NA	1,600 - 2,300
Size > 50 and < 1,000 bbl	NA	NA	NA	NA	65 - 90
Size > or = 1,000 bbl	NA	NA	NA	NA	9 - 38
Diesel and Other Oil Spills	NA	NA	NA	NA	800 - 1,100
Blowouts	50 - 73	24 - 33	14 - 26	20 - 45	108 - 177
Service-Vessel Trips (1,000 trips)	8,549 - 9,929	1,278 - 1,599	271 - 508	228 - 506	10,326 - 12,544

* See Figure IV-1.

** Water depth totals may not add up to the OCS total because of rounding.

*** 100% of gas is assumed to be piped.

Projected length of OCS pipelines does not include length in State waters.

NA means that information is not available.

Table IV-4

OCS Offshore Scenario Information Related to OCS Program Activities in the Western Planning Area for the Years 1998-2036

	Offshore Subareas*				Total WPA**
	W0-60	W60-200	W200-900	W900-3000	
Wells Drilled					
Exploration and Delineation Wells	851 - 1,290	265 - 407	291 - 468	398 - 1,100	1,805 - 3,265
Development Wells	794 - 1,359	247 - 429	272 - 493	372 - 1,159	1,685 - 3,440
Oil Wells	44 - 94	38 - 84	115 - 211	88 - 441	285 - 830
Gas Wells	750 - 1,265	209 - 345	157 - 282	284 - 718	1,400 - 2,610
Workovers and Other Well Activities	10,400 - 11,600	6,500 - 6,700	1,900 - 2,500	1,200 - 3,800	20,000 - 24,600
Production Structures					
Number Installed	198 - 341	31 - 54	23 - 41	18 - 59	270 - 495
Structure Removals Using Explosives	67 - 102	12 - 19	2 - 3	0	81 - 123
Total Structure Removals	95 - 145	17 - 27	5 - 8	3 - 10	120 - 190
Method of Oil Transportation***					
Percent Piped	92%	100%	100%	>90%	>94% - <96%
Percent Barged	8%	0%	0%	0%	<1% - <2%
Percent Tankered	0%	0%	0%	>9%	>3% - <5%
Pipelines					
Length of Installed Pipelines (km)#	3,760 - 5,330	NA	NA	NA	4,140 - 5,770
Length of Installed Oil Pipelines (km)#	NA	NA	NA	NA	790 - 1,510
Length of Abandoned Pipelines (km)#	NA	NA	NA	NA	400 - 720
Length of Removed Pipelines (km)#	NA	NA	NA	NA	4 - 70
Accidents					
Crude Oil Spills					
Size < or = 1bbl	NA	NA	NA	NA	6,900 - 13,900
Size > 1 and < or = 50 bbl	NA	NA	NA	NA	200 - 400
Size > 50 and < 1,000 bbl	NA	NA	NA	NA	10 - 15
Size > or = 1,000 bbl	NA	NA	NA	NA	0 - 11
Diesel and Other Oil Spills	NA	NA	NA	NA	100 - 200
Blowouts	13 - 20	5 - 7	4 - 7	5 - 16	27 - 50
Service-Vessel Trips (1,000 trips)	1,287 - 1,619	264 - 321	80 - 126	52 - 163	1,683 - 2,229

* See Figure IV-1.

** Subarea totals may not add up to the planning area total because of rounding.

*** 100% of gas is assumed to be piped.

Projected length of OCS pipelines does not include length in State waters.

NA means that information is not available.

Table IV-5

OCS Offshore Scenario Information Related to OCS Program Activities in the Central Planning Area for the Years 1998-2036

	Offshore Subareas*				Total CPA**
	C0-60	C60-200	C200-900	C900-3000	
Wells Drilled					
Exploration and Delineation Wells	1,303 - 1,745	741 - 965	598 - 940	878 - 1,370	3,520 - 5,020
Development Wells	1,743 - 3,272	991 - 1,809	800 - 1,763	1,176 - 2,571	4,710 - 9,415
Oil Wells	739 - 1,497	627 - 1,140	586 - 1,257	758 - 1,576	2,710 - 5,470
Gas Wells	1,004 - 1,775	364 - 669	214 - 506	418 - 995	2,000 - 3,945
Workovers and Other Well Activities	71,800 - 75,300	32,800 - 34,800	4,700 - 7,500	4,000 - 8,700	113,300 - 126,300
Production Structures					
Number Installed	433 - 821	123 - 227	67 - 148	62 - 124	685 - 1,320
Structure Removals Using Explosives	300 - 428	34 - 52	2 - 7	0	336 - 487
Total Structure Removals	428 - 612	49 - 74	7 - 19	6 - 15	490 - 720
Method of Oil Transportation***	98.8% 74.5%	39.8%			
Percent Piped	97%	100%	100%	> 90%	> 96%
Percent Barged	3%	0%	0%	0%	< 1%
Percent Tankered	0%	0%	0%	> 9%	< 3%
Pipelines					
Length of Installed Pipelines (km)#	17,140 - 24,250	NA	NA	NA	25,270 - 35,200
Length of Installed Oil Pipelines (km)#	NA	NA	NA	NA	5,260 - 9,950
Length of Abandoned Pipelines (km)#	NA	NA	NA	NA	3,590 - 6,390
Length of Removed Pipelines (km)#	NA	NA	NA	NA	26 - 380
Accidents					
Crude Oil Spills					
Size < or = 1bbl	NA	NA	NA	NA	48,100 - 64,700
Size > 1 and < or = 50 bbl	NA	NA	NA	NA	1,400 - 1,900
Size > 50 and < 1,000 bbl	NA	NA	NA	NA	55 - 75
Size > or = 1,000 bbl	NA	NA	NA	NA	7 - 32
Diesel and Other Oil Spills	NA	NA	NA	NA	700 - 900
Blowouts	36 - 51	19 - 26	10 - 19	14 - 28	79 - 124
Service-Vessel Trips (1,000 trips)	7,208 - 8,222	1,011 - 1,269	189 - 380	168 - 330	8,576 - 10,201

* See Figure IV-1.

** Subarea totals may not add up to the planning area total because of rounding.

*** 100% of gas is assumed to be piped.

Projected length of OCS pipelines does not include length in State waters.

NA means that information is not available.

Table IV-6

OCS Offshore Scenario Information Related to OCS Program Activities in the Eastern Planning Area for the Years 1998-2036

	Offshore Subareas*				Total EPA**
	E0-60	E60-200	E200-900	E900-3000	
Wells Drilled					
Exploration and Delineation Wells	59 - 115	4 - 21	2 - 4	35 - 65	100 - 205
Development Wells	98 - 160	7 - 29	4 - 6	56 - 90	165 - 285
Oil Wells	33 - 59	4 - 8	2 - 3	26 - 55	65 - 125
Gas Wells	65 - 101	3 - 21	2 - 3	30 - 35	100 - 160
Workovers and Other Well Activities	300 - 600	0 - 100	0	200 - 300	500 - 1,000
Production Structures					
Number Installed	25 - 40	1 - 4	1	3 - 5	30 - 50
Structure Removals Using Explosives	6 - 8	0 - 1	0	0	6 - 9
Total Structure Removals	9 - 12	0 - 1	0	1 - 2	10 - 15
Method of Oil Transportation***					
Percent Piped	100%	100%	100%	> 90%	100%
Percent Barged	0%	0%	0%	0%	0%
Percent Tankered	0%	0%	0%	0%	0%
Pipelines					
Length of Installed Pipelines (km)#	25 - 120	NA	NA	NA	40 - 180
Length of Installed Oil Pipelines (km)#	NA	NA	NA	NA	8 - 45
Length of Abandoned Pipelines (km)#	NA	NA	NA	NA	2 - 6
Length of Removed Pipelines (km)#	NA	NA	NA	NA	0 - 2
Accidents					
Crude Oil Spills					
Size < or = 1bbl	NA	NA	NA	NA	300 - 700
Size > 1 and < or = 50 bbl	NA	NA	NA	NA	10 - 20
Size > 50 and < 1,000 bbl	NA	NA	NA	NA	0 - 1
Size > or = 1,000 bbl	NA	NA	NA	NA	0 - 2
Diesel and Other Oil Spills	NA	NA	NA	NA	5 - 10
Blowouts	1 - 2	0	0	1	2 - 3
Service-Vessel Trips (1,000 trips)	54 - 88	2 - 9	2	8 - 13	67 - 112

* See Figure IV-1.

** Subarea totals may not add up to the planning area total because of rounding.

*** 100% of gas is assumed to be piped.

Projected length of OCS pipelines does not include length in State waters.

NA means that information is not available.

Tables IV-2 through IV-6 show the magnitudes of the impact factors that are projected to occur from a proposed action and from the OCS Program. These quantities are expressed as the total amount generated over the life of leases resulting from a proposed action, which is assumed to be 35 years, and over the period 1998-2036 for the OCS Program.

a. Infrastructure and Operations

(1) Seismic Surveying Operations

There are two general types of offshore, geophysical seismic surveys, both performed to obtain information on subsurface geologic formations. High-resolution seismic surveys collect data up to 300 m deep and are used for the initial site evaluation for drilling rig emplacement and for platform design and emplacement. High-energy common depth point (CDP) seismic surveys obtain data about geologic formations up to several thousands of meters deep, enabling industry to more accurately assess potential hydrocarbon reservoirs in order to optimally locate exploration and development wells and to minimize the number of wells required to develop a field.

Seismic surveying operations are conducted from vessels that tow an array of geophysical instruments. Large vessels in the 250- to 300-ft (75-90 m) class are typical of those used to acquire CDP seismic data. The vessels follow precise, preplotted lines so that overlapping coverage of the seafloor is achieved. With seismic gear deployed, the operating vessel speed is typically 4-7 knots or about 4½-8 mph. Surveying operations are usually conducted 24 hours a day. Radio communications with other vessels are maintained at all times during the surveying.

A typical marine seismic source is a sleeve-type air gun array, which releases compressed air into the water creating an acoustical energy pulse that penetrates the seafloor. The air guns are towed 5-10 m below the sea surface and release compressed air every several seconds, creating a regular series of strong acoustic impulses separated by silent periods lasting 5-15 seconds, depending on survey type and depth to the target formations. The acoustic signals are reflected off the subsurface sedimentary layers and recorded near the water surface by hydrophones spaced along streamer cables. The streamers are towed behind the vessel at a depth of 5-10 m below the surface of the water. The receiver cable relays the information on the reflected energy signal to the onboard computers, which record and partially process the data. Individual streamers can be 3 km or longer in length. Tail buoys with radar reflectors and strobe lights are used to mark the end of the streamers.

Sound from the seismic source is focused downward, so there should be little, if any, noticeable sound from the seismic source at the water surface near the vessel. Sound reflected from the sea bottom may be above ambient levels at the surface. Sounds will also be produced by the propulsion system and equipment aboard the towing vessel.

Advances in surveying technology and computer processing of the seismic data have lead to the development of three-dimensional (3D) seismic surveying. State-of-the-art interactive computer mapping systems represent the subsurface in three dimensions and can enhance various aspects of the data set. The geologic model can be viewed from various angles, from cross-sectional cuts to "peeling away" sedimentary layers. This 3D seismic modeling requires much denser data coverage than the older two dimensional (2D) seismic surveys. Multiple source and multiple streamer technology are used for 3D seismic surveys. A typical 3D survey might employ a dual array of 18 guns per array, each producing 8.62 megapascals peak to peak energy. Each array might emit a 3,000-in^3 (about 49,000 cm^3) burst of compressed air at 2,000 psi (136 atm), generating approximately 4,500 kJ of acoustic energy for each burst. At 10 m from the source, the pressure experienced is approximately ambient pressure plus 1 atm (14.7 psi). The streamer array might consist of six parallel cables, each approximately 3,000 m long, spaced 75 m apart. There would be 240 groups of 16 hydrophones spaced at 40-m intervals along the cables.

Prior to 1989, explosives (dynamite) were occasionally used to generate seismic pulses. Explosives have since been replaced by piston-type acoustic sources that generate superior acoustic signals and that do not cause the damaging environmental impacts associated with explosives. Acoustical energy from explosives is characterized by rapid rise time (high velocity), high peak pressure, and rapid energy decrease. Seismic air guns are considered nonexplosive and have long rise times to peak pressure (low velocity). It is assumed that no explosives will be used in future seismic surveys on the OCS.

Seismic surveying began in the northern Gulf of Mexico in 1960. A total of 1.6 million line-miles of 2D data and 7,500 blocks of 3D data have been collected over the Gulf OCS. Over the last 5 years, the number of prelease geological and geophysical exploration permits in the Gulf has averaged about 130 permits annually, with 50-70 3D seismic survey permits annually. Most prelease surveys done under G&G permit are speculative CDP surveys, which support several proposed lease sales. With the implementation of deepwater royalty relief and the record-breaking number of bids at the 1996 Gulf of Mexico lease sales, MMS anticipates an increase in the number of permit applications. The geophysical surveying companies anticipate conducting large speculative 2D and 3D geophysical surveys in deepwater areas. Current surveys are incorporating denser grids with more line-miles of data, are covering larger areas, and are moving out into progressively deeper water. State-of-the-art 3D seismic data have enabled industry to identify, with greater precision, where the most promising deepwater prospects are located. This 3D technology is being used in developed areas on the shallower shelf to identify bypassed hydrocarbon-bearing zones in currently producing formations and new productive horizons near or below currently producing formations. It is also being used in developed areas for reservoir monitoring and field management. Prelease surveys are assumed to decline in number as data coverage becomes complete, although some previously surveyed areas may be resurveyed to gather better data as technology advances.

Postlease seismic surveying may included high-resolution, 2D, 3D, or 4D surveying. High-resolution surveying is usually done on a site-specific or lease sale basis or along a proposed pipeline route. These surveys are used to identify potential shallow geologic hazards for engineering and site planning for bottom-founded structures. They are also used to identifying environmental resources such as hard-bottom areas, topographic features, potential chemosynthetic community habitat, or historical archaeological resources. Postlease high-resolution seismic surveying is assumed to be done once for each lease that is drilled, and a single high-resolution survey over a lease will usually suffice for all of the exploratory, delineation, and development wells drilled on the lease and will support any potential facilities siting. A single high-resolution survey may be planned to cover multiple adjacent leases, especially all those belonging to a designated exploration or production unit. Under the proposed action, as many as 115 exploratory and delineation wells will be drilled. If each of these wells is on a different lease, as many as 115 new leases may require high-resolution surveying. High-resolution surveys are also done along the proposed route of pipelines.

High-energy seismic surveying (2D, 3D, and 4D, which is a series of 3D surveys collected over time) may also be done post-lease. The 3D seismic technology allows more accurate identification of potential reservoirs, increasing success rates for exploratory drilling and aiding in the identification of additional reservoirs in "known" fields. The 4D seismic surveying is primarily used for reservoir monitoring and management, as well as to identify bypassed "pay zones." Through time-lapsed surveys, the movement of oil, gas, and water in reservoirs can be observed over time. Postlease CDP surveys are costly and are usually done over a single lease or over an exploration or development unit, which may include leases from multiple sales as well as unleased blocks. Postlease CDP seismic surveys may occur periodically throughout the productive life of a lease.

New technology allows the collection of both compression waves and shear waves reflected from subsurface layers. The receiver cable must be laid on the seafloor because shear waves cannot move through the water column; the sound source is the same. This technology provides additional detail on the geology and fluids beneath the seafloor. Because it is a slow and costly process, this technology will likely be limited to small areas over potential reservoir already identified through 2D or 3D surveying. Because of the operational constraints imposed by the greater water depths and the greater depths to the potential hydrocarbon reservoirs, this technology might also be appropriate for use in the deepwater areas of the Gulf.

(2) Drilling and Production Operations

(a) Exploration and Delineation Phase

Offshore exploratory wells in the Gulf of Mexico are drilled from three types of drilling rigs. The type of rig used depends primarily on the water depth at the drilling location. Since the water depth ranges in which each type of rig is utilized overlap, other factors such as rig availability and daily rig rates are also considered when deciding upon the type of rig to use. Using these considerations, the model used in this analysis is as follows:

Drilling Rig	Water Depth
Jack-up rig	up to 100 m
Semi-submersible	100 to 750 m
Drillship	greater than 750 m

As operations move into progressively deeper waters, new technologies may be developed to drill exploration and delineation wells. Ship-shape vessels (floating production and/or storage and/or offloading vessels) may be used to drill deepwater exploration wells, especially wells that would require extended well testing, 1-2 weeks or longer, in order to fully evaluate potential producible horizons and to justify the huge costs of deepwater development. These extended tests may result in requests for flaring large volumes of gas and burning or barging large volumes liquid hydrocarbons. If a ship-shape vessel with storage capacity is used as the drilling platform, the well stream resulting from the extended well test could be stored and later processed.

This scenario assumes that the average time required to drill an exploration/delineation well is 40 days and that the average well depth is 4,115 m. The average well depth is greater in deepwater (water depths greater than 450 m), with total well depths in the 4,500- to 5,500-m range. During drilling operations, each rig provides 133 person-years of employment each year.

Proposed Action Scenario: The total number of exploration and delineation wells projected to be drilled associated with a proposed action is 35-115. Most of these wells are projected to be in the shallow shelf areas or in the deepwater areas. Exploratory drilling related to a proposed sale is projected to begin the year of the sale and to reach peak activity 4-9 years after the sale.

OCS Program Scenario: At present, 250-350 exploration or delineation wells are drilled annually in the Gulf. By far, the majority of these are in the CPA. Exploratory drilling is projected to be at its peak in the Western Planning Area (WPA) in 2003-2010, in the Central Planning Area (CPA) over the next 8-10 years, and in the Eastern Planning Area (EPA) in 2016-2025. The overall annual rate is expected to decline over time as the hydrocarbon potential of more areas is tested through drilling. By the year 2036, Gulfwide exploratory drilling may be as low as 55-80 wells annually. The total number of exploration and delineation wells projected to be drilled Gulfwide through the year 2036 is 5,425-8,490. It is projected that 1,805-3,265 of those wells will be drilled in the WPA, 3,520-5,020 wells in the CPA, and 100-205 wells in the EPA.

(b) Development and Production Phase

Development wells are drilled from production platforms, drill rigs, or drillships. The number of wells per platform in the Gulf of Mexico can range from 2 to 60, depending upon the size of the prospect being developed, the type of production platform being used, and the drilling/production strategy to be used for resource conservation. In this analysis, it is assumed that 4-28 wells will be drilled for each production platform, with platforms in deeper waters having more wells per platform. An estimated 18-20 percent of the development wells drilled will not go on production. Of the wells that are completed and go on production in all water depths in the WPA, 5-7 percent will be subsea completions (Figure IV-2). In water depths greater than 450 m, a significantly higher percentage of the wells that go on production will be subsea completions.

Production components for a subsea well are located on a template on the seafloor with the template supporting production components for one or more wells. Production components may include well heads, "Christmas trees," manifolds, control equipment, umbilicals, etc. A subsea system can range from a single-well template with production going to a nearby platform to multiple templates producing through a manifold, pipeline, and riser system to a distant production facility. Subsea systems rely on a remote site or host facility for utility and well control services. Centralized or host production facilities in deep water or on the shelf may support several satellite subsea developments, potentially developing several different fields. Unlike wells from conventional fixed platforms, subsea wells do not have surface facilities directly supporting them during the production phases. A drilling rig must be brought on location to provide surface support to reenter the well for workovers and other types of well maintenance. In addition, should the production system fail and a blowout result, surface support must be brought on location to regain well control.

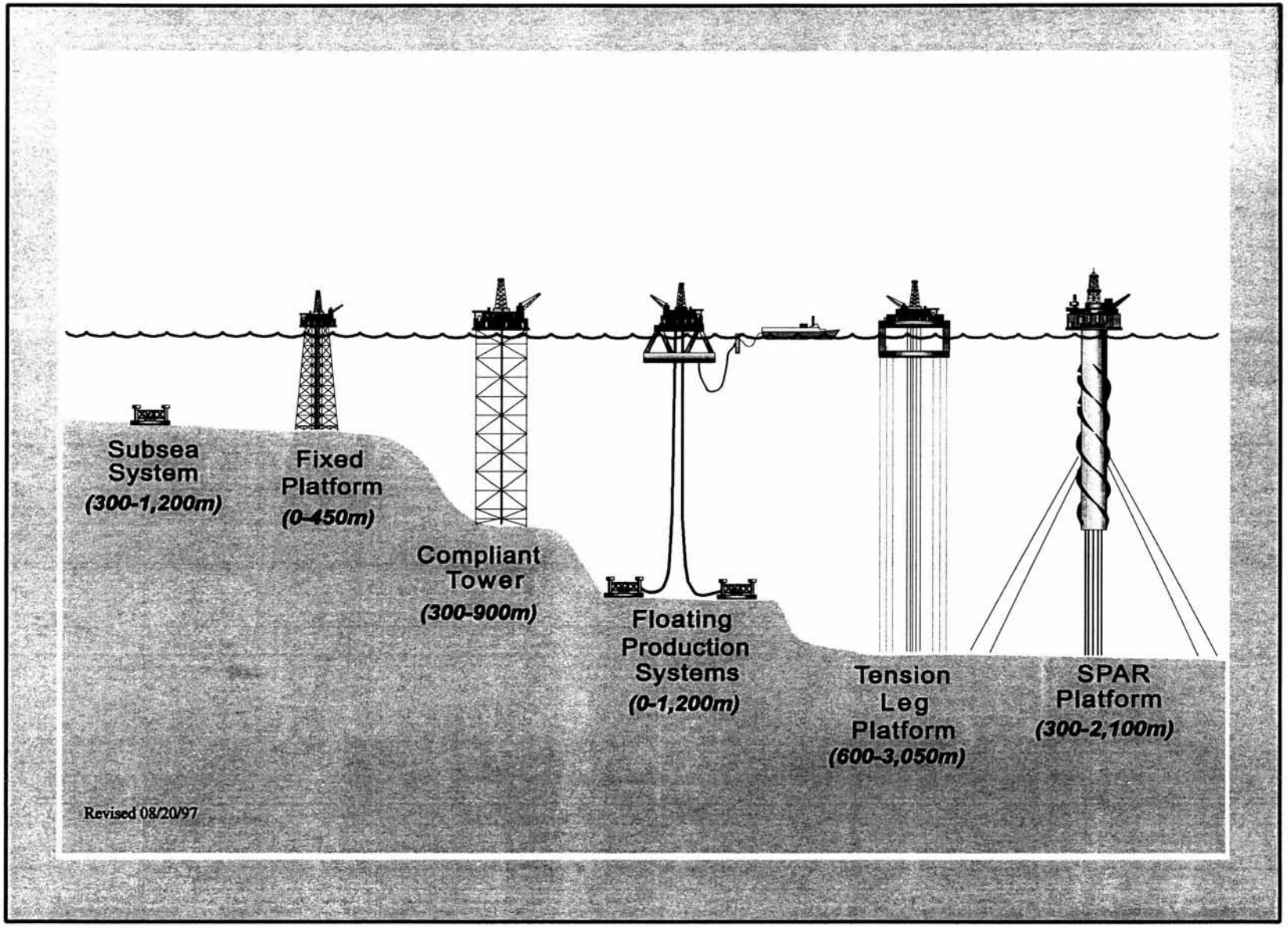


Figure IV-2. Platform Development Systems in the Gulf of Mexico.

Although the use of subsea systems has recently increased as development moves into deeper waters, subsea systems are not new to the Gulf and are not exclusively used for deepwater development. The first subsea wells in the Gulf were installed in 1964. Subsea systems are currently used in water depths up to 2,100 m. As of September 1996, there were 139 subsea wells in the Gulf of Mexico in all water depths.

The average depth of a development/production well is assumed to be 3,050 m and requires about 35 days to drill. The average well depth is greater in deepwater (greater than 450 m), with total depths in the 4,500- to 6,000-m range, and they take proportionately longer to drill. A platform rig can drill an average of nine wells per year in shallow water. For development drilling in deeper water, drilling vessels can drill an average of six wells per year. Each development drilling operation provides approximately 115 person-years of employment each year.

Drilling rigs operating in the deep waters of the Gulf of Mexico more than quadrupled between 1991 and 1996, from an average of 4 rigs drilling monthly to 17 rigs. Drilling activities are currently constrained by the overall availability of rigs capable of working in these water depths, the availability of rig crews, and riser availability.

The type of production structure to be installed at a site depends mainly on water depth (Figure IV-2). At water depths less than 450 m, it is assumed that conventional fixed platforms that are rigidly attached to the seafloor will be used. Fixed platforms consist of a jacket (a vertical section made of tubular steel members supported by piles driven into the seafloor) with a deck to provide space for crew quarters, drilling rigs, and production facilities. Fixed platforms are economical for installation in water depths up to 450 m. In less than 200 m, 20 percent of the platforms will be manned (defined as having sleeping quarters on the structure). In depths between 200 and 450 m, all platforms are assumed to be manned, with 14 people working on site per shift. It is assumed that helipads are located on 66 percent of platforms in water depths less than 60 m, on 94 percent of platforms in water depths between 60 and 200 m, and on 100 percent of the platforms in water depths between 200 and 450 m.

At water depths exceeding 450 m, traditional platform designs based on rigid attachment to the seafloor will not be used. Deepwater structures used and proposed for the Gulf of Mexico include compliant towers, tension leg platforms (TLP's), and SPAR platforms (Figure IV-2). A compliant tower consists of a narrow flexible tower and a piled foundation that supports a conventional deck for drilling and production operations. Compliant towers are usually used in water depths between 300 and 900 m. Unlike fixed platforms, compliant towers can withstand significant lateral deflections. A TLP consists of a floating structure held in place by tensioned tendons connected to the seafloor by templates secured with piles. The tensioned tendons provide broad depth range and limited vertical motion. The TLP's can be used in water depths up to 2,100 m. A SPAR platform consists of a large-diameter cylinder supporting a conventional deck, three types of risers (production, drilling, and export), and a hull that is moored via a taut catenary system of 6-20 lines anchored to the seafloor. SPAR's are now used in water depths up to 900 m and may be used in water depths as great as 3,000 m. All of these facilities will be manned and will have helipads. Production from compliant towers, TLP's, and SPAR's will be transported via pipeline. Additional storage capacities of 50,000-100,000 bbls of oil may be required on these deepwater production facilities to ensure enough volume and pressure for pipeline flow.

Floating production systems (FPS's) are ship-shape platforms that can have any combination of the capabilities including drilling, production, separation, storage, and offloading. An FPS is anchored in place with wire rope and chain to allow for vertical motion and will employ subsea completions connected to the surface deck via production risers that are designed to accommodate the platform's vertical motion. Floating production, storage, and offloading (FPSO) will be used for development of marginal fields, where projected production is not enough to justify the expense of installing pipelines to shore or to connect to the existing pipeline system (Lovie, 1997). Oil production from FPSO's is expected to be barged or tankered. FPSO's may have storage capacities up to 900,000 bbl of oil. Produced gas is expected to be piped, although industry is considering the options of conversion to a liquid state or reinjection for later production. FPS/FPSO's with drilling capabilities may be used to drill and "produce" from exploratory wells requiring extended well testing, and they may be used to both drill the development wells and support production activities from a single field.

SeaStar tension leg platforms are floating mini-TLP's of relatively low cost projected to be used to develop smaller deepwater reservoirs that would be uneconomical to develop using conventional deepwater production systems. SeaStars may also be used as utility, satellite, or early production platforms for larger deepwater

discoveries. The world's first SeaStar platform is scheduled for installation in the Gulf of Mexico in 1998. SeaStars will be used in water depths ranging from 180 to 1,100 m.

The average life of a production platform is assumed to be 20 years. The average life of a gas well is 12 years; 14 years for an oil well.

Proposed Action Scenario: The total number of development wells projected to be drilled associated with a proposed action is 50-190. Of these wells, 5-45 are projected to be oil wells and 45-145 are projected to be gas wells. Development drilling related to a proposed sale is projected to begin as soon as 1 year after the sale and to reach peak activity 9-11 years after the sale.

Some 8-27 production platforms are projected to be installed to support a proposed action. More than 60 percent of these projected platforms are expected to be conventional fixed platforms in water depths less than 60 m. This takes into consideration that more wells will be drilled per platform in deepwater. By definition, the life of a proposed action is from the sale until removal of the last platform and site clearance. All of the platforms associated with proposed action activities are projected to be removed within 35 years.

OCS Program Scenario: At present, 300-575 development wells are drilled annually in the Gulf. Of these, an estimated 54-115 wells will not go on production, and 15-40 wells will be subsea completions. Current rates by planning area are 60-100 wells annually in the WPA, 225-475 wells annually in the CPA, and no development wells currently in the EPA. By far, the majority of the development wells are being drilled in the CPA. The overall annual rate is expected to decline over time as more areas reach peak development. Development drilling is projected to be at its peak in the WPA in 2002-2009 with 60-110 wells drilled annually, in the CPA through the next seven years with 225-475 wells drilled annually, and in the EPA in 2005-2013 with 3-11 wells drilled annually. By the year 2036, development drilling in the Gulf of Mexico may be as low as 70-100 wells annually.

The total number of development wells projected to be drilled Gulfwide through the year 2036 is 6,560-13,140. In the WPA, 1,685-3,440 wells are projected with more than 75 percent being gas wells. In the CPA, a total of 4,710-9,415 development wells are projected with only slightly more oil wells (55-60%) being projected than gas wells. In the EPA, 165-285 development wells are projected with more than 70 percent being gas wells.

At present, 90-150 platforms are installed annually in the Gulf. The majority of these, more than 80 percent, are conventional fixed platforms in water depths less than 60 m. Although the rate of platform installation in deeper water areas (greater than 200 m) is expected to increase over the next decade, the overall annual platform installation rate is expected to decrease. The number of platforms installed annually is expected to be greater than the number of platforms removed annually. Recently, 3D seismic technology is being used in developed areas on the shelf to identify bypassed hydrocarbon-bearing zones in currently producing formations and new productive horizons near or below currently producing formations. Many existing platforms that would have been removed are now being left in place to develop these new targets.

(3) Workover Operations and Other Well Activities

Workover operations are conducted on a well, after the initial completion, to maintain or restore the productivity of the well, to evaluate a geologic formation or reservoir, or to abandon the well. In 1990, about 4,200 completions, workovers, and abandonment operations took place in the Gulf of Mexico. Examples of workover operations are acidizing the perforated interval in the casing, plugging back, squeezing cement, milling out cement, jetting the well in with coiled tubing and nitrogen, and setting positive plugs to isolate hydrocarbon zones. About 20 percent of all workover operations will require a jack-up rig or other major rig. Workovers on subsea completions require that a rig be moved on location to provide surface support. Workovers can take from a few days to several months to complete, with an average of about 10 days. A typical workover provides work for 58 employees. Each producing well averages one workover or well treatment every 4 years (USEPA, 1993).

Other well operations included well completions, well treatments, and abandoning wells. Completion is the process of installing the downhole equipment to allow production of oil or gas from the hydrocarbon-bearing formation. Completion activities include setting and cementing the casing, perforating the casing and surrounding cement, installing production tubing and packers, and gravel-packing the well. Completions will occur on approximately 80 percent of the development wells drilled. Well treatments are done to improve well

productivity. In the Gulf of Mexico, acidizing is the most common well treatment. During abandonment operations, all of the equipment in the well is removed and the well is plugged with cement. All abandonment operations require rig activity. There will be one abandonment operation per well.

Proposed Action Scenario: Between 147 and 748 workovers and other well operations are projected as a result of a proposed action. This projection takes into account the fact that not all projected development wells will go on production.

OCS Program Scenario: Well operations occur at about a rate of once every 4 years for each producing well. Total well operations for the OCS Program will be at a rate of about 4,000-5,000 per year. These well operations will be conducted both on wells that were in place prior to a proposed actions and on those installed in the future. The number of producing wells is expected to increase slowly but steadily over the next 30-40 years; associated well operations will also increase.

(4) Structure Removals

Lessees are required to remove all structures and related underwater obstructions from their Federal OCS leases within one year of the cessation of production or the lease's termination. Production platforms anchored to the seafloor by steel pilings are the dominant type of structure in water depths less than 400 m. Approximately 70 percent of removals of these conventional, fixed platforms require the use of explosives (Shaw, written communication, 1996; USDOI, MMS, 1987a). For further discussion on explosive removals, see Section IV.A.3.c.(1). Approximately 117 personnel are directly or indirectly employed for each removal. MMS data indicate that approximately 123 (87 explosive) and 118 (81 explosive) structures were removed from the Gulf of Mexico in 1994 and 1995, respectively, and nearly 75 percent of all removals occurred in the CPA. These numbers are assumed to reflect the prevalent distribution of OCS activity.

The MMS and NMFS have conferred extensively in the development of platform removal precautions. The NMFS has instituted a comprehensive program to protect sea turtles and cetaceans. Since NMFS's protective observer program began in 1986, the number of documented sea turtles impacted by explosives was only two during 1986-1994 (Gitschlag and Herczeg, 1994; NRC, 1996). A dead or injured turtle drifting below the water surface was sighted 1.5 hours after the explosive removal of a structure in 1986 (Gitschlag and Renaud, 1989). Only one injured turtle has been observed since 1987, when monitoring became mandatory (NRC, 1996); in 1991, within one minute of detonation, a loggerhead turtle with a fracture down the length of its carapace surfaced 5-30 m from the detonation site. Other turtles have been removed from the vicinity of platforms slated for removal, prior to detonation of the explosives. If cetaceans are observed in the vicinity of a removal site, detonations are postponed until the animals have vacated the area. No cetacean has been recorded as harmed.

In October 1995, NMFS issued regulations authorizing and governing the taking of bottlenose and spotted dolphins incidental to the removal of oil and gas drilling and production structures in State waters and on the Gulf of Mexico OCS for a period of 5 years (*Federal Register*, 1995). Letters of Authorization for Incidental Take must be requested from, and issued to, individual applicants (operators) to conduct the activities (platform removals) pursuant to the regulations.

Proposed Action Scenario: All platforms installed as a result of a proposed action, 8-27 projected platforms, are projected to be removed within 35 years following the lease sale. It is projected that these removals will begin about 2011.

OCS Program Scenario: At present, platforms are being removed at a rate of 45-65 annually. This rate is expected to decrease over time. The MMS projects that, during the years 1998-2038, a maximum of 190 platforms will be removed from the WPA and 720 platforms from the CPA.

b. Offshore Transport

Transportation of oil and gas to shore in the Gulf of Mexico has relied on an ever-expanding pipeline network, except for a very small percentage of oil that continues to be barged from shallow water areas to onshore oil terminals.

Future oil and gas production will continue to be piped from offshore leases to shore. Pipeline installation technology appears to be keeping pace with industry's ability to develop oil resources in the deepwater areas

of the Gulf. Although the oil and gas industry has analyzed the option of tankering in the Gulf from deepwater fields (INTEC Engineering, 1985) and has developed tankering scenarios as part of the DeepStar Project, tankering has yet to occur. The DeepStar Project is a cooperative industry-sponsored workgroup that identifies and develops economically viable, low-risk method to produce hydrocarbons from deepwater leases in the Gulf of Mexico. The tankering scenario developed as part of the DeepStar Project is now more than 10 years old. For this EIS analysis, tankering is assumed to take place only from marginal fields in water depths greater than 900 m where projected production is not enough to justify the expense of installing pipelines. All gas is assumed to be piped, although industry is exploring the options of conversion to liquid forms or reinjection for later production. It is assumed that minor amounts of barging of oil will continue to occur.

(1) Pipelines

Pipelines are the primary method used to transport liquids and gases between OCS production sites and onshore facilities where any combination of metering, distribution, and processing may occur (Sections IV.B.1.d. and e.). A variety of products are transported by pipe in the Gulf of Mexico. These products include unprocessed bulk oil and bulk gas; mixtures of gas and condensate; mixtures of gas and oil; processed condensate, oil, or gas; produced water; methanol; liquid propane; fuel oil; and a variety of chemicals used by the OCS industry offshore.

Pipelines in the Gulf are designated as either trunklines or gathering lines. Gathering lines are typically short segments of small-diameter pipelines that transport materials from a production facility or from several wells to a central facility for one or several leases, e.g., a trunkline or central storage or processing terminal. Trunklines are typically larger-diameter pipelines that transport production from several oil fields offshore to shore. Because of the nature of the pipeline network, some materials will flow through several trunklines before reaching shore.

A pipeline system is made up of a series of connected trunklines and gathering pipelines that transport materials from numerous wells to one or several shore facilities (Section IV.B.1.e.(1)). Six pipeline systems of the CPA are known to transport produced materials from the WPA.

As of February 1997, a total of 87 oil pipeline systems were operating in the Gulf, 15 of which were in the WPA. Tables IV-7 and IV-8 provide the length of pipelines installed in the WPA and the rest of the Gulf region, based on data available during February 1997. According to regulations, pipelines in less than 60 m of water should be buried unless a waiver to these regulations is issued with the permit. No cumulative records are maintained for these waivers. Therefore, up to the length of pipe installed in less than 60 m of water may have been trenched and buried upon installation. A review of available historical data for the period 1965-1996 revealed that pipelines were installed at an increasing rate per year. This trend is expected to continue with the upsurge in OCS activities due to 3D seismic surveying technology and deepwater royalty relief. Based upon the curve generated by this data, the rate may not begin to decline until after about 2015.

The typical life span of a pipeline has been estimated to be about 20 years, but with current corrosion management technology, that life time has been significantly increased. Much of the aging pipeline system is assumed to be replaced or expanded upon at the above described historical rates in order to continue to provide adequate pipeline transport.

As of December 1996, about 4,207 km of pipelines were known to have been abandoned in the Gulf OCS region, 424 km of which are in the WPA (Tables IV-2 and IV-4). Historically since 1980, 85-130 km of pipeline were abandoned during any given year.

As of December 1996, 353 km of pipelines were known to have been removed from the Gulf OCS region, all of which were removed from the CPA in water depths of 0-60 m. Since 1970, removals have occurred infrequently. During that period, 0-110 km were removed each year.

The trend toward increased leasing and development in deepwater areas of the Gulf will extend pipelines into water depths that will require new technology. Projected technological advances will allow pipeline installations in all water depths of the OCS. One approach to installing deepwater pipelines has been to assemble long segments (up to 10 km in length) of pipe onshore and then towing the prefabricated pipe to the production site. This approach has been used for several projects in the Green Canyon and Mississippi Canyon Areas. At present, no similar projects have been proposed, and as of the summer of 1996, the company that performed these bottom-tow installations had no expectations of similar new projects.

Table IV-7

Facilities Projected to be Existing and Active in the Western Planning Area Immediately Prior to Sale 171 (August 1998)

	Offshore Subareas*				Total WPA
	W0-60	W60-200	W200-900	W900-3000	
	Total as of 12/31/95** / 1995 Annual / Existing Facilities Prior to Sale				
Wells Drilled					
Exploration and Delineation Wells***	1,573 / 44 / 273 - 283	612 / 16 / 47 - 49	171 / 8 / 39 - 41	10 / 5 / 4 - 5	2,366 / 73 / 363 - 378
Development Wells	1,403 / 37 / 959 - 968	841 / 37 / 636 - 639	165 / 3 / 121 - 122	0 / 0 / 3 - 5	2,409 / 77 / 1,719 - 1,734
Oil Wells	185 / 1 / 132 - 134	111 / 8 / 87 - 88	22 / 1 / 17 - 18	0 / 0 / 0 - 1	318 / 10 / 236 - 241
Gas Wells	1,218 / 36 / 827 - 834	730 / 29 / 549 - 551	143 / 2 / 104 - 104	0 / 0 / 3 - 4	2,091 / 67 / 1,483 - 1,493
Production Structures Installed	534 / 16 / 408 - 417	108 / 4 / 92 - 94	9 / 1 / 11 - 12	0 / 0 / 1 - 2	651 / 21 / 512 - 525
Length of Installed Pipelines (km)#	2,242 / 84 / 2,370 - 2,400	NA / NA / NA	NA / NA / NA	NA / NA / NA	3,462 / 127 / 3,700 - 3,830

* See Figure IV-1.
** Includes wells that have been plugged and abandoned, and platforms that have been removed.
*** A percentage of exploration and delineation wells may be temporarily abandoned and go on to production once the structure is in place.
# Projected length of OCS pipelines does not include length in State waters.
NA means that information is not available.

Table IV-8

Facilities Projected to be Existing and Active in the Gulf of Mexico Immediately Prior to Sale 171 (August 1998)

	Offshore Subareas*				Total OCS
	0-60	60-200	200-900	900-3000	
	Total as of 12/31/95** / 1995 Annual / Existing Facilities Prior to Sale				
Wells Drilled					
Exploration and Delineation Wells***	7,507 / 215 / 1,457 - 1,524	2,931 / 73 / 347 - 364	685 / 49 / 129 - 136	90 / 11 / 17 - 19	11,213 / 348 / 1,950 - 2,043
Development Wells	14,733 / 356 / 8,532 - 8,667	5,661 / 162 / 3,913 - 3,972	531 / 38 / 389 - 394	4 / 1 / 11 - 16	20,929 / 557 / 12,845 - 13,049
Oil Wells	7,807 / 122 / 4,117 - 4,186	2,867 / 70 / 1,812 - 1,842	231 / 29 / 158 - 161	2 / 1 / 5 - 8	10,907 / 222 / 6,092 - 6,197
Gas Wells	6,926 / 234 / 4,415 - 4,481	2,794 / 92 / 2,101 - 2,130	300 / 9 / 231 - 233	2 / 0 / 6 - 8	10,022 / 335 / 6,753 - 6,852
Production Structures Installed	4,689 / 101 / 3,417 - 3,511	484 / 16 / 442 - 456	21 / 2 / 24 - 26	0 / 0 / 4 - 7	5,194 / 119 / 3,887 - 4,000
Length of Installed Pipelines (km)#	12,500 / 567 / 13,400 - 13,500	NA / NA / NA	NA / NA / NA	NA / NA / NA	24,622 / 907 / 26,310 - 27,190

* See Figure IV-1.
** Includes wells that have been plugged and abandoned, and platforms that have been removed.
*** A percentage of exploration and delineation wells may be temporarily abandoned and go on to production once the structure is in place.
# Projected length of OCS pipelines does not include length in State waters.
NA means that information is not available.

Pipeline transportation of oil production from wells in water depths greater than 450 m may present technical challenges due to water depth and related pressures and temperatures on the seabed. Challenges to deepwater pipelines include designing flow systems that can withstand the high external hydrostatic pressures at the seafloor, adapting existing lay-vessel and mooring technology to deepwater operating conditions, and resolving tie-in problems at deepwater production structures. Several options for transporting deepwater production are being considered by industry. Pipelines may be used in water depths greater than 450 m to transport mixtures of oil, water, gas, and condensate directly from deepwater production facilities via mixed or bulk lines to centralized processing platforms located on the shelf edge or closer to shore. Additional oil storage capacity may be required on the deepwater production facilities for pipeline flow assurance. From the platforms in shallower waters, the processed materials would then be piped to shore.

Another likely scenario is that production will be piped, via gathering lines and flexible risers, from subsea facilities to floating processing and storage facilities (FPSO's). Because gas pipelines are less expensive and gas flow through pipelines would not encounter the problems of oil flow in deepwater, produced natural gas is expected to be piped from these facilities and liquid products would be tankered to shore.

Projected new trunklines are assumed to usually serve more than one lease. Because of the large expense of installing a new trunkline system, production from more than one lease sale is assumed to be typically needed to economically justify installation. For those exceptionally large finds in deepwater where existing pipelines cannot accept the production because of the chemical composition or accessible pipeline systems are at capacity, exceptions may occur.

In water depths less than 200 m, a lay barge will be used; the barge can lay pipe at an average of 1.6 km per day. Between 200 and 900 m water depth, reel barges or towing from shore may be used. Reel barges can lay pipe at the rate of 16 km per day. In water depths greater than 900 m, the "J-curve" method and towing from shore may be utilized. The "J curve lay barge" method is used to install pipe in a vertical or steeply inclined orientation from a surface vessel. Because only one pipe-joining station can be used, this method takes considerable time, and only about 0.5 km of pipe can be laid per day.

Proposed Action Scenario: The proposed action is projected to generate 0.5-1.0 percent of the pipelines to be generated by the OCS Program during the 35 years following the sale. Hence, the proposed action is projected to generate 130-420 km of pipelines, of which 104-300 km may be buried. All of the pipelines resulting from the proposed action will eventually be abandoned, about 10-20 percent of which will be removed, given present trends.

OCS Program Scenario: During the period of 1998-2036, about 29,450-41,140 km of pipelines are projected to be installed Gulfwide. Of that length, up to 29,700 km may be buried upon installation. During that period, 3,990-7,120 km of pipelines are projected to be abandoned; 30-440 km pipelines are projected to be removed. Of those removed, up to about 60 km may have been buried.

In the WPA during 1998-2036, about 4,140-5,770 km of pipelines are projected to be installed to support OCS Program activities in the WPA. Some of these pipelines may be installed into the CPA, where they will join existing pipeline systems to support WPA activities. Up to 3,760-5,330 km may be buried upon installation. During that period, 400-720 km of pipelines are projected to be abandoned; 4-70 km of pipelines are projected to be removed.

(2) Barges

Barges may be used offshore to transport oil and gas, supplies such as chemicals or drilling mud, or wastes between shorebases and offshore platforms. Barges are non-self-propelled vessels that must be accompanied by one or more tugs. Because of this, barge transport is usually constrained to shallow waters of the Gulf, close to the shoreline.

Barging of OCS oil from platforms to shore terminals is an option used by the oil industry in lieu of transporting their product to shore via pipeline. As of October 1996, 53 Gulf of Mexico OCS platforms transported oil to shore by barge. Not all of these platforms offload directly to barges; instead, 27 of these platforms pipe their oil to other platforms where it is stored and then offloaded into barges. All of the leases from which barging has occurred are located in water depths less than 60 m with the exception of one lease located in slightly deeper water. As of October 1996, about 8 percent of the oil produced in the WPA in water depths less than 60 m was barged to shore; about 3 percent of the oil in the CPA was barged. These

percentages have been extremely stable over time. An examination of historical data reveals neither any significant decline in barging activity nor any significant increase. At present, there are three barge systems operating in the WPA and eight systems operating in the CPA. Although the volume of oil barged is projected to remain fairly constant, the percentage of the total production that is barged will decline as more oil production occurs farther offshore in the deepwater areas of the Gulf.

A platform operator generally decides at the beginning of a development project whether the production will be barged or piped. Barging is used very infrequently as an interim transport system prior to the installation of a pipeline system. The capacity of oil barges used offshore can range from 5,000 to 80,000 bbl. Barges transporting oil typically remain offshore for as long as one week while collecting oil; each trip is assumed to be five days.

Other types of barging operations may occur in connection with OCS operations. Besides barging from platform to shore terminal, a few platform operators choose to barge their oil to other platforms where it is then offloaded to storage tanks and later piped to shore. Recently there has been some barging of oil from deepwater sites during extended well testing; this activity is likely to increase in the future. Storage and barging of the well stream from extended well tests is an alternative to flaring the gas and burning the liquids produced during well testing. No information is currently available on the number of barge trips associated with these other types of offshore oil barging operations. Secondary intracoastal barging of OCS-produced oil from terminal to terminal or from terminal to refinery also occurs along the Gulf Coast and is discussed under the coastal scenario (Section IV.B.1.i.).

Tables IV-2 provides the percentages of oil barged to shore for the proposed action and Gulfwide OCS Program by subarea. Tables IV-3 through IV-6 provide the percentages of oil barged to shore for the OCS Program Gulfwide and by planning area. Section IV.B.1.e. describes the shore terminals receiving OCS-produced barged oil. Only primary barging activity from offshore production platforms to onshore terminals is considered in these projections.

Assuming that about 10 (a range of 8-12) barge systems will remain operating in the Gulf (with 3 barge systems operating in the WPA) and that each barge system will go out once a month to pick up oil from the platforms in the system, about 120 trips are projected to occur annually Gulfwide. It is assumed that one of the three barge systems operating in the WPA will provide service to an offshore platform resulting from the proposed action during the major production period (a 15-year time period). Given this, about 12 barge trips per year and 180 barge trips total (15 years times 12 trips per year) will occur to support proposed action operations.

(3) Oil Tankers

Shuttle tanker transport of Gulf of Mexico OCS-produced oil has not occurred to date. Some tankering of Gulf oil is projected for future OCS operations, especially from leases located in deepwater beyond the existing pipeline network. In early 1997, discussions between industry and MMS began with the goal of determining the feasibility of tanker transport of OCS-produced oil. A workshop was held in April 1997 to identify significant issues related to four areas: environmental effects, conservation of oil and gas resources, technology, and regulatory framework. Discussions are ongoing. Because MMS must review the safety and environmental risks of any tankering proposal, tankering is not expected to begin in the Gulf until after the year 2000.

Although there is no reason that tankering does not take place in shallow waters, none has occurred historically in the Gulf. For this EIS scenario, it is assumed that this trend will continue and tanker transport will occur only from deepwater fields. Since 1-3 production facilities are projected to be built in water depths greater than 900 m under the proposed action scenario, tankering from these facilities is not assumed to occur. Between 80 and 180 new production facilities are projected to be installed in water depths greater than 900 m under the Gulfwide OCS Program, and a small percentage of these may tanker.

For those operations where tankering is assumed to occur, it is assumed that the oil will be produced by subsea completions linked to a tanker-based floating production, storage, and offloading system, offloaded into a shuttle tanker, and brought directly to existing tanker terminals located at major port areas (Section IV.B.1.e.(3)).

To develop a scenario for analytical purposes, the following assumptions are made regarding future OCS oil and gas tanker transportation. First, technological advances in pipelaying will keep pace with the expansion of the oil industry into the deeper waters of the Gulf beyond the continental slope. Second, all natural gas will be piped. Third, tankering will only occur in water depths greater than 900 m. Fourth, all production occurring in water depths greater than 900 m but within 50 mi from the existing pipeline infrastructure will be transported via pipelines that tie into the existing pipeline system (about 25% of the 900-m subarea). Fifth, tankering will only take place from marginal fields. In general, about 25 percent of oil resources are developed from marginal fields. Sixth and final, for those oil resources that are located in areas that meet the above criteria, there is a 50/50 chance that the oil will be tankered instead of piped. These assumptions result in an estimate that 9-10 percent of the oil in the 900-3,000-m subarea will be tankered and about 2-3 percent of all future OCS-produced oil will be tankered. Shuttle tankers that would most likely service OCS operations in the Gulf have capacities ranging from 20,000 deadweight tonnage (dwt) (133,000 bbl) to 50,000 dwt (333,000 bbl). Applying these sizes to the assumed percentages of oil tankered yields estimates that between 60 and 100 tanker trips a year, starting in the year 2000, could occur from OCS Gulfwide Program activities.

(4) Service Vessels

Approximately 24 types of service vessels cater to the OCS oil industry. Turner and Cahoon (1988) reported an average of over 2,000 service-vessel trips per month in the Gulf of Mexico OCS, carrying an average of 337 tons of cargo per trip. These vessels produce noise above and underwater, discharges, and air emissions; make waves that erode channel banks; and disturb the sea bottom with anchors.

There are three categories of service vessels: supply, crew, and utility vessels. Service-vessel size categories include large vessels usually 50-70 m in length, small vessels that are mainly crew boats 32 m in length, and utility boats typically 30.5 m in length. About 68 percent of the service vessels are large supply boats (Turner and Cahoon, 1988) with a 3.5-m draft when loaded and a capacity of 300 mt. Crew boats draw 2.0-2.8 m of water. Utility boats draw 3.0-3.7 m of water and carry water, cement, drilling fluids, equipment, food, and miscellaneous supplies. With the increase in the number of large deepwater development facilities that are located great distances offshore, larger supply vessels with greater cargo carrying capacities and "fast" crew boats are being used.

The following assumptions about service-vessel activity are made as part of the scenarios: (a) crew boats have six vessel crew members per boat; supply boats have seven crew members; (b) a "trip" is a round trip between a service base and an offshore site (all trips are assumed to originate from service bases (Section IV.B.1.a.)); (c) for the proposed actions, the number of trips is calculated at a rate of 3 trips per week for 40 days per exploratory well, plus 3 per week for 60 days per development well, plus 2 per week for 20 years per platform; (d) for the OCS Program, service-vessel trip estimates include trips to existing, as well as projected, OCS platforms; (e) a vessel takes two hours to reach a service base once in a navigation channel in coastal Texas and about four hours in coastal Louisiana; (f) during offshore journeys, vessels travel an average of 282 km per round trip in 12 hours in the WPA and 418 km in 17 hours per trip in the CPA; (g) since larger, deeper-draft vessels are needed to reach distant oil and gas deepwater exploration and production sites (water depths greater than 450 m), some new vessels will be built, and (h) services vessels are most likely to use the closest ports and service bases, but may need to go farther to obtain appropriate facilities (for example, few ports in the Western Gulf have channels deep enough to accommodated the deeper draft vessels used to support deepwater operations).

Proposed Action Scenario: The average annual number of service-vessel trips for the proposed action would amount to 550-1,000 trips.

OCS Program Scenario: The projected average annual number of service-vessel trips for the OCS Program within the WPA is 65,000-77,000 trips. This represents approximately 15 percent of Gulfwide projected service-vessel trips per year (400,000-500,000 trips annually Gulfwide).

(5) Helicopters

Helicopters are the primary mode of transporting personnel between shore bases and offshore platforms and drilling rigs. A helicopter trip is defined as one takeoff and one landing, and an average trip lasts 16

minutes. The average distance to the more than 3,800 platforms presently operating in the Gulf is approximately 130 km from the shore base. On an average flight, a helicopter might visit 3-4 offshore facilities before returning to shore.

According to the Helicopter Safety Advisory Conference, the estimated number of helicopter trips in support of Gulfwide OCS operations have been increasing steadily since 1994 to almost 1.7 million trips annually, carrying 3.5 million passengers in 1996. Based on recent leasing trends (larger lease sales and more deepwater leasing), the numbers of both trips and passengers should continue to increase.

The recent upsurge in deepwater leasing may create a need to increase the size of the helicopter fleet used by the offshore industry. Recent deepwater discoveries are 160-320 km from shore. A single trip to one of these deepwater facilities may monopolize a helicopter for an entire day.

All drilling rigs and pipelaying barges have helipads, and about 60 percent of nearshore (less than 150 m water depth) production platforms have helipads. All new platforms in water depths greater than 150 m are assumed to have helipads. It is assumed that helicopters will visit exploratory drilling rigs, development drilling structures, and production platform complexes once or twice a day, and pipeline lay barges once a day.

The FAA Advisory Circular 91-36C encourages pilots to maintain higher than minimum altitudes near noise-sensitive areas. Corporate policy states that helicopters should maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. When flying over land, the specified minimum altitude is 1,000 ft over unpopulated areas such as wildlife refuges and national parks. In addition, the Marine Mammal Protection Act requires helicopter pilots to maintain 1,000 ft of airspace within 100 yd (91 m) of marine mammals. Environmental analyses in past lease sale EIS's have shown that these minimum flight altitudes effectively mitigate significant impacts to the endangered and threatened species analyzed. The potential impact of air emissions by helicopter trips is analyzed in the sections on air quality.

3. Offshore Disturbances

a. Infrastructure Emplacement

(1) Bottom Area Disturbance

Structures emplaced or anchored on the OCS to facilitate oil and gas exploration, development, and production include drilling rigs (jack-ups, semi-submersibles, and drillships), production platforms, subsea systems, and pipelines. The emplacement of these structures disturbs some area of the sea bottom beneath the structure. If anchors are employed, some area around the structure is also disturbed. Jack-up rigs and semi-submersibles are assumed to be used in water depths less than 750 m and to disturb about 1.5 ha (3.7 ac) each. In water depths greater than 750 m, dynamically-positioned drillships will be used, disturbing no bottom area (except the very small area right where the well is drilled). Conventional, fixed platforms installed in water depths less than 450 m will disturb about 2 ha. At water depths exceeding 450 m, compliant towers, tension leg platforms (TLP's), SPAR platforms, and floating production systems (FPS's) will be used (Figure IV-2). A compliant tower consists of a narrow flexible tower and a piled formation that supports a conventional deck. A compliant tower is assumed to disturb the same bottom area--about 1.5 ha--as a conventional, fixed platform. A TLP consists of a floating structure held in place by tensioned tendons connected to the seafloor by templates secured with piles. A TLP is assumed to disturb about 5 ha of bottom area. A SPAR platform consists of a large-diameter cylinder supporting a conventional deck, three types of risers (production, drilling, and export), and a hull that is moored via a taut catenary system of 6-20 lines anchored to the seafloor. The bottom area disturbed by a SPAR is dependent on the anchor configuration and is assumed to be about 5 ha. An FPS consists of a semi-submersible drilling vessel anchored in place with wire rope and chain. An FPS is assumed to disturb about 1.5 ha of sea bottom. Subsea systems, located on the ocean floor, are connected to the surface deck via production risers and are assumed to disturb less than 1 ha each. Emplacement of pipelines will disturb 0.32 ha per kilometer of pipeline.

Impacts from bottom area disturbance are of concern near sensitive areas such as topographic features, chemosynthetic communities, and archaeological sites. Regulations and mitigating measures protect these sensitive areas from potential impacts resulting from bottom area disturbance.

(2) Sediment Displacement

Sediment displacement (resuspension of sediments) is caused by pipeline trenching. Trenching or burying is required in water depths less than 61 m as an engineering precaution to reduce the movement of pipelines by high currents and storms. Trenching also reduces the risk of fishing gear becoming snagged, and of anchor or trawl damage to the pipeline. It is assumed that 5,000 m^3 of sediment will be resuspended for each kilometer of pipeline trenched.

Sediment displacement also occurs as a result of the removal of pipelines. It is projected that the number of pipeline removals (or relocations) will increase. It is assumed that 5,000 m^3 of sediment will be resuspended for each kilometer of pipeline removed in water depths less than 61 m.

b. Infrastructure Presence

(1) Anchoring

Each exploration rig, platform, and pipeline emplacement on the OCS disturbs some surrounding area or areas where anchors are set to hold the rig, structure, or support vessel in place.

Pipelaying barges use an array of eight 9,000-kg anchors to position the barge and to move it forward along the pipeline route. These anchors are continually moved as the pipelaying operation proceeds. The area actually affected by these anchors depends on water depth, wind, currents, chain length, and the size of the anchor and chain.

Mooring buoys may be placed near drilling rigs or platforms so that service vessels need not anchor, especially in deeper water. These temporarily installed anchors will most likely be smaller and lighter than those used for vessel anchoring and, thus, will have less impact on the sea bottom. Moreover, installing one buoy will preclude the need for numerous individual vessel-anchoring incidents. Service-vessel anchoring is assumed to not occur in water depths greater than 150 m (it is assumed that the vessels will always tie up to a platform or buoy) and only occasionally in shallower waters.

Barges are assumed to always tie up to a production system rather than anchor. Drillships use dynamic positioning systems to remain in place and do not anchor.

(2) Space Use Conflicts

During OCS operations, the area occupied by structures, anchor cables, and safety zones is unavailable to commercial fishermen. Exploratory drilling rigs spend approximately 40-60 days on site and are a short-lived interference to commercial fishing. A bottom-founded production platform in water depths less than 450 m, with a surrounding 100-m navigational safety zone, requires approximately 6 ha of space. In water depths greater than 450 m, production platforms will be compliant structures (such as TLP's and SPAR's) and FPS's (Figure IV-2). The use of tanker-based FPSO's is also being considered by operators in the Gulf. The U.S. Coast Guard has not yet determined what size navigational safety zone will be required during offloading operations. Factoring in navigational safety zones, these structures will require 7-20 ha of space. Production structures in all water depths have a life expectancy of 20-30 years.

Virtually all commercial trawl fishing in the Gulf of Mexico is performed in water depths less than 200 m (Louisiana Dept. of Wildlife and Fisheries, 1992). Longline fishing is performed in waters greater than 100 m and usually beyond 300 m. The MMS data indicate that the total area lost to commercial fishing due to the presence of production platforms has historically been less than 1 percent of the total area available. Even though compliant structures in deeper water will take up more space, there are few of them compared to the number of bottom-founded platforms in water depths less than 300 m.

Proposed Action Scenario: Based on a maximum expected number of 23 bottom-founded and 4 compliant structures, 218 ha (539 ac) will be lost to commercial fishing in the WPA as a result of a proposed action. This represents less than one-tenth of a percent of the total area available (14.5 million ha, 35 million ac) to commercial fishing in the WPA.

OCS Program Scenario: The overall annual rate of platform and structure installation is expected to decline over time as identified fields are developed and fewer new reservoirs are located. Annual structure

installation from Gulfwide OCS Program activities will remain in the 50-90 range until 2004, gradually dropping to 20 per year in 2020 and below 10 per year in 2036. Annual structure installation from OCS Program activities in the WPA is in the 8-14 range and is expected to decline over time. It is assumed that the total area lost to commercial fishing due to the presence of OCS production platforms will continue to be less than 1 percent of the total area available to commercial fishing.

(3) Aesthetic Interference

Drilling rigs and very large production platforms operating in the first tier of Federal oil and gas leases off Texas, 16 km from shore, may be barely perceptible from shore in the fairest of weather conditions, but would likely be indistinguishable from objects such as ships. On a clear night, lights on the top of drilling derricks could be visible almost to where they dip below the horizon from the curvature of the earth (about 32 km). Platforms and drilling rigs established in the first two or three tiers of nearshore Federal oil and gas leases off Louisiana, (5-16 km from shore, about 5% of the platforms in water depths less than 60 m) can be readily seen and recognized during good weather conditions from the coastal shorelines.

c. Infrastructure Removal

(1) Explosive Removal Disturbance

Conventional, fixed, multileg platforms. which are anchored into the seafloor by steel pilings, predominate in water depths less than 450 m. Because of the strongly overbuilt condition of these structures that must withstand probable hurricane conditions over an average 20-year life span, explosives are used to sever conductors and pilings. The MMS requires severing at 5 m below the seafloor to ensure that no part of the structure will ever be exposed to and interfere with commercial fishing. Possible injury to biota from explosive use extends outward 900 m from the detonation source and upward to the surface. Based on MMS data, it is assumed that approximately 70 percent of removals of conventional, fixed platforms in the Gulf of Mexico in water less than 450 m deep will be performed with explosives.

A number of offshore operators, dive companies, and engineering firms in the Gulf of Mexico are engaged in research and development of safe technology and removal method alternatives to explosives (Bottom Line Newsletter, 1992; Snyder, personal communication, 1992). Alternative methodologies such as mechanical cutting and inside burning that might be used to sever pilings of multileg structures are often ineffective and are always hazardous to underwater workers.

Proposed Action Scenario: A range of 5-16 explosive removals is projected for a typical proposed action. More than 80 percent of these will be in water depths less than 60 m.

OCS Program Scenario: At present, explosive platform removals are occurring at a rate of 35-50 platforms annually in water depths less than 60 m; few platforms have been removed to date in greater water depths. During the period 1998-2036, a maximum of 133 explosive platform removals are projected in the WPA, 504 explosive removals in the CPA, and 10 explosive removals in the EPA.

(2) Abandoned Bottom Debris

Bottom debris is herein defined as material resting on the seabed (such as cable, tools, pipe, drums, and structural parts of platforms, as well as objects made of plastic, aluminum, wood, etc.) that is accidentally lost (e.g., lost overboard during hurricanes) or tossed by workers from fixed structures, jack-up barges, drillships, and pipeline emplacement operations. Varying quantities of ferromagnetic bottom debris may be lost or tossed per operation. The maximum quantity of bottom debris per operation is assumed to be several tons. Extensive analysis of remote-sensing surveys within developed blocks indicates that the majority of ferromagnetic bottom debris associated with OCS exploration and development activities falls within a 450-m radius of the site. Concerns about entanglement of fishing gear with abandoned debris at old platform sites has led MMS to issue NTL 90-03 and NTL 92-02, which establish guidelines for removing bottom debris and gear after platform removal operations. The Fishermen's Contingency Fund was established to provide recourse for recovery of equipment losses due to entanglement. In FY 94, a total of 141 claims were received and 88 were approved.

In FY 95, a total of 82 claims were received and 60 were approved (Jackson, written communication, 1996). Monies paid as a result of approved claims were $325,054 in FY 94 and $263,924 in FY 95. It is assumed that offshore operators will adhere to the guidelines published in NTL's 90-03 and 92-02 and that the amount of bottom debris remaining at platform sites will be reduced in the future.

Proposed Action Scenario: Several hundreds of tons of bottom debris may result from activities associated with the proposed actions. It is assumed that the majority of this debris will be removed from the seafloor during the platform removal process as a result of the efficacy of platform removal regulations.

OCS Program Scenario: It is estimated that about 100,000 tons of bottom debris (both ferromagnetic and nonferromagnetic) have been deposited on the seafloor as a result of prior OCS oil and gas activity. Oil and gas activities on the Gulf of Mexico OCS over the next 30-40 years will likely add several tens of thousands of tons of bottom debris on the seafloor. It is assumed that the majority of future lost or tossed debris will be removed from the seafloor during the platform removal process as a result of the efficacy of platform removal regulations.

d. Operational Waste Discharged Offshore

The major operational wastes generated during offshore oil and gas exploration and development include drilling fluids and cuttings and produced waters. Other major wastes generated by the offshore oil and gas industry include the following: from drilling--waste chemicals, fracturing and acidifying fluids, and well completion fluids; from production--produced sand, workover fluids, deck drainage, and miscellaneous well fluids (cement, BOP fluid); and from other sources--sanitary and domestic wastes, gas and oil processing wastes, ballast water, storage displacement water, and miscellaneous minor discharges.

In order to develop oil and gas at the temperature and pressures encountered in deep water, it is MMS's understanding that more extensive and frequent use of a number of chemical compounds to enhance throughput of the oil and gas (flowline enhancers) are occurring and being anticipated. Examples include wax inhibitors, hydrate inhibitors, corrosion inhibitors, and asphaltene inhibitors (depending on the composition of oil).

Major contaminants found in OCS oil-field wastes can include high salinity, heavy metals, crude oil compounds, organic acids, priority pollutants, hazardous wastes, and radionuclides. Harmful properties of the receiving waters that can result from OCS discharges include low pH, high biological and chemical oxygen demand, and high suspended solids. Each waste stream will be discussed individually.

Offshore wastes can be discharged overboard only if they are covered by a USEPA NPDES permit. (See Section I.C., *The Clean Water Act,* for a discussion of the USEPA permitting program.) After many years of debate, the USEPA recently issued more restrictive discharge guidelines called effluent limitations and new source performance standards. These limitations and standards are now being incorporated into Gulf of Mexico NPDES permits, which in turn place further conditions on discharges to reduce impacts.

The current general NPDES permit for USEPA Region 6, which covers the Gulf of Mexico west of the Mississippi River, will expire in 1997. More restrictive limitations on the levels of various contaminants in discharges, discharge-rate restrictions, and monitoring and toxicity testing requirements currently contained within this permit are expected to continue and to eliminate any significant biological or ecological effects from discharges such as those documented in the past. The USEPA's Region 4, whose jurisdiction generally covers the area east of the Mississippi River, has proposed a general NPDES permit for activities in water depths greater than 200 m. The proposed permit incorporates the new effluent limitations and requires a zero discharge within 1,000 m of areas of biological concern. Operations in shallower waters would be covered by individual permits. For EIS purposes, the MMS assumes that Region 4 will be covered by a permit similar to the Region 6 permit; all discussions of permit requirements apply Gulfwide.

A number of major field research programs have investigated the fate and effects of OCS discharges around drilling sites and production platforms in the Gulf of Mexico. Major studies have included the Offshore Ecology Investigation in Louisiana Waters conducted by the Gulf Universities Research Consortium (Ward et al., 1979); the Central Gulf Platform Study of the continental shelf off Louisiana conducted by the Southwest Research Institute (Bedinger, 1981); the Buccaneer Field Study conducted off Galveston, Texas, by the National Marine Fisheries Service (Middleditch, 1981); the Produced Water Study conducted by Batelle for the American Petroleum Institute (Neff et al., 1989); the Gulf of Mexico Offshore Operations Monitoring

Experiment (GOOMEX) (Kennicutt, 1995a); a study recently completed as part of the Department of the Energy program on the impact of produced-water discharges (Continental Shelf Associates, 1997a); and an industry-sponsored study evaluating the ecological and human health implications in fish and invertebrates of produced-water discharges (OOC, 1997). There have also been several studies that focused on estuarine and nearshore Louisiana waters (Boesch and Rabalais, 1989a and b; Rabalais et al., 1991; St. Pé, 1990; CSA, 1997b). Other research assessing the fate of contaminants discharged from oil and gas operations into Gulf waters include Sauer (1981); Boothe and Presley (1985 and 1989); Gettleson and Laird (1980); Thompson et al. (1988); Tillery and Thomas (1980); Steimle and Associates (1992); and a number of monitoring programs conducted for industry by Continental Shelf Associates, Inc. (1982, 1984, 1986a and b, 1988, 1989a and b, and 1992); and Continental Shelf Associates and Barry Vittor and Associates (1989a and b). Because drilling and production sometimes occur together and other wastes may be discharged during the life of a platform, results from studies cannot always separate the impacts of one waste stream from another.

The following discussion provides an overview of what is known about past produced water and drilling muds and cuttings discharged in association with production and drilling of oil and gas in the Gulf of Mexico. Information is provided on transport in the water column, incorporation into bottom sediments, water column and benthic organism effects, toxicity of components, water quality exceedances, and bioaccumulation.

Assumptions regarding the transport, persistence, fate, and effects of OCS wastes that are projected to be discharged into Gulf waters under the future OCS Program and proposed actions are formulated based on a review of completed studies, information found in the ocean discharge criteria evaluation completed for the new NPDES General Permit (Avanti Corporation, 1993a), and information found in USEPA's supporting documents for their newly promulgated effluent limitations (USEPA, 1993). Given the new permit restrictions, it is assumed that many of the impacts from OCS discharges identified in historical studies will no longer be occurring. Any discussion of the extent of impacts attributable to OCS discharges makes a distinction between impacts from discharges that have occurred and impacts from discharges that will occur in the future.

(1) Drilling Muds and Cuttings

The major sources of contamination from drilling operations are drilling fluids (also known as drilling muds) and cuttings. Drilling fluids are suspensions of solids and dissolved materials in a base of water or oil that are used in rotary drilling to remove cuttings from beneath the bit, to control well pressure, to cool and lubricate the drill string, and to seal the well. Drill cuttings are the fragments of rock generated during drilling and carried to the surface with the drilling fluid.

Drilling fluids are composed of bulk constituents and special-purpose additives. Although water-based systems are most commonly used, oil-based fluids are used for a variety of applications, such as high-temperature wells, deep holes, and wells where sticking or hole stabilization is a problem. In addition, water-based drilling fluids may have diesel oil or mineral oil added to them for lubricity. The principal contaminants of concern in drilling muds include hydrocarbons and heavy metals. Harmful changes in the receiving waters that can occur from drilling discharges include biochemical oxygen demand, chemical oxygen demand, and suspended solids. The primary concern in drill cuttings is oil and other mud constituents that adhere to or are mixed with waste cuttings.

Synthetic drilling fluids, which may substitute for oil-based muds, have recently been used in the Gulf. At present, there is tremendous controversy surrounding this practice. Industry, the USEPA, and others are attempting to examine the frequency of use and are developing some study protocols to examine any possible impacts that could be occurring. The USEPA plans to address this waste stream in the reissued NPDES permit. No information is available as of this writing.

Drilling muds and cuttings can be discharged overboard only if they meet requirements found in the NPDES permit. The USEPA NPDES permit requirements for the years 1992-1997 include (a) limit the acute toxicity to a minimum 96-hour LC_{50} of 30,000 ppm as measured in the diluted suspended particulate phase; (b) prohibit the discharge of oil-based drilling fluids, oil-contaminated drilling fluids, or drilling fluids containing diesel oil and any drill cuttings generated while using these fluids; (c) prohibit the discharge of free oil (static sheen test); (d) limit the amount of cadmium and mercury in stock barite used in drilling fluids to 1 mg/kg for mercury and 3 mg/kg for cadmium, and prohibit the discharge of any cuttings generated when

using muds to which barite with these levels of mercury and cadmium have been added; and (e) limit the drilling fluid discharge rate to 1,000 bbl per hour unless the well is within a controlled discharge rate restriction area, where the discharge rate will be less as determined by a rate table.

It is assumed that there will be 7,861 bbl of drilling fluids and 2,681 bbl of cuttings discharged overboard per exploratory well, and 5,808 bbl of drilling fluids and 1,628 bbl of cuttings produced per development well (USEPA, 1993). The different volumes are based on the average depths for the two types of wells. These volumes exclude the volumes of any drilling wastes not discharged offshore but transported to shore for disposal. Historically, on average, about 12 percent of the mud and 2 percent of the cuttings fail permit limits (USEPA, 1993) and thus cannot be discharged. Also, about 15 percent of wells drilled deeper than 10,000 ft are assumed to use some oil-based muds (USEPA, 1993), which must be brought onshore for disposal.

The physical dispersion of drilling discharges in the water column has been the subject of considerable study (e.g., NRC, 1983; Neff, 1981; Petrazzuolo, 1981; Menzie, 1983; Ecomar, Inc., 1980; Engelhardt et al., 1988; Avanti Corporation, 1993a and b). The turbidity plume created by the discharge of drilling muds and cuttings is greatly influenced by the current direction and speed. Turbulence caused by bottom topography and currents and the drilling platform wake also influence the dispersion of drilling discharges in the water column. Generally, suspended solids in drilling mud plumes spread to extremely dispersed levels within a few thousand meters from the discharge point. For a current speed of 10 cm/sec, a modeled plume of drilling mud was dispersed by a millionfold decrease from original levels at about 2,500 m from the discharge point for a discharge rate of 1,200 bbl/hr and at about 1,300 m for a discharge rate of 21 bbl/hr (Avanti Corporation, 1993a). Actual drilling and associated discharges only occur about 50 percent of the time a drilling rig is on-site. Low-level continuous or frequent, intermittent discharges occur from the solids control equipment only during drilling. High-volume, bulk discharges at high rates of discharge (500-1,500 bbl/hr) and lasting for a period of 20 minutes to 3 hours (Petrazzuolo, 1981; Avanti Corporation, 1993a) take place once or twice during the drilling of a well.

Past Fate and Effects of Drilling Discharges

Elevated levels of metals, primarily barium and chromium, have been measured in sediments associated with discharge of drilling fluids and cuttings near rigs and platforms. Other metals with elevated concentrations around drilling sites include arsenic, cadmium, copper, mercury, nickel, lead, vanadium, and zinc. Sediment enrichment of these metals seldom have exceeded a factor of 10, with the exception of barium and chromium, which have had enrichment factors of up to 300-fold and 36-fold, respectively (Avanti Corporation, 1993a). The spatial extent of this enrichment has usually been distance-dependent around platforms. Metals either exhibited a general distribution out to 300-500 m around a platform or have shown a distribution pattern based on bottom current flows extending farther. Significant barium enrichment has been found 1,000-3,000 m downcurrent from the discharge plume. Avanti (1993a) concluded that barium and probably other fluid contaminants are relatively mobile and, because of this, on time scales of a year or more, were found to spread over a large area (greater than 3 km). In general, discharged muds have been found to cause some heavy metal sediment contamination 1,000 to a few thousand meters from the discharge point (Avanti Corporation, 1993b).

Biological effects on benthic organisms from drilling discharges were identified generally out several hundred meters (USEPA, 1993a; Avanti Corporation, 1993b). Documented biological effects include elimination and inhibited growth of seagrasses, declined abundance in benthic species, altered benthic community structure, and decreased coral coverage. Small magnitude, localized effects on benthic marine organisms in proximity to OCS drilling sites have been measured out to 300-500 m away from the discharge point, causing altered community structure (Kennicutt, 1995), and out to 1,000 m resulting in changes in abundance. Benthic effects have been detected as long as 10 years after the drilling discharge ceases in shallow, low-energy areas.

Uptake and bioaccumulation of metals associated with drilling discharges have occurred (Kennicutt, 1995; CSA, 1997a). In general, several metals including barium, cadmium, chromium, and lead have been shown to have accumulated. Measured enrichment was generally very low and depuration release levels were high. No gross functional alterations in marine organisms have ever been reported (Avanti Corporation, 1993a).

Future Fate and Effects of Drilling Discharges

Previous studies reflect the impacts of contamination from earlier discharges when higher levels of metals and some discharge of muds and cuttings contaminated with oil were allowed; these studies do not necessarily reflect current NPDES permit limitations and industry practices. For example, the pre-1986 general NPDES permit allowed the discharge of cuttings from oil-based muds, subject only to a visual sheen observation test, and some petroleum compounds could have still been discharged. The USEPA recently set restrictions on the levels of mercury and chromium in barite, which should decrease the levels of metal contaminants found in the drilling muds and cuttings plume. Cadmium, mercury, arsenic, chromium, copper, and lead are expected to be decreased in the discharge plume with a subsequent decrease from historical levels in the sediments around drilling sites. The levels of barium and other metals, however, should not be affected because the recent NPDES permit requirements do not change their levels in the drilling muds to be used. Given this, the areal extent of sediment chemical contamination is expected to be decreased from historical levels for some chemicals but not for all drilling contaminants. Sediment enrichment, primarily of barium, will continue.

Modeling water quality criteria based on average conditions is sometimes used to estimate potential environmental damage even though extrapolation of the results to ecological conditions continues to come under criticism. Although the USEPA's model determined that the use of "clean" barite (with the limitations placed on it under the new permit) significantly reduced the number of exceedances of water quality criteria from previous calculated exceedances, USEPA still projected some future exceedances. Using models of a projected typical discharge, USEPA determined that, at the 100-m mixing zone for the modeled plume, water quality criteria will be exceeded twice in the water column and 3-9 times in sediment pore water (depending on the number of wells drilled) (USEPA, 1993) or an average of six times. Beyond 200-500 m from the discharge point, concentrations of contaminants in drilling mud should fall below the toxicity limits (USEPA, 1993). These conclusions must be considered in light of the fact that the laboratory tests do not account for activities that occur in the natural environment: leaching of the metals causing the exceedances, solubility of the metals, and bioavailability of these metals (Avanti Corporation, 1993a). Furthermore, the tests were run on a composite average and do not account for ranges in types of muds used. Despite these caveats, the USEPA recognized that potential toxic effects characterized in modeled and laboratory conditions could occur and so requires in their current permit that all drilling mud discharges be tested for toxicity. If the test results show toxicities are being exceeded, the muds cannot be discharged. Given this, it is expected that drilling effluents will not be acutely toxic to pelagic or benthic species once mixed with the receiving water, except within 100 m from the discharge point in very shallow waters.

Sediment effects are depth dependent. Drilling wastes discharged at deepwater sites are likely to be subject to ample dilution and dispersion, and it is uncertain how much of the discharge will reach deep-sea sediments, where impacts have been identified. A geophysical survey documented the extent of drilling discharges at several previously drilled oil and gas sites in about 400-m water depths (Nunez, personal communication, 1994). Accumulations of cuttings were still found extending from the previous well locations in finger-like projections to a maximum of about 610 m (the average being 450 m). Side-scan sonar records of these areas indicate that they were distributed in thin accumulations of less than 0.3 m thicknesses. It is assumed that discharges of drilling muds and cuttings would probably be distributed across broader areas of the seafloor at greater water depth and would generally be distributed in thinner accumulations than in shallower areas on the continental shelf. Levels of contaminants in deep-sea sediments from drilling discharges would be extremely low or unmeasurable. Smothering and toxic effects from these thin accumulations are expected to be much less than documented at shallower sites. Because studies have yet to be conducted on how waste plumes impact sediments surrounding deepwater discharge sites under varying oceanographic conditions, there is no way to conclusively verify these assumptions.

Metal and hydrocarbon contaminants discharged in drilling mud and cuttings could contribute to the long-term, regional degradation of offshore water quality. Averaging USEPA estimates on annual inputs (USEPA, 1993), drilling muds and cutting discharges from the OCS oil industry would contribute about 1.65 million pounds per year of contaminants. Any determination of long-term impacts is not definitive without accounting for the residence times of the added compounds and the assimilative capacities of the receiving waters. Neither of these factors is calculable. Conclusions about long-term changes to marine resources from contaminant inputs are provided in Section IV.D.2.

The EIS assumptions about the areal extent around a discharge point and possible effects of elevated contaminants in the water column and in sediments from future drilling discharges are provided at the end of this section.

(2) Produced Waters

Produced water constitutes the largest single source of material discharged into the Gulf during normal oil and gas operations. Produced water (also known as production water or produced brine) is the total water discharged from the oil and gas extraction process. It comprises the formation waters, injection water (if used for secondary oil recovery and broken through into the oil formation), and various chemicals added during the oil and water separation process. During production of oil and gas, formation water (also called fossil or connate water), which is located in the permeable sedimentary rock strata, may be brought up to the surface. This water comprises the bulk of produced water. Treating chemicals may be added deliberately by the offshore operator to treat or prevent operational problems that may occur in the production process (Stephenson, 1991). Treating chemicals can generally be classified into three categories: production treating chemicals, gas processing chemicals, and stimulation and workover chemicals. Produced waters can be high in total dissolved solids (salinity) and total organic carbon, metals, and low in dissolved oxygen. Because these waters are closely intermingled with petroleum, they contain variable concentrations of dissolved and dispersed petroleum hydrocarbons. High concentrations of other soluble organic compounds have been found, particularly phenols and carboxylic organic acids (Neff, 1997a). The recently completed industry bioaccumulation study provides an excellent literature review of the description and evaluation of the metals and organic compounds found in produced water (OOC, 1997).

Concentrations of naturally occurring radioactive materials (NORM) greater than background levels are found to exist in oilfield produced waters. Radium activity levels as high as 2,801 picoCuries per liter (pCi/l) have been reported. Based on a number of analyses of large data sets of Gulf of Mexico produced water, the mean concentrations of Ra-226 range from around 160 pCi/l to 262 pCi/l, and Ra-228 from 181 to 277 pCi/l (Rabalais et al., 1991; Stephenson and Supernaw, 1990; Louisiana Dept. of Environmental Quality, 1990; USEPA, 1993).

The general NPDES permit, issued for the period 1992-1997, (a) limits the oil and grease level in produced waters to 29 mg/l monthly average and 42 mg/l daily maximums; (b) restricts the flow rate to 25,000 bbl/day; (c) requires chronic, static, aquatic toxicity analyses of produced-water effluents; and (d) requires monitoring of produced-water discharges. Although not yet issued, it is expected that except for (d), which has been completed, these restrictions will continue.

Projections of the amount of produced water from offshore operations are derived from information contained in the development documents for USEPA (1993) effluent limitation regulations. For a typical well, about 450 bbl of produced water per oil well per day and about 68 bbl of water per gas well per day can be expected. Of this amount, it is estimated that 10 percent will be reinjected. There are no data to show that these averages will change in the future due to development of deepwater and subsalt reservoirs.

Produced-water discharges are not expected to take place at every platform or well. The trend in the Gulf of Mexico is for water treatment and separation of the well stream to occur at only designated locations. A recent industry review of 1992 discharge monitoring reports submitted annually to USEPA (Shell Oil Company, 1994) found that only 29 percent of existing platforms contain water treatment systems and discharge their produced waters. As industry uses more sophisticated methods of developing shallow oil and gas fields and is required to conduct more complex treatment protocols, it is likely that operators will increasingly use centralized processing facilities. As this trend is expected to continue into the future, fewer and fewer platforms will discharge water generated by their own wells. Given this, in water depths less than 400 m, for the next 10 years, about one-third of the platforms will discharge overboard; after that, only about one-fourth of the shallow-water platforms are assumed to discharge their own produced water.

Industry's projections (DeepStar, 1994) for deepwater are that the oil and gas produced in deepwater will most likely be piped from subsea completions through mixed line pipelines to large processing facilities primarily operating on the shelf break. These large processing facilities will separate and process the production streams into oil, gas, and water, and then discharge the treated water. The exception to this process would be whenever an FPSO is chosen as the surface facility receiving oil and gas from subsea completions.

These FPSO's, able to operate in any water depth, would process the well stream prior to the transport of the products to shallower locations. Given this, in water depths greater than 400 m, no produced water will be discharged from production facilities, except at FPSO sites.

Metal and hydrocarbon contaminants discharged in produced water could contribute to the long-term, regional degradation of offshore water quality. Averaging USEPA estimates on annual inputs (USEPA, 1993), produced-water discharges from the OCS oil industry would contribute about 44 million pounds per year of contaminants. Any determination of long-term impacts is not definitive without accounting for the residence times of the added compounds and the assimilative capacities of the receiving waters. Neither of these factors is calculable. Conclusions about long-term changes to marine resources from contaminant inputs are provided in Section IV.D.2.

Past Fate and Effects of Produced-Water Discharges

Previous studies summarized here reflect the impacts of contamination from earlier produced-water discharges. These studies do not necessarily reflect current NPDES permit limitations and industry practices. Any discussion of the extent of impacts attributable to OCS produced-water discharges makes a distinction between impacts from discharges that have occurred and impacts from discharges that will occur in the future. Many of these studies examined discharges that occurred in much shallower water depths than what will occur in the future.

Previous studies detected petroleum hydrocarbons, metals, and radium in the water column at some distances downcurrent from produced-water discharges. Hydrocarbons and metals in the produced-water plume have been shown to adsorb onto sediment particles in the water column and settle to the seafloor or contaminate the seafloor directly through bottom impact from the discharge plume, depending on the water depth. Historically, moderate petroleum and metal contamination of sediments have been found out to several hundred meters downcurrent from the discharge point and have been detected at low concentrations even farther, out to 2,000 m (CSA, 1997a). Historically, small-scale, localized effects on benthic organisms out to 200-500 m have been well documented, even in high-energy, open-ocean environments.

It appears that the level of impact that has been measured from produced-water discharges is dependent on how long the discharge occurred and on the water depth and energy of the receiving environment. Discharges of produced water can be continuous discharges (10-30 years or more) creating a potential for longer exposure periods for accumulation of petroleum hydrocarbons in sediments near discharge sources (Avanti Corporation, 1993a). Chronic lethal and sublethal effects of produced waters have been well documented in low-energy areas where the hydrocarbons are not rapidly being removed from the system (USEPA, 1993). Radium above background levels has been detected in the water column out to 1,000 m and in sediments out to 500 m downcurrent from discharges in coastal Louisiana waters (Rabalais et al., 1991) Rabalais et al. (1991) found contamination still existing in sediments surrounding a closed produced-water treatment facility in Louisiana wetlands. In contrast, a recently completed study examining terminated produced-water discharges discharged into shallow, coastal Louisiana waters (CSA, 1997b) found that the contaminant concentrations measured in surrounding sediments returned to near background levels after termination of the discharges.

Future Fate and Effects of Produced-Water Discharges

To control the extent of petroleum hydrocarbon contamination that occurred in the past, the USEPA has reduced the allowable concentration of petroleum hydrocarbons in produced water. The salinity plume made by the produced water, once thought the greatest concern, is now known to disperse very rapidly. Precipitation of many metals, such as barium sulfate and micro particulate oxyhydroxides of iron and manganese, results in the co-precipitation or adsorption of most of the other metals found in produced water, lowering their concentrations in solution in the water column (CSA, 1997a). Elevated hydrocarbons in the produced-water plume are directly correlated with the levels of hydrocarbons in the produced water. Although historically, light, aromatic hydrocarbons such as benzene were observed at elevated levels out to 3.5 km away from the platform (Middleditch, 1981), two recent studies found that the levels of polycyclic petroleum hydrocarbons

2,000 m from four produced-water discharges were no different from levels measured at reference points (CSA, 1997a; OOC, 1997).

Based on laboratory tests, the produced-water discharge plume is only toxic when the effluent is present at levels greater than 10 percent in the receiving waters. In order to test the toxicity of produced-water discharges under the current permit conditions, the USEPA modeled dilutions of produced-water plumes in the water column at 100 m from the discharge point and compared the dilution to this 10 percent limit. Using a range of discharge rates (500-25,000 bbl/day), outfall pipe diameters (4-25 inches), and distance of the outfall pipe to the surface (3-15 m), the USEPA predicted dilutions ranging from less than 0.5 to 3 percent effluent remaining, with an average of about 1 percent (Avanti Corporation, 1993a). Given how quickly produced water appears to dilute, most future discharges of produced water are expected to be diluted enough at 100 m from their discharge point that they are no longer toxic. These predicted dilutions were also used to calculate concentrations of contaminants in future produced-water discharges and to compare these concentrations to water quality criteria. For a 15-m water depth, only one of the pollutants (arsenic) exceeded water quality criteria (human health criteria) in the water column at the 100-m mixing zone (Avanti Corporation, 1993a). At the modeled discharge dilution in 3 m of water, five of the 15 pollutants failed to meet one of their respective water quality criteria at the edge of the 100-m mixing zone (Avanti Corporation, 1993a). Because of these exceedances and to assure no toxic conditions, the USEPA's resulting NPDES general permit requires that produced waters be diluted to the expected dilutions modeled at the 100-m mixing zone prior to discharge and that they pass chronic toxicity laboratory tests. Given this and the fact that the modeled water quality exceedances were only present for very shallow water conditions, future produced-water plumes are not expected to result in any acute or chronic impacts to water column biota.

Sediment contamination is dependent on water depth. Recent industry models of produced-water discharges of 7,000 and 11,000 bbl/day predicted that the plumes would not penetrate further than 30 m into the water column, even under weak density stratification (Smith, written communication, 1995). Modeled produced-water plumes reached neutral buoyancy rapidly, and further plume dispersion was horizontal. In many instances, the traditional surface platforms processing oil from a few wells that are in place in shallow water will shift to large central processing and storage facilities, which will function as a hub for production from other floating platforms and from multiple subsea well locations. It is assumed that, given the number of wells being handled by these facilities, the produced water separated and processed is likely to be at the maximum allowable rate of 25,000 bbl/day. Also, the model examined only salinity changes, rather than all chemical components in a discharge plume, so that the 30-m penetration depth may not represent the depth that all chemical components may reach due to dilution and dispersion from their original enrichment in the discharge over ambient water. Given these factors, it is assumed that the worst-case depth penetration of a surface produced-water plume would be 100 m. More modeling and field verification is needed on this subject.

There is weak or contradictory evidence of bioaccumulation of a few chemicals found in OCS discharges occurring in fish and benthic organisms associated with platforms (CSA, 1997a; OOC, 1997). Both CSA (1997a) and the OOC (1997) studies identified a few stations where higher levels of contaminants in benthic organisms were correlated with discharge inputs, but in most instances there were no statistically-significant differences in concentrations of the compounds between discharging and reference platforms. Although most contaminants were detectable in soft-tissue organisms, concentrations were below levels that would represent a hazard to marine animals or man. Arsenic showed the most potential for statistically-significant evidence of bioaccumulation, being measured at higher levels near platforms discharging produced water than at nondischarging platforms in 3 out of 12 cases. The same difference was found for polycyclic aromatic hydrocarbons in one instance. Mercury and arsenic were measurable in all tissue samples analyzed from both nondischarging and discharging platforms. Arsenic and cadmium were detected above a risk-based concentration set to measure human health concerns. The authors contend that the risk-based concentration is overly conservative and that levels of arsenic and cadmium included both the toxic and nontoxic forms of these metals, considering their elevation on so many samples from both the discharging and nondischarging platforms.

The results of the OOC study are expected to assist the USEPA in the development of the 1997-2002 general NPDES permit. Since the new NPDES permit has not been developed as of the writing of this EIS,

it is assumed that limits in the new permit will be set to restrict any bioaccumulation determined to be of concern and occurring from OCS discharges.

(3) Summary of Assumptions About Future Fate and Effects from OCS Major Discharges

- The levels and areal extent of discharged contaminants measured in the water column or sediments will be reduced from levels and coverage measured in the past because of current USEPA regulations and NPDES permits that contain more restrictive limits.

- Plumes of drilling fluids and produced water mix rapidly with ambient seawater. None of the contaminants are expected to be in solution in concentrations great enough to produce adverse effects to water-column organisms. Biofouling organisms on submerged platform structures may be exposed to harmful concentrations of some contaminants in the discharge plumes. Contaminants in produced water and drilling discharges should be undetectable in the water column by 1,000 m from the discharge point.

- Sediment contamination is water-depth dependent. In very shallow waters, elevated levels of petroleum hydrocarbons and/or metals from produced water, drilling fluids, or drill cuttings may be measured in sediments as far as 2,000-3,000 m downcurrent from the discharge but, in general, sediment accumulation of elevated levels of hydrocarbons and metals is expected to occur out to no more than 100 m in deeper waters from the point that the plume reaches the seafloor, if detectable at all. Produced water discharged from surface facilities is not expected to reach water depths greater than 100 m and will not cause any seafloor sediment contamination for operations beyond this water depth. Drilling discharges from facilities located in water deeper than 400 m could reach the seafloor but would result in extremely low levels of sediment contamination, if any at all, and any cuttings would be distributed in very thin accumulations. More information is needed on the vertical transport of surface discharges into deep waters.

- Adverse effects from OCS discharges are most likely to occur in the sediments downcurrent from and within 100 m of the discharge point, particularly if the water depth is shallow and the discharge rate is high. If this occurs, impacts are expected to be of a low magnitude. Toxic effects on the benthos beyond 100 m are expected to be controlled through the NPDES permit requirements. Peterson et al. (1996), summarizing the recently completed GOOMEX study, concluded that the heavy metals in barite, the release of produced waters, and the organic shedding from the platforms appear to be the major determinants of observed biological response patterns that extend to a distance of 100-200 m away from the gas production platforms on the Gulf of Mexico shelf.

- There is contradictory evidence that bioaccumulation of a few chemicals found in OCS discharges may be occurring in fish and benthic organisms to a small extent (Kennicutt, 1995; CSA, 1997a; OOC, 1997).

- After an operation ends, the impact of any past discharges is related to the residence time in the sediments of any elevated contaminants that resulted from the discharge. Some sediment contamination from drilling was measurable up to 10 years after the drilling operation ceased (Kennicutt, 1995). A recently completed study examining terminated produced-water discharges in coastal Louisiana waters (CSA, 1997a) found that the contaminant concentrations measured in surrounding sediments returned to near background levels after termination of the discharges. An earlier study at a different produced-water facility had found contamination still existed five years after discharges ceased (Rabalais et al., 1991).

- All other minor waste discharges will be rapidly assimilated and dispersed. No impacts are expected to occur from these minor discharges.

- Although the current general NPDES permit requirements are expected to decrease levels of contaminants in offshore oil and gas discharges significantly, the total level of contaminants estimated by the USEPA (1993) to be discharged annually from drilling muds and cuttings are about 1.65 billion pounds per year, and the total level expected from produced water is about 44 million pounds per year. Given these levels, some regional, long-term contamination of inner shelf sediments is expected to continue to occur, especially in the shallow shelf areas where historically OCS operations have been concentrated. Despite this contamination, regional-scale biological or ecological alterations have not been demonstrated to be occurring, although current studies may not be sufficient to make conclusions regarding regional-scale impacts (Avanti Corporation, 1993).

(4) Well Treatment, Workover, and Completion Fluids

Well treatment fluids are any fluids used to restore or improve productivity of the formation. Well completion fluids are used to prepare the well for actual oil extraction. These fluids include salt solutions, weighted brines, polymers, and various additives used to prevent damage to the well bore. Workover fluids are used to restore an abandoned well to production or to repair a well. Composition of these fluids varies, but they are usually low solid-weighted brines with specialty additives, or acidic solutions. Contaminants can vary greatly, with the greatest concern being when an acidizing agent is used in well treatment. Other contaminants can include oil and grease (range of 0.1-14,000 mg/l), metals, a variety of organic compounds, biocides, and NORM. Because these fluids are sometimes used to dissolve NORM-contaminated scale buildups, their waste streams have been found to have radioactive isotope concentrations as high as 25,000 pCi/l. One Gulf operator reported well treatment fluid usage of 1,283 bbl during one workover activity (USEPA, 1993). The USEPA's general NPDES permit for the period 1992-1997 requires that these fluids meet all produced water requirements for oil and grease and free oil, and that priority pollutants can only be discharged in trace amounts.

Disposal methods for treatment, workover, and completion (TWC) fluids commonly used include mingling with the produced-water system, neutralization of pH and overboard discharge, reuse, or onshore disposal and/or treatment. The USEPA allows TWC fluids to be commingled with the produced-water stream if the produced water/TWC fluid discharges passes the toxicity test requirements of the NPDES permit. However, according to USEPA, facilities with less than 10 producing wells may not be able to commingle the TWC fluids with the produced-water stream for treatment and overboard discharge because of the relatively low volume of produced water generated and/or the size of the produced-water treatment system (USEPA, 1993). Analysis of the MMS database shows that about 73 percent of all platform complexes have less than 10 well slots; therefore, operators of these facilities would have to dispose of their wastes by means other than overboard discharge.

Estimates of the volumes of TWC fluids account for reuse of the fluids. Three hundred barrels of workover fluids will be used per job; these fluids will be recycled once. Two hundred fifty barrels of treatment fluids will be used per well treatment operation (treatment fluids cannot be recycled). Each well averages one treatment or one workover every four years. Given this, each well will average 200 bbl of treatment or workover fluid every four years. Three hundred barrels of completion fluids will be used per job. These fluids can be used twice, and completion only occurs once per well.

(5) Production Solids and Equipment

Solid wastes, as discussed here, include production sands, salvaged and discarded tubular pipes, pipe scale, and tank-bottom sludge. Other solid wastes such as used filters, drums, cement bags, crates, plastics, and a variety of domestic wastes are discussed in Section IV.A.3.e. Produced sands, as defined in this EIS and by the USEPA permitting program, refers to slurried particles used in hydraulic fracturing, the accumulated

formation sands, and scale particles generated during production. Produced sand also includes desander discharge from the produced-water stream and blowdown of the water phase from the produced-water treating system. Produced sands are, in reality, a mixture of many different kinds of solids. The primary component is sand (SiO_2), with varying amounts of mineral scale, corrosion products, and other formation fines.

Produced solids associated with oil and gas production are gravimetrically separated out of the production stream and accumulate in production tubing, flowlines, and various oil and gas process vessels. These solids are removed periodically to improve production. Low volumes of these fine sands may be drained into drums on deck or are carried through the oily water treatment system and appear as suspended solids in the produced-water effluent or settle out in treatment vessels. Due to the oil-wetting of clay particles and the presence of paraffin, grease, and other hydrocarbon-containing materials that are in various quantities in tank bottoms, accumulations in tank bottoms are often referred to as sludges. If sand volumes are large, the solids are removed in cyclone separators, producing a solid phase waste.

The principal contaminants of concern in the sludge or sand mixtures are oil and NORM. The Offshore Operators Committee reported radium levels in produced sand from 17 OCS locations in the Gulf and found Ra-226 levels averaging 37 pCi/g and Ra-228 averaging 38 pCi/g (Offshore Operators Committee, 1991). The Louisiana Mid-Continental Oil and Gas Industry surveyed State oil and gas operators in 1992. They found 54 percent of operators reported radium levels between 5 and 30 pCi/g; 33 percent between 30 and 100 pCi/g; 10 percent between 100 and 500 pCi/g; 2 percent between 500 and 1,000 pCi/g; and 1 percent reported radium levels greater than 1,000 pCi/g. In general, Ra-226 levels for marine sediments average 1-17 pCi/g.

The USEPA NPDES permit covering the period 1992-1997 imposes a zero discharge on these wastes. Industry will use either downhole encapsulation, well injection, or shipment onshore for disposal. During 1992 through 1994, the MMS approved 53 applications for encapsulation (six of which were later canceled) and 5 applications for injection (2 of which were later canceled). Of the three injections that were completed, two involved the same OCS well.

Not all scale is removed from equipment. Scale may adhere to processing and water separation equipment and piping, as well as transport equipment. Pipes removed from wells that are no longer in production may have accumulations of scales within. This equipment may contain Ra-226 and Ra-228 in concentrations averaging 0.1-2,800 pCi/g. According to some sources, radium has been measured as high as 100,000 pCi/g in some scale originating on the OCS. These tubular goods must be cleaned to remove the NORM contaminants before the transfer of ownership. In the past, there were significant problems associated with the disposal of solid wastes contaminated with NORM. Prior to an understanding that some oil-field solids contained elevated NORM levels, the materials were taken to normal disposal facilities or sold for scrap metal and reused. Once it was realized that the solids were contaminated with NORM, a number of existing sites had to be closed or had to conduct expensive cleanup operations to remove NORM-contaminated soils. In particular, a large number of pipe-cleaning yards, scrap metal sites, and some playgrounds that used contaminated pipe were found to be highly contaminated with NORM. Regulations prohibiting the disposal of NORM-contaminated solid wastes at such sites resulted in large stockpiles of NORM-contaminated materials throughout the Gulf Coast, these stockpiles themselves representing a risk. Finally, in 1994, the openings of two NORM disposal sites in Louisiana and one treatment facility in Texas resolved the problem.

(6) Deck Drainage

Deck drainage results from rain runoff, miscellaneous leakage and spills, and wash down of the platforms or drilling rigs. Deck drainage is usually contaminated with oil and grease and a number of hazardous chemicals and trace metals in low concentrations. Measurements of effluent oil and grease content range from 1 to 16,908 ppm; and oil and grease in the discharged drainage range from 1 to 673 ppm, showing that oil and grease can greatly exceed the discharge limits of produced waters (USEPA, 1993). The source of the oil in the deck drainage is any residual oil from previous spills and the leakage of oils and other production chemicals used by the facility. Oil may also be present due to the wash down solvents. Platforms have pans and sumps that collect such drainage. The drainage is gravity separated into waste materials and effluent. The effluent can be treated, separated, or combined with produced water and then discharged overboard. The waste materials are treated, used in the drilling mud system, or transported to shore for disposal. The USEPA NPDES permit covering the years 1992-1997 prohibits any discharge of free oil as determined by visual sheen.

The quantities of deck drainage can vary greatly. An analysis of 950 Gulf of Mexico platforms during 1982-1983 measured deck drainage quantities ranging from 1 to 4,304 bbl/day with an average of 50 bbl/day (USEPA, 1993). For analytical purposes, deck drainage can be calculated at 50 bbl per platform per day. No estimates are provided for the proposed action and the OCS Program because impacts are considered negligible.

(7) Treated Domestic and Sanitary Wastes

Domestic wastes are wastewater originating from sinks, showers, laundries, and galleys, as well as wastewater from safety shower and eyewash stations and fish-cleaning stations. Domestic wastes also may include solid materials (paper, boxes, etc.) that are combustible. Rubbish, trash, and other refuse are discussed in Section IV.A.3.e. Sanitary wastes are composed of human body wastes from toilets and urinals. Some platforms combine sanitary and domestic wastewater for treatment; others maintain sanitary wastes separately for treatment by an approved marine sanitation device.

The volume and concentration of sanitary wastes will vary widely with time, occupancy, platform characteristics, and operation situation. In general, a typical manned platform will discharge 0.075 m^3 per person per day of treated sanitary wastes and 0.110 m^3 per person per day of domestic wastes (USEPA, 1993). In offshore operations, toilets are usually flushed with brackish water or seawater. Concentrations of fecal coliform bacteria serve as an indicator of the potential pathogenicity of water resulting from the disposal of human wastes. Specific levels of suspended solids and chlorine residual in an effluent are indicative of corresponding levels of fecal coliform. If the suspended-solid levels in an effluent are less than 150 mg/l and the chlorine residual is maintained at one mg/l, then fecal coliform levels should be less than 200 per 100 ml. Properly operating biological treatment systems on offshore platforms have effluents containing less than 150 mg/l of suspended solids; therefore, chlorine residual is a reasonable control parameter. Domestic wastes contain no fecal coliform so must only be ground up by a comminutor so that the discharge will not result in any floating solids. It is expected that such discharges are rapidly diluted and dispersed and no analysis on the impact of these discharges is performed for the proposed action.

(8) Minor Discharges

The term "minor discharges" is defined by USEPA (1993) to include all other point-source discharges other than produced water, drilling fluids, deck drainage, well-treatment and workover fluids, and sanitary and domestic wastes. These wastes are assumed to be minor, and no regulatory control exists (USEPA, 1993). These sources are categorized into 15 "minor wastes" that include desalinization unit discharge, blowout preventer (BOP) fluid, laboratory wastes, ballast/bilge water, noncontact cooling water, uncontaminated seawater used for a variety of operations, boiler blowdown, excess cement slurry, diatomaceous earth filter media, painting wastes, uncontaminated freshwater, accidentally discharged bulk transfer materials, water flooding discharges, and test fluids. No projections of volumes or contaminant levels of minor discharges are made for the OCS Program or the proposed action because impacts are considered negligible.

(9) Support-Vessel Discharges

Operational discharges from vessels include bilge and ballast waters, and sanitary and domestic wastes. New regulations promulgated under the international protocols provided by MARPOL 73/78 (33 CFR 157) have significantly limited bilge and ballast water discharges from oil tankers and other large vessels. These regulations now require that terminal areas maintain onshore receptacles to receive these waste waters. The regulation at 33 CFR 157.10B specifically provides even greater restrictions on oil tankers carrying OCS-produced oil. Because of this, it is assumed that all ballast and bilge waters from projected OCS tanker operations will be discharged into onshore receiving stations.

Operators of support vessels, such as crew and supply service boats and tug boats associated with barging, may still discharge oily bilge waters into the water. The required treatment process on board the vessel limits the oil content in the bilge water as a function of the vessel's distance from shore. Based on a NERBC (1976) analysis of bilge water generated as a function of size and tonnage of work boats, vessels averaging 60 dwt

discharge 55 liters/hr and vessels averaging 100 dwt discharge 90 liters/hr. As OCS operations move farther offshore, the size of support vessels is expected to increase, resulting in larger volumes of bilge water discharged per vessel. These larger volumes would be compensated by the reduced frequency of trips for deepwater operations. Section IV.A.2.b.(4) discusses service vessels in general and provides estimates of the number of trips occurring. For analysis purposes, it is assumed that 70 liters/hr of bilge water is discharged from a typical support-vessel trip offshore.

Tributyltin (TBT) has been used since the 1960's as an antifouling agent in marine paints. TBT enters the marine environment slowly through deterioration of the painted surfaces. Since 1989, its use has been banned in paints applied to boats less than 25 m, but it is still being used on larger vessels such as aluminum-hulled service boats. Monitoring studies have shown that TBT levels have decreased in the Gulf of Mexico since this ban. However, data have also shown that marine life in the Gulf may be continuing to be exposed to butyltin compounds (Kannan et al., 1997). Since this problem is not isolated to the oil and gas industry, no quantitative information is available.

e. Trash and Debris

Oil and gas operations on the OCS generate waste materials made of paper, plastic, wood, glass, and metal. Most of this waste is associated with galley and offshore food service operations and with operational supplies such as shipping pallets, containers used for drilling muds and chemical additives (sacks, drums, and buckets), and protective coverings used on mud sacks and drilling pipes (shrink wrap and pipe-thread protectors). Some personal items, such as hardhats and personal flotation devices, are accidentally lost overboard from time to time. Generally, galley, operational, and household wastes are collected and stored on the lower deck near the loading dock in large receptacles resembling dumpsters. These large containers are generally covered with netting to avoid loss and are returned to shore by service vessels for disposal in approved landfills.

The MMS regulations, the NPDES general permit, and the U.S. Coast Guard's regulations implementing MARPOL 73/78 Annex V prohibit the disposal of any trash and debris into the marine environment. Victual matter or organic food waste are allowed to be ground up into small pieces and disposed of overboard from structures located more than 20 km from shore.

Information provided by industry gives some indication on the amount of trash historically generated during the drilling of an average offshore well. A typical well drilled to about 4,300 m might require 9,300 mud sacks, 100 pails, 250 pallets, 225 shrink wrap applications, and two 55-gallon drums. Drilling operations require the most supplies, equipment, and personnel, and therefore, generate more solid waste than production operations.

Over the last several years, companies have employed waste reduction and improved waste handling practices to reduce the amount of trash offshore that could potentially be lost into the marine environment. Improved waste management practices, such as substituting paper cups and reusable ceramic cups and dishes for those made of styrofoam, recycling offshore waste, and transporting and storing supplies and materials in bulk containers when feasible, are commonplace. Experimental technology, such as reinjection of waste materials reduced to slurry into downhole formations, is also under development. These practices have resulted in a marked decline in the loss and discard of trash and debris.

f. Air Emissions

OCS activities that use any equipment that burns a fuel, that transports and/or transfers hydrocarbons, or that results in accidental releases of petroleum hydrocarbons or chemicals will cause emission of air pollutants. Some of these pollutants are precursors to ozone, which is formed by complex photochemical reactions in the atmosphere.

The criteria pollutants considered here are nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur oxides (SO_x), volatile organic chemicals (VOC), and particulate matter less than 10 microns in size (PM_{10}). Emissions for the new criteria pollutant, $PM_{2.5}$, were not calculated for this analysis because currently there are no established emission factors for that pollutant. However, $PM_{2.5}$ emissions would be similar than those calculated for PM_{10} and the predicted impacts for that pollutant were found to be negligible. Criteria pollutant emissions from OCS platforms and drilling operations are estimated using the emission rates presented in

Table IV-9. These emission rates are derived from a 1991-1992 MMS inventory of offshore OCS structures (Steiner et al., 1994).

Emissions of air pollutants during loading, storage, and transportation of crude oil and gas are calculated using the methodology and emission factors presented in USEPA publication AP-42 of 1985 with supplements A, B, and C. Helicopter emissions are also calculated using the methodology presented in the previous reference.

Table IV-9

Average Annual Emission Rates from OCS Infrastructures in the Gulf of Mexico

	NO_x	CO	SO_x	VOC	PM_{10}
Platforms (tons/platform/year)	50.88	11.84	8.55	38.58	0.93
Exploration Well (tons/well)[1]	19.82	5.28	2.32	1.91	0.57
Development Well (tons/well)[2]	21.49	5.73	2.52	2.07	0.61

[1] Assumes a 4,115-m hole, 40-day drilling period, and a power consumption of 120 horsepower hour/foot.

[2] Assumes a 3,050-m hole, a 35-day drilling period in less than 400-m water depth, a 60-day drilling period in greater than 400-m water depth, and a power consumption of 180 horsepower hour/foot.

Source: USDOI, MMS, Gulf of Mexico OCS Region estimates, 1994.

Emissions of regulated pollutants from OCS-related accidents are presented in Table IV-10. It is assumed that emissions of air pollutants from oil spills cease completely after three days.

Table IV-10

Emissions Associated with OCS-Related Accidents
(tons/hour)

Accident Type	VOC*	NO_x	SO_x	CO	PM_{10}
140-bbl spill					
First hour	3.6	---	---	---	---
Second hour	1.8	---	---	---	---
10,000-bbl spill					
First hour	259.9	---	---	---	---
Second hour	132.24	---	---	---	---
Blowout** - No Fire	0.9	---	---	---	---
Blowout** - With Fire	0.31	0.02	0.21	0.34	0.07

*Assumes a 0.912 conversion factor from the THC to VOC.
**Assumes a blowout of 1 MMcf/day (gas) and 1,000 bbl/day (oil).
Source: USDOI, MMS, 1983.

Proposed Action Scenario: Total amounts of emissions of the regulated air pollutants associated with the proposed action are presented in Section IV.D.1.a.(4).

OCS Program Scenario: Total amounts of emissions of the primary air pollutants are presented in Section IV.D.1.d.(4). These amounts include emissions from existing major platform complexes.

g. Noise

Noise associated with OCS oil and gas development results from seismic surveys, the operation of fixed structures such as offshore platforms and drilling rigs, and helicopter and service-vessel traffic. Noise generated from these activities can be transmitted through both air and water, and may be continuous or transient. Offshore drilling and production involves various activities that produce a composite underwater noise field. The intensity level and frequency of the noise emissions are highly variable, both between and among the various sources. Noise from proposed OCS activities may affect resources near the activities. The level of underwater sound depends on receiver depth and altitude, aspect, and strength of the noise source. The time during which a passing airborne or surface sound source can be received underwater is increased in shallow water by multiple reflections.

Seismic vessels generally operate at low hull speeds and follow a systematic pattern during survey. The noise generated by airguns is intermittent, with pulses generally less than one second in duration, for relatively short survey periods of several days to weeks (Gales, 1982). Airgun arrays produce noise pulses with very high peak levels; however, the short duration of each pulse limits the total energy. Levels are expected to be less than 200 dB at distances beyond 90 m from the source (Gales, 1982).

Drilling operations often produce noise that includes strong tonal components at low frequencies, including infrasonic frequencies in at least some cases. Drillships are apparently noisier than semisubmersibles (Richardson et al., 1995). Sound and vibration paths to the water are through either the air or the risers, in contrast to the direct paths through the hull of a drillship.

Machinery noise generated during the operation of fixed structures can be continuous or transient, and variable in intensity. Underwater noise from fixed structures ranges from about 20-40 dB above background levels within a frequency spectrum of 30-300 Hz at a distance of 30 m from the source (Naval Ocean Systems Center, 1982). These levels vary with type of platform and water depth. Underwater noise from platforms standing on metal legs would be expected to be relatively weak because of the small surface area in contact with the water and the placement of machinery on decks well above the water.

Aircraft and vessel support may further ensonify broad areas. Noise generated from helicopter and service-vessel traffic is transient in nature and extremely variable in intensity. Helicopter sounds contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al., 1995). Helicopters often radiate more sound forward than backward; thus, underwater noise is generally brief in duration, compared with the duration of audibility in the air. Water depth and bottom conditions strongly influence propagation and levels of underwater noise from passing aircraft. Lateral propagation of sound is greater in shallow than in deep water. Helicopters, while flying offshore, generally maintain altitudes above 700 ft during transit to and from the working area and an altitude of about 500 ft while between platforms. Service vessels transmit noise through both air and water. The primary sources of vessel noise are propeller cavitation, propeller singing, and propulsion; other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al., 1995). Propeller cavitation is usually the dominant noise source. The intensity of noise from service vessels is roughly related to ship size, laden or not, and speed. Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladen vessels. Noise increases with ship speed, which would usually be greater offshore.

h. Accidents

(1) Blowouts

Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids from a wellhead or wellbore are called blowouts. Blowouts have caused the greatest number of fires, explosions, deaths, injuries, and property damage or loss of offshore rigs (Danenberger, 1980; Fleury, 1983).

Blowouts can occur during any phase of development: exploratory drilling, development drilling, production, completion, or workover operations. From 1971 to 1993, there were on the average of 7 blowouts per 1,000 wells drilled (USDOI, MMS, 1994). It is assumed from the historical distribution that 14 percent of all blowouts could result in the spillage of crude oil or condensate, with 4 percent of the blowouts resulting in spills greater than 50 bbl. From 1971 to 1993, a total of 1,059 bbl of crude oil and condensate were spilled in an overall total of 150 blowouts (USDOI, MMS, 1994). The duration of documented blowouts was variable: 61 percent lasted one day, 25 percent lasted one week, and 13 percent lasted over one week (Fleury, 1983).

Severe subsurface blowouts could resuspend and disperse abundant sediments within a 300-m radius from the blowout site. The fine sediment fraction could be resuspended for more than 30 days. Sands (coarse sediment fraction) would settle at a rapid rate within 400 m from the blowout site, particularly in a 30-m water depth and a 35-cm/sec blowout scenario.

Proposed Action Scenario: The estimated number of blowouts resulting from the proposed action in the WPA is 1-2 blowouts.

OCS Program Scenario: For OCS Program activities in the WPA, the estimated number of blowouts is 27-50 in all water depths. For the Gulfwide OCS Program, the estimate is 108-177 blowouts in all water depths Most of these blowouts will occur in water depths less than 60 m because that is where most of the OCS activity is expected to occur.

(2) Offshore Spills

Accidental discharges can occur during almost any stage of exploration, development, or production on the OCS. In addition to crude oil spills, chemical, diesel, and other oil-product spills can occur in association with OCS activities. Oil spills occur as a result of many causes, e.g., equipment malfunctions, ship collisions, pipeline breaks, human error, or severe storms. Many oil spills are not directly attributable to the oil-extraction process but are indirectly related to the support activities necessary for recovery and transportation of the resource. Spills occurring in inland waters from OCS-related operations are discussed in Section IV.B.2.d.

In order to analyze the possible effects of oil spills that could occur from OCS oil and gas production, MMS conducts a formal assessment of the risks of spill occurrence and contact using an in-house computer trajectory model and database. A description of the trajectory model, called the OSRA (oil spill risk assessment) model, and its results are part of this EIS process and are referenced here (Price et al., 1997). The spill events database maintained and analyzed by MMS includes all spills occurring on the OCS in the Gulf of Mexico and resulting from OCS oil and gas postlease exploration, drilling, production, and oil transport operations.

Offshore oil spillage from OCS operations is small compared with the volume of oil produced. Since 1980, OCS operators have produced about 5.5 BBO of oil, while the amount of oil spilled offshore totaled about 61,500 bbl (0.001%) or 1 bbl spilled for every 89,500 bbl produced. The volume of oil spilled from pipelines and platforms during the period 1980-1995 declined significantly from the previous period of 1964-1979. For example, between 1964 and 1979, more than 400,000 bbl of crude oil were spilled from OCS platforms and pipelines as compared to about 56,000 bbl between 1980 and 1995 (Anderson, 1997).

Oil-Spill Categories/Nomenclature

Spills on the OCS are predominantly crude oil and condensate spills, and records of spills have focused on the volumes and rates of these spills. Other spills of OCS-related oils have occurred, such as diesel from drilling operations, oily drilling muds while being offloaded, and production chemicals. There has only been one diesel spill > 1,000 bbl in the Gulf of Mexico. The MMS records maintained of oil spills other than crude oil show an average spill size of 34 bbl, but these records have not been analyzed further to allow the development of information for different size categories. For purposes of EIS analysis, oil spills are divided into five categories. This terminology will be used throughout the document.

Size Category	Symbol
Crude Oil Spills	
1 bbl or less	$\leq$ 1 bbl
greater than 1 bbl and less than or equal to 50 bbl	$>$ 1 bbl and $\leq$ 50 bbl
greater than 50 bbl and less than 1,000 bbl	$>$ 50 bbl and $<$ 1,000 bbl
greater than or equal to 1,000 bbl	$\geq$ 1,000 bbl
Other Oil-Type Spills	
(not broken down into size categories)	

Deepwater Spills

Although spills by nature are unforeseeable events, in the mature development areas of the Gulf of Mexico, the MMS can rely on past experiences to predict many factors regarding oil spills. These factors include spill frequency, behavior, impacts, and spill response protocols. Much less can be predicted about spills in deepwater. To date, there have been no spills. As industry rapidly expands operations into deeper waters with new improved technological advances, all parties involved are attempting to assess what could happen if a spill were to occur. Significant variables now being evaluated are outlined here.

New potential sources of spills are expected. These sources include the extended well testing procedures that may occur, different oil storage, new types of production facilities, and new methods of transporting the oil from the well site to the surface facility and from the surface facility to shore.

- Because of the development costs in deepwater, industry often conducts extended well testing operations prior to establishing a final plan. Oil produced during this operation may be loaded onto a barge unless onsite storage is available. There have been very little barging operations conducted in deepwater. Since no storage of the oil is usually available, offloading may occur under difficult sea conditions. Testing would be aborted under severe sea conditions. Barging associated with extended well testing is expected to occur infrequently, once during the life of any one field. Barge spills and barging operations in general are discussed in Sections IV.C.4. and IV.A.2.b.(2), respectively.

- Traditional sea bottom-supported platforms handling oil from a few wells may be replaced by subsea well complexes or by large central processing and storage facilities in deepwater. Floating production facilities (FPO, FPS, FPSO) (Section IV.A.2.a.(2)(b)) will function as a hub for production from other floating facilities and from multiple subsea well locations. Spill risk from these new, floating facilities may be different from facilities in shallower waters. Although floating systems are safely used in other parts of the world, the use of floating, production, storage, and offloading (FPSO) vessels is of particular concern in the Gulf. Spills from deepwater centralized facilities could be larger than those at smaller production sites. Common maximum production capacities for FPSO's, for example, are currently 120,000 bbl/day (Lovie, 1997). Large volumes of oil will need to be stored at these central processing facilities to handle the number of well streams being processed or because the oil cannot be transported immediately. Storage capacities in the existing FPSO fleet range from 55,000 to 2,000,000 bbl. The turret and stack manifold systems have been known to spill small quantities of oil in the North Sea.

- The produced well stream may be carried from the subsea well to the surface vessel through the water column a great distance by risers (flexible gathering lines that must remain suspended in the water column) rather than trenched on the seafloor in order to allow for movement of the floating structures above. There may be as many as 36 risers (Lovie, 1997). Very little is known about their risk of oil spillage.

- New, large diameter pipeline systems are expected to service most of the deepwater operations. Because of the volumes of oil that must be transported long distances (recently a 400,000 bbl/day line was installed) and because of the unique characteristics

of some of this oil, these systems are not expected to tie into the existing network but will extend from offshore to shore. Spill risk from pipelines is well known. Given that the greatest cause of pipeline spills is anchor damage in shallow waters, it is surmised that the risk of a spill from a pipeline while in deepwater would be much less. Nevertheless, the ability to stop the spill at the seafloor once it begins and the ability to ensure pipeline integrity in the long term must be analyzed further.

- Shuttle tankers are most likely to service FPSO's. Shuttle tankers are currently routinely used in the Gulf to offload oil from large supertankers, and the risk of spill occurrence is well known. Shuttle tankers that would most likely service OCS operations in the Gulf have capacities ranging from 20,000 deadweight tonnages (dwt) (133,000 bbl) to 50,000 dwt (333,000 bbl). This EIS provides estimates of tanker transport of OCS-generated crude, accounting for the probabilities of shuttle tanker spill occurrence and the estimated number of vessel spills. Sections IV.A.2.a.(2)(c) and IV.A.3.h.(2) provide further information.

- The transfer operation from FPSO to shuttle tanker may be a source of spill mishap at the production site. Although designed to be the safest system possible, the transfer of oil from one vessel to another is currently known to have one of the highest risks of occurrence of small spills. The U.S. Coast Guard has determined that there have been about seven spills per 1,000 transfers. Safety features allow the transfer operation to be quickly shut down thus preventing large spills from occurring.

- Although not a new source, the risk of spills from loss of well control (blowouts) in deepwater may be very different from the risk in shallow water. Of particular concern is the ability to stop a spill once it begins, especially a spill from a high rate flow well. Wells in deepwater are being projected to flow at rates up to 15,000 bbl/day.

Given what appears to be an increased number of new sources as well as larger spill size risk, it is important that one not conclude that there is an increased risk of spills in deepwater. Although not factored into our spill rates, one of the major causes of spill occurrence on the OCS has been interactions with other vessels. For example, 20 percent of the total numbers of spills and 74 percent of the volume of oil spilled from 1971 to 1984 was due to other vessels' mishaps. Since deepwater operations will be consolidated into fewer numbers of surface structures located away from the highest vessel traffic areas, the risk of collision should be much less. Also, hurricanes and storms have played a large part in causing spills from platforms in the Gulf. Many of the floating production systems projected for use in the Gulf were originally designed for sustaining the difficult environment of the North Sea, and it is expected that these structures will be able to better withstand the forces of storms. Although many believe that the risk of spills from tankers is much greater than from platforms and pipelines, this is not borne out by an examination of statistics on historical occurrences versus volume handled. (See Section IV.C.4. for a more detailed discussion of tanker versus platform spill risk.) Vessels have more spills simply because there is so much more oil being transported by vessels. Also, many vessel spills occur close to shore due to collisions, resulting in more damage to sensitive coastal environments. FPSO vessel operations will not have the same risk profile as the maritime industry.

An important factor in assessing spill risk is the fact that deepwater spills occur far from sensitive coastal features. The OSRA model results were used to determine the likelihood that a spill occurring in deepwater could be transported to shore based only on physical oceanography and wind transport. Compared to probabilities for shallower water depths (as high as 99%), there is a 46 percent probability for operations between 900 and 3,000 m and a 7 percent probability from operations in greater than 3,000 m of water that a hypothetical spill could reach the U.S. shoreline in 30 days. The OSRA model results do not factor in the likelihood that the spilled oil would persist as a slick for this time period. The resultant surface slick may dissipate naturally over time or be able to be cleaned up prior to reaching coastal waters. Thus, only the largest of slicks are expected to remain on the surface of the water long enough for a significant quantity of oil to reach coastal resources.

Another important consideration is the fact that a deepwater spill may occur at the seafloor thousands of feet below the surface of the Gulf sea surface. The MMS is currently funding a study on the analysis of oil-

spill behavior and countermeasures for subsea well blowouts in deepwater and is examining the transport mechanisms of oil spilled in deep water at the seafloor from a pipeline leak. Field trials and modeling efforts recently completed by IKU (Rye and Brandvik, 1997) showed that the stratification of the ambient water masses may prevent the subsurface plume from reaching the sea surface. If the oil were to reach the sea surface, it may consist of oil droplets that would form a very thin surface slick spread out over a larger area. This slick may dissipate rapidly. Not all of the oil originally released is expected to reach the surface in the form of a surface slick.

To further complicate any assessment of spill risk, little is known about the characteristics of oil that will be produced in deepwater. Initial information shows that some of the oil may be fairly heavy (an API gravity in one instance of 10), may be waxy, and/or contain high asphaltenes, high metals, and high sulfur. All of these characteristics will affect the way spilled oil will weather over time; lighter oils with low asphaltene content are known to dissipate rapidly.

Until more of the uncertainties can be realized, this EIS only discusses deepwater spills in a general sense. For example, the OSRA model combined probabilities for spill risk occurrence and contact take into account spill potential from platforms, pipelines, and tankers in deepwater but the spill rates used are not unique to deepwater. Until generalities can be developed for what is expected to occur in deepwater, an in-depth analysis of the potential for spills from deepwater operations will be best handled at the time of the plan of development. A NEPA analysis can be completed that will best be able to analyze spill risk associated with the specific technology being proposed and the oil type expected to be developed.

Oil-Spill Occurrence Rates

Oil-spill occurrence rates are calculated based on the assumption that spills occur in direct proportion to the volume of oil handled. In 1994, MMS revised its oil-spill occurrence rates for large spills (Anderson and LaBelle, 1994). An examination of the two major sources of OCS-related offshore spills--platforms and pipelines--shows that the greater risk of a large spill is from a pipeline. There have been no spills $\geq$ 1,000 bbl from OCS platforms since 1980. Based on this trend, MMS calculated a decline in the OCS platform spill rate from the rates previously used by MMS (Anderson and LaBelle, 1990; Lanfear and Amstutz, 1983). However, there have been six spills > 1,000 bbl from pipelines since 1981, resulting in an increase of this occurrence rate. The occurrence rate for small spills > 1 bbl and < 1,000 bbl is based on an analysis of small spill occurrences between 1976 and 1989 (Lugo-Fernandez, 1993).

Oil-Spill Occurrence Rates

Size Category	Rate
Crude Oil Spills	
$\leq$ 1 bbl	95.7% of all OCS spills
> 1 bbl and $\leq$ 50 bbl	152 spills/BBO handled
> 50 bbl and < 1,000 bbl	6 spills/BBO handled
$\geq$ 1,000 bbl	
Platform	0.45 spills/BBO handled
Pipeline	1.32 spills/BBO handled
Shuttle Tanker*	0.55 spills/BBO handled
Other Oil-Type Spills	73 spills/BBO handled

*The shuttle tanker spill rate is not based on data related to OCS production because there have been no shuttle tanker spills. Instead, the at-sea spill rate for all tankers in U.S. waters is used (Anderson and LaBelle, 1994) and includes spills in offshore State waters as well as OCS waters.

Projected Spill Events

Using the above spill rates, oil-spill occurrence estimates were calculated for production and transportation of oil during the life of a typical proposed action and for the Gulfwide OCS Program between the years 1997

and 2036. The number of projected spills ≤ 1 bbl is based on the assumption that the frequency of these spills relative to the frequency of larger spills (95.7% of all spills will be ≤ 1 bbl) will remain constant into the future (Anderson, 1997). Figure IV-3 provides the frequency distribution for large spill ($\geq$ 1,000 bbl) occurrences for the range of oil resources analyzed for a proposed action and for the Gulfwide OCS Program. The probability of a certain number of spills was computed assuming a Poisson probability distribution (Price et al., 1997).

For a proposed action, there is a 2-15 percent chance that one or more spills will occur. Examination of Figure IV-3 shows that, for the proposed action, there is a 2-13 percent chance that one large spill ($\geq$ 1,000 bbl) will occur and less than a 1 percent chance of two large spills. There is as much as a 98 percent chance that no large spills (zero spills) will occur. Table IV-2 provides the number of spills in each size category estimated to occur during the life of a proposed action.

For the Gulfwide OCS Program, there is a 100 percent chance that one or more large spills ($\geq$ 1,000 bbl) will occur, with the possible number of spills occurring showing a widespread frequency distribution (Figure IV-3). If the low resource estimate is produced, there could be as many as 29 large spills occurring (0.01% probability), with a mean number of 19 large spills estimated. For the high resource estimate, as many as 38 large spills could occur (0.01% probability), with the mean number being 26 large spills. Tables IV-3 through IV-6 provide the total number of spills in each size category estimated to occur during the years 1997-2036.

Probabilities of Contact for the Proposed Action Analyses

The proposed action analyses, which incorporate the likelihood of a hypothetical large offshore oil spill contacting a specific resource or land segment, use MMS's oil spill risk assessment model results called "conditional probabilities." These probabilities are different from those used in previous EIS's. These probabilities only provide information about the trajectory of a hypothetical spill based on current and wind conditions and do not factor in any information about the likelihood of spill occurrence. Because of changes in the offshore subareas used for resource estimations (changes made necessary by the recent national assessment of U.S. oil and natural gas resources), the resolution of the OSRA model inputs no longer sufficiently supports combined probabilities for a proposed action, as used in previous EIS's. Conditional probabilities of contact to a specific environmental resource or land segment are based on the "condition" that a spill occurs. These probabilities were calculated for hypothetical pipeline segments that depict offshore corridors where there are either existing pipelines or where future pipelines may be emplaced. Appendix C provides a figure showing these pipeline segments. The probability that a large offshore oil spill will contact a specific environmental resource or land segment from each of the projected pipeline segments was calculated for 3, 10, and 30 days. The complete results of the OSRA analysis, which include seasonal information, are presented in the OSRA report (Price et al., 1997). The probability associated with a pipeline segment can be used to represent the conditional probabilities of spills from production platforms directly adjacent to the pipeline. There have been additional changes to the model since the last Final EIS, which was for Lease Sales 166 and 168 (USDOI, MMS, 1996c). A number of modifications were made to the locations of the environmental resources, and equidistance land segments have replaced county/parish land segments.

The OSRA model's results represent only hypothetical pathways of oil slicks as single points in the ocean and do not take into consideration the processes that might alter the quantity or properties of the oil, such as the original volume of oil spilled or the amount removed from the sea surface by cleanup, dispersion, evaporation, and other weathering processes. These processes are discussed below.

Probabilities of Occurrence and Contact for the Gulfwide OCS Program

Contact with environmental resources and land segments by large offshore spills ($\geq$ 1,000 bbl) occurring from the OCS Program is estimated from combined probabilities generated by the OSRA model. The combined probabilities of a large oil spill occurring and contacting Gulf of Mexico environmental resources or land segments within 3, 10, and 30 days are presented in Appendix C. Unlike the proposed action's conditional probabilities (which assume spill occurrence and account only for the trajectory of a hypothetical spill as influenced by winds and currents), the OCS Program's probabilities account for both the trajectory of a hypothetical spill and the probability of a spill occurrence based on the estimated volume of oil to be produced or transported and on the oil transportation scenario.

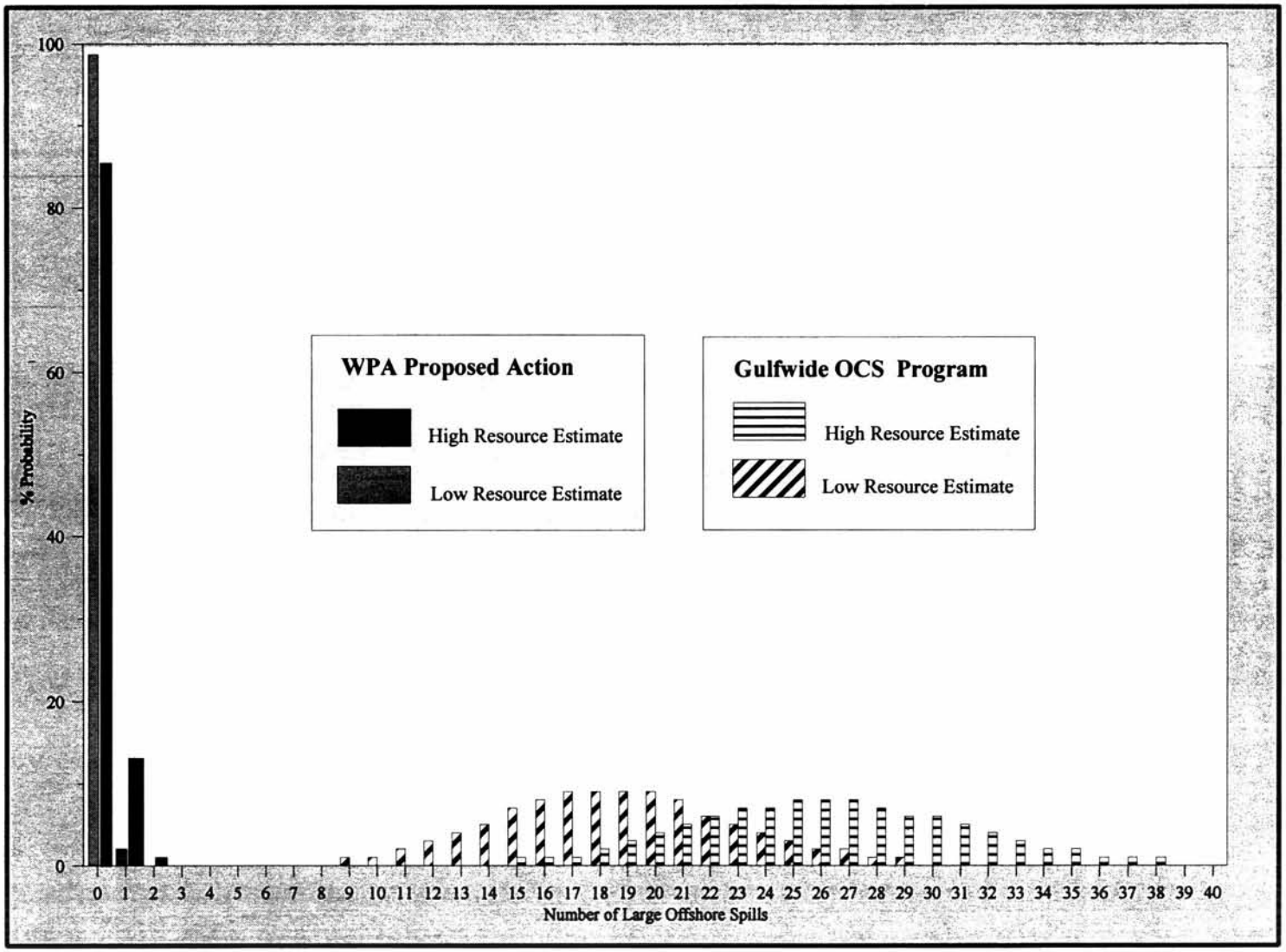


Figure IV-3. Probability that a Certain Number of Large Offshore Spills (≥1,000 bbl) will Occur from the Development of a Range of Resources for the Proposed Action and the OCS Program.*

*OCS Program spill numbers include spills from the proposed action.

Assumptions about Land Contact from Small Offshore Oil Spills

The likelihood that a small offshore spill will reach land is not based on the OSRA model results. Because the model does not take into account the loss of volume of an oil slick over time, the model is not used for smaller spills, which may not persist long enough to be simulated by trajectory modeling. Conditional probabilities for each subarea (Price et al., 1997) show that only spills in the 0-60 m offshore subarea have a reasonable risk of reaching land within 3 days (the best timeframe provided for persistence of small spill slicks). For offshore oil spills > 50 bbl and < 1,000 bbl projected to occur under the proposed action, none are expected to reach land. For offshore oil spills > 50 bbl and < 1,000 bbl projected to occur under the Gulfwide OCS Program, it is assumed that 2-3 spills will reach land.

Analysis of OSRA Model Results

Appendix C provides the conditional probabilities that, if an oil spill were to occur at a given origin point, it will, within 3, 10, or 30 days, contact particular land segments represented as different equidistant segments of the coastline. In other words, the OSRA model calculates the likelihood of spills starting on the OCS at different locations and reaching different parts of the coastline (as determined by oceanographic and wind movements). The model also calculates the conditional probabilities that a hypothetical oil spill starting at a particular offshore location will contact designated environmental resources. Appendix C provides a listing of these resources as well as a map of the equidistant land segments. More information and maps of the locations of these resources can be found in the OSRA report (Price et al., 1997).

The trajectories simulated by the model represent only the hypothetical pathway of oil slicks; they do not involve any direct consideration of cleanup, dispersion, or weathering processes that could alter the quantity or properties of oil that could eventually contact environmental resources or land. An implicit analysis of weathering can be considered by using the three selected time periods of slick movement--3, 10, and 30 days. More information is provided on EIS assumptions about weathering and cleanup for these time periods in the following subsections.

The origins of the hypothetical spills modeled were represented as line segments or areas. Two thousand trajectories were generated from an array of sites distributed within the areas or along the line segments. The areas represented the offshore production subareas (Figure C-1, Appendix C) based on water-depth distributions. The lines represented simplified existing and projected pipeline systems.

Relative Risks from Modeled Origins

The model results can be examined to determine if any particular spill origin location or locations pose a higher risk to resources. This determination is based on the assumption that those origin points with consistently higher probabilities of contact pose the highest risk. Resource information is distributed within 15 subareas that represent water-depth distributions. These subareas were originally used to represent starting points for spills from platforms. Because of the size of the subareas and the model's method of distributing trajectories along starting points equidistant within each subarea, the results of the conditional probabilities were averaged over the whole subarea. These averaged results do not support use of the trajectories to represent a spill occurring from a platform. Nevertheless, the subarea conditional probabilities can be used to compare the relative risk of OCS spill contact as a function of water depth (somewhat correlated with distance from shore). The results are not unexpected. The deeper the water, and thus the farther from shore, the less likely it is that an oil spill will reach coastal resources. For example, in the WPA, spills from W0-60 have a 62 percent probability of contacting land within 10 days, while spills in water depths greater than 900 m only have a 1 percent probability of contact within 10 days. Hypothetical spills from waters deeper than 900 m show a greater than 10 percent probability of contact with coastal resources only if the spill were to remain on the surface of the water for 30 days.

Because the probabilities given for the large subareas do not represent spill risk from production points in the Gulf, it was decided that the probabilities given for pipeline segments can be viewed as a proxy for the risk of spills from production operations adjacent to the pipeline. Examination of the relative risk of hypothetical spills from pipeline segments shows that the risk of contact was mostly controlled by distance from shore and a westerly movement assumed to be related to the Mississippi River circulation. All of the segments within 50 mi of land associated with pipeline systems making landfall within Texas or the Chenier

Plain of Louisiana exhibit more than a 50 percent risk of spill contact with land within 10 days. For pipeline segments making landfall east of the Atchafalaya River, only those segments within about 20 mi of land exhibit a 50 percent probability of contact. East of the Mississippi River, only those segments beginning from the shore and extending 10 or 20 mi offshore exhibit probabilities greater than 50 percent. The projected pipelines system off Mississippi and Alabama coming from Florida and paralleling the coast also shows a 50 percent risk of contact with shoreline resources if a spill were to occur and reach land within 10 days.

Relative Risks to Environmental Resources and Land Segments

The conditional probability results can also be used to determine relative risk of a proposed action spill contacting environmental resources and land segments of concern. Except for one system making landfall in Louisiana, pipeline system routes A through I would be used to carry oil produced as a result of the proposed action in the WPA (Figure C-2, Appendix C), and the model conditional probability results are summarized for these segments. Out of all of the resources examined, the likelihood of contact within 3 days from hypothetical spills from the proposed action is highest for Texas coastal waters and major recreational beaches; the highest probabilities being 92 percent for coastal waters and 66 percent for recreational beaches from a spill originating off Freeport and south of Galveston. The recreational beaches having the highest probabilities of contact within 3 days are Kenedy/Kleberg/Nueces/Aransas (51%), Brazoria (37%), Galveston beaches (34%), and Cameron (26%). Also a high probability of contact within 3 days is shown for Espiritu Santos/Matagorda Bays (40%), Galveston and West Bays (31%), and Laguna Madre seagrasses (31%). No other resources have contact probabilities greater than 25 percent.

For a greater than 25 percent likelihood that a resource will be contacted by a hypothetical spill within a 10-day trajectory time period, the risk of contact to the above resources continues to increase and a number of resources are added. These resources include Padre Island National Seashore (44%), Calhoun (36%) and Matagorda (36%) recreational beaches, and Corpus Christi/Aransas Bays (30%). There are no additional resources at risk if the trajectory time period is extended to 30 days. Inferred from the above modeled contact probabilities, the most likely time for a spill to contact coastal resources is within 10 days; the probabilities for 30 days are only a few percent higher. For example, for Galveston Bay there is a 42 percent probability of contact within 10 days and a 44 percent probability of contact within 30 days.

Based on the model's results, resources located in Louisiana are not at a high risk of contact from spills originating in the WPA. For spills contacting within 3 days, only the Chenier coastal barrier, with a probability of contact of 29 percent, has a probability greater than 0.5 percent. If a spill originating in the WPA were to remain on the surface of the water for 30 days, only the Chenier coastal barrier is at a high risk, increasing to 56 percent. Louisiana coastal waters have a 6 percent chance of being contacted, and Louisiana recreational beaches have a 4 percent chance of contact within 30 days.

One pipeline system (System S on Figure C-4, Appendix C) is hypothesized to bring oil from WPA deep water areas into the CPA, making landfall near Point Au Fer east of the Atchafalaya River. Although most of the oil on this system would originate from platforms located in the CPA, some of the risk of spill contact should be attributable to WPA operations. As expected, this line shows high probabilities of contact from hypothetical spills to Louisiana coastal waters (81% in 10 days), particularly Vermilion/Atchafalaya Bays (16% probability for 10 days) and the Chenier coastal barrier (13% probability for 10 days). Louisiana recreational beaches do not appear to be at a high risk, with only a 6 percent likelihood of contact if the slick were to last for as long as 30 days.

Some offshore resources are at a risk of contact from a spill originating in the WPA. There is a 35 percent likelihood that a spill would reach the area of the Flower Garden Banks National Marine Sanctuary within 3 days and a 14 percent likelihood for Stetson Bank. By 30 days, the probabilities of contact have increased but not by much; for the Flower Gardens, the likelihood of contact increases to 42 percent; for Stetson Bank, the risk of contact increases to 19 percent.

Spill Size Estimates

Oil spill sizes have varied from less than 1 bbl to approximately 200,000 bbl (spilled in 1967). Most offshore OCS spills are very small. Using data from 1980 to 1985, 95.7 percent of all OCS-related offshore spills were $\leq$ 1 bbl, while only 0.8 percent were greater than 10 bbl. However, as expected, most of the volume of oil spilled originated from spill events that were greater than 10 bbl (94.2% of the total volume spilled).

Except for spills 1 bbl or less, spill size projections for OCS offshore pipelines and platforms are based on an analysis of OCS records from 1980 to 1995. Because records for spills of ≤ 1 bbl are limited, 1 bbl was chosen as the assumed size for all spills in this category for computational purposes. Because there have been no OCS tanker spills, the average size of large spills from all U.S. tanker traffic is used (Anderson and LaBelle, 1994; Anderson, 1997).

Size Category	Size Estimate	Method of Projection
Crude Oil Spills		
≤ 1 bbl	1 bbl	Assumed
> 1 bbl and ≤ 50 bbl	4 bbl	Average
> 50 bbl and < 1,000 bbl	150 bbl	Average
Platform	100 bbl	Median
Pipeline	168 bbl	Median
≥ 1,000 bbl		
Pipeline	5,000 bbl	Median
Platform	1,500 bbl	Median
Shuttle Tanker	26,000 bbl	Assumed
Any Source	6,500 bbl	Average
Other Oil-Type Spills	34 bbl	Average

Weathering

A number of processes that alter the chemical and physical characteristics of the original hydrocarbon mixture occur when oil is spilled. Collectively, these are referred to as weathering or aging of the oil. Weathering, primarily, together with atmospheric and oceanographic conditions, determines the time that the oil remains on the surface of the water and the characteristics of the oil at the time of contact with a particular resource. Chemical, physical, and biological processes operate on the spilled oil to change its hydrocarbon compounds, selectively reducing many of the components in the slick and breaking down the slick until it can no longer be recognized as a cohesive mass floating on the surface of the water. Such weathering processes include evaporation of volatile hydrocarbons into the atmosphere, dissolution of soluble components, dispersion of oil droplets into the water column, emulsification and spreading of the slick on the surface of the water, chemo- or photo-oxidation of specific compounds creating new components that are often more soluble, and biodegradation of the slick reducing its remaining mass. Over time, if the slick is not completely dissipated, a tar-like residue may be left, which breaks up into smaller tar lumps that usually sink.

Numerical computer modeling of weathering processes is used to project oil remaining on the ocean surface and to predict the composition of oil as a function of time. Table IV-11 provides the model results of the MMS open-ocean oil weathering model (Kirsten, 1992) for a spill of the above determined average size of 6,500 bbl. The oil type chosen was a crude oil composite carried by the largest volume pipeline system in the Central Gulf into the Gibson terminal. Some of the lighter components of this oil had already been purged. The oil type was about 21 percent volume gasoline plus naphtha, 31 percent residuum, and had a bulk gravity of 34.50°API. Wind speeds used in the model represent the passage of a cold front and range from 4 to 8 m/sec (8.9-17.9 mph). The assumed temperature of the water, 23°C, was indicative of late fall conditions.

Length of Coastline Affected

Table IV-11 provides data on the likely length of shoreline contacted. These data are calculated using formulas found in Ford (1985). Ford performed a statistical analysis of worldwide historical spill occurrences to describe the median length of coastline affected from spills of various sizes and under various climatological conditions and different geographical regions.

Table IV-11

Weathering Characteristics* and Projected Shoreline Contacted by a Typical Large Spill**

Time Elapsed	Barrels Remaining	Volume Remaining (%)***	Slick Area (m^2)	Slick Thickness (mm)	Mass Evaporated (%)	Mass Dispersed into Water (%)	Likely Kilometers of Shoreline Contacted
4 hrs	5,600	86	2.1×10^5	4.20	11	1	22
12 hrs	5,100	78	3.3×10^5	2.50	17	2	21
1 day	4,800	74	4.5×10^5	1.70	19	4	20
2 days	4,300	66	6.0×10^5	1.10	24	8	19
3 days	3,900	60	7.1×10^5	0.87	26	11	18
4 days	3,800	58	8.1×10^5	0.73	28	12	18
5 days	3,600	55	8.7×10^5	0.65	29	13	18
6 days	3,500	54	9.3×10^5	0.58	31	14	17
7 days	3,300	51	1.0×10^6	0.52	32	15	17
8 days	3,300	51	1.0×10^6	0.49	32	15	17
9 days	3,100	48	1.1×10^6	0.45	33	16	16
10 days	3,000	46	1.1×10^6	0.42	34	17	16

* Does not account for any changes to spill volume from subsurface occurring as oil rises from the ocean floor to the surface of a water body.

** A 6,500-bbl spill was modeled using winter cold front conditions.

*** % volume loss will not equal % mass evaporation plus % mass dispersion. Mass calculations are based on the weight of different oil components.

Spill Response

Offshore Response and Cleanup

This document assumes that mechanical containment and recovery will be the primary response method used offshore. Dispersant application would be approved for a large spill if it appeared sensitive shoreline resources could be at risk and it could be applied far enough offshore. Dispersant application can result in the dispersion of 30-50 percent of the oil slick. The use offshore of mechanical or chemical cleanup or other means to prevent landfall is preferable to shoreline cleanup. Bioremediation will not be used, however, as an offshore response option.

The OSRA probabilities are provided for contact within 3, 10, or 30 days. Because a spill could contact at anytime within these timeframes (e.g., a spill contact within 3 hours would be reported to contact within 3 days), MMS does not assume any loss of volume of a slick from offshore cleanup operations prior to reaching land. It is assumed that about 10 percent of spills $\geq$ 1,000 bbl will be removed from the water if the spill does not make landfall. Spills of less than 50 bbl will not likely be cleaned up because the oil will spread to a thickness not recoverable by mechanical skimming equipment and would likely dissipate prior to equipment reaching the spill site.

Onshore Response and Cleanup

The following assumptions are made regarding the cleanup of spills that contact coastal resources:

- *Employment*: Based upon recent experience involving shoreline cleanup operations of oiled coastlines, it is assumed that 100 temporary/contract personnel would be required per kilometer of shoreline for the cleanup of somewhat inaccessible beach and marsh areas that are slightly oiled with numerous scattered pockets of extensive oiling.

- *Timeframe*: A cleanup would take 4-6 weeks.

- *Perched Shell Beach Shoreline Cleanup:* Cleanup options will be limited since access and erosion problems will be encountered. After the oiling of a perched shell beach with a light oil (e.g., 34.5°API), if erosion and access problems are encountered, cleanup options would include no action and bioremediation (either nutrient enrichment or bacterial enrichment). Cleanup techniques that will be used if access and erosion is not a problem include manual debris removal, manual sediment removal, cold-water deluge flushing, and vacuum.

- *Barrier Island/Fine Sand Beaches Cleanup*: In the event of a landfall, mechanical cleanup will not be used if heavy equipment could disrupt bird habitats or sea turtle nesting. After the oiling of a barrier island/fine sand beach with a light oil (e.g., 34.5°API), if access and erosion are primary concerns, cleanup options would include (a) no action, particularly if the beach is an area used by nesting birds or sea turtles; (b) manual debris removal; (c) manual sorbent application; and (d) manual scraping. Heavy equipment (e.g., motor grader/elevating scrapper, motor grader/front end loader, backhoe, beach cleaner, dragline/clamshell, cold-water deluge flooding, or low-pressure, cold-water washing), as well as other cleanup options, will be used only if access and erosion are not considered a problem. Methods that would keep sediment loss to a minimum would be selected.

- *Salt Marsh Cleanup*: Offshore spills of less than 50 bbl that impact the edge of marsh areas would not be cleaned because of the minimal impact expected to these areas as weighed against the greater impact that manual cleanup might have on the area. In all cases, cleanup options that avoid causing additional damage to the marshes will be selected. After the oiling of a salt marsh with a light oil (34.5°API), cleanup options

include (a) no action, (b) manual debris removal, (c) manual sorbent application, (d) cold-water deluge flooding, (e) low-pressure washing, (f) nutrient enrichment, and (g) vacuum pumps from boats. In addition, the burning of small impacted marsh areas may be conducted if conditions warrant. No cutting of the marsh will occur. Natural recovery will be an option when only a small amount of marsh is affected and/or only a small amount of oil impacts the edge of the marsh.

(3) Vessel Collisions

Vessel collisions with the OCS infrastructure have been minimized through the implementation of U.S. Coast Guard regulations for marking both fixed structures and moored objects with lights, sound-producing devices, and radar reflectors, as well as the inclusion of these structures on nautical charts. Notification of the addition or removal of fixed structures is listed in the U.S. Coast Guard's Notice to Mariners. After a marked structure has been in place for a while, it often becomes a landmark and an aid to navigation for vessels (particularly fishing boats and vessels supporting offshore oil and gas operations) that operate in areas with high densities of fixed structures. Yet, the key mitigation factors for reducing vessel collisions have been the establishment of a series of safety fairways, traffic separation schemes, and anchorages to provide an unobstructed approach for vessels using U.S. ports. Fairways play an important role in the avoidance of collisions on the OCS, particularly in the case of the larger oceangoing vessels. In general, no fixed structures, such as platforms, are allowed in fairways. Temporary underwater obstacles, such as anchors and attendant cables or chains attached to floating or semisubmersible drilling rigs, may be placed in a fairway under certain conditions. Fixed structures may be placed in anchorages, but the number of structures is limited. Visual 2 maps the currently designated fairways and anchorages in the Gulf of Mexico.

From 1960 to 1986, there were at least 75 vessel mishaps involving OCS platforms that caused fatalities, injuries, pollution, and the loss of property. Most of the vessel mishaps were the result of service vessels (crewboats) colliding with the superstructure of platforms. Seventy-seven percent were OCS vessels and 23 percent were non-OCS vessels. Fatalities occurred during two of these mishaps. Twenty-nine of these mishaps (39%) resulted in major property damage, and the remainder resulted in minor property damage. Furthermore, from 1970 to 1994, there were at least 13 vessel collisions with pipeline risers (USDOI, MMS, Pipeline Damage and Repairs database).

The OCS service vessels, shuttle tankers, and barges could collide with marine mammals, turtles, and other marine animals during transit. To prevent and limit such collisions, NMFS has provided all boat operators, since 1972, with "Whalewatching Guidelines" derived from the Marine Mammal Protection Act. These guidelines suggest safe navigational practices based on speed and distance limitations when encountering marine mammals. Nonetheless, the frequency of vessel collisions with marine mammals, turtles, or other marine animals would probably vary as a function of spatial and temporal distribution patterns of the living resources and the pathways of maritime traffic (coastal traffic is more predictable--defined and more constant--as opposed to offshore traffic). Furthermore, collision frequency with living resources would vary as a function of vessel speed (supply/utility vessels--11 knots; crew vessels--20 knots), the number of vessel trips, and the navigational visibility.

i. Hydrogen Sulfide

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." 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.

The Occupational Safety and Health Administration's permissible exposure limit for H_2S is 10 ppm, 30 times lower than the "immediately dangerous to life and health" level of 300 ppm set by the National Institute for Occupational Safety and Health. Despite a low human odor threshold for the gas in air (less than 1 ppm), H_2S is considered to be an insidious poison because the sense of smell rapidly fatigues and, therefore, fails to provide a good warning of gas concentration.

The principal route of exposure to H_2S is inhalation. Like carbon monoxide and the cyanides, H_2S is classified as a chemical asphyxiant. Exposure to this gas can interfere with cellular respiration and cause death if an individual's cells are deprived of oxygen (biochemical suffocation). At low concentrations (i.e., less than 10 ppm), H_2S causes irritation of the eyes, mucous membranes, and upper respiratory system. When exposed to higher concentrations (10-50 ppm), persons tend to experience mild eye and upper respiratory irritation, headaches, and dizziness.

Concentrations of 50-200 ppm can cause severe eye and respiratory tract irritation, acute conjunctivitis, lacrimation, and difficulty breathing, as well as a sudden loss of consciousness. Prolonged exposures at these levels may lead to bronchitis, pneumonitis, and migraine headaches.

At higher levels, H_2S can cause a severe loss of motor coordination, coma, pulmonary edema, respiratory paralysis, and, ultimately, death. At about 500-700 ppm, loss of consciousness and possible death can occur in 30-50 minutes. At 700-1,000 ppm, the victim experiences rapid unconsciousness, cessation of respiration, and death. At 1,000-2,000 ppm, unconsciousness occurs at once, with cessation of respiration and death in a few minutes (USDOE, 1994; U.S. Dept. of the Army, COE, 1980 and 1982).

Fate of H_2S in the Water Column

H_2S is extremely soluble in water with 4,000 ppm dissolving in water at 20° C and one atmosphere pressure. The toxicity of H_2S is derived primarily from its nondissociative state (USEPA, 1986). Based on these characteristics, and because of the lack of modeling input, a descriptive narrative about the fate of H_2S in the water column is given. A slow-leak of H_2S that is not detected by any monitoring equipment will create a zone of anoxia and hypoxia around the site that will be determined by the solubility of H_2S and Henry's Law. The extent and characteristics of this zone will be influenced by the temperature, local mixing, and seasonality. Because of the high solubility of H_2S in water, all of the toxicant will be dissolved in the water column producing a chemical oxygen demand (COD) that will consume all the oxygen in the water column. As one moves away from the source, dilution and mixing of H_2S will form hypoxia. In the summer, with water-column stratification, any hypoxia already present below the thermocline would be intensified by a slow H_2S leak. The duration and extant of this hypoxia is not known because modeling information is not available at this time. In the winter, when the water column is well-mixed, the hypoxia may not be as severe as under summer conditions.

Toxicological Impacts of H_2S on Fish

Fish will strongly avoid any water column that is contaminated with H_2S, provided an escape route is available. In terms of acute toxicity testing, fish can survive at levels reaching 0.4 ppm (Van Horn 1958; Boon and Follis 1967; Theede et al., 1969 in USEPA, 1986). Walleye eggs (*Stizostedion vitreum*) did not hatch at levels from 0.02 to 0.1 ppm (Colby and Smith, 1976 in USEPA, 1986). The hatchability of northern pike (*Esox lucius*) was substantially reduced at 25 ppb with complete mortality at 45 ppb. Northern pike fry had 96-hour LC_{50} values that varied from 17 to 32 ppb at O_2 levels of 6 ppm. Sensitive eggs and fry of northern pike exhibited no observable effects at 14 and 4 ppb, respectively (Adelman and Smith, 1970 in USEPA, 1986). In a series of tests on the eggs, fry and juveniles of walleyes, white suckers (*Catostomus commersoni*), and fathead minnows (*Pimephales promelas*), with various levels of H_2S from 2.9 to 12 ppb, eggs were the least sensitive while juveniles were the most sensitive. In 96-hour bioassays, fathead minnows and goldfish (*Carassius auratus)* varied greatly in tolerance to H_2S with changes in temperature (Smith and Oseid 1972; Smith, 1971 in USEPA, 1986). Pacific salmon (*Oncorhynchus sp.*) experienced 100 percent mortality within 72 hours at 1 ppm.

On the basis of chronic toxicity testing, juveniles and adults of bluegill (*Lepomis macrochirus*) exposed to 2 ppb survived and grew normally. Egg deposition in bluegills was reduced after 46 days exposure to 1.4 ppb (Smith and Oseid, 1972 in USEPA, 1986). White sucker eggs were hatched at 15 ppb, but juveniles showed growth reductions at 1 ppb. Safe levels for fathead minnows were between 2 and 3 ppb. For *Gammarus pseudolimnaeus* and *Hexagenia limbata*, 2 and 15 ppb, respectively, were considered safe levels (Oseid and Smith, 1974 in USEPA, 1986).

Toxicological Impacts of H_2S on Wildlife

Wildlife may be exposed to air pollution through three possible exposure pathways: (1) inhalation of gases or small particles; (2) ingestion of particles suspended in food or water; and (3) absorption of gases through skin. The inhalation route is the most likely pathway for exposure to H_2S. An individual organism's response to a pollutant varies greatly and depends on the type of pollutant, the duration of exposure, and the amount taken up by the individual. Factors such as the individual's age, sex, health, and reproductive condition also play a role in its response (Maniero, 1996).

While impacts on humans are well-documented, the literature on the impact of H_2S on wildlife is sparse, with no information available for marine mammals and turtles. Given the toxicity of H_2S to humans, however, similar impacts on marine mammals and turtles are likely. More information is available for birds.

In general, birds seem more tolerant of H_2S than mammals, indicating that birds may have a higher blood capacity to oxidize H_2S to nontoxic forms. In tests with white leghorn chickens, all birds died when inhaling H_2S at 4,000 ppm. At 500 ppm, no impact was observed on ventilation, while between 2,000 and 3,000 ppm respiratory frequency and tidal volume become irregular and variable in these birds (Klentz and Fedde, 1978).

The Sulfur Bay Wildlife area of Lake Rotorua, New Zealand, provides an example in nature of bird species tolerating higher levels of H_2S. The red-billed gull, dabchick mallard duck, black swan, and caspian tern, among 62 native and transient bird species, lived, nested and reared their young where natural H_2S ranged from 0.125 to 3.9 ppm.

In the western United States, oil production and geothermal operations often flare or vent pipes to release the natural gases accumulated during drilling, storage, and pipeline operations, with significant impacts on wildlife (Maniero, 1996). Five great horned owls (*Bubo virginianus*) died from H_2S poisoning in a North Dakota oil field. The carcasses were collected at the base of the vents, where they serve as a vantage point for these birds (Bicknell, 1984). This H_2S-poisoning event was a significant anthropogenic impact on great horned owls (Franson and Little, 1996). In Wyoming, 237 animals including raptors, passerines, and rabbits were killed in oil fields with high H_2S (Esmoil, 1991).

H_2S Operations in the Gulf

The presence of H_2S within formation fluids occurs sporadically throughout the Gulf of Mexico OCS. 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. The occurrences of H_2S offshore Louisiana are mostly on or near piercement domes with caprock and are associated with salt and gypsum deposits. There has also been some evidence that petroleum from deepwater plays contain significant amounts of sulfur (cf. Smith, written communication, 1996; Thorpe, 1996).

Encounters with H_2S in oil and gas operations have caused injury and death throughout the United States but none, to date, in the Gulf of Mexico region. Federal regulations at 30 CFR 250.67 require all lessees, prior to beginning exploration or development operations, to request a classification of the potential for encountering H_2S. The classification is based on previous drilling and production experience in the areas surrounding the proposed operations, as well as other factors. Production of sour gas and oil may proceed in one of two ways. The product will either be "sweetened" (removal of H_2S from the hydrocarbons) offshore or it will be transported onshore to a processing facility equipped to handle H_2S hydrocarbons, where the product is sweetened. Several processes have been developed for gas sweetening based on a variety of chemical and physical principles. The processes include solid bed absorption, chemical solvents (e.g., amine units), physical solvents, direct conversion of H_2S to sulfur (e.g., Claus units), distillation, and gas permeation (Arnold and Stewart, 1988). Gas streams with H_2S or CO_2 are frequently treated by amine units offshore to reduce the corrosive properties of the product. A byproduct of this process is the acid gas stream, which is frequently treated as a waste and flared if SO_2 emissions are not of concern. In cases where SO_2 emissions must be minimized, other options for handling the acid gas must be sought. Sulfur recovery units to further process the H_2S to elemental sulfur or reduced sulfur compounds is a common method of treating the acid gas stream. Reinjection of the acid gas is another option that may be used but may cause formation of shallow hazards.

Another option would be to send the untreated gas to shore for treatment; this requires the use of "sour gas" pipelines built to handle the highly corrosive materials.

All operators on the OCS involved in production of sour gas or oil are required to file an H_2S contingency plan. This plan delimits procedures to ensure the safety of the workers on the production facility. In addition, all operators are required to adhere to National Association of Corrosion Engineers (NACE) Standard Material Requirement MRO175-90 for Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment (NACE, 1990). These engineering standards serve to enhance the integrity of the infrastructure used to produce the sour oil and gas, and further serve to ensure safe operations. The MMS has issued a final rule governing requirements for preventing hydrogen sulfide releases, detecting and monitoring hydrogen sulfide and sulphur dioxide, protecting personnel, providing warning systems, and establishing requirements for hydrogen sulfide flaring. The rule went into effect on March 28, 1997. An associated Notice to Lessees and Operators (NTL) titled "Hydrogen Sulfide (H_2S) Requirements" was issued on April 7, 1997, to provide clarification, guidance, and information on the revised requirements. The NTL provides guidance on sensor location, sensor calibration, respirator breathing time, measures for protection against sulfur dioxide, requirements for classifying an area for the presence of H_2S, requirements for flaring and venting of gas containing H_2S, and other issues pertaining to H_2S-related operations.

B. Coastal Scenario for Future OCS Operation

1. Coastal Infrastructure

a. Service Bases

Service bases are communities of businesses that load, store, and supply equipment, supplies, and personnel needed at offshore work sites. Table IV-14 lists the service bases located along the Gulf Coast that serve OCS activities. Although each service base primarily provides services, supplies, and equipment for the OCS planning area and subarea in which it is located, each may also provide significant services for other the OCS planning areas and subareas.

As OCS operations move into progressively deeper waters, larger vessels with deeper drafts will also be used in some areas. Typically, these deeper draft vessels will not need channels with depths greater than 6-7 m. Industry interest in deepwater tracts is expected to increase activity levels at service bases that can be accessed by deeper draft vessels. These bases currently include Port Isabel, Corpus Christi, Harbor Island, Freeport, Pelican Island (Galveston), Sabine Pass, and Port Arthur in Texas; Lake Charles, Berwick, Port Fourchon, and Venice in Louisiana; Pascagoula in Mississippi; and Theodore and Mobile in Alabama. The channels to Empire and Cameron, Louisiana, are considered marginally deep enough to support OCS traffic.

Some channels in and around some service bases will be deepened and expanded in support of deepwater vessels and other port activities, some of which will be OCS related. Expansions of some existing service bases, such as Port Fourchon, Louisiana, are expected to occur to capture and accommodate the business that is being and will be generated by the increased and continuing interest in oil and gas development on the OCS.

Port expansions often generate conflicts with other coastal resource users located in the port and its vicinity. Such conflicts are discussed in Section IV.D.1.a.(13). Navigation channels are discussed in Section IV.B.1.j. Waterborne traffic at service bases is discussed in Section IV.A.2.b.(3).

Proposed Action Scenario: The proposed action is assumed to be responsible for 0.3-0.7 percent of the use and expansion of service bases as a whole.

OCS Program Scenario: Deepening navigation channels leading to and within service base ports is projected. Sixty-seven percent of the collective service base capacities and expansions are assumed to support OCS operations. Up to two additional service bases may be developed in the vicinity of Alabama and the Florida Panhandle.

b. Helicopter Hubs

Heliports are facilities where helicopters can land, load, and offload passengers and supplies, and be refueled and serviced. A total of 325 heliports have been built and are used throughout the coastal area of the Gulf. There were 33 operating helicopter hubs, or major base locations, in the coastal areas of Texas, Louisiana, and Alabama in 1990. These hubs are used primarily as flight support bases to service the offshore oil and gas industry. Based on an examination of the helicopter industry's flight patterns, it is assumed that 60 percent of the offshore flights result in a helicopter crossing the coast.

Proposed Action Scenario: Approximately 0.5-1.0 percent of OCS-related usage of heliports will be to support operations resulting from a proposed action.

OCS Program Scenario: No helicopter hub construction or closures are anticipated during the next 35-40 years. Although the Gulf of Mexico helicopter fleet declined by about 25 percent in the late 1980's and early 1990's, deepwater operations may create a need to increase the fleet as each trip to a deepwater operation may require the full use of a helicopter for an entire day.

c. Construction Facilities

Construction facilities include production platform fabrication yards, pipeyards, and shipyards. Because of the nature or large size of OCS structures, access to a navigation channel is of prime importance to these facilities. The locations of these facilities are shown on Visual 1. The locations of these yards do not indicate the planning area or facilities serviced by them.

Production platforms and their structural components used to develop State and OCS offshore oil and gas fields are fabricated and partially assembled at platform fabrication yards. Louisiana has the largest number of platform yards; the majority of these are concentrated in coastal Subarea LA-2. Approximately 93 percent of activities at these facilities are OCS related.

Pipeyards are contracted to store and coat pipe that will be used for offshore and onshore OCS pipelines. Although they do not generally "supply" pipe, pipeyards do coat surfaces of pipes with metallic, inorganic, and organic materials to protect the pipe from corrosion and abrasion, which also adds weight to counteract buoyancy. Eighteen of the 25 pipeyards that serve Gulf OCS activities are divided equally between coastal Subareas TX-2 and LA-2. The OCS Program is estimated to account for 49 percent of activities at pipeyards. Many pipeyards also handle pipe for non-OCS- and nonpetroleum-related industries. Approximately 10 percent of their activities are assumed to be nonpetroleum related.

Shipyards build OCS support vessels for both inshore and offshore petroleum industry as well as for a variety of unrelated industries. Ten shipyards supporting the petroleum industry were identified. Approximately 30 percent of their activities are assumed to be nonpetroleum related; the remainder are petroleum related. The OCS Program is estimated to account for 65 percent of activities at shipyards.

Over the past 10 years, many platform yards and pipeyards in coastal regions have closed or have gone idle. With the resurgence of OCS activities in the Gulf, reactivation and construction of some of these types of facilities are anticipated.

d. Processing Facilities

(1) Refineries

A refinery separates the naturally occurring components of crude oil into marketable products. In the Gulf of Mexico, oil is either delivered directly to a refinery from the OCS via pipeline or barge, or it is first delivered to an oil terminal via pipeline or barge and then piped, barged, or trucked to a refinery. Table IV-12 shows the number of existing refineries that process at least some OCS crude. Visual 1 shows the locations of OCS-related refineries. The current capacity of these refineries is approximately 5 million bbls per day (Oil and Gas Journal, 1996); OCS crude accounts for about 20 percent of the operating capacity of these facilities (Rainey, 1992). Due largely to a combination of favorable economics, recent discoveries in the deepwater shelf and slope regions of the Gulf, availability of infrastructure, deepwater royalty relief, the opportunity to lease new prospects, and the use of new technology to extend the life of current fields and accurately find new

Table IV-12

Coastal Infrastructure Related to OCS Program Activities in the Gulf of Mexico for the Years 1998-2036

	Coastal Subareas*														Total OCS Program	
	LA-1		LA-2		LA-3		MA-1		TX-1		TX-2		FL-1			
	Existing / New**															
Refineries	4 /	0	4 /	0	3 /	0	1 /	0	3 /	0	13 /	0	0 /	0	28 /	0
Gas Processing Plants	12 /	1 - 2	13 /	1 - 2	5 /	1	5 /	1	12 /	1 - 2	14 /	0 - 1	1 /	0	62 /	5 - 9
Oil Pipeline Shore Facilities	24 /	4 - 30	14 /	2 - 20	20 /	3 - 23	1 /	0 - 3	5 /	0 - 6	10 /	1 - 13	0 /	0	74 /	10 - 95
Pipeyards	3 /	0 - 1	9 /	0 - 3	2 /	0 - 1	1 /	0 - 2	1 /	0 - 1	9 /	0 - 3	1 /	0	26 /	0 - 11
Platform Yards	7 /	0 - 1	18 /	0 - 3	8 /	0 - 1	6 /	0 - 2	5 /	0 - 1	1 /	0 - 1	0 /	0	45 /	0 - 9
Ship Yards	0 /	0 - 1	2 /	0 - 1	3 /	0 - 1	4 /	0 - 2	0 /	0 - 1	1 /	0 - 1	0 /	0	10 /	0 - 7
Helicopter Hubs	8 /	0	8 /	0	4 /	0	1 /	0	6 /	0	6 /	0	0 /	0	33 /	0
Service Bases	8 /	0	12 /	0	6 /	0	4 /	0	8 /	0	6 /	0	0 /	0 - 3	44 /	0 - 3
Barge Terminals	1 /	0	3 /	0	1 /	0	0 /	0	2 /	0	4 /	0	0 /	0	11 /	0
Waste Disposal Facilities	3 /	1	4 /	1	0 /	1	2 /	1	8 /	1	2 /	1	0 /	0	19 /	6
Navigation Channels***	7 /	0	8 /	0	12 /	0	5 /	0	6 /	0	7 /	0	0 /	0	39 /	0
Pipeline Landfalls	64 /	39 - 77	50 /	30 - 60	60 /	36 - 72	11 /	6 - 17	3 /	1 - 4	26 /	16 - 31	0 /	0	214 /	128 - 261
Onshore Pipelines (km)	2,560 /	1,570 - 3,060	800 /	490 - 960	960 /	590 - 1,150	176 /	108 - 330	120 /	73 - 144	1,040 /	640 - 1,240	0 /	0	5,656 /	3,471 - 6,884

* See Figure IV-1.

** Existing infrastructure refers to the maximum number of existing facilities that will be used to support future operations. New infrastructure refers to new facilities projected to be built to support future operations. Expansion of existing facilities is not included as new infrastructure.

*** Individual coastal subarea totals do not add up to the OCS Program total because some navigation channels span more than one subarea (Section IV.B.1.j.).

ones, production from the Gulf of Mexico OCS is expected to increase dramatically over the next four years. The MMS's Gulf of Mexico Region projects an increase in oil production from 0.9 million barrels per day to as much as 1.7-1.9 million bbls per day.

No new refineries are expected to be built to support OCS production. Financial and legal considerations make it unlikely that any new refineries will be built in the U.S. (USDOE, EIA, 1997). Refineries are operating at near capacity; however, some minimal increase in capacity is expected as a result of technological improvements in the existing refineries. It is assumed that OCS oil will become a larger percentage of the throughput of existing refineries, some existing refineries will increase their capacities, and some refineries that currently process only imported oil will begin handling OCS oil.

(2) Gas Processing Plants

Natural gas produced on the OCS is piped to a processing facility for processing if necessary; otherwise, the gas is transported via transmission lines for distribution to consumers. Gas processing plants remove impurities from raw gas to meet preset standards of the purchasing agent before the gas is commercially distributed. Some gas processing facilities simply remove any liquids (water and condensate) from the gas; others may "sweeten" the gas by removing hydrogen sulfide. Some processing plants also recover saleable natural gas liquids, such as butane, propane, and ethane from condensate, if these components are present in quantities that make extraction economically feasible. An average gas processing plant occupies between 20 and 30 ha.

The number of existing gas processing plants that are assumed to process OCS gas is shown in Table IV-12. Visual 1 shows the locations of most of the larger Gulf coast gas processing plants. It is assumed that OCS gas will account for 50-65 percent of the utilized capacity of the coastal gas processing plants.

The MMS projects that gas production from the Gulf OCS will remain fairly steady or increase from 13.9 billion cubic feet per day in 1995 to as much as 17.2 billion cubic feet per day in 2000. Gas plants in the coastal zone that are assumed to process OCS gas are running at 60-90 percent capacity (overall average as of July 1996 is about 73%) (Oil and Gas Journal, 1996). Because of the unused capacity of existing processing plants, a new plant is assumed to be constructed in association with a new gas pipeline landfall only under certain circumstances. A new gas processing plant might be built if a new landfall occurs in a coastal area where existing gas infrastructure is sparse. A new processing plant might also be constructed to handle gas production with a specific chemical composition or that contains impurities such as hydrogen sulfide.

Additional new construction of gas processing plants is projected as a result of the increase in deepwater development. It is assumed that all deepwater gas production will be piped to shore. It is further assumed that, because of the configuration of the OCS planning areas, some of the deepwater gas pipelines from the WPA will go into Louisiana. Gas processing plants are expected to close if utilization falls to less than 25 percent of capacity.

e. Terminals

(1) Oil Pipeline Shore Facilities

Pipeline shore facilities are an operational portion of most pipeline systems and are located inland of a pipeline's landfall. Such facilities usually separate, process, pump, meter, and store oil, water, or gas to some degree. Metering is often for royalty purposes. Most liquid royalty metering occurs onshore; royalty metering of gas is conducted offshore.

The OCS pipelines carry mixtures of oil, condensate, gas, and produced water in various proportions. Many "gas" pipelines carry some amount of liquids. Pipelines carrying any amount of liquid petroleum are serviced by the shore facilities discussed here. Pipeline facilities that handle only gas are considered part of a gas processing complex (Section IV.B.1.d.).

After metering, liquids are either piped or barged to refineries for processing or to other sites for further storage prior to going to refineries. Water is usually disposed into on-site injection wells. Gas is piped to a processing facility for further refinement if necessary; otherwise, it is transported via transmission lines for distribution to consumers.

The following table provides the number of pipeline shore facilities by subarea that currently support OCS pipeline systems coming ashore. Visual 1 (1997) provides locations of pipeline shore facilities as of 1996. A typical facility occupies 2-25 ha and may be located near the beach or farther inland. Although older facilities may have been located in wetlands, present permitting programs discourage companies from constructing new facilities in wetlands. During 1951 through 1974, shore facilities supporting liquid-carrying pipelines were installed at an average rate of 2.33 facilities per year. Since 1974, the average installation rate declined to 1.71 pipelines per year, with a minimum of zero and a maximum of 5 installed per year. The yearly rate for installations is directly related to the rate of new pipeline land falls, which is projected to increase over the near future. Available data on the abandonment of these facilities begins in 1985 and indicates an average abandonment rate of two facilities per year, with a minimum of one and a maximum of four abandoned per year. The yearly rate for abandonments is projected to increase. To project future OCS-related installations and abandonments, logarithmic curves were applied to the installation period of 1965 through 1996 and the abandonment period of 1985 through 1996. The resulting projected installations and abandonments and their distributions are found in Table IV-13.

Table IV-13

Historical and Projected Installation and Abandonment of Shore Facilities for Liquid-Carrying Pipelines Supporting the OCS Program

Coastal Subarea	Active on 1/1/97	Installed 1951-1996	Projected Installation 1998-2036	Abandoned 1985-1996	Projected Abandonment 1998-2036
Texas	15	19	9	4	13
TX-1	5	6	3	1	3
TX-2	10	13	6	3	10
Louisiana	58	77	38	20	65
LA-1	24	32	16	8	26
LA-2	14	21	10	7	23
LA-3	20	24	12	5	16
Mississippi	0	0	0	0	0
Alabama	1	1	1	0	0
Total OCS Program	74	97	48	24	78

(2) Barge Terminals

Barge terminals are the receiving stations where oil is first offloaded from barges transporting oil from OCS platforms. These facilities usually have some storage capabilities and processing facilities, and the oil may be metered for royalty purposes. Some barge terminals may also serve as pipeline shorebases. Most of the land required for a terminal is for storage tanks. Space requirements are expected to range from 6 to 25 ha (NERBC, 1976).

There are 11 barge terminals currently being used by the OCS oil industry (Tables IV-12 and IV-14). Six Texas terminals receive oil barged from both WPA and CPA leases; five terminals located in Louisiana are presently receiving and are expected to continue receiving barged oil from platforms located in the CPA. Of these terminals, three receive only barged oil. These barge terminals may also receive oil from State production or imports.

Table IV-14

Waterway Usage by OCS-Related Navigation for the Years 1998-2036

Coastal Subarea	Waterway	Approximate Proposed Action Usage *	Approximate OCS Program Usage	Service Base	Barge Terminal	Tankering Port Area**
TX-1	Channel to Aransas Pass	< 1%	< 10%	Port Aransas		
	Brazos Santiago Pass	< 1%	< 10%	Port Isabel		
	Corpus Christi Ship Channel	< 1%	< 10%	Corpus Christi Ingleside	Corpus Christi	Corpus Christi
	Matagorda Ship Channel	< 1%	< 10%	Harbor Island	Matagorda Island	
	Port Mansfield Cut	< 1%	< 10%	Port Mansfield		
	Gulf Intracoastal Waterway	< 1%	< 10%	Rockport Port O'Connor		
TX-2	Freeport Harbor Channel	< 1%	< 10%	Freeport		Freeport
	Houston Ship Channel	< 1%	< 10%			Houston
	Texas City Channel	< 1%	< 10%		Texas City	
	Galveston Channel	< 1%	< 10%	Galveston Pelican Island		
	Matagorda Ship Channel	< 1%	< 10%			
	Gulf Intracoastal Waterway	< 1%	< 10%	Surfside		
	Sabine Pass Ship Channel	< 1%	< 10%	Sabine Pass Port Arthur	Beaumont Nederland Port Arthur	
LA-1	Calcasieu Ship Channel	< 1%	< 10%	Cameron Lake Charles Gibbstown	Lake Charles	Lake Charles
	Freshwater Bayou	< 1%	< 10%	Intracoastal City Kaplan		
	Gulf Intracoastal Waterway	< 1%	< 10%	Weeks Island		
	Mermentau Navigation Channel	< 1%	< 10%	Grand Chenier		
	New Iberia Canal	< 1%	< 10%			
	Vermilion River	< 1%	70%	Louisa		
	Bayou Teche	< 1%	70%			

* Approximately 0.5-1.0% of OCS-related usage is attributed to a proposed action (based on BOE resource estimates).
** Possible major entranceways for future OCS tankering that are likely to be traversed by a shuttle tanker coming from offshore waters to inland terminals within each port area (Section IV.B.1.e.(3)).

Table IV-14. Waterway Usage by OCS-Related Navigation for the Years 1998-2036 (continued)

Coastal Subarea	Waterway	Approximate Proposed Action Usage *	Approximate OCS Program Usage	Service Base	Barge Terminal	Tankering Port Area**
LA-2	Atchafalaya R./B. Chene	< 1%	30%	Amelia Bayou Boeuf Berwick Freshwater City Morgan City Gibson	Gibson	
	Bayou Black	< 1%	50%			
	Bayou Boeuf (not GIWW)	< 1%	75%			
	Bayou Lafourche/Belle Pass	< 1%	40%	Fourchon Leeville		
	Gulf Intracoastal Waterway	< 1%	40%			
	Houma/Caillou/Terrebonne	< 1%	30%	Dulac Houma Theriot Gibson Cocodrie	Gibson	
	Wax Lake Outlet	< 1%	< 10%		Columet	
	Mississippi River	< 1%	< 10%		Norco	Mississippi River
LA-3	Barataria Waterway	< 1%	< 10%	Grand Isle		
	Mississippi River Southwest Pass South Pass Tiger Pass Red Pass Baptiste Collette Main Pass Pass a Loutre	< 1%	< 10%	Venice		
	Empire Waterway	< 1%	20%	Empire	Empire	
	Miss. River Gulf Outlet	< 1%	< 10%			
	Bayou La Loutre	< 1%	20%	Hopedale Yscloskey		
	Gulf Intracoastal Waterway	< 1%	< 10%	Harvey		
MA-1	Bayou LaBatre	< 1%	< 10%	Bayou LaBatre		
	Mobile Bay	< 1%	< 10%	Mobile Theodore		Mobile
	Pascagoula/Bayou Casotte	< 1%	< 10%	Pascagoula		Pascagoula
	Gulf Intracoastal Waterway	< 1%	< 10%			
	Theodore Channel	< 1%	< 10%			

* Approximately 0.5-1.0% of OCS-related usage is attributed to a proposed action (based on BOE resource estimates).

** Possible major entranceways for future OCS tankering that are likely to be traversed by a shuttle tanker coming from offshore waters to inland terminals within each port area (Section IV.B.1.e.(3)).

No major modifications or new barge terminals are expected to be constructed in the foreseeable future to support OCS operations because barging is expected to remain stable. Section IV.A.2.b.(2) discusses OCS barging operations in general.

(3) Tanker Port Areas

No tankering of OCS oil is presently occurring. It is likely that tankered oil will be moved similar to the lightered oil currently being shuttle tankered in association with import operations. The port areas where this tanker terminal activity now occurs can be identified and are listed below. These port areas are listed under import oil landings information maintained by the U.S. Department of Energy (USDOE, EIA, 1997). The port areas identified by the USDOE include a number of terminals that are linked to refinery complexes in the general area. Because no new refinery complexes are projected to be constructed in the future (Section IV.B.1.d.(1)), no additional tanker terminals are expected to be constructed for possible future OCS tankering. Table IV-15 provides the major port areas that are likely to be traversed by a shuttle tanker coming from offshore waters to inland terminals within each port area. A general discussion of potential tanker transport of oil produced at OCS offshore platforms is provided in Section IV.A.2.b.(3).

Table IV-15

Hypothetical Tanker Port Areas for Receipt of Gulf of Mexico OCS Crude Oil

Subarea	Port Area	Percentage of Tankered Oil*
TX-1	Corpus Christi	6.7%
TX-2	Freeport	4.0%
TX-2	Houston/Galveston/Texas City	33.8%
TX-2	Port Arthur/Beaumont	19.9%
LA-1	Lake Charles	5.7%
LA-3	Mississippi River Ports (includes New Orleans, Baton Rouge, Gramercy, and St. Rose)	27.3%
MA-1	Pascagoula	1.0%
MA-1	Mobile	1.6%

*The percentage of oil projected to be shuttled into each port area is based on the percentage of the Gulf's total refinery capacity that the refineries associated with each port area.

f. Disposal and Storage Facilities for Offshore Operational Wastes

Storage and Disposal Sites for Nonhazardous Oil-field Waste (NOW)

In the Gulf area, offshore oil-field wastes that are not discharged or disposed of onsite are brought onshore for disposal and taken to specially designated commercial oil-field waste disposal facilities. In Louisiana, these sites are referred to as NOW sites or "nonhazardous oil-field waste" disposal sites. Section IV.B.2.c.(3)

provides further information regarding the types of offshore OCS-generated, oil-field wastes that are brought onshore for disposal.

In Texas, there are 10 existing commercial oil-field waste disposal facilities that receive all of the types of wastes that would come from OCS operations (4 stationary treatment, 5 landfarms, and 1 commercial pit); in Louisiana, there are 7 facilities (5 land treatment, 1 incinerator, and 1 chemical stabilization facility); and in Alabama, there are 2 landfarm/landtreatment facilities that are expected to continue servicing the OCS industry (Table IV-12). Included in these numbers are one site in Texas and two sites in Louisiana that process naturally occurring radioactive material (NORM)-contaminated, oil-field wastes. Disposal and storage of this waste were significant problems in the 1980's and early 1990's; however, these facilities have successfully solved these problems.

Liquid wastes brought onshore may include produced water that fails toxicity requirements; water extracted from sludge; or treatment, workover, and completion fluids. At commercial waste treatment facilities, liquid wastes are usually injected into disposal wells. As of February 1997, there are 94 disposal wells located in the Texas coastal zone and 17 in the Louisiana coastal zone. These wells could be used for disposal of OCS-generated liquid wastes.

Solid wastes may include oil-based drilling muds and cuttings, production storage tank sludges, or produced oily sands and solids. At commercial waste disposal facilities, solid wastes are usually put into pits, land treated, land farmed, or undergo a stationary treatment process to remove contaminants. The solid material generated after processing can be used on roads or as landfill cover. Very often, however, the solid material is being stored indefinitely on site.

Liquid wastes are usually transported to shore by barge or on tanks located on supply boats. Once onshore, the wastes are generally transported to commercial oil-field waste disposal facilities by vacuum truck or barge. In Texas, the waste haulers are permitted and responsible for tracking the wastes. There are more than 700 approved companies; the number of these hauling OCS wastes is unknown. There are 12 approved transfer stations that receive OCS-generated wastes in the Louisiana coastal zone.

It is expected that all of the present commercial waste disposal sites will continue to operate indefinitely into the future, using all currently permitted acreage. The need for new facilities will be dependent on the capacity of the existing facilities to handle future wastes. In 1993, as input into the USEPA effluent limitation guideline regulations, the MMS completed an analysis of the total capacity of the Gulf's commercial waste disposal industry (USDOI, MMS, 1993; USEPA, 1993). The analysis indicated that there would be sufficient capacity at commercial waste disposal sites for receipt of all future OCS-generated wastes expected as a result of the new regulations. Since that time, however, estimates of offshore production and associated wastes have increased, with oil production expected to almost double by the year 2000. The ability to determine future capacity is complicated by the fact that these facilities do not just receive OCS-generated wastes but service other domestic oil and gas operations, some as far away as California, as well as some foreign operators. Furthermore, in the last five years or so, there has been a tremendous amount of competition among operators of commercial waste disposal facilities with facility ownership changing hands and new facilities opening. Given this, there does not appear to be any reasonable indicator that can be used to project new facilities. Given that waste disposal is likely to continue to be very competitive and the OCS industry will continue to grow, this EIS assumes that every subarea will have a new waste disposal facility open sometime in the next 35 years, with subareas TX-1 and LA-1 having openings in the next 10 years.

g. Landfills

In addition to drilling and production wastes, trash and debris from the offshore oil industry are shipped onshore for disposal. These wastes include mud bags, drums, crates, and a variety of domestic wastes. There are no estimates of the total volumes of trash and debris generated offshore and brought onshore for disposal. Section IV.A.3.e. provides some estimates of trash and debris wastes generated during the drilling of a typical well. Based on these quantities alone, it appears that the levels of trash and debris generated by the offshore industry can be very high.

The OCS-generated trash and debris are not allowed to be disposed of at the commercial oil-field waste disposal sites discussed in the previous section. Instead, the trash and debris are disposed of at either municipal or industrial landfills, depending on the method or company an operator hires to haul the trash from

their service base or directly from the offshore facility. Not only does MMS not have any estimates of future or current trash and debris and debris being generated by the OCS industry, MMS does not have a listing of the existing landfills currently receiving OCS-generated trash (Table IV-12). The MMS cannot, therefore, analyze landfill capacity to receive future OCS trash and debris. The MMS believes that the OCS industry will continue initiating better trash and debris recycling and disposal methods to reduce the volumes that must be sent to landfills. However, considering that there is a growing problem with inadequate landfill capacities and that OCS operations such as well drilling will increase in the next few years, it is assumed that the expected levels of trash and debris transported from future OCS operations will result in the need for one additional landfill. No new municipal landfills to receive OCS-generated trash and debris are projected to be established in Texas. One new municipal landfill is projected to be established in Louisiana (Subarea LA-3); this landfill will not be located in wetlands.

h. Coastal Pipelines

Data concerning existing and projected future pipelines are provided in Tables IV-12, IV-13, and IV-16. A historical survey of pipeline installation rates into State waters and onto shore was performed for the period of 1950-1996. During the period 1963-1996, an average of eight OCS-related pipelines per year were installed into State offshore waters of the Gulf. The average was one and seven installations into State waters per year in the WPA and CPA, respectively, with 9.6 and 5.1 km, respectively, being the average lengths through state offshore waters. The number and status of existing pipelines passing from OCS waters into State waters, as of February 1996, are found in Table IV-16.

Table IV-16

Numbers and Status of Existing OCS-Related Pipelines that Cross Between Federal and State Territorial Waters, and Pipeline Lengths in State Offshore Waters

Status	WPA	CPA	EPA	Total
Active Number of Pipelines	35	233	0	268
Inactive Number of Pipelines	6	37	0	43
Abandoned Number of Pipelines	3	42	0	45
Total Number of Pipelines	44	312	0	356
Average Number of Pipelines Installed per Year	1	7	0	8
Average Pipeline Length through State Waters (km)	9.6	5.1	0	-
Estimated Total Pipeline Length through State Waters (km)	422	1,591	0	2,013

From the historical analysis, 315 OCS pipelines with a cumulative length of about 1,778 km are projected to be installed into State offshore waters, Gulfwide, during the period of 1998-2036. Of these, 41 OCS pipelines with a cumulative length of 394 km are estimated for the WPA.

A pipeline landfall is the site where a pipeline first crosses a shoreline from the Gulf of Mexico. A total of 214 OCS-related pipeline landfalls have been identified around the Gulf, 29 are located in the WPA. Of the 214 landfalls, 186 transport produced oil, gas, and water ashore from the OCS; 9 transport fuel, propane, or produced water offshore; and 19 are inactive. Many inactive and abandoned pipelines can be, and have been, reactivated. They stand in reserved support of the OCS Program, according to their owners (Visual 1 and Tables IV-12, IV-13, and IV-16)

Historically, approximately 69 percent of pipelines crossing from Federal to State territorial waters make landfall. Using this percentage, 34 pipeline landfalls are projected for the WPA and 255 landfalls are projected Gulfwide, in support of the OCS Program.

Typically, a proposed action is projected to represent 0.5-1.0 percent of the total projected OCS pipelines and landfalls. But, because the trend towards deepwater exploration and development involves much greater costs per production effort, the rate of production per lease to justify that greater cost is assumed to be greater than that of wells in much shallower water. Hence, some of these leases may cause a landfall to satisfy its own needs, or in association with other leases.

Each landfall in Texas and western coastal Louisiana (coastal Subarea LA-1) is estimated to result in 40 km of inland pipelines. Each landfall in central and eastern coastal Louisiana (LA-2 and LA-3), Mississippi, and Alabama is estimated to include construction of 16 km of inland pipeline. Table IV-12 describes the estimated distribution of existing landfalls and inland, coastal pipelines.

The length of OCS-related pipelines in Texas is unknown. In 1989, approximately 4,450 km of OCS-related, coastal pipelines were operating in Louisiana and Mississippi in support of OCS operations in the CPA (Wicker et al., 1989). In 1996, approximately 170 km were known to be operating in Alabama. The MMS has initiated a study to be completed during 2001 that will provide a greater understanding of pipelines passing through coastal areas and of the pipelines' impacts.

Some WPA production is presently transported to shore in LA-1 through six CPA pipelines that originally transported CPA production. In the future, limited additional WPA production may also be transported ashore via existing CPA pipelines, without causing additional landfalls.

Proposed Action Scenario: The proposed action will contribute 0.5-1.0 percent to the need for construction of OCS-related pipeline segments in State waters and onto State lands. Large discoveries in deepwater areas may need sole-support pipelines and so may cause the installation of 0-2 pipelines and associated landfalls to support their needs.

OCS Program Scenario: The OCS Program is projected to cause construction of 277-537 pipeline segments into State waters Gulfwide, generating 1,560-3,040 km of offshore coastal pipelines during 1998-2036. For the same period, the above described landfalls are projected to generate 2,770-6,790 km of onshore OCS-related pipelines Gulfwide. Table IV-12 shows the projected distribution of new pipeline landfalls and onshore lengths.

i. Coastal Barging

A general discussion of barging operations from offshore platforms to onshore terminals is found in Section IV.A.2.b.(2). A discussion of the onshore barge terminals is found in Section IV.B.1.e.(2).

The percentage of OCS oil estimated to be barged from offshore platforms to shorebases (percentage listed in Tables IV-2 through IV-5) is only a portion of the total amount of OCS oil barged in coastal waters. There is a tremendous amount of barging that occurs in the coastal waters of the Gulf of Mexico, and no estimates exist of the volume of this barging that is attributable to the OCS industry. Secondary barging of OCS oil often occurs between terminals or from terminals to refineries. Oil that is piped to shore facilities and terminals is often subsequently transported by barge up rivers, through the Gulf Intracoastal Waterway, or along the coast. An analysis of oil that is either piped, barged, or tankered at some point within the coastal waters of the Gulf of Mexico in 1995 (statistics taken from USDOE, 1997) shows that about 6 percent of all oil transported through coastal waters originated from OCS production. Some portion of this 6 percent was barged; the remaining amount was piped prior to reaching refineries. In the future, barged OCS-generated oil is not likely to make up a significantly larger percentage of the total oil transported than what is currently occurring.

j. Navigation Channels

Thirty-nine channels, with a cumulative length of approximately 3,650 km, are used in support of OCS Program activities in the WPA and CPA. Approximately 440 km and 1,580 km of canals, rivers, and bayous help make up the WPA and CPA channels, respectively (derived from Turner and Cahoon, 1988; Wicker et al., 1989). Table IV-14 lists the channels and Visual 1 shows their locations.

The OCS Program accounts for approximately 12 percent of traffic on these navigation channels (Turner and Cahoon, 1988) and for as much as 69 percent of channel traffic on some channels, such as the Vermilion Bay/Bayou Teche system. Future OCS and other traffic use of navigation channels is expected to continue

unchanged. The current system of channels is believed to be generally adequate to accommodate traffic generated by the future OCS Program.

As exploration and development activities increase on deepwater leases in the Gulf, vessels with generally deeper drafts and longer ranges will be used. Typically, however, no channel deeper than 6 m will be needed to accommodate these deeper draft vessels. The navigation channel to Pass Fourchon, Louisiana, is anticipated to be deepened as a result of the OCS Program.

2. Coastal Disturbances

a. Navigation Channels

The types of disturbances generated by use and maintenance of navigation channels include vessel wakes; dredging for installation, widening, deepening, and maintenance; disposal of dredged materials; and hydrodynamic modifications. In addition, OCS-related uses may create multiple-use conflicts.

Vessel wakes cause navigation canals to widen at rates of 0.95-2.54 m/yr (Johnson and Gosselink, 1982). Based on this information, it is assumed that each OCS-related navigation channel will widen at a rate of 1.5 m/yr. Widening of waterways is often at the expense of developments located along their banks. Approximately 440 km and 1,580 km of OCS-related canals, rivers, and bayous are found inshore in the WPA and CPA, respectively.

Surveys to determine the need for maintenance dredging of each navigation channel are typically scheduled every two years. Maintenance dredging is then performed on an as needed basis. Consequently, dredging cycles vary broadly from channel to channel and from channel segment to channel segment.

In 1993, the U.S. Army Corps of Engineers (COE) provided information on dredging cycles and estimated volumes of dredged materials displaced per cycle. Based on this information, annual Federal maintenance of OCS-related channels over the 35-year life of a proposed action is likely to displace approximately 1.3 billion m^3 and 2.8 billion m^3 of materials in the WPA and CPA, respectively.

Materials from maintenance dredging are primarily disposed of on existing spoilbanks and in spoil disposal areas. Additional spoil disposal areas are developed as needed and must be evaluated and permitted by the COE and relevant State agencies prior to construction. When placing the material on typical spoilbanks, the usual fluid nature of the mud and subsequent erosion causes spoilbank widening, which may bury adjacent wetlands, submerged vegetation, or nonvegetated water bottoms. Consequently, adjacent soil surfaces may be elevated, converting wetlands to uplands, fringes of shallow waterbodies to wetlands, and some nonvegetated water bottoms to shallower water bottoms that may become vegetated due to increased light at the new soil surface. Twelve percent of impacts associated with erosion, maintenance, deepening, and poorly maintained mitigation structures of navigation canals is attributed to OCS Program activities.

Installation and maintenance of any navigation channel connecting two or more waterbodies immediately changes hydrodynamics in its vicinity. For the Gulf, these changes are typically associated with saltwater intrusion, reduced freshwater retention, changed circulation patterns, changed flow velocities, and erosion. When navigation channels are permitted for construction through sensitive wetland habitats or when sites are permitted for dredged material disposal, measures are required to mitigate unavoidable adverse environmental impacts. Structures constructed to mitigate adverse hydrodynamic impacts and accelerated erosion include dams, weirs, bulkheads, rip-rap, shell/gravel mats, and gobi mats. Typically, little or no maintenance is performed on these structures. Many mitigation facilities, particularly in regions where the soil is poorly consolidated and has a high organic content, are known to become ineffective within a few years of construction due to the lack of maintenance. The number of mitigation structures associated with OCS-related navigation and pipeline channels is unknown.

A few port channels may be deepened to as much as 6 m in the next 10 years to accommodate deeper draft vessels, many of which will be OCS related. The Fourchon Channel in Louisiana is the only one proposed for deepening at present. Resulting dredged material will be placed in designated spoil disposal areas. Preliminary COE documents state that dredged material from the Fourchon project are anticipated to be used to produce approximately 182 ha of wetlands.

The OCS-related use of navigation channels may pose potential multi-use conflicts. Construction of larger platforms, such as tension-leg platforms, may require suspension of low elevation cables across adjoining

navigation canals in order to gain the greater leverage needed to pull structures up-right. Such conflict has occurred near Ingleside, Texas, during periods when construction of tension leg platforms required stretching cables across the Gulf Intracoastal Waterway, which stopped navigational traffic for several hours. This scenario may occur as many as 20 times during construction of a TLP, and a typical event may last 8-12 hours.

Several actions can be taken to mitigate this potential conflict. These activities can be scheduled when canal use is at a minimum. The local port authority, Coast Guard, neighboring businesses using the canal, and other major users of the canal should be notified of upcoming activities. Also, notice of any unusual use of navigation canals should be provided to the construction company for the purposes of minimizing impacts through cooperative scheduling.

b. Pipelines

The term "landfall" refers to the site where a pipeline leaving the Gulf of Mexico crosses a shoreline. New landfalls are anticipated to be allowed on beaches with a good sand supply in their longshore currents, which will reestablish the beach if dredged. If under permitting processes the sediment supply to a beach to be crossed is shown to be inadequate to repair a dredged landfall beach, the pipeline landfall may be accomplished by directionally boring deep under the shoreline. Directionally boring a pipeline under a barrier beach and associated dunes will not disturb the beach or dunes and has become a preferred method of installing pipelines at barrier beach landfalls.

Inland, OCS-related pipelines cross open water, wetlands, leveed land, uplands, and developed and undeveloped lands. The length of existing pipelines crossing wetlands is unknown at this time. The data are being collected to derive these numbers in the WPA and CPA; no onshore OCS-related pipelines are found in the EPA. For OCS-related pipelines that make landfall in Texas, 25 percent of their onshore lengths is assumed to cross wetlands. For coastal Subareas LA-1, LA-2, LA-3, or MA-1, 50,75, 75, and 30 percent of the length of pipeline routes passing through these areas, respectively, are assumed to be through wetlands.

New pipeline canals through wetlands are typically 3 wide, which is necessary for the push-ditch method of pipeline construction (Turner and Cahoon, 1988). Since 1970, backfilling newly dredged pipeline canals has been required by permitting agencies. Typically, installation of a new pipeline through wetlands disturbs a 30.5-m-wide path. After backfilling, the right-of-way may revegetate or remain shallow open water, a result of ditching and use of marsh buggies (Wicker et al., 1989). This remaining impact is estimated to be a water channel 1.5 m wide in wetland areas. Backfilling newly dredged pipeline canals is typically more successful in freshwater wetlands with higher inorganic content in the soils and a no tidal influence.

Pipeline maintenance activities that disturb onshore habitats are very infrequent, and for analyzing the OCS Program and proposed action, these activities will be considered insignificant. When pipelines are permitted for construction through sensitive wetland habitats, measures are required to mitigate unavoidable adverse environmental impacts. Structures constructed to mitigate adverse hydrodynamic impacts and accelerated erosion include dams, weirs, bulkheads, rip-rap, shell/gravel mats, vegetative plantings, and gobi mats. Typically, little or no maintenance is performed on these structures. Many mitigation facilities, particularly in coastal regions with unstable sediments, are known to become ineffective within eight years of construction due to the lack of maintenance. The number of related mitigation structures constructed on OCS-related pipeline channels is unknown.

Existing canals with little to no transient boat traffic were studied in the deltaic region of Louisiana (Craig et al., 1980). These canals typically widened at rates of 2-14 percent per year, causing wetland loss and habitat transition. Canal widening is typically due to subsidence, flow through the canal, and waves generated by wind or boats. Widening rates are determined by the natures of the soil, binding vegetation, and erosional forces at each site. The Louisiana deltaic regions (coastal Subareas LA-2 and LA-3) have the highest canal widening rates, followed by the Cheniere Plain (coastal Subarea LA-1) (Tabberer et al., 1985). Texas, Mississippi, Alabama, and Florida have still lower canal widening rates, largely due to the higher inorganic content of their soils.

Based on this information, pipeline canals in coastal Texas are assumed to widen at a rate of 1 percent per year. Canals in coastal Subareas LA-2 and LA-3 are assumed to widen at a rate of 5 percent, and in coastal Subarea LA-1 at 3 percent per year. For computations, typical pipeline canals are assumed to be 4 m wide.

c. Discharges and Wastes

(1) Onshore Facility Discharges

Facilities in the coastal zone that provide services to the OCS oil and gas industry generate a variety of wastes that may be discharged to associated waterbodies. Such wastes may be the result of processing operations conducted by the facility or may simply be the result of man's presence, such as effluents from toilets and kitchens and vessels docked at the facility. Besides such point-source discharges, the facility also results in nonpoint-source discharges, such as runoff, to nearby waterbodies.

Depending on the proximity of the support facility to a municipality, sanitary and domestic wastewater from support facilities is collected and delivered to a municipal treatment plant or receives secondary treatment in an on-site treatment plant. Secondary treatment includes chlorination prior to discharge to the receiving waters.

Pipeyards, platform-construction facilities, and pipeline shore facilities may contaminate surrounding waters by releasing thermal effluents and a variety of process waters, as well as solid waste such as metal scraps, and other debris. Gas processing plants and refineries discharge a number of types of wastewaters, including cooling and boiler waters, and process waters. These waters may be contaminated with dissolved hydrocarbons, sulfuric acid, chromium, zinc, phosphates, alkaline substances, and suspended solids. Cooling water represents a significant portion (70-100%) of the wastewater effluent from an oil refinery or gas processing plant. Chemicals added to the cooling water stream to reduce corrosion and fouling within the tower and the condenser system (including chromium and chlorine) may be extremely toxic to aquatic organisms. Although it does not constitute the greatest volume of water used in refining operations, process water may be the most contaminated. The processing chemicals are added during crude-oil desalting, steam distillation, steam stripping, etc. Process water discharged from refining plants is of considerable volume and is highly toxic due to its anaerobic and highly reduced character and the presence of numerous heavy metals (primarily three toxic metals--mercury, cadmium, and cyanide), sulfides, and ammonia, which are produced together with the oil and gas.

Naturally occurring radioactive material (NORM) deposits can accumulate in gas-plant equipment, separation-facility equipment, and the areas around pipeyard. In gas-plant equipment, NORM deposits may accumulate from radon-222 (radon) gas. Components having the highest levels of NORM include reflux pumps, propane pumps and tanks, and other pumps and product lines. In separation facilities where the separation of water occurs onshore, water handling equipment can become contaminated with NORM. Heater treaters, water knockouts, liquid product tanks, separators, tubing and piping, water transfer pumps, and other produced-water handling equipment accumulate radium isotopes in the form of scale. This contamination can enter surrounding waterbodies through discharged water or runoff.

Antifouling marine paints used on structures at service bases and marine terminals and on service vessels can enter the marine environment slowly through deterioration of the painted surfaces.

The greatest cause of contamination from support facilities has been identified as nonpoint-source discharges. The facility's presence, along with the associated access routes, alters the natural hydrology and geography of the area over time, resulting in increased runoff from the land. Saltwater intrusion may occur if the facility is built through wetlands. If existing vegetation is modified, increased erosion and land loss around the facility may take place. Increases of nonpoint-source pollution due to runoff at support facilities may contribute particulate matter, heavy metals, oil and grease, fecal coliform, high nutrient loadings, and radionuclides (particularly from pipeyards) to local streams, estuaries, and bays, causing elevations of the contaminants in the surrounding waters, low dissolved oxygen levels, and high turbidity.

(2) Coastal Service-Vessel Discharges

Vessel operational discharges are intentional routine discharges during normal operating procedures and include sanitary and domestic water discharges, bilge waters, and ballast waters. Discharges of sanitary and domestic wastes from service vessels are estimated at 0.227 m^3 per person per day (NERBC, 1976). Support-vessel operators servicing the OCS industry offshore may still discharge oily bilge waters in coastal waters, but they must treat the bilge water to limit its oil content prior to discharge. Based on an NERBC (1976)

analysis of bilge water generation from vessels of various deadweight tonnage (dwt) and on the information on size and tonnage of work boats, 32 percent of the vessels are within 60 dwt and would discharge 1,300 liters/24-hr day, and 68 percent of the vessels are 60-100 dwt and would discharge 22,000 liters/24-hr day. The amount of bilge water discharged into coastal waters from OCS service vessels is dependent on the transit time that it takes for the service vessel to travel from its dock down the navigation channel to the open waters of the Gulf.

(3) Offshore Wastes Disposed Onshore

If OCS drilling and production wastes cannot meet the USEPA NPDES permit restrictions or if these limitations require zero offshore discharge, offshore operational wastes must be transported to shore for onshore disposal.

Section IV.A.3.d. provides general information on specific types of OCS offshore operational wastes and their contaminants. Section IV.B.1.f. provides information on onshore storage and disposal. The following provides information on the major types and quantities of waste that are expected to be brought onshore for disposal. Produced water is omitted from the discussion because the vast majority of the produced-water discharges are meeting the NPDES permit restrictions.

Treatment, Workover, and Completion Fluids

This EIS uses assumptions developed by the USEPA for volumes of treatment, workover, and completion (TWC) fluids requiring onshore disposal. The USEPA allows TWC fluids to be commingled with the produced-water stream if the produced-water/TWC fluid discharges pass the toxicity test requirements of the NPDES permit. However, according to the USEPA, facilities with less than 10 producing wells may not be able to commingle the TWC fluids with the produced-water stream for treatment and overboard discharge because of the relative volume of produced water generated and/or the size of the produced-water treatment system (USEPA, 1993). Analysis of the MMS database shows that about 73 percent of all platform complexes have less than 10 well slots; thus, operators of these facilities would have to dispose of their wastes by other means than overboard discharge. Spent TWC fluid is stored in tanks on tending workboats or on platforms and, therefore, can be transported to shore on regularly scheduled supply boats or workboats. It is expected that the TWC wastes will be taken to shorebases and transferred to commercial waste treatment facility barges and disposed of down commercial disposal wells. Offshore wells are projected to generate an average volume of 200 bbl from either a well treatment or workover job every 4 years. Each new completed well will generate about 150 bbl of completion fluid.

Drilling Muds and Cuttings

Projections of the quantities of muds and cuttings brought onshore are based on the following assumptions: (a) some oil-based drilling mud will be used when drilling beyond 3,048 m; (b) exploration and delineation wells will be drilled to an average of 4,115 m; (c) all oil-based muds will be shipped onshore; (d) 5 percent of the fluids are assumed to go with the drill cuttings after muds/cuttings separation; and (e) the USEPA effluent limitation guidelines and NPDES requirements are adhered to by industry so that some of the muds shipped onshore failed toxicity tests or the limitations for barium, mercury, chromium, oil and grease, or priority pollutants. Based on an analysis of the above assumptions and calculations from the drilling of typical wells in the Gulf, the USEPA and MMS developed the following estimates: quantities of muds and cuttings brought onshore are 1,595 bbl of mud and 386 bbl of cuttings per exploratory well drilled and 444 bbl of mud and 108 bbl of cuttings per development well drilled (USEPA, 1993).

During the drilling of a well, both regularly scheduled supply boats and dedicated supply boats, depending on the drilling phase, will be used to haul the muds and cuttings to shore (USEPA, 1993). Regular supply boats can carry 10 cutting boxes on deck and store 2,500 bbl of fluids in tanks below deck; dedicated supply boats carry 16 cutting boxes and can store 2,500 bbl of fluids below deck. Helicopters might also be used to support drilling operations in deepwater areas of the Gulf.

Production Solids

Current USEPA NPDES permits prohibit operators in the Gulf of Mexico from discharging any produced sands offshore, with the exception of downwell disposal. The USEPA defines most solid material and/or sludge generated during production as produced sands. Cutting boxes (15- to 25-bbl capacities), 55-gallon steel drums, and cone-bottom portable tanks are used to transport the solids to shore via offshore service vessels. It is assumed that about 95 percent of produced sands will be brought onshore for disposal; the other 5 percent is assumed to be disposed of downwell offshore. Estimates of total produced sand expected from a typical platform are from 25 to 250 bbl per day according to the USEPA (1993), or 0.05 percent of the oil produced (USEPA, 1976).

No projections of quantities of oil-field pipe brought onshore are made. Historically, after production ceased, oil-field pipe was routinely pulled and brought to pipeyards to be stacked and reamed out for later reuse. To avoid worker exposure to dust particles containing elevated levels of radionuclides during pipe cleaning, it is assumed that pipe will remain in place in the future.

(4) Beached Trash and Debris

Trash loads exceeding several tons per kilometer continue to be reported from coastal cleanups along Texas and Louisiana beaches. Items such as 55-gallon drums, 5-gallon buckets, paint cans, hard hats, pipe-thread protectors, shrink wrap, stripping lumber, wooden pallets and wire spools, empty mud chemical sacks, plastic and glass containers, large pieces of styrofoam, and cardboard boxes are common items recognized on coastal beaches. Possible sources related to OCS operations include drilling rigs, production platforms, workboats, crewboats, supply or service vessels, oil barges, shuttle tankers, pipelaying barges, and geological, geophysical, or environmental research vessels.

Because deliberate offshore disposal of solid waste is prohibited from offshore oil and gas operations, it is assumed that only the accidental loss of trash and debris from all phases of OCS operations will contribute solid wastes to the Gulf of Mexico. The latest opinions cited by government and industry have estimated oil and gas operations in the Gulf contribute up to 13 percent of the cumulative trash loads currently affecting coastal beaches in the WPA and CPA. Oil and gas operational debris should decline with better waste handling and waste management practices currently being employed by offshore oil and gas operators.

d. Coastal (Inland Water) Oil Spills

Occurrence

Spills can occur at onshore storage, processing, or transport facilities as part of OCS oil and gas industry support operations. In particular, spills have likely occurred from barging of OCS crude, from mishaps during fuel and crude oil transfer operations, from storage tank leaks, from coastal and onshore pipeline breaks, and from refinery spills. Section IV.C.4. discusses all spills occurring in the waters of the U.S. coastal zone of the Gulf of Mexico from any source. For purposes of spill projections, "coastal" will include "inland" spills, defined as spills occurring on waters inland of the shoreline. Inland spills estimates include only those spills that reach navigable waters of the coastal zone. Spills in wetlands are included because navigable waters are defined to include all wetland areas.

Although MMS does not maintain records of OCS-related spills in State offshore waters, no spills > 50 bbl are known to have occurred. Furthermore, the spill database used to determine OCS coastal spills (the U.S. Coast Guard's database) also defines coastal spills as those spills inland of the shoreline.

Determining if spill incidents that occurred in inland waters were from OCS industry operations is difficult. The MMS does not regulate non-OCS activities, and the MMS spill database contains only spill incidents that occur in Federal waters. Coastal spills from OCS operations are calculated as a proportion of all coastal spills discussed in Section IV.C.4. If one assumes that spill risk is proportional to the volumes of oil handled, then OCS-related spills can be estimated based on comparing the volume of oil moved around the Gulf from OCS operations versus State oil and gas production (Section IV.C.1.a.), intra-Gulf transport, and import/export oil activities (Section IV.C.2.c.). Based on this analysis, which was completed using 1995 oil

volumes, spills related to OCS operations occurring in the coastal area are estimated to be about 6 percent of all coastal spills occurring in Gulf coastal waters.

Table IV-17 provides the estimated number of inland water, coastal spills projected to occur for the 39-year time period of the Gulfwide OCS Program. Table IV-18 provides the number of coastal spills projected to occur in a representative year in the future (the year 2015 was chosen) from the Gulfwide OCS Program. Table IV-17 also provides the total estimated number of inland water, coastal spills projected to occur over a 35-year period for a typical proposed lease sale, broken down by spill size category.

Table IV-17

Coastal Oil Spills Occurring from the Proposed Action and the OCS Program

Size Category	Assumed Size	Proposed Action	Gulfwide OCS Program*
≤ 1 bbl	1 bbl	35-70	2,300-3,200
> 1 bbl and ≤ 50 bbl	4 bbl	10-15	600-800
> 50 bbl and < 1,000 bbl	150 bbl	1-2	60-80
≥ 1,000 bbl	3,000 bbl	0-1	0-35

*Also found in Table IV-18.

Fate and Potential Areas Affected by Coastal Spills

In order to complete an analysis of OCS-related spill impacts, assumptions were made for the following: the time period it takes for the major sheen to dissipate; the time period it takes for contaminant levels to reach background levels; and the area of potential contact. The following estimated time periods and maximum area contacted are based on a review of field studies on historical spill occurrence (Webb et al., 1985; Alexander and Webb, 1987; Delaune et al., 1979; Fischel et al., 1989) and/or reasonable approximations.

In open bays, the area of potential contact is the maximum area covered if oil remained together and spread out to 1 mm in thickness and is assumed to be about 0.8 ha for each 50 bbl spilled. In marsh, the area of potential contact is the area that the oil will cover after final spreading and is assumed to be about 2.7 ha for each 50 bbl spilled. The area of potential contact in marsh is projected to be larger than that projected for an open bay due to the smearing of the oil from tidal movement over time. The time projected for sheen dissipation in marsh assumes no burial of oil or pooling of small amounts of oil into very low energy spots. Except for spills > 1,000 bbl, no cleanup is assumed to occur. Any cleanup occurring will likely decrease the area affected and the length of time that the oil could be detected in the affected waterbody.

The following assumptions are made for each spill size category:

- *Spills ≤ 1 bbl:* Concerns about spills of this size are usually related to frequency of occurrence. These spills are expected to have very temporary residence time and the sheen will dissipate within 6 weeks.

- *Spills > 1 bbl and ≤ 50 bbl:* Sheen will dissipate from the surface within 6 weeks, and contaminant levels will reach background level within 6 months.

- *Spills > 50 bbl and < 1,000 bbl:* Sheen will dissipate from the surface within 6 weeks for an open bay and within 6 months for a marsh area. Contaminant levels will reach background level within 1 year for an open bay (high energy) and within 5 years for a marsh (low energy).

- *Spills ≥ 1,000 bbl:* After cleanup, in an open bay, sheen will dissipate from the surface within 6 weeks, and contaminant levels will reach background level within 2 years. In

a marsh, sheen will dissipate within 1 year, and contaminant levels will reach background level within 10 years.

Spill response measures expected to occur when an offshore oil spill contacts coastal resources (described in Section IV.A.3.h.(2)) would be the same measures taken for the cleanup of a coastal spill.

e. Noise

Coastal noise is associated with OCS-related helicopter and service-vessel traffic. Noise generated from these activities can be transmitted through both air and water, and is transient in nature. The intensity level and frequency of the emissions are highly variable, both between and among the various sources. Coastal noise from OCS-related activities may affect biological resources near the activities.

Helicopter sounds contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al., 1995). Helicopters, while flying over land, generally adhere to corporate policy regarding minimum operational altitude. Service altitudes over land are generally above 1,000 ft in environmentally nonsensitive or uninhabited areas and 2,000 ft in sensitive areas, which include National Parks and Wildlife Refuges (Osborne, personal communication, 1992). Ninety percent of the helicopter flights over coastal areas will adhere to these flight patterns.

Service vessels transmit noise through both air and water. The primary sources of vessel noise are propeller cavitation, propeller singing, and propulsion or other sources (including auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake) (Richardson et al., 1995). Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladen vessels. Noise increases with ship speed; speed restrictions on vessels operating within coastal waterways significantly reduce noise emissions in environmentally sensitive and populated areas.

f. Disturbances to Navigation

Construction of larger platforms, such as tension-leg platforms, requires the use of greater leverage or power than usually needed in the erection of some component structures to be attached. To accomplish these constructions, low-elevation cables have been suspended across adjoining navigation canals to gain the leverage needed to pull structures upright. This activity has stopped navigational traffic on canals for several hours in the Ingleside, Texas, area.

Several actions can be taken to mitigate this impact. These activities can be scheduled during the time of the day and week when canal use is at its minimum. The local port authority, Coast Guard, neighboring businesses using the canal, and other major users of the canal should be notified. Also, notice of any unusual, scheduled use of the canal should be requested from these agencies and canal users for the purposes of minimizing impacts through cooperative scheduling.

C. Other Cumulative Activities Scenario

1. State Oil and Gas Activities

a. Leasing and Production

The State of Texas offers oil and gas leases each April and October. As of March 14, 1996, some 329 drilling rigs were operating within the State; 21 were located in State offshore waters and 1 was located in State inshore waters (Oil and Gas Journal, 1997).

The Louisiana Mineral Board conducts lease sales monthly. As of March 14, 1996, some 181 drilling rigs were operating within the State; 98 were located in State offshore waters and 24 were located in State inshore waters (Oil and Gas Journal, 1997).

The State of Mississippi conducts lease sales upon request. As of March 14, 1996, there were 12 drilling rigs operating in Mississippi; none were operating in State waters (Oil and Gas Journal, 1997).

The State of Alabama conducts general lease sales annually. If a specific tract is of interest, a lease sale can be conducted upon request. As of March 14, 1996, five drilling rigs were operating within the State (Oil and Gas Journal, 1997).

The State of Florida has experienced very limited drilling in coastal waters. At present, a moratorium has stopped drilling activity in Florida State waters, and the State has no plans for lease sales in the future. As of March 14, 1996, no drilling rigs were operating within the State (Oil and Gas Journal, 1997).

A review of oil and gas production in State coastal regions was performed for the period 1977-1996. (The percentages in this and the following paragraph represent the approximate percentage of a given year's total.) During 1977, cumulative State oil production represented about 66 percent of total U.S. production in the Gulf. During the period reviewed, cumulative State production declined to about 27 percent in 1996. Texas production declined from about 160 million bbl (23%) in 1997 to about 46 million bbl (7%) in 1996. Louisiana oil production declined from about 240 million bbl (31%) to about 75 million bbl (16%). Mississippi oil production was about 75,000 bbl (<0.01%), peaked in 1979 at about 520,000 bbl (0.08%), and declined to about 15,000 bbl (<0.01%) in 1996. Alabama oil production was somewhat steady during the period, beginning at about 18 million bbl (2.5%), reaching its greatest production of about 22 million bbl (3.5%) in 1980 and its smallest production of about 16 million bbl (3.5%) in 1996. Only production in northwest Florida was considered in this review, excluding the production that occurs in the southernmost region of Florida's mainland. In northwest Florida, production was highest in 1977 at about 42.5 million bbl (6%) and declined to about 4.5 million bbl (1%) in 1996.

During the review period, cumulative gas production declined from about 4.8 tcf (58%) to about 1.9 tcf (22%) in 1996. Texas gas production declined from about 1.8 tcf (22%) in 1977 to about 0.6 tcf (10%) in 1996. Louisiana production for the period began at about 2.9 tcf and declined somewhat steadily to about 1 tcf (12%) in 1996. In Mississippi, gas production ranged from about 4 bcf (0.05%) in 1977 to about 28 bcf (0.33%) in 1979, from where it declined to about 2 bcf (0.02%) in 1996. Due to gas discoveries in Mobile Bay and offshore State waters, Alabama production rose from about 55 bcf (0.7%) in 1977 to about 305 bcf (5%) in 1996. Production in northwest Florida declined from about 58 bcf in 1977 to about 9 bcf (0.1%) at the end of the period reviewed.

For the purpose of comparing projected future State production with projected OCS production, the above described 20 years of State production data were combined and used to generate logarithmic curves to project oil and gas production during the period 1998-2036. Socioeconomic trends influencing domestic production during the period reviewed were assumed to continue through 2036, barring unforeseeable social or military unrest. Also, the application of 3D seismic activity and other technological advances are expected to bolster declining State production rates at least over the next 10-20 years. These curves indicate that 4-5 BBO and 45-65 tcf of natural gas may be cumulatively produced from these States' coastal regions during the period of interest.

b. Pipeline Infrastructure for Transporting State-produced Oil and Gas

Extensive pipeline systems exist across the States of Texas and Louisiana for transporting oil and gas produced from State and private leases. The total number and lengths of state pipelines are unknown. All of the Gulf States are presently identifying the existing pipeline systems and logging them into geographical information system (GIS) databases. Once these GIS databases are brought up to date, a cumulative analysis of pipelines around the Gulf can be performed.

2. Other Major Offshore Activities

a. Dredged Material Disposal

Dredging operations considered here include new channelization, maintenance, and modification of existing channels; dam construction; sediment harvesting; and streambank or shoreline changes. A discussion of dredging in inland coastal regions around the Gulf is presented in Section IV.C.3.c. Dredged sediments are dispersed into coastal waters by the dredging activity; dumping dredged materials into waterbodies; and

dumping dredged materials onto spoilbanks or into spoil containment areas from where they overflow and subsequently erode.

Dredged materials from channels are often contaminated with toxic heavy metals, organic chemicals, pesticides, oil and grease, and other pollutants originating from municipal, industrial and vessel discharges and nonpoint sources, and thus can result in contamination of areas formerly isolated from major anthropogenic sources (USEPA, 1979). Hence, sediment discharges from dredging operations can be major point sources of pollution in coastal waters in and around the Gulf. In addition, inland and shallow offshore disposal can change the natural flow or circulation of waterbodies and the navigability of waterbodies.

In 1989, the USEPA estimated that more than 90 percent of the volume of material dumped in the oceans around the U.S. consisted of sediments dredged from U.S. harbors and channels (USEPA, 1989). As of February 1996, in response to the Marine Protection, Research, and Sanctuaries Act of 1972, the USEPA had finalized the designation of 27 dredged material disposal sites in the Gulf of Mexico. Another 12 sites in the Gulf are considered interim sites for dredged material disposal. Eleven of the 12 are presently being processed for USEPA designation; the Atchafalaya River Site is expected to remain an interim site. Of these 39 designated and interim sites, 13, 19, and 7 are located in the Western, Central, and Eastern Planning Areas, respectively. Some designated sites have never been used. The 39 sites primarily facilitate the COE's bar-channel dredging program. Generally, each bar channel of navigation channels connecting the Gulf and inland regions has one to three disposal sites used for disposal of maintenance dredged material. These are usually located in State waters.

The COE records disposals on these 39 sites and others. For the period of 1976 through 1995, these records reveal that approximately 872 million m^3 of dredged materials were disposed at permitted, offshore sites in the Gulf. If historical annual disposal volumes are fitted to a logarithmic curve and the rate is assumed to continue as per that curve, a projection to the year 2036 reveals that approximately 2.2 billion m^3 of dredged materials, with a yearly average of about 55 million m^3, may be disposed of in the Gulf.

b. Marine Transportation

An extensive maritime industry exists in the northern Gulf between major Gulf ports and ports outside the northern Gulf via the Bay of Campeche, the Yucatan Channel, and the Straits of Florida. There is also a substantial amount of domestic waterborne commerce along the Gulf Coast. In addition to coastwise transport between ports, much of the vessel traffic in the Gulf is inland using the Gulf Intracoastal Waterway (GIWW), which follows the coastline inshore and through bays and estuaries, and in some cases offshore, from Brownsville, Texas, to Fort Myers, Florida.

(1) Non-OCS-Related Oil Tanker and Barge Activities

Extensive refinery capacity, easy port access, and a well-developed transportation system have contributed to the development of the Gulf Coast region as an important center for handling oil to meet the world's energy needs. Both petroleum products and crude oil are imported and exported. Crude oil is tankered into Gulf refineries from domestic production occurring in the Atlantic and Pacific Oceans; crude oil produced within the Gulf region is barged among Gulf terminals to reach refineries and onshore transportation routes; and petroleum products produced by a number of large refinery complexes are barged or tankered to other states, both inside and outside of the Gulf, to provide the nation's energy. Besides being the leader in domestic offshore oil production, between 60 and 65 percent of the crude oil being imported into the United States comes through Gulf waters. The Gulf area also includes the Nation's Strategic Petroleum Reserve and the Louisiana Offshore Oil Port (LOOP), the only deepwater crude-oil terminal in the country.

Tanker imports and exports of crude and petroleum products into the Gulf are projected to continue to increase by the U.S. Dept. of Energy (DOE). In 1995, approximately 1.689 BBO of crude oil and 0.195 BBO of petroleum products were offloaded at Gulf ports. Surprisingly, approximately the same volume, 0.186 BBO, of petroleum products was exported. By the year 2015, these volumes are projected to almost double. About 2.38-2.55 BBO of crude oil and 0.6-1.0 BBO of petroleum products are projected to be imported. The year 2015 is chosen because imports of crude oil are projected by DOE to begin stabilizing by this year as refinery distillation capacity reaches maximum utilization rates. Ranges given represent two DOE estimates

for growth of petroleum consumption, ranging from 16.4 to 33 percent growth between 1995 and 2015. Additional petroleum products will be needed to fill the widening gap between refinery production and the demand for refined products. By 2015, refined products are projected to make up 19-26 percent of all petroleum being imported, compared with 10 percent in 1995.

Crude oil will continue to be tankered from Alaska, California, and Atlantic production into the Gulf for refining. In 1995, about 18 million bbl of crude were tankered from outside states, almost all of this coming from California and Alaska (17.8 million bbl). Almost 20 times more petroleum products are being tankered or barged in and out of the Gulf to other states--312 million bbl leaving the Gulf and 11 million bbl tankered into the Gulf. Based on consumer growth demand projections, by the year 2015, waterborne movements of crude oil and petroleum products into and out of the Gulf from other States is expected to climb as high as 0.46 BBO annually.

To handle the large quantities of crude and petroleum products that enter and exit the Gulf and to meet the Gulf States' energy needs, a tremendous amount of coastwise transport of oil occurs. According to Corps of Engineers statistics (U.S. Dept. of the Army, COE, 1996), in 1995 about 0.4 BBO of oil were transported between ports, at some time entering offshore Gulf waters. By 2015, this amount is expected to reach between 0.47 and 0.53 BBO. Adding to this, large volumes of oil brought into terminals or produced at refineries are transported to other locations within the Gulf using the extensive internal waterway system of the Gulf. About 1.3 BBO of crude oil and petroleum products were transported within the Gulf's waterway systems in 1995, with almost 30 percent of this volume being transported along the Gulf's Intracoastal Waterway at some time in its travel. By the year 2015, this volume is expected to grow to approximately 1.5-1.7 BBO.

Marine transportation traffic could occasionally be subject to operational errors, which could result in oil spills, groundings, or collisions involving other vessels or fixed structures such as platforms and rigs. Of all the marine traffic operating in Gulf waters, the greatest environmental pollution risk is posed by barge and tanker transport of crude oil and petroleum products. Section IV.C.4. projects oil spills from the marine transportation of the above-discussed volumes of crude oil and petroleum products tankered and barged in Gulf waters.

(2) Louisiana Offshore Oil Port

The Louisiana Offshore Oil Port (LOOP), a corporation owned by five oil companies, provides offshore terminal facilities for offloading and temporary storage of crude oil from tankers too large for conventional ports (typically supertankers with drafts greater than 12 m and up to 700,000 dwt) and for transporting the oil to shore via pipeline, thus avoiding the need for lightering (transfer to smaller vessels). LOOP is located in 35 m of water in Grand Isle Block 59, approximately 30 km from shore (Visual 2). Vessels access LOOP via the designated safety zone and fairway, which are devoid of mobile drilling operations and permanent structures. Since 1994, the safety zone was expanded by 15 percent. An anchorage area is also designated in the vicinity of LOOP. Fixed and mobile structures may be placed in anchorages under certain spacing limitations. In 1996, the LOOP offloaded 823,000 bbl/day of foreign crude oil from tankers (13% of the nation's crude oil imports) and 60,000 bbl/day of domestic crude oil. Oil is moved from LOOP to refineries through five outgoing pipelines, the main pipeline (LOOP capline-LOCAP) carrying approximately 650,000 bbl/day.

c. Military Activities

The air space over the Gulf of Mexico is used extensively by the Department of Defense (DOD) for conducting various air-to-air and air-to-surface mission operations. Nine military warning areas and five water test areas are located within the Gulf (Figure II-2). These warning and water test areas are multiple-use areas, where military operations and oil and gas development have coexisted without conflict for many years.

The Western Gulf has two warning areas used for military operations. The areas total approximately 12 million acres, or 33 percent of the area of the WPA.

Warning Areas	Defense Operations Conducted
W-228	Carrier operations, air-to-air gunnery, rocket firing, aircraft operations, submarine operations
W-602	High-altitude training

In addition, six blocks in the Western Gulf are used by the Navy for mine warfare testing and training. Mustang Island Area Blocks 793, 799, and 816 have been excluded from proposed action. Mustang Island Area, East Addition Blocks 732, 733, and 734 will carry a multi-use mitigation stipulation if leased.

d. Artificial Reefs and Rigs-to-Reefs Development

Artificial reefs have been used along U.S. coastlines since the early 19th century. Stone (1974) documented that the use of obsolete materials to create artificial reefs has provided valuable habitat for numerous species of fish in areas devoid of natural seafloor topographic prominences. Further, Stone et al. (1979) found that reefs in marine waters not only attract fish, but in some instances enhance the production of fish as well. However, the long-standing debate as to whether artificial reefs contribute to biological production or merely attract the associated marine resources still remains within the artificial reef scientific arena. The generally accepted conclusion among the artificial reef researchers is that artificial reefs both attract and produce depending on numerous parameters, including associated species, limiting environmental factors, fishing pressure, and types of artificial reef materials used.

In 1984, the U.S. Congress, as it recognized the social and economic value in developing artificial reefs, passed the National Fishing Enhancement Act (NFEA). The NFEA directed the Secretary of Commerce to develop and publish a long-term National Artificial Reef Plan (NARP) to promote and facilitate responsible and effective artificial reef use based on the best scientific information available. Under the leadership of the National Marine Fisheries Service, the NARP was developed in 1985 (Stone, 1985). This was the first effort at the Federal level to establish national guidelines to assist States, individuals, and organizations in the development and management of artificial reefs. The NARP states that properly designed, constructed, and located artificial reefs can enhance the habitat and diversity of fishery resources; enhance recreational and commercial fishing opportunities; increase the energy efficiency of recreational and commercial fisheries; and contribute to coastal economies. The NARP provides general criteria for selection of materials for artificial reefs. These criteria include (1) function--how well a material would function as habitat; (2) compatibility--how compatible a material is with the surrounding environment; (3) durability--how long a material will last in the environment and maintain its function; (4) stability--how stable a material will be when exposed to storms, tides and currents, and other external forces; and (5) availability--how available a material is to an artificial reef program, including the costs of acquisition, transportation, preparation, and deployment.

One of the most significant recommendations in the NARP was the encouragement of the development of state-specific artificial reef plans. The majority of the states along the Gulf of Mexico coast and Atlantic seaboard have taken leadership roles in artificial reef development and management. They have developed State-specific plans and have established protocols for siting, deployment, and evaluation of materials for artificial reefs. The Gulf States Marine Fisheries Commission and Atlantic States Marine Fisheries Commission coordinated State artificial reef program activities. The Commissions formed Artificial Reef Working Committees comprised of State artificial reef program personnel and representatives from appropriate Federal agencies. These committees meet jointly to discuss artificial reef issues of a national scope and meet separately to discuss issues specific to the Gulf and the Atlantic. As a result, these committees have been influential in shaping regional and national artificial policies and allow for future positive program changes within both State and Federal agencies.

Rigs-to-Reefs is a catchy term for converting obsolete, nonproductive offshore oil and gas platforms into artificial reefs (Reggio, 1987). Offshore oil and gas platforms began functioning as artificial reefs in 1947 when KerrMcGee completed the world's first commercially successful oil well in 5.6 m of water, 70 km south of Morgan City, Louisiana. Today, approximately 3,800 offshore oil and gas structures exist on the Gulf of Mexico OCS. These platforms have created the world's most extensive defacto artificial reef system. The

addition of these platforms has enhanced both the fish populations and the recreational and commercial fishing industries of the Gulf (Stanley, 1994). The MMS regulations require that these platforms be removed within one year after production and disposed of onshore. Disposal of obsolete offshore oil and gas platforms is not only a financial liability for the oil and gas industry but can be a loss of productive marine habitat (Reggio and Kasprzak, 1991).

The use of obsolete oil and gas platforms for artificial reefs has proved to be highly successful. Their large numbers, design, longevity, and stability have provided a number of advantages over the use of traditional artificial reef materials. To take advantage of the availability of obsolete oil and gas platforms as valuable reef fish habitats, the States of Louisiana and Texas, in 1986 and 1989 respectively, passed legislation enabling Rigs-to-Reefs (RTR) and developed RTR plans. Each State sets up a mechanism to transfer ownership and liability of a platform from oil and gas companies to the State when the platform ceases production. The oil and gas company would save money by donating a platform to the State for a reef rather than dismantling the platform and disposing of it onshore. The company donates a portion of these savings to the State to support the artificial reef program. Since the inception of the RTR plans, more than 100 retired platforms have been donated and used for reefs offshore Texas and Louisiana. Mississippi and Alabama are currently developing RTR plans to take advantage of the opportunity to use retired platforms for artificial reefs.

In the WPA, the Texas Parks and Wildlife Department has created 37 RTR projects to date and are currently developing about 3 new projects a year. Hence, during the next five years, 15 new RTR transfers are likely, with a potential for over 100 new RTR structures added to the Texas offshore artificial reef program over the next 35 years.

3. Other Major Onshore/Coastal Activities

a. Submergence of Wetlands

Submergence of wetlands along the Gulf Coast is caused by eustatic sea-level rise and land subsidence. Eustatic sea-level rise is caused by the reduction of the volume of water stored in the polar ice caps. Land subsidence is caused by a variety of localized natural and manmade events such as down-warping or horizontal movement of the earth's crust; weighted surface compression; and oxidation, consolidation, settling, and dewatering of surface sediments (Swanson and Thurlow, 1973). Locally, subsidence and sea-level rise can be offset by sedimentation, dredged-material placement, and peat formation.

During this century, the rate of eustatic sea-level rise along the Texas and Louisiana coasts has been relatively constant at 2.3 mm/yr (23 cm/century), although the rate has varied from a sea-level decrease of 3 mm/yr to a maximum increase of 10 mm/yr over decade-long periods (Turner and Cahoon, 1988). Submergence in the Gulf is occurring most rapidly along the coast of Louisiana, and more slowly in Texas. Depending on local geologic conditions, the subsidence rate varies across coastal Louisiana from 3 to 10 mm/yr. One of the major factors causing greater submergence rates is reduced sedimentation, resulting from deltaic abandonment, flood control, and channelization of rivers.

Fluid withdrawal can cause localized subsidence above the producing reservoirs. Groundwater withdrawal has compounded subsidence in some areas along the Texas coast (Ratzlaff, 1980). In coastal Louisiana, about 400 km^2 of wetlands have a subsidence potential greater than 10 cm because of fluid withdrawal (Turner and Cahoon, 1988).

b. River Development and Flood Control Projects

In recent decades, alterations in the upstream hydrology of the rivers draining into the northern Gulf of Mexico have resulted in a variety of coastal impacts. Dams and reservoirs on upstream tributaries trap much of the sediment load in the rivers. The suspended sediment load of the Mississippi River has decreased nearly 60 percent since the 1950's, largely as a result of dam and reservoir construction upstream (Tuttle and Combe, 1981; Turner and Cahoon, 1988).

In a natural system, over-bank flooding introduces sediments into adjoining wetlands. If those wetlands are subsiding, as in Louisiana, sediment introduction is necessary for the continued existence of the wetlands,

particularly in areas with brackish and saline waters. Flood control on the Mississippi and other rivers has largely eliminated flood-borne sedimentation in Gulf coastal wetlands, contributing to their deterioration.

Channelization of the Mississippi and other rivers in conjunction with flood control levees has also contributed to wetland loss and interrupted wetland creation around the Gulf by preventing distribution of alluvial sediments across deltas and flood plains. Prior to channelization, the flow of rivers was distributed among several distributary channels that delivered sediment over a broad area during high river stages. Today, sediment from the Mississippi River is primarily discharged through the main channel directly to the deep waters of the continental slope. Sediment deprivation will continue as a major impacting factor to coastal Texas and Louisiana. Reintroduction of sediments to coastal areas is being considered by the Louisiana Coastal Wetlands Conservation and Restoration Task Force to restore wetlands in Louisiana.

c. Dredging

An analysis of dredging activity for oil and gas projects that occurred in coastal Louisiana during 1988 was done to determine the magnitude of dredging impacts expected under the cumulative scenario. Similar information has not been compiled for Texas, Mississippi, or Alabama. The data for this analysis came from COE, New Orleans District, permit applications. Dredging projects for inshore oil and gas activities included maintenance dredging of existing rig access canals and drill slips, and dredging of new canals and slips. A total of 129,471 m of canals were maintenance dredged through wetland areas. The typical maintenance depth of a channel was 2.4 m. This activity generated a total of 4,455,644 m^3 of dredged material, 82 percent of which was disposed onto existing continuous spoil banks; the remainder was disposed into spoil containment areas or into surrounding waters. Three percent of the projects planned to provide gaps in the continuous spoil banks to maintain surface drainage off marsh surfaces. Only 2 percent of projects proposed to place the spoil in a wetland area to create or maintain wetlands. An additional 52,833 m of maintenance dredging was done through open-water coastal areas, generating 1,313,184 m^3 of dredged material. This material was disposed into surrounding waters.

In 1988, 11,344 m of new rig access channels and drill slips were dredged in wetland areas. These projects generated 580,451 m^3 of material. Another 53,380 m of similar new dredging occurred in open-water coastal areas, generating 3,324,933 m^3 of material. As a result of new dredging, 30.5 ha of wetlands were lost. Nearly half of these impacts occurred in brackish marshes. In 63 percent of the projects, the spoil was to be disposed of onto continuous spoil banks. About 7 percent of the projects proposed gapped spoil banks, and 3 percent proposed spoil disposal onto wetland surfaces to encourage vertical wetland accretion.

Dredging for pipeline installations was included in 61 proposed projects in wetland areas (pipelines totaling 123 km in length) and 29 projects in open-water coastal areas (pipelines totaling 42 km in length). The pipeline canals dredged in wetland areas would have been backfilled with dredged and other materials after installing the pipe.

On the basis of the above data, 9-10 million m^3 of dredged material will be generated and disposed of during the peak year in Louisiana as a result of onshore oil and gas operations. About 80 pipeline installation projects will occur in wetland and estuarine areas, involving about 165 km of pipe. All pipeline projects are assumed to be backfilled.

Numerous small, non-oil-related channels are maintained throughout the coastal regions by State, county, industrial, and private interests. These dredging projects are reviewed by Federal, State, and county agencies as well as by the public to identify and mitigate adverse impacts upon social, economic, and environmental resources. Unfortunately, databases are not maintained concerning inland dredge and fill activities.

The COE is charged with maintaining all of the larger navigation channels around the Gulf. Maintenance dredging of these channels, subsequent disposal of dredged materials, and assigned responsibilities are described in Section IV.B.2.a. The COE operations are projected to generate about 1.3 and 2.8 billion m^3 of dredged materials from OCS-related channels in the WPA and CPA, respectively, during the period related to the proposed action. During the period of interest for the OCS Program, 1998-2036, about 1.5 and 3.2 billion m^3 of dredged materials are projected to be generated from these channels of the WPA and CPA, respectively.

4. Major Sources of Oil Contamination in the Gulf of Mexico

Petroleum hydrocarbon contamination of the Gulf of Mexico is occurring from a number of offshore, coastal, and land-based sources. Major sources of petroleum hydrocarbons into Gulf waters include natural seeps; offshore and coastal oil production activities; atmospheric inputs; marine transportation (especially tanker operations); coastal, municipal, and industrial wastes; and urban and river runoff. The presence of petroleum hydrocarbons in the marine environment is, to some extent, unavoidable. Hydrocarbons in Gulf waters have been identified as generated by both natural geochemical processes and by anthropogenic inputs (pyrogenic and petrogenic). Although the Gulf comprises one of the world's most prolific offshore oil-producing provinces, onshore sources of hydrocarbons to Gulf waters far outweigh the contributions from offshore domestic production of oil.

Table IV-18 provides the number of all spill events projected to occur within U.S. navigable and offshore waters of the Gulf of Mexico area for a representative future year (around 15-20 years after the proposed action). No annual average for spills is appropriate because of differences in trends for each type of activity that could spill oil. Domestic inland oil production is expected to continue its decline (Section IV.C.1.). Domestic offshore production is projected to almost double by the year 2000 or soon after, but then is expected to begin declining (Section IV.A.1.). Because the energy needs of this nation are projected to continue to increase dramatically, declining domestic oil and gas production must be replaced by imports of both crude oil and petroleum products from outside this country. Trends in future vessel transport of oil in the Gulf are forecast and discussed in Section IV.C.2.c. Projections are given for future volumes of imported and exported oil moved coastwise along the Gulf Coast, andtransported within coastal rivers and the intracoastal waterway. In summary, the volume and type of oil being handled by different activities will shift, activities that have very different risks of spillage associated with them.

a. OCS-Related Oil Spills

Spills occurring both in inland and offshore waters from the OCS Program are described in Sections IV.A.3.h.(2) and IV.B.2.d. Total numbers of spills estimated to occur offshore for the 39-year analysis period are shown in Tables IV-2 through IV-6. To allow a cumulative assessment of spill risk in the Gulf of Mexico, an annual estimate for a representative year was developed and is provided in Table IV-18.

b. Non-OCS-Related Oil Spills

Cumulatively, other spills can occur from a variety of activities related to the extensive energy producing activities of the Gulf States. The majority of non-OCS-related Gulf spills occur from oil development in State offshore and coastal waters; from tankers, barges, and other vessels, especially from those vessels involved in the importation and coastwise transport of petroleum products and crude oil; and from non-OCS-related oil processing, transport, and storage. Table IV-18 provides projections of the number of non-OCS-related spill occurrences projected to occur both inland and offshore in the Gulf area for a representative future year.

The projections of non-OCS-related future spill occurrence shown in Table IV-18 were formulated using primarily five data sources: the U.S. Coast Guard's (USCG) database on spill incidents in all navigable waters (USDOT, Coast Guard, 1989); an analysis by the USCG of transfer spills (USDOT, Coast Guard, 1993); MMS's database and analysis of crude oil and petroleum product spills $\geq$ 1,000 bbl from worldwide tanker and barge operations (Anderson and Lear, 1994; Anderson and LaBelle, 1994); the Oil Spill Intelligence database on worldwide spills (Oil Spill Intelligence Report, 1995); and a continuing analysis of two databases on the volumes of oil moved around in Gulf waters by various transport modes (Rainey, 1992; USDOE, EIA, 1997; USCOE, 1996). Database information was supplemented by personal communications with a number of individuals dealing with vessel transport and oil-spill incidents in the Gulf of Mexico area.

Crude oil spills are the most common spills (25% of spills), followed closely by diesel and fuel oil spills.

Table IV-18

Projected Annual Oil Spill Occurrence
for Offshore Waters of the Gulf of Mexico
and Coastal Inland Waters of the Gulf of Mexico

Source	Number of Large Spills (> 1,000 bbl)	Number of Small Spills (< 1,000 bbl)
Offshore		
Total All Sources	4-5 per year	1,270-1,950 per year
Non-OCS Program	3-4 per year	200-250 per year
Tanker Traffic (average size: 26,000 bbl)	1 per year	
Barge Traffic (average size: 5,500 bbl)	2-3 per year	
OCS Program	1 per year	1,045-1,700 per year
Platform ≥ 1,000 bbl (average size: 1,500 bbl)	1 every 6-8 years	
Pipeline ≥ 1,000 bbl (average size: 8,500 bbl)	1 every 2-3 years	
Shuttle Tanker ≥ 1,000 bbl (average size: 26,000 bbl)	1 in next 40 years	
1 bbl or less (assumed size: 1 bbl)		1,000-1,625 per year
1 < bbl ≤ 50 (average size: 4 bbl)		45-70 per year
50 < bbl ≤ 1,000 (average size: 150 bbl)		2-3 per year
Other Oils		20-30 per year
Coastal		
Total All Sources	10-15 per year	950-1,050 per year
Non-OCS Sources	10-12 per year	875-950 per year
Tankers ≥ 1,000 bbl (average size: 26,000 bbl)	1 per year	
Barge Traffic ≥ 1,000 bbl (average size: 5,500 bbl)	7-8 per year	
Other ≥ 1,000 bbl (assumed size: 3,000 bbl)	3-4 per year	
OCS Sources	1 per year	75-100 per year
Pipelines ≥ 1,000 bbl (assumed size: 3,000 bbl)	1 every 4 years	
Other ≥ 1,000 bbl (assumed size: 3,000 bbl)	1 per year	75-100 per year

Footnotes:

Average probability distributions of small oil spills (offshore or inland) is based on U.S. Coast Guard historical statistics (exception: OCS offshore spill distribution is based on historic spill rates):

1 bbl or less: 78%
1 < bbl ≤ 50: 20%
50 bbl < 1,000: 2%

Frequency distribution by State for inland coastal spills is based on U.S. Coast Guard historical statistics:

Alabama: 6%
Louisiana: 34%
Mississippi: 3%
Texas: 43%
Florida: 14%

Non-OCS-Related Offshore Spills

Most offshore small spills occur during the offloading and onloading of fuel and crude oil. There are about 3 or 4 spills per 1,000 transfers, with an average spill size of 3 bbl. Lightering of oil from supertankers to smaller shuttle tankers is a common practice in the Gulf. Another major cause of spills is collisions between vessels. The frequency of such spills increases as the proximity to shore increases because of the often congested waterways in the Gulf.

It is assumed that all offshore large spills not related to OCS oil development will occur from the extensive barge and tanker maritime operations that occur in offshore waters of the Gulf. From 1974 through July 1990, 82 tanker and barge spills greater than 1,000 bbl occurred in the Gulf region (Rainey, 1992). Only nine of these spills occurred in Federal offshore waters. Thirty-four spills were crude oil and 48 spills were petroleum product. Thirty-five spills were from tankers and 47 spills were from barges.

Non-OCS-Related Coastal Spills

Coastal spills primarily occur from import tankers while at ports or in bays and harbors; from the inland vessel transport of crude oil and petroleum products along channels, bayous, rivers, and especially while traversing the GIWW; from transmission pipeline transport of petroleum products; from pipeline transport of crude oil; and from storage tanks. For coastal spills, navigation channels have the most occurrences and the largest spills. The percentages of coastal spill occurrences in different water body types are 16 percent in open and sheltered waters, 61 percent in channels and rivers, and 23 percent in ports and harbors.

Coastal spills occur most frequently during transfer operations. The USCG examined spills during transfer operations and determined that there are about 5-6 spills per 1,000 transfers of oil at ports and terminals, with an average spill size of 18 bbl (Oil Spill Intelligence Report, 1993).

The majority of large spills occur near terminals and are associated with coastal barging operations of petroleum products (Rainey, 1992). Louisiana has experienced the majority of large spills. During the period 1974-1990, there were 18 crude oil spills and 19 petroleum product spills in Louisiana's coastal area (Rainey, 1992). The majority of these spills occurred on the Mississippi River.

c. Spill Rates for OCS Development Versus Tankers

An MMS analysis of large ($\geq$ 1,000 bbl) tanker and barge spills and OCS platform and pipeline spills was used to develop the risk of spill occurrence based on the volume of oil handled (Anderson and LaBelle, 1994). The spill rate for barges is the highest rate: 4.8 spills $\geq$ 1,000 bbl per BBO transported. This rate is used for spills from barges in both offshore and inland waters. The U.S. tanker spill rates for spills $\geq$ 1,000 bbl are 0.51 spills per BBO at sea and 0.70 spills per BBO in port. The spill rates for import tanker spill occurrences in the Gulf of Mexico are one-half these rates because it is assumed that 50 percent of the spills related to tankering will occur on the inbound portion of the journey through the Gulf of Mexico and that 50 percent will occur while the tanker is outside of the Gulf of Mexico or at the loading port. Therefore, rates used for projecting spill occurrence in this EIS from oil imported or tankered from outside waters into the Gulf are 0.255 spills per BBO at sea and 0.35 spills per BBO in ports and harbors.

By comparison, the spill rate for spills $\geq$ 1,000 bbl from OCS platforms is 0.45 spills per BBO produced, and the spill rate for OCS pipelines is 1.32 spills per BBO transported, resulting in a total spill rate of 1.77 spills $\geq$ 1,000 bbl per BBO produced and transported. Considering the frequency of recent tanker spills, it is surprising that, using the exposure variable of volume of oil handled, the spill rate from OCS development is only slightly larger than the spill rate from tankering (1.77 versus 1.21). However, the volume of oil imported through the Gulf of Mexico is more than five times the amount produced on the OCS. Clearly it is the sheer volume of oil transported by tankers that results in such frequency.

Other factors to be considered when comparing OCS development to tankering operations are the size of the spills and the most likely locations of the spills. Platform spills normally occur much farther from coastal areas than tanker spills. The OCS pipeline spills have occurred more frequently closer to the shoreline where anchor damage can occur more easily. The average tanker spill is more than three times the volume of the average OCS pipeline spill, and tankers have resulted in a number of very large catastrophic spills in the Gulf

area (the *Mega Borg*, 93,000 bbl; *Burmah Agate*, 248,000 bbl; and the *Ocean 255* barge, 231,000 bbl), two of which were similar in size to the *Exxon Valdez* spill (241,000 bbl) in size. The average size of OCS pipeline spills is 8,500 bbl compared with the average size of tanker spills in U.S. waters of 26,000 bbl (Anderson, 1997).

d. Mass Balance of Oil Inputs into Gulf Waters

Mass balance is a comparison of the major sources of oil contamination in the Gulf (Table IV-19). It is provided to give a perspective of the relative contribution of OCS operations to other sources of petroleum contaminating Gulf waters. It is important to understand that this exercise provides only order of magnitude rough estimates. There are major problems associated with any attempt to establish values for the inputs and flux of petroleum into the Gulf. The approach taken here is to use the concepts, assumptions, and estimates (when applicable) developed by the National Academy of Sciences (NAS) (NRC, 1985) and to apply them to Gulf of Mexico values. Other sources that revised NAS's estimates or assumptions were also used. The contribution from petroleum sources from Mexico and Cuba was not calculated.

Volume of Petroleum Entering Gulf Waters from Spills

The total contribution of petroleum inputs to Gulf waters from spills was analyzed in 1995 (USDOI, MMS, 1995) and is estimated to be about 89,000 bbl per year or 0.012 million metric tons annually (Mta) (Table IV-19). The projected contribution from non-OCS-related spills is an order of magnitude greater than the amount projected to be spilled annually from OCS-related spills.

The volume of oil spilled in the United States from tankers and barges appears to be decreasing over time, although there is tremendous variability in the volume and number of spill incidents since 1978, and any trends may not be statistically valid (Welch, 1994). The decrease in volume may be a result of more restrictive conditions placed on tanker operations and better response and containment by OPA 90 (Welch, 1994). The total number of spills in the United States, however, continues to increase. This is not surprising if one assumes that spills are proportional to the volume of oil in a system. Given the tremendous amount of petroleum needed to meet future United States energy demands, the risk of oil spills will probably continue to rise.

Table IV-19

Inputs of Petroleum Hydrocarbons to Gulf of Mexico Waters from Various Sources

Source	Million Metric Tons Annually
Spills	0.012
OCS-Related	0.001
Non-OCS-Related	0.011
Produced Water from OCS Production	0.003
Upriver Runoff	0.009
Municipal Wastewater Discharges	0.024
Urban Runoff	0.005
Industrial Discharges	0.009
Natural Seepage	0.027

Operational Discharges

While spills capture the public's attention and can cause short-term detrimental effects, it is the chronic, low-level inputs of petroleum hydrocarbons that represent the greatest source of petroleum contamination to the Gulf of Mexico. Major sources of such discharges include illegal operational discharges from tankers

while at sea; natural seepage; and coastal, municipal, and industrial discharges and runoff. Recent MARPOL regulations have significantly reduced the levels of operational discharges associated with vessel operations. Terminals are now required to maintain onshore disposal facilities for receipt of this waste.

Besides oil spills from OCS operations, oil may enter Gulf waters from OCS operations by operational discharges, primarily the discharge of produced waters. Produced water, when discharged overboard (after treatment that removes the majority of the entrained oil content), is limited by the new general NPDES permit to containing, on an average, 29 mg/l oil content (USEPA, 1993). The total amount of OCS produced water discharged was projected (for amounts, see the Final EIS for Sales 157 and 161) and multiplied by the allowed amount of entrained oil (29 mg/l) to determine the contribution to the petroleum levels in Gulf waters from OCS discharged produced waters. This calculation results in 0.003 Mta of petroleum hydrocarbons entering Gulf waters from operational produced-water discharges associated with OCS production (Table IV-19).

Upriver Runoff

The Mississippi River is the major source of petroleum contamination in the Gulf of Mexico, carrying large quantities of petroleum hydrocarbons into Gulf waters from both upland and coastal communities located along its route. Gulf of Mexico sediment samples collected within a broad crescent around the Mississippi River reflect petroleum contamination from the River's discharge (Bedinger, 1981; Brooks and Giammona, 1988). The NAS (NRC, 1985) estimates that 0.013 Mta of hydrocarbons enter ocean water from river runoff, draining the interior of the United States. Using the fact that the Mississippi River drains two-thirds of the U.S., petroleum hydrocarbons in the River's discharge are calculated by taking two-thirds of 0.013 Mta; about 0.009 Mta (Table IV-19). This estimate only includes runoff entering the Gulf from upriver activities.

The hydrocarbon burden measured at the mouth of the Mississippi River is also from coastal inputs. Primarily urban runoff and routine, low-level effluents from industry wastewater and municipalities located along the river in the area near the Gulf of Mexico contribute large quantities of petroleum hydrocarbons. The contributions of these sources are calculated separately from river runoff and are accounted for in the following estimates of inputs from other chronic, low-level sources.

Urban Runoff and Municipal Wastewater from Coastal Communities

Man's extensive use of fossil fuels, as well as lack of recycling discarded oils, is reflected in the large contributions of petroleum hydrocarbons found in municipal wastewater and urban runoff. Significant volumes of petroleum hydrocarbons are deposited in urban areas from a variety of sources--asphaltic roads; the protective asphaltic coatings used for roofs, pipes, etc.; oil used in two-cycle engines, especially outboard boat motors; gas station runoff; and unburned hydrocarbons in car exhaust. These sources are either directly flushed by rainfall and runoff into storm drains and into coastal waters or rivers, or are weathered, broken down, and then dispersed. The Automotive Information Council estimated in 1990 that 8.3 MMbbl (approximately 1.2 Mta) of used motor oil is generated annually in the U.S. by do-it-yourselfers (Automotive Information Council, 1990). They estimated that 60 percent of this is poured on the ground, thereby adding 5.7 MMbbl of oil to the urban environment annually (0.814 Mta). Much of this discarded oil contributes to the petroleum loading found in municipal wastewater and urban runoff. The NRC (1985) determined that municipal wastewater and urban runoff contributes almost 26 percent of petroleum contamination to the world oceans. To determine an estimate of the amount of petroleum entering the Gulf from urban runoff and municipal wastewater, the NRC methodology was applied to Gulf of Mexico statistics. Multiplying the Gulf of Mexico U.S. coastal population of 14.7 million people (USDOC, NOAA, 1990) by an average input per person results in a rough estimate of 0.024 Mta from U.S. municipal wastewater and 0.005 Mta from urban runoff (Table IV-19).

Industrial Effluents

Other major land-based sources of petroleum hydrocarbons in Gulf waters include refineries and other industry effluents. Coastal refineries in the Gulf area have a total design capacity of 310,000 Mta. Using a discharge rate for U.S. refineries of 0.5 g/Mta capacity (NRC, 1985), the contribution of petroleum

hydrocarbons from Gulf Coast refineries is 0.0000015 Mta, which is negligible when compared with other sources.

Industrial discharges enter coastal rivers (particularly the Mississippi River) that drain into the Gulf or directly drain into coastal waters. If one assumes that Gulf industries are evenly distributed in our coastal zone, and if the NRC's estimate of nonrefinery industrial waste input (0.2 Mta) is multiplied by one-third (the NRC's estimate of U.S. waters compared to world waters) and then multiplied by the ratio of the U.S. coastal population to the Gulf of Mexico's U.S. population, an estimate of 0.009 Mta of industrial effluent petroleum hydrocarbon contribution can be made (Table IV-19).

Natural Seepage

Naturally occurring hydrocarbon seepage has long been identified as a significant source of hydrocarbons. Tar balls coming from natural seeps were used by early indigenous man living along the Gulf Coast to construct their hunting tools. Given that the Gulf is a prolific petroleum-producing province, its seafloor is also pocketed with oil oozing out from holes. Accurately calculating the volume of oil naturally seeping is problematic. Often the volume measured floating on the surface of the water or beached has been used as the best indicator of the volume originally seeped. Recently, MacDonald (1993) estimated the volume of natural seepage for an area of the continental slope off Louisiana by using satellite imagery. He estimated a natural seepage rate of about 120,000 bbl per year (0.016 Mta) from a 23,000 km^2 area. Earlier estimates by Wilson et al., (1973) were based on the geologic relative potential. Wilson estimated that the northern and Mexican Gulf areas could be seeping as much as 204,000 bbl of oil per year (0.027 Mta) (Table IV-19). Given that MacDonald's estimate would be a significant subset of Wilson's estimates, the numbers are within reason. The mass balance below relies on Wilson's earlier estimate, despite the limitations of its calculations.

Mass Balance

There are other sources of petroleum hydrocarbons not estimated in this exercise and, therefore, a complete mass balance cannot be done. Inputs from erosion of sedimentary rocks; atmospheric inputs; operational discharges from vessels (i.e., bilge and oily ballast, and fuel oil sludge); and dredged material disposal are not quantified. Although not all sources are accounted for here, comparisons between the above sources can be made.

D. ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTIONS AND ALTERNATIVES

1. Proposed Western Gulf Sales 171, 174, 177, and 180

a. Alternative A - The Proposed Action

(1) Impacts on Sensitive Coastal Environments

(a) Coastal Barrier Beaches and Associated Dunes

This section considers impacts to the physical shape and structure of barrier beaches and associated dunes by activities of the proposed action. The major impact-producing factors associated with the proposed action that could affect barrier beaches and dunes include oil spills, pipeline emplacements, navigation canal dredging and maintenance dredging, and support infrastructure construction. Impacts that affect those portions of barrier islands landward of the barrier dune system are considered in the wetland analysis. Impacts to other aspects of the barrier environment, such as animals, the recreational value of beaches, and archaeological resources are described in other sections.

Mitigating adverse impacts is the responsibility of the party causing the impact (e.g., government agency, company, or individual) in accordance with requirements set forth by the appropriate Federal and State permitting agencies. Although the MMS has no direct regulatory responsibility or authority over coastal activities causing landloss or over mitigation requirements, opportunities and potential needs for mitigation are documented in this EIS.

The occurrence of spills, and their subsequent distribution over the Gulf, which may include contact with a barrier shoreline, largely depends upon where each spill originates; the nature of the spilled material; and the prevailing seasonal, meteorological and oceanographic circumstances. The oil spill risk analysis (OSRA) model is a method of approximating these circumstances for the purposes of identifying probabilities of contact to environmental resources by hypothetical spills from generalized, hypothetical pipeline systems and production platforms of the OCS Program (Section IV.A.3.h.(2) and Appendix C). Environmental resources include the land segments around the northern Gulf (Figure C-1).

Projected oil spills associated with the proposed action and OCS Program are described in Sections IV.A.3.h. and IV.B.2.d., and Tables IV-2 through IV-6. Section IV.A.3.h. and Appendix C provide probabilities for landfall by oil spills resulting from the proposed action and OCS Program. Typically, greater risks of oil spills are found in association with greater concentrations of spill sources, such as pipeline landfalls, number of pipeline segments, greater pipeline lengths, and number of related, oil-handling facilities. Spills within 50 mi of shore typically have a greater probability of contacting land than do spills occurring farther away from shore.

Oil produced by the proposed action will be generally commingled and transported through the existing and proposed OCS pipeline systems. Because of the general mixing, the proposed action will be analyzed as 0.1-0.7 percent of the OCS Program.

Cleanup operations of large oil spills can affect barrier beach stability. 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, especially in a sand-starved, eroding-barrier setting as found along the Louisiana Gulf Coast and to a lesser degree in some areas of Texas. Gulf State governments recognize these problems and have established policies to limit sand removal by cleanup operations.

In coastal Louisiana, dune line heights range from 0.5 to 1.3 m above mean high tide levels. In Texas, dune elevations exceed those in Louisiana. An analysis of 37 years of tide gauge data from Grand Isle, Louisiana, shows that the probability of water levels reaching sand dune elevations ranges up to 16 percent. This probability is lower for most of Texas because of higher base elevations. Strong winds would be required to produce tides high enough to carry oil from a spill across the beach and onto the dunes. These strong winds would also accelerate oil slick dispersal, spreading, and weathering, thereby reducing impact severity at the

landfall site. Hence, significant dune contact by a spill associated with the proposed activity is very unlikely. Additionally, a study in Texas showed that oil disposal on sand and vegetated sand dunes had no significant deleterious effects on the existing vegetation or on the recolonization of the oiled sand by plants (Webb, 1988).

According to U.S. Coast Guard data, 69 percent of oil spills occurring in State waters occurs inshore. Most inshore spills result from barge, tanker, pipeline, refinery, and storage tank accidents involving transfer operations, leaks, and pipeline breaks. Terminals that receive OCS oil and most waterway segments with OCS-related usage are not located near barrier beaches or dunes. When transporting cargoes to terminals or refineries, oil barges make extensive use of interior waterways, remote from barrier beaches. Consequently, oil spilled from a barge in transit or during oil transfer operations at a terminal would not likely contact a barrier beach. As examples, the September 1989 spill from a barge in Mississippi Sound oiled the landward side, but not the Gulf side, of Horn Island. Similarly, the October 1992 Greenhill Petroleum Corporation oil spill, just inland of East Timbalier Island, Louisiana, oiled inland shorelines but did not impact barrier beaches or dunes. Other smaller inland oil spills have similarly impacted coastal islands. Without adequate evidence to the contrary, inland pipeline or barge accidents are assumed to result in spilled oil contacting inland shores of a barrier island, with unlikely, significant adverse impacts to barrier beaches or dunes. For an inland barge or pipeline accident to affect a barrier beach, the accident would need to occur in the vicinity of a tidal inlet.

Pipeline landfall sites on barrier islands could cause accelerated beach erosion and island breaching. Studies have shown that little to no impact to barrier beaches results from pipeline landfalls employing modern installation techniques, such as directional boring (Wicker et al., 1989; LeBlanc, 1985; Mendelssohn and Hester, 1988).

The OCS Program is accredited with an average of 12 percent of navigation traffic on OCS-related channels and impacts related to those channels. The proposed action represents 0.5-1.0 percent of the OCS Program. Periodic maintenance dredging of existing OCS-related navigation channels through barrier passes and associated bars is expected. Jetties installed to reduce channel shoaling and dredge-maintained bar channels affect the stability of adjacent barrier landforms where jetties or the bar channel serve as sediment sinks that intercept sediment from longshore drift. Material from maintenance dredged bar and pass channels is typically discharged to nearby, ocean dump sites in the Gulf (Section IV.C.2.a.). This dredging usually removes sediment from the littoral sediment drift or routes it around the beach immediately downdrift of the involved channel. Placement of dredged material in shallow coastal waters can form shoals that impair coastal navigation by vessels such as shrimp boats and recreational vessels. These adverse impacts can be mitigated by discharging material from maintenance dredging onto barrier beaches or strategically into the longshore sediment current, downdrift of the maintained channel. Adverse impacts of sediment sinks created by jetties can be mitigated by reducing the jetty length to the minimum needed and by filling the updrift side of the jetty with appropriate sediment.

No new navigation channels are expected to be dredged as a result of the proposed action or OCS Program. The channel leading to Port Fourchon, Louisiana (Belle Pass), is expected to be deepened to accommodate larger service vessels used for deepwater operations. Permits have been issued to dredge 1.875 million yd^3 of material over the next 5 years to deepen and lengthen the channel. The channel's existing jetties are not expected to be modified. The deepened bar channel and its maintenance through barrier passes would enhance its ability to capture sediment and reduce sediment supply to beach areas downdrift. The deeper channel would intensify the chronic erosion problem to the west of the inlet jetties, which presently is largely attributed to the jetties. Ninety percent of this activity has been attributed to the OCS Program. As mitigation, a U.S. Army Corps of Engineers' (COE) initial feasibility report for deepening the Belle Pass channel calls for the use of the dredged material to stabilize the retreating beach west of the jetties.

No onshore infrastructure used to support OCS operations has been constructed recently on barrier beaches in Texas and Louisiana, except for pipeline landfalls. Due to the rapid rates of barrier beach erosion in Louisiana, several OCS-related facilities that were originally constructed a safe distance from the water are now located in dune and beach zones. This is of greatest concern in Cameron and Lafourche Parishes and across the deltaic plain. Threatened facilities will generally be moved to safer locations, or their functions will be assumed by other existing facilities. Construction of replacement facilities and the expansion of existing ones would result in the loss of habitat on barrier islands and other more inland areas.

Previous studies have shown that efforts to stabilize and "armor" beaches usually lead to accelerated erosion in areas away from the protected beach. Those efforts that seemed effective were only effective in the

short term at the site targeted. Hence, construction techniques and sites should be selected to preclude disturbance or destabilization of barrier beaches and dunes.

Proposed Action Analysis

The proposed action is projected to represent 0.1-0.7 percent of the oil produced by the OCS Program in the Gulf during the period 1998-2032 (derived from Table IV-1). Proposed action production is said to be mingled in pipelines with other OCS production at sea before going ashore. Resulting proposed action impacts of oil production are then assumed for the purposes of this analysis to represent about 0.1-0.7 percent of the impacts of oil production of the Gulf OCS Program.

The OCS Program is projected to have 9-38 large spills (≥1,000 bbl) and 65-90 spills between 50 and 1,000 bbl in OCS waters. Depending upon where a spill occurs, the OSRA analysis for conditional probability (Table C-2) indicates that OCS spills in the WPA, originally consisting of 1,000 bbl or more of oil, had a less than 0.5-95 percent probability of contacting the U.S. Gulf Coast within 10 days and a 15 to greater than 99.5 percent probability of contact within 30 days. That analysis projected that land segments 4, 6, 7, 8, and 10 (Figure C-2) have the greatest probabilities for landfall within 10 days by oil spilled at certain sites in OCS waters. Their respective probabilities were less than 0.5-57 percent for contact. These highest probabilities were associated with the pipeline segments nearer to the shore. These land segments contain coastal recreational beaches of Jefferson, Galveston, Brazoria, Madagorda, and Nueces Counties in Texas. If smaller spills persist as a consolidated slick for 3, 10, or 30 days, they would have a similar probability for landfall. Otherwise, smaller spills have significantly smaller probabilities of contacting that coast due to their size and dispersion rates.

The OSRA analysis for combined probability (Table C-1) largley concurs such that for those segments in the WPA, segments 4 and 6-10 were projected to have the highest probability of oil-spill landfall from the OCS Program 10 days after the spill; segments 6-10 had the highest probability after 30 days. Oil pipelines in the vicinity of land segment 4 are largely projected to be built.

Two to three OCS spills greater than 50 and less than 1,000 bbl are projected to reach land (Section IV.A.3.h.(2)). If the slicks from these smaller spills persist 3, 10, or 30 days, they may have a similar probability of contacting this coast, causing proportionally less impacts. Offshore spills in OCS waters of less than 50 bbl and inland spills are discounted from significantly impacting barrier beaches or dunes. Where needed, mechanical cleanup methods will be used, minimizing the removal of beach sand.

For non-spill events, 0.5-1.0 percent of the activities and impacts of the OCS Program are representative of the proposed action, based on Table IV-1 and BOE resource estimates.

Although 17-35 new pipeline landfalls are projected to result from OCS activities in the WPA (Section IV.B.2.a.), none are projected to significantly impact barrier beaches or dunes because of the directional boring technology used. The permitting process urges the use of these types of technology. The proposed action represents 0.5-1.0 percent of the need and impacts for these pipeline landfalls.

The average contribution of the proposed action to vessel traffic in the OCS-related navigation canals is approximately 0.06-0.12 percent. Correspondingly, 0.06-0.12 percent of beach erosion caused by interrupted littoral drift of barrier beach sediments by channel jetties and channels maintained by dredging is also accredited to the proposed action. Such impacts are considered most significant in coastal Louisiana, where sediments are inorganic and sediment supply is low.

In general, sediments from maintenance dredging of bar channels and tidal inlets can benefit barrier beaches considerably, if dredged materials are placed strategically downstream of the channel in the interrupted longshore sediment drift. Such placement would help mitigate adverse impacts caused by the presence of jetties and artificially deepened tidal passes. A corresponding 0.06-0.12 percent of the benefit would be attributable to the proposed action where it occurs. This mitigation does not occur on OCS-related channels.

Summary and Conclusion

Production streams of the proposed action and the rest of the OCS Program are mixed in the pipelines before entering State waters. For this analysis, the proposed action's oil production is projected to represent

0.1-0.7 percent of overall actions, volumes, and impacts of oil production of the OCS Program. For other OCS activities and impacts, the proposed action is said to represent 0.5-1.0 percent.

The OCS Program is projected to have 9-38 large spills (≥1,000 bbl) and 65-90 spills between 50 and 1,000 bbl in OCS waters; these spills could contact barrier beaches. OCS spills in the WPA, originally consisting of 1,000 barrels or more of oil, has a less than 0.5-95 percent probability of contacting the U.S. Gulf Coast in 10 days; if the smaller spills persist as a consolidated slick for 10 or 30 days, they would have a similar probability for landfall. Otherwise, smaller spills have significantly smaller probabilities of contacting the coast due to their size and dispersion rates. In the WPA, barrier beaches in land segments 6, 7, 8, and 10 (Jefferson, Galveston, Chambers, Brazoria, and Matagorda Counties of Texas) have the highest risk of being contacted by a spill. Where a spill contacts barrier beaches, oiling is expected to be light. Should the spill cleanups proceed as described in Section IV.A.3.h.(2), impacts are projected as moderate to minimal. Cleanup methods will be selected for minimizing removal of beach sediments. Hence, no significant impacts to the physical shape and structure of barrier beaches and associated dunes are projected to occur as a result of the proposed action.

No new coastal infrastructure (navigation channels, service bases, platform yards, petroleum terminals, etc.) is projected to be built on barrier beaches and dunes. Facilities constructed previously in or close behind dune zones where erosion rates are high will have to relocate if erosion threatens the site of the facility. The projected 128-261 new pipeline landfalls for the OCS Program in the WPA are not anticipated to cause significant impacts to barrier beaches as a result of the proposed action, due to the nonintrusive installation methods being used.

Maintenance dredging of barrier inlets and bar channels is expected to occur, which, combined with channel jetties, generally cause very localized impacts on adjacent barrier beaches downdrift of the channel due to sediment deprivation. Sediment from maintenance dredging of channels is available for use in mitigating such impacts at an additional cost to the maintenance project. The worst of these situations is found on the sediment-starved coasts of Louisiana, where sediments are largely organic. Deepening the channel to Port Fourchon, Louisiana, is expected to accelerate existing and continuing adverse impacts on nearby barrier features. The strategic placement of dredged material from deepening and maintenance of this OCS-related channel is proposed to mitigate the impact by benefitting barrier beaches immediately west of that channel's jetties. The proposed action is responsible for 0.06-0.12 percent of these impacts.

In conclusion, the proposed action is not expected to adversely alter barrier beach configurations significantly as a result of related spills or beyond existing impacts in very localized areas downdrift of artificially jettied and maintained channels. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas.

(b) Wetlands

Wetlands considered in this analysis include forested wetlands (bottomland and swamp), marshes, and seagrass beds. Swamps and marshes are scattered throughout the inland coastal zone. Seagrasses in the WPA are found as disrupted, widely scattered beds in shallow, high-salinity coastal lagoons and bays. The most extensive beds are found in Laguna Madre. Lower-salinity, submerged beds of aquatic vegetation are found inland and discontinuously in coastal lakes, rivers, and the most inland portions of some coastal bays.

The OCS oil and gas activities that could adversely affect wetlands and seagrass beds include oil spills, pipeline construction, pipeline canals, dredging of new navigation channels, maintenance dredging and vessel usage of navigation channels, and construction and maintenance of inshore facilities.

Offshore oil spills associated with the proposed action can result from platform accidents, pipeline breaks, or navigation accidents. An offshore oil spill is much less likely than an inshore spill to significantly contact vegetated coastal wetlands or seagrasses, both of which are located inland in the WPA. The OSRA analysis for conditional probability for hypothetical spills originating from generalized existing and projected future pipelines and associated platforms indicates that spills from offshore facilities within 50 mi of shore have the highest probability of contacting land. Interpretation of the OSRA analysis and pipeline and pipeline landfall distributions, as described in Section IV.D.1.a.(1)(a), indicates that the estuaries of the northeastern Texas coast (OSRA coastal segments 7-10) have the highest probabilities and risks of being contacted by an OCS-related oil spill.

Coastal spills can result from storage, barge, or pipeline accidents. Most of these occur as a result of transfer operations. U.S. Coast Guard data indicate that approximately 69 percent of coastal spills occur inland. All coastal spills projected in Section IV.B.2.d. are assumed to occur inland of the barrier coast. The proposed action is projected to represent 0.5-1.0 percent of Gulfwide, OCS oil production and related impacts. For the following analysis, spills of less than 1 bbl and about 60 percent of spills between and inclusive of 1 and 50 bbl are assumed to enter coastal waters near or at OCS-related transfer facilities, where wetlands have already been heavily impacted. These smaller spills are assumed to be confined and managed as called for in spill control requirements for such facilities, thereby causing no significant impacts on wetlands. The remaining 40 percent (4-6 spills) of coastal spills between and inclusive of 1 and 50 bbl are assumed to average 20 bbl each. The 1 or 2 spills (between and inclusive of 50 and 1,000 bbl oil) and the 1 potential spill of greater than or equal to 1,000 bbl of oil described in Section IV.B.2.d. are assumed to result from pipeline or navigation accidents away from transfer facilities.

Uncontained spills resulting from navigation accidents will be largely confined in navigation channels. Slicks will quickly spread through the channel by tidal, wind, and traffic currents. Spills that damage wetland vegetation fringing and protecting canal banks will accelerate erosion of those once-protected wetlands and spoilbanks (Alexander and Webb, 1987).

Numerous investigators have studied the immediate impacts of oil spills on wetland habitats in the Gulf area. Often, seemingly contradictory conclusions are generated from these impact assessments. This contradiction can be explained by differences in oil concentrations contacting vegetation, kinds of oil spilled, types of vegetation affected, season of year, preexisting stress level of the vegetation, soil types, and numerous other factors. In overview, the data suggest that light-oiling impacts will cause plant die-back with recovery within two growing seasons without artificial replanting. Therefore, most impacts to vegetation are considered short term and reversible (Webb et al., 1985; Alexander and Webb, 1987; Lytle, 1975; Delaune et al., 1979; Fischel et al., 1989). Because OCS-related pipelines traverse wetland areas, pipeline accidents could result in high concentrations of oil directly contacting limited areas of wetland habitats (Fischel et al., 1989) or open waters. The area of interior wetlands contacted by any given spill would be limited by the fluid nature of the oil, water levels, weather, and the density of the vegetation.

The critical concentration of oil is that concentration above which impacts to wetlands will be long term and recovery will take longer than two growing seasons, and which causes plant mortality and some permanent wetland loss. Critical concentrations of various oils are currently unknown and are expected to vary broadly for wetland types and wetland plant species. Louisiana coastal wetlands are assumed to be more sensitive to oil contact than are Texas coastal wetlands because of higher cumulative stress.

Based on data from Mendelssohn et al. (1990), recovered vegetation is expected to be the ecologically functional equivalent of unaffected vegetation. A reduction in plant density was therefore studied as the principle impact from spills. Mendelsohn and his co-workers showed that oil could persist in the soil for more than 5 years if a pipeline spill occurs within the interior of a wetland where wave-induced or tidal flushing is not regular or vigorous.

In coastal Louisiana, the critical concentration of oil resulting in long-term impacts to wetlands is assumed to be 0.1 liter per square meter (l/m^2). Concentrations less than this will cause die-back of the above-ground vegetation for one growing season, but limited mortality. Higher concentrations will cause mortality of contacted vegetation, but 35 percent of the affected area will recover within 4 years. Oil will persist in the wetland soil for at least 5 years. After 10 years, permanent loss of about 10 percent of the affected wetland area will be expected as a result of accelerated landloss indirectly caused by the spill. If a spill contacts wetlands exposed to wave attack, additional and accelerated erosion will occur, as documented by Alexander and Webb (1987).

Wetlands in Texas occur on a more stable substrate and receive more inorganic sediment per unit of wetland area than wetlands in Louisiana. They have not experienced the extensive alterations caused by canal dredging and rapid submergence rates that affect wetlands in Louisiana. The works of Webb and his colleagues (Webb et al., 1981 and 1985; Alexander and Webb, 1983 and 1985) are used to evaluate impacts of spills in these settings. For wetlands along more stable coasts, such as in Texas, the critical oil concentration is assumed to be 1.0 l/m^2 (Alexander and Webb, 1983). Concentrations below this will result in short-term, above-ground die-back for one growing season. Concentrations above this will result in

longer-term impacts to wetland vegetation, including plant mortality extensive enough to require recolonization.

Using these studies, the following model was developed. For every 50 bbl of oil spilled and contacting wetlands, approximately 2.7 ha of wetland vegetation will experience die-back. Thirty percent of these damaged wetlands are assumed to recover within 4 years; 85 percent within 10 years. About 15 percent of the contacted wetlands are expected to be converted permanently to open-water habitat.

In the WPA, seagrass beds generally occur at depths of 50 cm or less. Seagrasses have generally experienced minor damage from oil-spill occurrences (Zieman et al., 1984; Chan, 1977). The relative insusceptibility of seagrasses to oil-spill impacts is partly the result of their subtidal location in a region with a micro-tidal range. The lack of low-tide exposure protects them from direct contact with oil. The degree of impact depends on water depth, tidal events in the affected area during the presence of floating oil, and oil density. Another reason for seagrass insusceptibility to oil spills is that a large percentage of their biomass is found in the root and rhizome (from which the leaves generate), which are buried. An oil spill that moves into the shallow water depths of a seagrass area in the WPA would be expected to cause slight damage to the vegetation. Some seagrass die-back would be expected for one growing season. No permanent loss of seagrass habitat is expected to result from the spill. The major impact to seagrass communities has been to the diversity and populations of the epifaunal community found in the grass bed. In the WPA, few seagrass beds are found near OCS-related navigation channels. A spill occurring in a navigation channel is expected to dissipate before it moves over seagrass beds.

As discussed in Section IV.D.1.a.(1)(a), petroleum reservoirs in deepwater areas could require their own pipeline landfall. Table IV-12 lists the projected number of additional OCS pipeline landfalls and their inshore lengths to be constructed during the proposed action. The proposed action is attributed with 0.5-1.0 percent of primary and secondary impacts to wetlands by OCS-related coastal pipeline construction, and maintenance of those installations.

After backfilling a pipeline canal with the materials originally dredged to dig the canal, its right-of-way may revegetate or remain as a shallow waterbody. In areas where soils have high organic content, as in deltaic plains or the Chenier Plain, backfilling does not usually fill a canal completely. In areas with soils having low organic content, the canal length is usually filled and naturally revegetated after backfilling. Most disturbances, described in Section IV.B.2., are anticipated to result in temporary adverse impacts that are assumed to be partially corrected after 6 years (Tabberer et al., 1985; Wicker et al., 1989). After pipelines are constructed and backfilled in wetlands of Texas, Mississippi, and Alabama, a shallow 1.5-m-wide channel is assumed to occupy about 0.3 ha/km of canal passing through wetlands. In coastal Subarea LA-1 (Figure IV-1), 0.68 ha/km is assumed to remain after backfilling these canals. After backfilling in coastal Subareas LA-2 and LA-3, 1.05 ha/km of open water is assumed to remain. For 6 years after backfilling, productivity of vegetation in the 5-m-wide strip of wetland directly over the pipeline is assumed to be reduced by 25 percent in Texas, Mississippi, and Alabama; by 40 percent in Louisiana coastal Subarea LA-1; and by 60 percent in Louisiana coastal Subareas LA-2 and LA-3. For the same period of time, productivity of vegetation in the 2.5-m-wide strips of wetland on either side of the strip directly over the pipeline is assumed to be reduced 11 percent in Texas and Subarea MA-1, 16 percent in Subarea LA-1, and 25 percent in Subareas LA-2 and LA-3. About 30 percent of new OCS pipelines that cross the offshore Federal/State boundary do not come ashore directly but rather link up to a previously existing pipeline that already makes a landfall; hence, no landfall or onshore pipeline construction will result (Section IV.B.1.h.).

Secondary impacts of pipeline channels are considered more damaging to coastal wetlands and associated habitats than the primary impacts (Tabberer et al., 1985). Secondary impacts include expansion of tidal influence, saltwater intrusion, hydrodynamic alteration, erosion, sediment export, flank subsidence, and habitat conversion. During reviews of pipeline projects for Federal and State permits, agencies consistently comment with concern upon the extent of these secondary impacts. As a result, structures engineered to mitigate secondary adverse impacts are included as permit requirements. The number of OCS-related mitigative structures around the Gulf or in the WPA is unknown.

Decisions to not maintain structures constructed to mitigate adverse impacts of pipeline construction allow structures to deteriorate and eventually fail. The significant, indirect, and adverse impacts upon wetlands that the structures were designed to prevent or mitigate then proceed, often at an accelerated rate.

No known effort has been made to document the frequency or extent of these failures or the severity of the resulting impacts.

Widening of pipeline canals over time is one of the more obvious secondary impacts. Craig et al. (1980) studied a series of canals in Louisiana and determined that the canals widened at rates of 2-14 percent per year. Dead-end canals that conducted no traffic or significant flow were shown to widen at rates within this range. Due to their shallow nature, OCS-related pipeline canals are assumed to widen at an average rate of 4 percent per year.

The length and width of OCS-related pipeline canals around the Gulf are unknown. For the purposes of this analysis, every pipeline constructed as a result of a landfall in coastal Texas and western coastal Louisiana is assumed to be 40 km long. Each pipeline constructed in coastal Subareas LA-2, LA-3, and MA-1 is assumed to be 16 km. Hence, the 183 existing CPA-related pipeline landfalls indicate that there are 4,489 km of OCS/CPA-related pipelines. The existing average canal width is assumed to be 4 m. In Subareas TX-1 and TX-2, 25 percent of each pipeline is assumed to be through wetlands. Each associated canal through wetlands will widen by 1 percent per year. In Subareas LA-1, 50 percent of the pipeline will be through wetlands, with widening rates of 3 percent per year. In Subareas LA-2 and LA-3, 75 percent will be in wetlands, with widening at 5 percent per year. In Subarea MA-1, 30 percent of the pipeline length will be through wetlands, with widening at 1 percent per year.

The present practice of discharging OCS-related produced water into inshore waters is anticipated to be discontinued by the year 2000. All OCS-produced waters transported to shore will either be injected or disposed of in Gulf waters and will not affect coastal wetlands (Section IV.B.2.).

No new navigation channel construction is anticipated as a result of the proposed sale. OCS Program deepwater activities are anticipated to increase, requiring use of some larger service vessels for efficient operations, which may shift some deepwater activities to shore bases associated with deeper channels. Some of the ports that can presently accommodate deeper-draft vessels may expand accommodations for these deeper-draft vessels. One example is Port Fourchon, which is deepening existing channels and dredging additional channels to facilitate its expansion. About 90 percent of the impacts generated by deepening the Port Fourchon Channel will be attributable to the OCS Program; 0.5-1.0 percent of this is attributable to the proposed action. Saltwater intrusion will not be a problem because the project will extend only 8.5 km inland and will be entirely in a saline environment where the existing dominant vegetation thrives in higher salinities.

Impacts to wetlands can occur from periodic maintenance dredging of navigation channels. If dredged material is deposited on existing spoil banks and disposal areas, the effects of spoil banks on wetland drainage is expected to continue unchanged, although there may be some localized and minor aggravation of existing problems. Typically, some dredged material intended for placement on a spoil bank is placed in adjacent wetlands or shallow water. Wetland loss due to this action is assumed to be offset by wetland creation as adjacent margins of shallow water are filled. In both cases, areas impacted are considered small. Even so, maintenance dredging will also temporarily increase turbidity levels in the vicinities of the dredging and disposal of materials, which could be harmful to seagrasses and other submerged vegetation.

The placement of dredged materials on wetland surfaces or on older spoil banks where underlying soils are composed largely of organic materials compresses the supporting soils and warps adjacent wetland surfaces downward, forming impoundments. This impact is referred to as flank subsidence. The MMS has funded a study that will be quantifying this and other canal-related impacts, which should provide insights for identifying these past and future impacts.

Executive Order 11990 requires that material from maintenance dredging be considered for use as a sediment supplement in deteriorating wetland areas to enhance and increase wetland acreage, where appropriate. Disposal of dredged material for marsh enhancement has been done only on a limited basis (Section IV.B.2.). Given the "mission statement" of the COE, which requires it to take environmental impacts into consideration during its decision-making processes, increased emphasis has been placed on the use of dredged material for marsh creation. For the proposed action, increased use of dredged material to enhance wetland habitats is encouraged as mitigation.

According to Johnson and Gosselink (1982), canals that have high navigation usage in coastal Louisiana widen about 2.58 m/yr, compared with 0.95 m/yr for little used canals. On average, the OCS-related

navigation canals are assumed to generally widen at an average rate of 1.5 m/yr. Approximately 2,020 km of OCS-related navigation canals, bayous, and rivers are found in the coastal regions around the Gulf, exclusive of channels through large bays, sounds, and lagoons. About 440 km of these channels are found around the WPA; another 810 km are found in Subarea LA-1. Prop-wash of vessel traffic in navigation canals resuspends sediments, increasing the turbidity of nearby coastal waters. Increased turbidity has the greatest potential impact upon seagrasses and other submerged vegetation. Major navigation canals, however, are not located close to known seagrass beds in the WPA.

Produced sands, oil-based drilling muds and cuttings, and some fluids from well treatment, workover, and completion activities will be transported to shore for disposal. Sufficient disposal capacity is assumed to be available for the proposed action (Sections IV.B.1.f. and g.). Due to permitting requirements, no new waste disposal site will be developed in wetlands. Some seepage from waste sites into adjacent wetland areas may occur and result in damage to wetland vegetation. State requirements should be enforced to prevent and correct such occurrences.

Various kinds of onshore facilities service OCS development. These facilities are described in Section IV.B.1. and Table IV-12. The placement of new facilities and the expansion of existing facilities in wetlands is discouraged by State and Federal permitting agencies. Any impacts upon wetlands are usually mitigated. All projected new facilities are attributed to the OCS Program, with an appropriate proportion attributed to the proposed action.

Proposed Action Analysis

The proposed action represents 0.5-1.0 percent of the OCS Program activities and related impacts in the Gulf during the period 1998-2032. With regard to oil specifically, the proposed action is projected to represent 0.1-0.7 percent of oil production and transport by the OCS Program in the Gulf during the period of 1998-2032 (derived from Table IV-1). Oil production of the proposed action is said to be mingled in pipelines with other OCS production at sea before going ashore. Resulting proposed action impacts of oil production for the purposes of this analysis then represents about 0.1-0.7 percent of the impacts of that of the Gulf OCS Program. About 5 percent of oil-production, coastal impacts of the proposed action are assumed to occur in Louisiana.

Sections IV.A.3.h.(2) and IV.B.2.d. provide projected numbers of offshore and coastal spills estimated to occur as a result of the proposed action. As discussed above, no offshore spills are assumed to significantly contact inshore wetlands. Should such a contact occur, oiling will be very light and spotty with short-term impacts to vegetation.

Coastal spills are the greater spill threat to interior wetlands. Using the spill projections in Tables IV-3 and IV-19 and the above spill assumptions, the proposed action's spills are projected to represent about 160-1,270 bbl of oil. These volumes are projected to impact about 9-70 ha of wetlands. After 4 and 10 years, about 2.7-21 and 7.7-58 ha initially impacted will recover, respectively. About 1.3-11 ha of wetlands will be converted to open water.

Table IV-12 shows the distribution of projected new, OCS-related pipeline landfalls and inland pipeline lengths for the proposed action. Table IV-20 provides projected wetland hectares that may be impacted by installation of inland projected inland pipelines that are directly related to these landfalls.

The resulting wetland losses caused by the widening of existing and projected inshore pipeline and navigation canals through wetlands are projected in Table IV-21. On average, 12 percent of traffic using OCS-related navigation channels is related to the OCS Program. Hence, 0.06-0.12 percent of the use of OCS-related navigation channel usage and impacts is attributed to the proposed action. Since the number of OCS-related mitigative structures is unknown, impacts creditable to the proposed action cannot be calculated. Associated with mitigation structures and canals are the impacts of altered hydrology and flank subsidence, for which methods of projecting rates of occurrence and extent of influence have not yet been developed. A MMS study of canal-impact issues has been funded and will have begun during the summer of 1997. These projections will be updated for subsequent EIS's using data presently being developed.

Table IV-20

Projected New Onshore Pipelines and Projected Impacts upon Wetlands
by the OCS Program and the Portion Representative of the Proposed Action (RPA)
during the Period 1998-2032

		TX-1	TX-2	Total
Pipeline in Wetlands (km)	OCS	16.5-32	140-280	156.5-312
	RPA	0.1-0.3	0.7-2.8	0.8-3.1
Wetlands Impacted (ha)	OCS	50-110	450-890	500-1,000
	RPA	0.3-1.0	2.3-8.9	2.6-9.9
Wetlands Converted to Open Water (ha)	OCS	7.4-14.3	60-130	67.4-144.3
	RPA	0-0.1	0.3-1.2	0.3-1.3
Wetland with 6-yr Reduced Plant Productivity (ha)	OCS	12-22	100-200	112-222
	RPA	0-0.1	0.1-0.6	0.1-0.7

Table IV-21

Projected Hectares of Wetlands Lost Due to Erosive Widening
of Existing and Projected OCS-Related Canals in Wetlands and
the Portion Representative of the Proposed Action (RPA)
during the Period 1998-2032

		TX-1	TX-2	LA-1	Total
Existing Pipeline Canals	OCS	4.5-5.5	39-48	NA	43.5-535
	RPA	0.0-0.1	0.2-0.5	NA	0.2-0.6
Projected Pipeline Canals	OCS	1.2-5	17.7-35	NA	18.9-40
	RPA	0.02-0.15	0.2-1.1	NA	0.22-1.25
Existing Navigation Canals	OCS	50-70	180-250	510-650	740-830
	RPA	0.3-0.5	0.9-1.9	2.6-5.1	3.8-7.5
Total	OCS	55.7-80.5	236.7-333	510-650	802.4-1,063.5
	RPA	0.32-0.75	1.3-3.5	2.6-5.1	4.22-9.35

Ninety percent of the need to deepen the Fourchon Navigation Channel is presently attributed to OCS Program activities. Hence, the creation of 0.1-0.3 ha of wetlands resulting from sediment placement and impoundments of the Fourchon Channel project can be attributed to the proposed action as mitigation. These sites in the Fourchon area may later be filled to provide additional commercial sites for this developing port facility. In this event, wetland mitigation and gains will be lost if not relocated.

Because much of the dredged material resulting from maintenance dredging will be placed on existing spoil disposal sites or used to enhance wetland habitats, no significant adverse impacts are expected to occur to wetlands from maintenance dredging credited to the proposed action.

Summary and Conclusion

Offshore oil spills resulting from the proposed action are not expected to significantly damage inland wetlands. As related to the proposed action, inland oil spills are expected to cumulatively impact about 9-70 ha of wetlands. Although these losses may occur broadly over these coastal regions, they have the highest probability of occurring in the coastal regions generally northeast of Matagorda County, in the vicinities where WPA oil is handled. After 4 and 10 years, about 2.7-21 and 7.7-58 ha, respectively, are projected to recover from the oil-spill impacts; 1.3-11 ha of wetlands are projected to be converted to open water. Five percent of these impacts are assumed to occur in Louisiana.

Seagrasses may be contacted by low concentrations of oil, if any, from these spills. No permanent impacts to seagrass are expected, although the epifauna in those beds will be damaged for 1-2 years.

The proposed action is projected to contribute to the construction of 17-35 new onshore pipelines in the WPA. The proposed action is representatively projected to impact about 2.6-10 ha of wetlands. Of that representative area, vegetative productivity on 0.1-0.7 ha will be suppressed; 0.3-1.3 ha would be converted to open water. As a secondary impact, wetlands will be converted to open water by continued widening of existing pipeline and navigational canals. The proposed action is projected to cause the loss of about 4.2-9.4 ha of the wetlands.

Maintenance dredging of navigation channels related to the proposed action are expected to occur with minimal impacts. Alternative dredged-material disposal methods can be used to enhance and create coastal wetlands.

Deepening an existing channel to accommodate larger service vessels is expected to occur within a saline marsh environment and affords the opportunity for creating 0.1-0.3 ha of wetlands attributable to the proposed action.

In conclusion, adverse impacts of installation, maintenance, continued existence, and the failure of mitigation structures of pipeline and navigation canals are considered the most significant continuing OCS-related and proposed action-related impacts to wetlands. Although these OCS-related impacts are considered locally significant where OCS-related canals pass through wetlands, the proposed action-related impacts would not be considered significant because of their low representative percentages of the OCS Program, their broad and diffuse distribution over coastal Texas, and the difficulty in distinguishing them from other ongoing, OCS-related impacts to wetlands.

(2) Impacts on Sensitive Offshore Resources

(a) Deepwater Benthic Communities

The deepwater chemosynthetic communities consist of organisms that are apparently most abundant in waters deeper than 400 m and that derive their energy, in the absence of light, from chemosynthetic processes rather than the photosynthetic processes of shallow water (see Section III.B.2.b. for a more detailed discussion of these communities). The primary chemosynthetic organisms are bacteria, both free-living as "bacterial mats" and symbiotic in the tissues of other organisms. The predominant large animals are tube worms, clams, and mussels.

The greatest potential for adverse impacts to deepwater chemosynthetic communities would come from those OCS-related, bottom-disturbing activities associated with pipelaying (Section IV.A.2.b.(1)), anchoring (Section IV.A.3.b.(1)), and structure emplacement (Section IV.A.3.a.), as well as from a seafloor blowout (Section IV.A.3.h.(1)). These activities cause localized bottom disturbances and disruption of benthic communities in the immediate area. Considerable mechanical damage could be inflicted upon the bottom by routine OCS drilling activities. The drilling operation itself disturbs a small bottom area. The presence of a conventional structure can cause scouring of the surficial sediments (Caillouet et al., 1981). Anchors from support boats and ships (or, as assumed in these water depths, from any buoys set out to moor these vessels), floating drilling units, and pipelaying vessels also cause severe disturbances to small areas of the seafloor. Many oil and gas support operations involving ships and boats would not result in anchor impacts to deepwater chemosynthetic communities because the vessels would tie-up directly to rigs, platforms, or

mooring buoys. In addition, there are at least two drill rigs operating in the Gulf of Mexico that rely on dynamic positioning rather than conventional anchors to maintain their position during drilling operations. The area affected by anchoring operations will depend on the water depth, length of the chain, size of the anchor, and current. Anchoring will destroy those sessile organisms actually hit by the anchor or anchor chain during anchoring and anchor weighing. While such an area of disturbance may be small in absolute terms, it may be large in relation to the area inhabited by dense chemosynthetic communities. Normal pipelaying activities in deepwater areas could destroy large areas of chemosynthetic organisms (it is assumed that 0.32 ha of bottom is disturbed per kilometer of pipeline installed). Pipelines will likely be used to transport the product ashore from those deepwater areas near the current pipeline network in both the Central and the Western Gulf. In areas not near the existing pipeline network, shuttle tankering might substitute for pipelines as a means of transporting the product; therefore, impacts to these deepwater communities would be precluded in the more isolated areas.

Because of the great water depths, discharges of drilling muds and cuttings are splayed across broader areas of the seafloor and are, in general, distributed in thinner accumulations than in shallower areas on the continental shelf. Information derived from a geophysical survey has documented the extent of drilling discharges at several previously drilled oil and gas sites in about 400 m water depths (Nunez, personal communication, 1994). At these sites, splays of cuttings were found extending from the previous well locations in finger-like projections to a maximum of about 610 m (and an average of about 450 m). An examination of side scan sonar record of these splays indicates that they were distributed in thin accumulations, less than 0.3 m thick. Little is known about the vulnerability of chemosynthetic organisms to sedimentation/smothering impact, but they may be less sensitive than the filter-feeding organisms of the pinnacle trend live bottoms. Individual tube worms are often found buried for more than half the length of their tubes by hemipelagic sediment (MacDonald, 1992). Presumably this burial occurs over long time intervals. Evidence of catastrophic burial of chemosynthetic communities can be found in the paleo-record as documented by Powell (1993). These burials were probably caused by catastrophic seismic events. Produced-water effluents from OCS operations are not projected to reach the seafloor at depths greater than 100 m (Section IV.A.3.d.) and would therefore not impact these organisms.

A blowout at the seafloor could resuspend large quantities of bottom sediments and even create a large crater, destroying many organisms nearby. Structure removals and other bottom disturbing activities could resuspend bottom sediments, but not at magnitudes as great as blowout events.

Because these communities use petroleum hydrocarbons as a food source (and indeed have been seen to be living among oil and gas bubbles), oil spills are not considered to be a potential source of adverse impacts. Thus, oil spills would have no impact on these communities.

The majority of the deepwater chemosynthetic communities are of low density and are widespread throughout the deepwater areas of the Gulf, so disturbance or destruction of a small area would not result in a major impact to chemosynthetic communities as an ecosystem. Areas so impacted could be repopulated from nearby undisturbed areas (although this process may be quite slow, especially for vestimentiferans).

High-density, Bush Hill-type communities are areas of high biomass and productivity found in association with high seafloor concentrations of seeping hydrocarbons. It is these chemosynthetic areas that are considered to be most at risk from oil and gas operations. The disturbance of a Bush Hill-type community could lead to the destruction of a community from which recovery would occur only over long time intervals (perhaps 200 years for a mature tube worm colony and 25-50 years for a mature mussel community) or would not occur at all. Recent information (MacDonald, 1993) indicates that the vulnerability of dense chemosynthetic communities to oil and gas impacts may depend on the type of community present. Tube worm and mussel communities may be more vulnerable than clam communities since they are less mobile and require longer time periods to reach larger (adult) sizes. The Notice to Lessees (NTL) 88-11 (which became effective on February 1, 1989) formalizes the MMS review process and makes mandatory the search for and avoidance of dense chemosynthetic communities (such as Bush Hill-type communities) or areas that have a high potential for supporting these community types, as interpreted from geophysical records. Under the provisions of this NTL, lessees operating in water depths greater than 400 m are required to interpret the geophysical records of that area for conditions that might indicate that the area may support chemosynthetic communities; if such conditions exist, the lessee must either move the operation

or provide photo-documentation of the presence or absence of chemosynthetic communities of the Bush Hill type. If such communities are indeed present, no drilling operations may take place in the area; if the communities are not present, drilling may proceed. The requirements set forth in NTL 88-11 are considered very effective in identifying areas of chemosynthetic communities. On rare occasions chemosynthetic community areas may not be properly identified by these procedures. Information from the Chemosynthetic Ecosystem Study (MacDonald, 1994) has greatly increased our confidence that the dense, Bush Hill-type communities are closely associated with the largest, most persistent, high-volume hydrocarbon seeps, which are the seeps most easily detected using standard geohazard survey methods. As new information becomes available, the NTL will be modified as necessary.

NTL 88-11 is a nonsale-specific mitigation measure applicable to all operations in appropriate water depths. These activities must conform to the protective measures outlined in the NTL and summarized above. Because of the administrative nature of an NTL, it is exercised on all applicable leases and is not an optional protective measure at the discretion of the Secretary of the Interior. The implementation of an NTL is unlike the stipulations proposed within this document. The stipulations are sale-specific protective measures that apply to specific leases and that may or may not be adopted by the Secretary at each lease sale.

An issue about which little is known, but about which there has been some speculation, is the potential impact to chemosynthetic organisms by the withdrawal by oil and gas production of their energy source--the hydrocarbons--from beneath the community. The seeps and vents around which these animals live are presumably pressurized from the deep reservoirs that force the gas or oil to the seafloor. When all of the recoverable hydrocarbons from these reservoirs are withdrawn by production operations (the amount that can be economically extracted by current technology is estimated to be 30% or less of the total hydrocarbons), it is possible that oil and gas venting or seepage would also slow or (more unlikely) stop. Current information does not allow a determination to be made as to whether this slackening of the pressure, which drives the seeps, would be reduced quickly (as they have been on land) or whether there may be enough oil already in the "conduit" to the surface to continue adequate levels of seepage for long periods. Such long-term impacts are poorly understood, but the distribution of these communities is known to occur in association with precise levels and types of chemical gradients at the seafloor; alterations to these gradients may potentially impact the type and distributions of the associated community. Ongoing studies of these communities have been designed to provide information that will lead to the resolution of this and other issues.

Proposed Action Analysis

Because high-density chemosynthetic communities are found only in water depths greater than 400 m, they would not be found in Subareas W0-60 or W60-200. They could be found within Subarea W200-900 and throughout Subareas W900-3000 and W3000+ (no activities are projected for offshore Subarea W3000+ because MMS resource estimates indicate that no economically recoverable resources exist in water depths greater than 3,000 m). The levels of projected impact-producing factors for Subareas W200-900 and W900-3000 are shown in Table IV-2. A total of 15-56 exploration and delineation wells are assumed to be drilled, 2-5 production structures installed, and several hundred kilometers of pipeline installed. Only one blowout is projected in these two subareas.

As noted above, the majority of these deepwater communities are of low density and are widespread throughout the deepwater areas of the Gulf. Physical disturbance to a small area would not result in a major impact to the ecosystem. The frequency of such impact is expected to be low, and the severity of such an impact is judged to result in minor disturbance to ecological function of the community, with no alteration of ecological relationships with the surrounding benthos.

High-density communities are, as noted above, largely protected from direct physical impacts by the provisions of NTL 88-11. Only a limited number of these communities have been found to date, but it is possible that more undiscovered communities exist. The impacts from bottom-disturbing activities are expected to be quite rare. Should they occur, these impacts could be quite severe to the immediate area affected, with recovery times as long as 200 years for mature tube worm communities. The severity of such an impact is such that there may be incremental losses of productivity, reproduction, community

relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

Low-density communities may occasionally sustain minor impacts from discharges of drill muds and cuttings or resuspended sediments. These impacts are most likely to be sublethal in nature and would be limited in areal extent. The consequences of these impacts to these widely distributed low-density communities are considered to be minor with no change to ecological relationships with the surrounding benthos.

High-density chemosynthetic communities would be largely protected from discharges of drill muds and cuttings and resuspended sediments by the provisions of NTL 88-11. The NTL is designed to direct oil and gas activities away from the vicinity of these communities. Other routine discharges from oil and gas operations are not expected to reach the depths where these communities exist. Drilling muds and cuttings would normally be spread out thinly over a large area, if they are deposited at all. Should these communities be exposed to these discharges or resuspended sediments, impacts would likely to be sublethal in nature and limited in areal extent. High-density communities are widely distributed, but few in number and limited in size. They have a high standing biomass and productivity. The consequences of these impacts to the ecological function of high-density communities would be minor with recovery occurring within 2 years. Minor impacts to ecological relationships with the surrounding benthos would also be likely.

Summary and Conclusion

The most serious impact-producing factor threatening the chemosynthetic communities is physical disturbance of the bottom, which could destroy the organisms comprising these communities. Such disturbance would come from those OCS-related activities associated with pipelaying, anchoring, structure emplacement, and seafloor blowouts. Drilling discharges and resuspended sediments have a potential to cause minor, mostly sublethal, impacts to chemosynthetic communities. Seafloor disturbance is considered to be a threat only to the high-density (Bush Hill-type) communities; the widely distributed low-density communities would not be at risk. The provisions of NTL 88-11 (currently in effect), requiring surveys and avoidance prior to drilling, will greatly reduce the risk of physical disturbance.

The proposed action is expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density Bush Hill-type chemosynthetic communities could experience minor impacts from drilling discharges or resuspended sediments, with recovery expected within 2 years. If physical disturbance (such as anchor damage) to high-density Bush Hill-type communities were to occur, impacts could be severe over a limited area, with recovery times as long as 200 years for mature tube worm communities. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

(b) Topographic Features

The topographic features of the Western Gulf sustaining sensitive offshore habitats are listed and described in Section III.B.2.

A Topographic Features Stipulation similar to the one described in Section II.C.1.c.(1) has been included in appropriate leases since 1973 and may, at the option of the Secretary, be made a part of appropriate leases resulting from this proposal. The impact analysis presented below for the proposed action includes the proposed biological lease stipulation. As noted in Section II.C.1.c.(1), the stipulation establishes a No Activity Zone in which no bottom-disturbing activities would be allowed and areas around the No Activity Zones (in most cases) in which shunting of drill cuttings and drilling fluids to near the bottom would be required.

The potential impact-producing factors on the topographic features of the Western Gulf are anchoring (Section IV.A.3.b.(1)), structure emplacement (Section IV.A.3.a.), effluent discharges (Section IV.A.3.d.), oil spills (Sections IV.A.3.h.(2)), blowouts (Section IV.A.3.h.(1)), and structure removal (Section IV.A.3.c.).

These disturbances have the potential to disrupt and alter the environmental, commercial, recreational, and aesthetic values of topographic features in the WPA.

The anchoring of pipeline lay barges, drilling rigs, or service vessels, as well as the emplacement of structures (e.g., pipelines, drilling rigs, or production platforms), potentially results in mechanical disturbances of the benthic environment. Anchor damage has been shown to be the greatest threat to the biota of the offshore banks in the Gulf (Bright and Rezak, 1978; Rezak et al., 1985). Such anchoring damage, however, would be prevented within any given No Activity Zone by the observation of the Topographic Feature Stipulation.

Considering the relatively elevated amounts of drilling muds and cuttings discharged per well (10,542 bbl/exploratory well; 7,436 bbl/development well) (USEPA, 1993), potential impacts on biological resources of topographic features should be particularly considered in the case of drill sites occurring in blocks directly adjacent to No Activity Zone boundaries (Topographic Features Stipulation). Potential impacts could be incurred through increased water-column turbidity, the smothering of sessile benthic invertebrates, and local accumulations of contaminants. The USEPA general NPDES permit sets special restrictions on discharge rates for muds and cuttings adjacent to topographic features bound by a No Activity Zone, so as to limit effects. Section IV.A.3.d. details the permit's general restrictions and the impacts of drilling muds and cuttings on marine water quality and seafloor sediments. The levels and areal extent of discharged contaminants measured in the water column or sediments will be reduced from levels and extent measured in the past because current USEPA regulations and NPDES permits contain more restrictive limits (Section IV.A.3.d.(9)). The effects of past muds and cutting discharges are discussed in Section IV.A.3.d.(1). A brief overview of the potential impacts on topographic features by drilling discharges follows.

Water-column turbidity and the smothering of sessile invertebrates of topographic features, if they were to be caused by drilling muds and cuttings, would probably be of little significance for two reasons. First, the Topographic Features Stipulation would limit the impact through the No Activity Zone, the shunting restrictions imposed within the 1-Mile Zone and 1,000-Meter Zone, and the USEPA general NPDES permit special restrictions on discharge rates in blocks adjacent to a No Activity Zone or sensitive areas, necessitating photodocumentation by industry. Secondly, studies have shown the rapid dispersion of drilling fluid plumes in the OCS within a 1,000-m range of the discharge point and the resilience of sessile invertebrates exposed or smothered with an extreme range of concentrations of drilling muds (Kendall, 1983). As for the local accumulation of contaminants, it is assumed that trace metal and petroleum contamination resulting from drilling muds and cuttings will occur mainly within a few hundred to a couple of thousand meters downcurrent from the discharge point and can be found up to 3,000 m downcurrent in shallow waters. Concentrations of contaminants decrease with an increasing distance from the drilling site. By examining sediments surrounding three gas production platforms (within a 100-m radius), Kennicutt et al. (1996) found low concentrations of petroleum and trace metal contaminants that would probably not induce a biological response in benthic organisms. The highest trace metal concentrations originating from discharged drilling fluids and found around platforms were strongly correlated with the presence of sand-size sediments. Shallow sites are subject to comparatively greater sediment removal and resuspension due to a high energy environment. Contaminants from previous discharges under less restrictive conditions have been found to remain in sediments surrounding drill sites for as long as 10 years (Kennicutt et al., 1996). Toxic effects could be incurred by benthic organisms of topographic features found in the vicinity of a No Activity Zone boundary should the plume flow of an operation consistently be directed toward and reach that boundary. Should effects occur, they would potentially persist for as long as 10 years following the onset of discharges.

Produced waters could also represent a significant potential source of impact to the biota of topographic features, considering that produced water constitutes the largest single discharge during routine oil and gas operations. The USEPA general NPDES permit's restrictions on the discharge of produced water limit the impacts on biological resources of topographic features. The recent evaluation of the bioaccumulation of offshore produced-water discharges conducted by the Offshore Operators Committee (1997) assessed that metals discharged in produced water would at worst affect living organisms found in the immediate vicinity of the discharge, particularly those attached to the submerged portion of platforms. Naturally occurring radioactive material in produced water was not found to bioaccumulate in marine animals (2 species of

molluscs, 5 species of fish). Because high molecular polycyclic aromatic hydrocarbons (PAH's) are usually in such dilute concentrations in produced water, they were found to pose little threat to marine organisms and their consumers, and were anticipated to not biomagnify in marine food webs. Monocyclic hydrocarbons and other miscellaneous organic chemicals are known to be moderately toxic but do not bioaccumulate to high concentrations in marine organisms, and are not known to pose a risk to their consumers.A detailed description of the impacts of produced waters on water quality and seafloor sediments is presented in Section IV.D.1.a.(3).

Oil spills potentially affecting topographic features and their biological communities could result from surface and seafloor spills. Surface oil spills may occur as a result of tanker spillages or platform spills. Spills on the seafloor could be caused by a tanker accident, pipeline rupture, or well blowout. Both surface and subsurface spills could result in a steady discharge of oil over a long period of time. The depth to which topographic features rise in the northern Gulf of Mexico (to within 15 m (49 ft) of the sea surface) and their distance from shore (more than 103 km (64 mi)) should protect any of the tropical reef plant and animal species they harbor from surface oil slicks. Oil from a surface spill can be driven into the water column; measurable amounts have been documented down to a 10-m depth, although modeling exercises have indicated such oil may reach a depth of 20 m. At this depth, the oil is found at concentrations several orders of magnitude lower than the amount shown to have an effect on corals (Lange, 1985; McAuliffe et al., 1975 and 1981; Knap et al., 1985). Because the crests of topographic features in the northern Gulf are found below 10 m, no concentrated oil from a surface spill could reach their sessile biota.

A subsurface oil spill could reach a topographic feature and would have the potential of considerably impacting the local biota contacted by the oil. Such impacts on the biota may cause severe and long-lasting consequences, including loss of habitat, loss of biodiversity, loss of live coverage, destruction of hard substrate, change in sediment characteristics, and reduction or loss of one or more commercial and recreational fishery habitats.

Subsurface spills could result in the formation and settling of oil-saturated material, and oil-sediment particles could come into contact with living coral tissue. Yet, a subsurface spill should rise to the surface, and any oil remaining at depth would probably be swept clear of the banks by currents moving around the banks (Rezak et al., 1983). Should any of the oil spilled come in contact with adult sessile biota, effects would be primarily sublethal, with few incidences of actual coral mortality. The sublethal effects could be long-lasting and affect the resilience of coral colonies to natural disturbances (e.g., elevated water temperature, diseases) (Jackson et al., 1989).

CSA (1992) modeled the potential impacts of a pipeline rupture using worst case scenario and assumptions (10,000 bbl spilled over 2-7 days) to maximize the estimates of dispersed oil concentrations reaching four topographic features (East Flower Garden, West Flower Garden, MacNeil, and Rankin Banks). In their model, CSA estimated that the worst case concentrations of crude oil reaching the four banks would be sublethal to the corals and much of the other biota present.

CSA (1994) also investigated the potential effects of oil spilled from a platform-pipeline complex proposed for installation near the Flower Garden Banks using a worst case scenario of high oil concentrations. Twenty-four different spill scenarios from two platforms and three pipelines were modeled (the maximum concentration of oil reaching the East Flower Garden Bank). The most damaging scenarios resulting from this modeling effort included a 2,617-bbl/day and a 1,000-bbl/day spill, both lasting 30 days and both occurring at the same platform location. Although the model predicted no acute toxicity to reef coral colonies, the values were within the range of acute toxicity to embryos and larvae of fish, corals, and other invertebrates.

In 1996, the Regional Response Team for Region VI (including the coastal states of Texas and Louisiana) approved the use of chemical dispersants on surface oil spills in exclusion zones of the northern Gulf such as the Flower Garden Bank National Marine Sanctuary (revised Federal On-Scene Coordinator Preapproved Dispersant Use Manual-Region VI Oil and Hazardous Substances Pollution Contingency Plan). Depending on the toxicity of the dispersant used, tradeoffs to responding to surface oil spills using dispersants include impacts on pelagic organisms and on the adult as well as the larval stages of benthic organisms on topographic features. Gulf of Mexico oil, however, is usually dispersed with Corexit 9527 and would reach the benthic dwellers at very low concentrations (less than 1 ppm) taking into account the depth

of the crests of topographic features (greater than 15 m), the dilution by seawater, and the added dispersion by currents. Such low oil concentrations would not be life threatening to larval or adult stages at depth (Fucik et al., 1994). Dispersants would probably not be approved during coral spawning time periods (e.g., August-September for major reef-building species) (Gittings et al., 1992b and 1994) in order to limit the impacts of oil pollution on the near-surface portion of the water column.

Dodge et al. (1995) observed that, compared to a control site and to a site exposed to oil alone, a 2-m deep reef environment off the Caribbean coast of Panama was negatively impacted by dispersed oil (probably at a concentration greater than 10 ppm) as it reduced the cover of all reef organisms as much as 40 percent, and particularly that of live substrate binding sponges. Ten years later, the same impacted sites regained or even exceeded their respective pre-impact live cover. Guzman et al. (1991), however, found that a prolonged exposure to oil alone, as well as a chronic exposure to oil, greatly depressed both the coverage and growth rates of reef corals within a 6-m-deep reef area along the Caribbean coast of Panama. Also, Bak (1987) showed that reef corals on the shallow (4-6 m) southwestern shore of Aruba (Netherlands Antilles) had incurred mortality, decreases in live coral cover by as much as 70 percent, reductions of species diversity (as many as 10 out of 24 species missing), and reef structural changes over a 10- to 15-km downstream shore length as a result of the exposure to long-term (1929-1985) and chronic oil spills, dispersed oil, and refinery discharges. *Diploria strigosa* appeared to be more resilient to oil pollution than other reef coral species since its cover did not seem to be affected by the pollutants. Therefore, it has been shown that oil as well as dispersed oil have the potential to greatly impact reef coral communities, particularly when the exposure is chronic and long term. The time needed for the recovery of such impacted reefs could exceed 10 years and would depend on the frequency and impact of future human-made and natural disturbances.

The proposed stipulation would preclude drilling in a No Activity Zone to prevent adverse effects from nearby drilling on topographic features. Oil spills originating outside the No Activity Zones would be dispersed to diluted concentrations in the water column prior to reaching topographic features (CSA, 1992 and 1994).

Oil or gas well blowouts are possible occurrences in the OCS. The benthic community exposed to the large amounts of resuspended sediments following a subsurface blowout could be subject to sediment smothering, exposure to resuspended toxic contaminants, and light attenuation. Should oil or condensate be present in the producing reservoir, liquid hydrocarbons could be an added source of negative impact on the benthic community (low-molecular-weight gases would dissolve in the water column until saturation is reached). The amounts of oil or sediments that settle vary as a function of the specific gravity of the oil or the sediments, and their dilution, dispersion, and response to currents (Brooks and Bernard, 1977). In most cases, currents should sweep the impact-producing materials around a topographic feature rather than deposit them on top of it (Rezak et al., 1983). The bulk of the blowout materials would be redeposited within a few thousand meters of their source (sand would be redeposited within 400 m of the blowout site). The extent of the damage incurred by the benthic community would depend on the amount and duration of exposure to sediments or oil. The consequences of a blowout directly on or near a topographic feature could last more than 10 years. Since the proposed stipulation would preclude drilling in the No Activity Zone, most adverse effects on topographic features from blowouts would likely be prevented.

The impacts of structure removal on topographic features can include water turbidity, sediment deposition, and explosive shock wave impacts. Both explosive and nonexplosive removal operations would disturb the seafloor by creating turbidity. Explosive methodologies generate considerably more turbidity. The deposition of resuspended sediments would occur much in the same manner as discussed for discharges of muds and cuttings, and would smother and perhaps cause the mortality of sessile benthic organisms. Turbidity could both reduce light levels and obstruct filter-feeding mechanisms, leading to reduced productivity, susceptibility to infection, and mortality. The shock waves produced by the explosive structure removals could also harm neighboring biota. Corals and other sessile invertebrates are apparently resistant to shock. O'Keeffe and Young (1984) described the impacts of underwater explosions on various forms of sea life using, for the most part, open-water explosions much larger than those used in typical structure removal operations. They found that sessile benthic organisms, such as barnacles and oysters, and many motile forms of life, such as shrimp and crabs, that do not possess swim bladders, were remarkably resistant to shock waves generated by underwater explosions. Oysters located 8 m away from the detonation of 135-

kg charges in open water incurred a 5 percent mortality. Crabs distanced 8 m away from the explosion of 14-kg charges in open water had a 90 percent mortality rate. Few crabs died when the charges were detonated 46 m away. O'Keeffe and Young (1984) also noted ". . . no damage to other invertebrates such as sea anemones, polychaete worms, isopods, and amphipods." Benthic organisms appear to be further protected from the impacts of subbottom explosive detonations by the very rapid attenuations of the underwater shock wave traversing the seabed away from the structure being removed. The shock wave attenuation is significantly less in mud than in the water column where it is known to impact fish up to 60 m away from a 11.3-kg charge blasted at a 100 m depth (Baxter et al., 1982). Theoretical predictions suggest that the shock waves of explosives set 5 m below the seabed as required by MMS regulations would further attenuate blast effects. Charges used in OCS structure removals are typically much smaller than some of those cited by O'Keeffe and Young. The *Programmatic Environmental Assessment for Structural Removal Activities* (USDOI, MMS, 1987a) predicts low impacts on the sensitive offshore habitats from platform removal precisely because of the effectiveness of the proposed stipulation in preventing platform emplacement in the most sensitive areas of the topographic features of the Gulf of Mexico. Impacts on the biotic communities, other than those on or directly associated with the platform, would be conceivably limited by the relatively small size of individual charges (normally 22.7 kg or less per well piling and per conductor jacket) and by the fact that charges are detonated 5 m below the mudline and at least 0.9 seconds apart (timing needed to prevent shock waves from becoming additive). The stipulation discussed above would preclude platform installation in the No Activity Zone, thus preventing adverse effects from nearby removals.

Structure emplacement and pipeline emplacement are other oil and gas activities that could resuspend sediments. The proposed stipulation would also prevent these activities from occurring in the No Activity Zone, thus preventing most of these resuspended sediments from reaching the biota of the banks.

Proposed Action Analysis

All of the 23 topographic features (shelf edge banks, low-relief banks, and south Texas banks) in the Western Gulf planning area are found in waters less than 200 m deep. They represent a small fraction of the Western Gulf area. The fact that the topographic features are widely dispersed in the Western Gulf, combined with the probable random nature of oil-spill locations, would serve to limit the extent of damage from any given oil spill to any one of the sensitive areas.

As noted above, the proposed Topographic Features Stipulation could prevent most of the potential impacts from oil and gas operations on the biota of topographic features, including direct contact during pipeline, rig, and platform emplacements and anchoring activities. Yet, operations outside the No Activity Zones could still affect topographic features through drilling effluent discharges, blowouts, and oil spills.

With the inclusion of the proposed Topographic Features Stipulation, no discharges would take place within the No Activity Zones. Drilling discharges would be shunted to within 10 m of the seafloor either within a radius of 1,000 m, 1 mi (1,609 m), 3 mi (4,828 m), or 4 mi (6,437 m) (depending on the topographic feature) around the No Activity Zone. This procedure would essentially prevent the threat of large amounts of drilling effluents reaching the biota of a given topographic feature. It has been estimated, however, that drilling effluents and produced waters could reach and impact topographic features 5-10 times during the life of this proposal. The severity of such impacts would probably be primarily sublethal such that there may be a disruption or impairment of a few elements at the regional or local scale, but no interference to the general system performance. Recovery to pre-impact conditions should take place within 2 years. The scale of disturbance and the duration of recovery would be similar in the case of blowouts outside the No Activity Zones.

One blowout is projected to occur in waters less than 200 m deep during activities resulting from the proposed action. With the application of the proposed stipulation, none of these blowouts should occur within the No Activity Zones. Furthermore, blowouts outside the No Activity Zones are unlikely to impact the biota of topographic features.

Some offshore resources are at risk from a spill originating in the WPA. Section IV.A.3.h.(2) provides a discussion of offshore oil-spill modeling results for the proposed action. There is a 35 percent likelihood

that a spill would reach the area of the Flower Garden Banks National Marine Sanctuary. The East Flower Garden Bank rises to within 16 m, and the West Flower Garden Bank to within 18 m of the sea surface. Any oil that might be driven to 16 m or deeper would probably be at concentrations low enough not to cause an impact; therefore, a surface oil spill would likely have no impact on the biota of the East Flower Garden Bank or the other topographic features.

On the other hand, a subsurface spill originating from a pipeline rupture or a blowout may cause sessile biota of topographic features to be impacted by oil, potentially causing sublethal and lethal effects. Yet, the Topographic Features Stipulation would limit such occurrences by keeping the sources of such adverse events geographically removed from the sensitive biological resources of topographic features.

Between 4 and 13 structure removals using explosives are projected for the W0-60 subarea, and 1 and 2 removals in the W60-200 subarea. The explosive removals of platforms should not impact the biota of topographic features since the Topographic Features Stipulation restricts the emplacement of platforms to locations most certainly farther than 100 m away from No Activity Zone boundaries. This emplacement would prevent shock-wave impacts and resuspended sediments from reaching the biota of topographic features.

Summary and Conclusion

The proposed Topographic Features Stipulation could prevent most of the potential impacts on live bottom communities from bottom-disturbing activities (structure removal and emplacement), operational discharges (drilling muds and cuttings, produced waters), blowouts, and surface and subsurface oil spills. Recovery from impact incidences of operational discharges and blowouts would take place within 10 years.

Contact with spilled oil would cause lethal and sublethal effects in benthic organisms. The oiling of benthic organisms is not likely because the proposed Topographic Features Stipulation would keep subsurface sources of spills away from the immediate vicinity of topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for adult sessile biota, including coral colonies in the case of the Flower Garden Banks, and there would be limited incidences of mortality. The recovery of harmed benthic communities could take more than 10 years.

Effects of the Proposed Action Without the Proposed Stipulation

The topographic features and associated coral reef biota of the Western Gulf could be adversely impacted by oil and gas activities resulting from the proposed action should they be unrestricted by the absence of the proposed Topographic Features Stipulation. This would be particularly true should operations occur directly on top of or in the immediate vicinity of otherwise protected Western Gulf topographic features.

The No Activity Zone would probably be the area of the topographic features most susceptible to adverse impacts if oil and gas activities are unrestricted by the Topographic Feature Stipulation and not followed up by mitigating measures. These impacting activities could include vessel anchoring and structure emplacement, discharges of drilling muds and cuttings, blowouts, surface or subsea oil spills, and ultimately the explosive removal of structures. All the above-listed activities have the potential to considerably alter the diversity, cover, and long-term viability of the reef biota found within the No Activity Zone. In most cases, recovery from disturbances would take 10 years or more. Long-lasting and possibly irreversible change would be caused mainly by vessel anchoring and structure emplacement (pipelines, drill rigs, platforms). Indeed, such activities would physically and mechanically alter benthic substrates and their associated biota over areas possibly ranging from tens to thousands of square meters per impact. Operational discharges would cause substantial and prolonged turbidity and sedimentation, possibly impeding the well-being and permanence of the biota and causing the decrease of live benthic cover. In the unlikely event of a blowout, sediment resuspension potentially associated with oil would also cause adverse turbidity and sedimentation conditions. In addition to affecting the live cover of a topographic feature, a blowout could alter the local benthic morphology, thus irreversibly altering the reef community. Oil spills (surface and subsea) could be harmful to the local biota should the oil have a prolonged or recurrent contact with the

organisms. Finally, the unrestricted use of explosives to remove platforms installed in the near vicinity of or on the topographic features could cause turbidity, sedimentation, and shock-wave impacts that would affect reef biota.

The shunting of cuttings and fluids, which would be required by the Topographic Features Stipulation, is intended to limit the smothering and crushing of sensitive benthic organisms by depositing the foreign substances in areas where they could not be displaced by currents onto the topographic features. The impacts from unshunted exploration and development discharges of drill cuttings and drilling fluids within the 1,000-Meter Zone and the 1-Mile Zone would definitely impact the biota of topographic features. Specifically, the discharged materials would cause prolonged events of turbidity and sedimentation, which could have long-term deleterious effects on local primary production, predation, and consumption by benthic and pelagic organisms, biological diversity, and benthic live cover. The unrestricted discharge of drilling cuttings and fluids during development operations within the 3-Mile Zone would be a further source of impact to the sensitive biological resources of the topographic features.

Therefore, in the absence of the Topographic Features Stipulation, the proposed action could cause long-term (10 years or more) adverse impacts to the biota of the topographic features, located in most cases on those portions of the topographic features that are in 85 m and less water depth.

(3) Impacts on Water Quality

(a) Coastal Waters

Water quality in coastal waters along the Gulf may be altered by a number of coastal operations supporting offshore OCS oil and gas development. Trash, discharges, runoff, and spills may be released from onshore facilities and vessel traffic. Saltwater intrusion and sediment disturbances from channel maintenance dredging, from onshore pipeline emplacements, and from canal widening may adversely affect coastal waters. Besides coastal sources, offshore spills and trash occurring in association with OCS operations and reaching coastal waters may impact water quality conditions.

Water quality is based on a waterbody's ability to support designated uses and the extent to which the waterbody attains water quality standards. When possible, an assessment of impact to water quality includes determining the nature and amount of contaminant inputs from a proposed action and comparing these levels with Federal and State water quality criteria. When this is not possible, the level of impact from an activity can be projected based on the likely percentage contribution the activity makes to the contamination. In general, the major designated uses of coastal waters include aquatic life support, contact and noncontact recreation, fish consumption, and shellfishing.

Proposed Action Analysis

Table IV-12 lists existing and projected onshore facilities by subarea assumed to support, to some degree, future OCS operations. Oil and gas facilities are located from Corpus Christi to Alabama, and offshore operators usually choose to stage their onshore support operations as close as possible to their offshore operation. The majority of the existing and new infrastructure that will support the proposed action--pipeline shorebases, gas processing plants, service bases, helicopter hubs, and barge terminals--are assumed to be located in coastal Texas and western Louisiana. Both Corpus Christi and Galveston, Texas, are projected to provide the major support bases for deepwater operations in the WPA. Six existing gas pipeline systems coming from the WPA and one new oil pipeline system from WPA deepwater operations are projected to make landfall in Louisiana either in Subarea LA-1 and LA-2 , and no new landfalls are associated with these systems.

OCS support facilities generate a variety of wastes that may be discharged to associated waterbodies. Such wastes may be the result of processing operations conducted by the facility or may simply be the result of man's presence, such as effluents from toilets, kitchens, and vessels docked at the facility. Section IV.B.2.c.(1) discusses the types of discharges occurring and some contaminants found in these discharges. The degree of environmental damage is related to how much contamination occurs from the discharge and

the characteristics of the receiving waters. Historical sediment and water contamination has been documented near such facilities in Louisiana (Louisiana Dept. of Environmental Quality, 1990; Louisiana Dept. of Transportation, 1984). In localized areas, waters near support facilities were found to be contaminated with petroleum compounds, heavy metals, naturally occurring radioactive materials (NORM), high total suspended sediments and organic carbon, and low dissolved oxygen. As long as these onshore support facilities are in operation, routine point- and nonpoint-source discharges and chronic spillages from them are expected to continue to degrade, to some degree, coastal and nearshore water quality.

The greatest cause of contamination from OCS-support facilities has been identified as nonpoint-source pollution. Runoff from support facilities is likely to contain oil, particulate matter, heavy metals, petroleum products, process chemicals, fecal coliform, high nutrient loadings, and radionuclides (particularly from pipeyards). This runoff can affect local streams, estuaries, and bays, causing elevated levels of contaminants, low dissolved oxygen levels, and high turbidity in the surrounding waters. The presence of facilities, along with the associated access routes, alters the natural hydrology and geography of the area over time, resulting in increased erosion and landloss. These facilities may also alter circulation in wetland areas and may affect flushing rates and salinity gradients, resulting in saltwater intrusion.

The severity of the contamination currently occurring from these facilities is not quantified, so it is difficult to project the extent of future degradation. More stringent water quality regulations by Federal and State agencies and greater adherence to regulations by facility operators are expected to occur and are already happening in some cases. These actions may improve or even reverse any existing degraded water quality conditions. Point- and nonpoint-source discharges from many other sources besides those from support oil and gas facilities are adversely affecting regional coastal waters in the Gulf. A discussion of the status of Texas's bays and State waters and of the major sources causing contamination is provided in Section III and in information found in two Texas water quality inventories (Texas Water Commission, 1992; TNRCC, 1996). Discharges from oil and gas support facilities were not identified as the major source of coastal water quality degradation in Texas bays in general; rather, major sources that contributed to the nonattainment of designated water quality uses were identified as a combination of unknown (43%), municipal (58%), and industrial (less than 1%) point sources, discharging fecal coliform bacteria and toxics, especially metals and priority organic pollutants. Galveston Bay's water quality may show the most influence from the oil and gas industry. Petroleum activity and oil spills were listed among the six major causes most influencing water quality degradation in Galveston Bay. Assuming no significant changes in sources, given this, the extent that point- and nonpoint-source discharges from oil and gas support facilities will contribute to regional coastal water degradation is assumed to be a small percentage, with some moderate localized impact occurring in Galveston Bay. The use of oil and gas onshore support facilities by activities resulting from the proposed action is estimated to be 0.5-1.0 percent of the total OCS Program usage of these facilities, thus further decreasing the percentage of the degradation attributable to the proposed action.

Some of the wastes generated offshore, such as oil-based drilling fluids, are brought ashore for disposal at commercial waste facilities (Section IV.B.2.c.(3)). In the past, offshore-generated wastes that were improperly transported, stored, treated, and disposed of resulted in contamination, primarily at coastal locations in Louisiana. Offshore wastes can be contaminated with NORM, toxic or hazardous compounds, heavy metals, and hydrocarbons. Section IV.B.2.c.(3) describes these wastes in more detail; Section IV.B.1.f. describes the disposal facilities. State regulations, particularly those of Louisiana, have, for the most part, eliminated historical disposal practices that caused such problems. Only human errors during a few onshore disposal operations are expected to cause any impacts. Such impacts would primarily occur in the vicinity of a few temporary storage facilities (usually service bases). It is assumed that the 3 projected and 13 existing commercial waste disposal facilities in coastal Texas and coastal Subarea LA-1 will be used for final disposal of offshore wastes generated from proposed action activities without environmental problems.

Vessel operations associated with the proposed action will result in bilge water and sanitary and domestic waste discharges, bank erosion, and spills. Discharged bilge water can contain petroleum and metallic compounds leaked from machinery; sanitary wastewaters contain small levels of suspended solids, fecal coliform, and chlorine from the treatment process. Approximately 550-1,000 service-vessel trips per year

would result from the proposed action. These service vessels will carry supplies and crew between offshore platforms and onshore service bases, and will primarily use major navigation channels located in Texas (Table IV-14). Based on assumptions regarding size, transit times, and crew (Section IV.A.2.b.(4)), and discharge volumes (Section IV.A.3.d.(8)), a typical service vessel will discharge approximately 280 liters of bilge water and 250 liters of sanitary wastes per round trip while in transit to and from its service base and open offshore waters. If one assumes all of these trips occur along the 400 km of channels in Texas used by the OCS industry, then this would equate to 600-1,300 liters per km per year. Large channels should assimilate these small daily inputs with no changes in water quality conditions. However, confined portions of some channels extensively used by OCS-related vessel traffic may have difficulty over time assimilating the long-term and continued discharge of bilge water and sanitary waste contaminants. For the proposed action, none of the channels are projected to be used to such an extent as to result in discharges that would exceed the assimilative capacity of the receiving waters. The percentage usage of any channel to support the proposed action activities is projected to be less than 1 percent (Table IV-14).

Based on this information, annual Federal maintenance of OCS-related channels over the 35-year life of a proposed action is likely to displace approximately 1.3 billion m^3 and 2.8 billion m^3 of materials in the WPA and CPA, respectively. OCS-related dredging operations are done for pipeline excavation and burial (Section IV.B.2.b.), navigation channel construction (Section IV.B.2.a), and maintenance of existing channels. Dredging operations release sediments into the water column, resulting in degradation of water quality from increased turbidity, obstructed light penetration, and resuspension of released sediment contaminants that can include heavy metals and pesticides. No new channels are projected. Federal maintenance of OCS-related channels is likely to displace approximately 13 billion m^3 during the period 1998-2036 in the WPA; an average of approximately 33 million m^3 per year. Less than 10 percent of channel usage in the WPA is attributable to OCS operations. An even smaller portion of navigation channel dredging would be completed to support vessel traffic from the proposed action. Some dredging will take place to install the 34 new pipeline landfalls and 713-1,384 km of onshore pipeline projected to be built in the Texas coastal zone under the Gulfwide OCS Program; the proposed action will contribute a small percentage to the need for construction. Zero to two onshore pipeline systems and landfalls are assumed to occur solely to support deepwater operations under the proposed action. Dredging operations, which are short-term activities, are expected to result in localized impacts, primarily increased turbidity, occurring over the duration of the maintenance dredging operations (up to several months). Given the large volumes estimated to be dredged during any one operation, localized water quality would be altered to a level that would temporarily preclude recreational and commercial uses; the periods between dredging operations should generally allow for the recovery of affected areas.

Even when channels and pipeline canals are not maintenance dredged, their banks slowly erode and widen with time, resulting in increased turbidity in the surrounding waters as well as possible input of contaminant compounds found in the levee sediments. Saltwater intrusion into fresher water habitats through channel and pipeline canals could result in vegetation die-off and soil erosion, which further degrade water quality. Throughout the timeframe that the navigation channels are projected to serve the OCS industry, erosion of channel maintenance dredged material from spoil banks, channel bank erosion due to vessel wakes, and the natural widening of pipeline canals would provide continuous low-level and long-term sediment turbidity in surrounding waters, adversely affecting water clarity, especially in small, confined portions of navigation channels.

Oil spills constitute one of the most visible forms of contamination. Spills of both crude oil and petroleum products could occur in coastal waters from proposed action activities: (1) from pipelines transporting oil to onshore terminals and coastal processing facilities; (2) during fuel and bulk transfer operations at terminals and service bases; (3) at refineries and storage facilities; and (4) from barge accidents in coastal waters. Spills could also occur in OCS waters from offshore operations, especially pipelines, and subsequently reach nearshore and coastal areas. For any one spill event, water quality degradation is a function of the amount of petroleum hydrocarbons residing in the water column.

For a proposed action, there is a 2-15 percent chance that one or more large spills will occur offshore. Examination of Figure IV-3 shows that, for a proposed action, there is a 2-13 percent chance that one large

offshore spill (≥ 1,000 bbl) will occur and less than a 1 percent chance of two large spills. There is as much as a 98 percent chance that no large spills (zero) will occur.

Despite the unlikelihood that a large spill would occur, if one were to occur, there is a very high probability that it would reach Texas nearshore coastal waters (as high as 92% for 3 days and 99% for 30 days). The bays with the highest probabilities of contact by a hypothetical offshore spill occurring within the WPA and reaching their waters within 10 days include Espiritu Santos/Matagorda Bays (57%) and Galveston and West Bays (54%). No spills less than 1,000 bbl occurring offshore are projected to reach coastal waters (Section IV.A.2.a.). Most of the oil spilled would reach nearshore open waters in the form of a slick floating on the water surface. The volume of oil remaining in the surface slick, the percentage lost to the water column, and the dimensions of the slick by the time the spill reaches coastal waters is a function of time (Table IV-11). About 1-5 percent of the surface slick volume dissolves into the water column soon after the spill occurs. By 10 days, another 17 percent disperses into the water column. The amount of oil dispersed and dissolved under an oil slick moving through open nearshore water is not likely to cause prolonged (more than a few months) adverse water quality conditions. Oceanographic processes should disperse the oil remaining in the water column in the nearshore environment after the surface slick moves away from the contaminated water column. Nearshore water quality could be affected for a longer time period, due to the backwashing of oil from an oiled shoreline into the surf zone. Oil returning to the surf would likely be trapped by longshore currents. Surf conditions would accelerate the amount of hydrocarbons dispersed into the shallow water column. This contamination would continue until its source, the oil on the shoreline, is removed. It is assumed that all shorelines oiled by an OCS spill would be cleaned up within six months. Most slicks in open coastal waters should significantly break up within 30 days and all sheen should be gone within six weeks after cleanup. Any contaminants originally dispersed in the water column in open coastal waters are assumed to reach background levels within six months.

Spills can also occur in coastal waters from proposed action activities. These spills would most likely occur along pipeline routes, associated with pipeline terminal activities, and along navigation channels. Table IV-17 provides the number of coastal spills projected to occur as a result of the proposed action for 35 years. On average, 1-2 coastal spills less than or equal to 1 bbl would occur each year and 1 coastal spill greater than 1 bbl and less than or equal to 50 bbl would occur every 2-4 years. For larger spills, over the 35-year timeframe, 1-2 coastal spills between 50 and 1,000 bbl, and 1 coastal spill greater than 1,000 bbl are estimated to occur. For purposes of analysis, it is assumed that all of these coastal spills will contact wetlands or confined, low-energy areas. Once in shallow protected bays or wetland areas, oil could accumulate in thick layers on clumps of marsh vegetation, protected pools, or embayments. The low energy in such areas and the thickness of the oil on the surface would contribute to slow weathering and removal of the oil. The oil coating the sediments and vegetation might be released into the surrounding water for a much longer time period. Some oil may become adsorbed onto suspended particles and bottom sediments and be subsequently reintroduced into the water column, thereby resulting in long-term effects. Studies of spills occurring in the Louisiana and Texas wetlands support these assumptions. The studies showed that spills resulted in some dieback and destruction of vegetation (2.7 ha/50 bbl), erosion, and the release of oil from contaminated sediments into overlying waters. When a dense oiling of the marsh surface occurred, adverse impacts were observed for more than one year from the time of the spill (Section IV.D.1.d.(1)(b)). Given this, it is assumed that for the one projected coastal spill greater than 1,000 bbl, degradation of coastal water quality would occur in confined areas resulting in the loss of some of the uses of the waters for up to 10 years from the onset of the spill. In the case of the smaller spills, there could be adverse changes in water quality parameters lasting from six months at 10-15 sites (> 1 bbl and ≤ 50 bbl) to five years at 2 sites (> 50 bbl and < 1,000 bbl). In all cases, the areal extent of this contamination is assumed to decrease significantly over the assumed time period and would be dependent on the proximity of the water to oiled vegetation and sediments. Background water quality conditions are assumed to return to normal within six weeks in wetlands that could be affected by spills of 1 bbl or less. The 1-2 coastal spills of 1 bbl or less estimated to occur each year are not expected to cause any measurable impact because they have a temporary residence time; the impact of these small spills is more dependent on the frequency of occurrence.

Primarily because so few sites are expected to be impacted by spill events and the impacts would be temporary, spills are not likely to become major contributors to regional petroleum contamination of Gulf

coastal waters. The number and volume of the spills estimated to occur in the coastal zone or to reach coastal waters from offshore operations would result in no more than acute, localized, and low-level impacts to coastal waters.

Summary and Conclusion

Future regional water quality degradation due to effluent discharges and runoff from onshore infrastructure and coastal waterway usage supporting proposed action operations would be very small in relation to all other sources. Because so many OCS support facilities are located throughout the coastal zone, the area of potential contamination will be widespread. Maintenance dredging of about 33 million m^3 of sediment annually will result in localized impacts (primarily increased turbidity and resuspended contaminants) that will preclude uses of the waters immediately surrounding dredged sites and that could last up to several months. Water clarity within the navigation channels where the majority of vessel operations occur will be compromised as a result of continuous sediment influx from bank erosion, natural widening, and reintroduction of dredged material back into surrounding waters. Primarily because so few sites are expected to be impacted by spill events and the impacts will be temporary, spills are not likely to become major contributors to regional petroleum contamination of Gulf coastal waters. The number and volume of the spills estimated to occur in the coastal zone or from offshore operations reaching coastal waters from a proposed action would result in no more than acute, localized, and low-level impacts to coastal waters. Excluding the short-term effects of dredging and oil spills, impacts to coastal waters from a proposed action should not disrupt current activity uses designated for these waters, with the exception of Galveston Bay. Discharges, spills, and dredging disturbances that will likely result from use of Galveston Bay are likely to contribute to a minor extent to the water quality problems of the Bay's waters.

(b) Marine Waters

Routine activities related to the proposed action that could result in marine water quality degradation include the emplacement and removal of rigs, production facilities, and pipelines on the seafloor; and the discharge of operational wastes. Accidental loss of debris to the seafloor and blowouts or spills of oil and hazardous substances also have the potential to alter offshore water quality. There is no indication that coastal water degradation due to the proposed action could have a significant effect on offshore waters.

Water quality is based on a waterbody's ability to support designated uses and the extent to which the waterbody attains water quality standards. When possible, an assessment of impact to water quality includes determining the nature and amount of contaminant inputs from a proposed action and comparing these levels with Federal and State water quality criteria. When this is not possible, the level of impact from an activity can be projected based on the likely percentage contribution the activity makes to the contamination. In general, ocean water uses include providing for healthy aquatic communities, contact recreation, and shellfishing.

Proposed Action Analysis

Bottom area disturbance occurs during the emplacement and removal of pipelines, drilling rigs, and production facilities. The emplacement and removal of most of these structures disturb some area of the sea bottom in proximity to and beneath the structures. The area disturbed is related to the water depth and type of facility. During drilling, jack-ups and semisubmersibles disturb about 1.5 ha each, while drillships used in waters deeper than 750 m do not disturb the bottom at all since they are dynamically positioned. Fixed, conventional platforms and compliant towers install pilings and disturb on the average about 2 ha, dependent upon their size and number of well slots. A TLP, used in water depths greater than 450 m, is held in place by tensioned tendons secured with piles, disturbing about 5 ha. The bottom area disturbed by emplacement of a SPAR, another type of deepwater production structure, is dependent upon the anchor pattern and is assumed to be about 5 ha also. FPSO's, floating vessels, are anchored and not likely to disturb more than 1.5 ha. Subsea completions, seafloor templates with production equipment connected via risers to surface

production facilities, are assumed to disturb less than 1 ha. Emplacements of pipelines will disturb about 0.32 ha per kilometer of pipeline plus the disturbance caused by the pipelaying barge. In general, pipelaying barges use an array of eight 9,000-kg anchors to position the barge and to move it forward along the pipeline route. These anchors are continually moved along the bottom as the pipelaying operation proceeds. Pipelaying operations in water depths shallower than 61 m, where the pipelines must be buried below the seafloor, result in additional resuspension of sediments. It is assumed that about 5,000 m^3 of sediment will be resuspended for each kilometer of pipeline.

Compared with the total area of the Gulf where these operations will occur (14,531,000 ha), bottom area disturbed from each of these emplacement operations is extremely small, and the disturbance produces only localized, temporary resuspension of bottom sediments. This resuspension can result in increases in water-column turbidity, and thus decreases in water clarity, of overlying offshore waters. In shallow waters, resuspension of any settled pollutants, such as trace metals, chlorinated hydrocarbons, and excess nutrients, that accumulated in the sediments could occur. Major sources of contaminants found in offshore sediments are coastal; therefore, sediment contamination generally depends on distance from shore. It is assumed that only bottom area disturbance from OCS operations in water depths less than 60 m would result in chemical contamination of the overlying waters since this is the area with the highest risk of contaminated sediments. This subarea is also the subarea where the greatest percentage of operations are proposed to occur (Table IV-2) and where pipeline entrenchment occurs. When the operations are occurring very frequently and in proximity to each other, water quality is at an increased risk. To determine if the frequency and number of operations in this subarea may have any aggregated the effect on water-column turbidity, the total area disturbed by emplacements projected for the proposed action was calculated for water depths less than 60 m. If all of the wells were drilled, platforms installed, and pipelines entrenched in the same year, this would only disturb about 300 ha, compared with the about 3.6 million ha of Subarea W0-60. In reality, these activities will occur over the entire development phase and with a widespread distribution. Given this, these operations are not expected to occur closely enough in time or space to result in combined effects; that is, impacts would only occur individually from each operation, resulting in localized, temporary changes in water quality conditions.

Blowouts could also increase water-column turbidity. During an extremely large blowout occurrence, most sediments would settle within 400 m, but finer sediments could remain in suspension for periods of 30 days or longer and thus be dispersed over larger distances. For the proposed action, 1-2 blowouts are estimated to occur. Given the extremely low number of blowout events estimated and the likelihood that these would only disturb surrounding sediments for a short time, if at all, blowouts related to proposed action activities are not expected to be a significant factor affecting future water quality.

Besides increased water-column turbidity, explosive platform removal may adversely influence water quality by releasing explosive by-products into the water column upon detonation of charges used to sever the legs and pilings of a structure. Resuspension of sediments has only a short-term local effect of a very limited nature. Between 5 and 16 explosive removal operations related to the proposed action are estimated to occur. These removals are projected to begin about 2011. More than 80 percent of explosive removals will be in water depths less than 60 m. Given the low estimated number of the explosive removals associated with the proposed action, negligible impacts on regional water quality are expected. There could be some temporary, localized, minor impact occurring in waters less than 60 m.

One of the greatest concerns by the public is the risk of oil spills during the exploration, development, and production of oil on the OCS. Oil spills present a threat to the water quality of any area contacted by the oil. The frequency of occurrence, the volumes being spilled, and the length of time petroleum hydrocarbons remain in the water column are the major factors determining the severity of the impact of oil spills on water quality. Historically, most oil spills have affected water quality during the life of the spill and only for a short time afterwards. The amounts of petroleum hydrocarbons that enter the water column from an overlying slick are dependent on the physical and chemical processes pushing surface oil into the water column, the size of the water surface covered by the slick, and the residence time that the slick remains on the surface of the water. Most of the spilled oil floats on the surface as a slick because hydrocarbons are relatively insoluble in water.

The oil dispersed and dissolved under an oil slick is not likely to cause prolonged (more than a few months) adverse water quality conditions once the slick is removed by cleanup or it naturally degrades by weathering. Many weathering processes act to remove oil from the water column. Oceanographic processes, sedimentation, chemical changes, bacterial action, and dilution of the oil should disperse the oil remaining in the water column after the surface slick is removed or moves away, depending on the energy of the system being affected.

Table IV-11 provides the modeling results for the weathering of a large spill having a typical size and chemistry known for Gulf OCS spills. The maximum slick area is projected to be about one million m^2 for a 6,500-bbl spill, reached in about seven days. This model assumes that the oil is a light crude with very little asphaltenes. Much of the oil that has been produced in the Gulf of Mexico is very light crude that disperses rapidly; however, there are indications that oils produced from deepwater areas may be much heavier, may be sour, and may contain higher concentrations of heavy metals and asphaltenes. Based on the modeling results and the fact that no spills of OCS origin have ever been tracked beyond 30 days, it is assumed that all surface slicks will have weathered and dispersed by 30 days after the spill occurs. Spills less than 50 bbl are expected to disperse rapidly, within a few days to one month. After the surface slick is gone, hydrocarbons remaining in the water column are not expected to be measurable after a few months. Given this, any one oil spill occurring in association with proposed action operations is expected to result in localized, short-term, minor impacts to offshore water quality, the length of time of the impact being no longer than 90 days. If spills are large enough, or occur very frequently and in proximity to each other, they could cause enough of an adverse influence to have long-term impacts to the uses of the waters affected. Section IV.A.3.h.(2) and Table IV-2 provide information on the number and sizes of oil spills estimated to occur from the proposed action. No more than 15 spills greater than 1 bbl and less than or equal to 50 bbl are estimated to occur during the 35-year period. Only 0-2 spills greater than 50 bbl are estimated to occur. These events are extremely unlikely to occur in the same area or in the same year. Based on the above factors, effects from these spills on marine water quality would be of short-duration (from a few days to 3 months) and are expected to affect only a small area of offshore waters at any one time.

The OCS oil and gas industry routinely generates a number of wastes that have the potential to degrade marine water quality. The discharge of drilling fluids and cuttings and produced water form the bulk of effluent discharge volumes from oil and gas development and production facilities. Treatment, workover, and completion fluids are projected to be commingled with the discharged produced water. The discharge of treated sanitary and domestic wastes and deck drainage from rigs, platforms, and support vessels may increase suspended solids, nutrients, chlorine, and biological oxygen demand (BOD) in a small area near the point of discharge. The constituents of these waste streams are known to dilute quickly, however, when discharged into the open Gulf. Section IV.A.3.d. provides further descriptions of information known about the characteristics, levels, and known impacts of OCS wastes discharged in association with drilling and the production of oil and gas in the Gulf of Mexico. Information is provided on the transport of these wastes in the water column, incorporation into bottom sediments, effects on water-column and benthic organisms, toxicity of components, water quality exceedances, and bioaccumulation. Current, or even more restrictive, limitations on the levels of various contaminants in drilling muds and cuttings and produced-water discharges, discharge-rate restrictions, and monitoring and toxicity testing requirements in the general NPDES permits are expected to eliminate significant biological or ecological effects from discharges, such as those documented in the past. All other minor waste discharges will be rapidly assimilated and dispersed. No impacts are expected to occur from these minor discharges. Assumptions regarding the level of contamination of water, sediment, and biota are given in Section IV.A.3.d. Referenced research is provided in that section.

Plumes of drilling fluids and produced water mix rapidly with ambient seawater. Beyond 100 m from the discharge point, none of the contaminants are expected to be at concentrations in the water column great enough to produce adverse effects to water-column organisms. Biofouling organisms on submerged platform structures may be exposed to harmful concentrations of some contaminants in the discharge plumes. Contaminants in produced water and drilling discharges should be undetectable in the water column by 1,000 m from the discharge point.

Sediment contamination and impacts are dependent on the water depth and current speed. In shallow waters, elevated levels of petroleum hydrocarbons and metals from produced water, drilling fluids, and drill cuttings may be measurable in sediments out as far as 2,000-3,000 m downcurrent from the discharge. In general, for operations occurring in water depths less than 100 m, retention within the sediments of the chemicals found in OCS discharges is likely to occur from several hundred to several thousand meters from the discharge point. Despite any possible sediment accumulation of these discharged chemicals, biological responses to levels retained by the sediments are not expected to be detectable beyond a couple of hundred meters. Toxic effects to the benthos from OCS discharges are expected to be very localized, limited to within 100 m from the discharge, and will be of a relatively small magnitude. Toxic effects beyond 100 m should be controlled through the NPDES permit requirements.

There is some evidence that bioaccumulation of a few chemicals found in OCS discharges may be occurring in fish and benthic organisms to a small extent. Two recently completed studies (Kennicutt, 1995; CSA, 1997b) found some long-lasting effects existed in the sedimentary environment around gas platforms. Both studies identified a few stations where higher levels of contaminants in benthic organisms were correlated with discharge inputs. Peterson et al. (1996) concluded that the heavy metals in barite, the release of produced waters, and the organic shedding from the platforms appear to be the major determinants of observed biological response patterns that extend to a distance of 100-200 m away from the gas production platforms on the Gulf of Mexico shelf. Industry just completed a large monitoring study (CSA, 1997b) that was conducted to provide information on possible bioaccumulation specifically associated with produced-water discharges. The results are expected to assist the USEPA in the development of the 1997-2002 general NPDES permit. The authors concluded that there was little evidence of bioaccumulation of produced-water contaminants. Although most contaminants were detectable in soft-tissue organisms, concentrations were below levels that would represent a hazard to marine animals or man. Mercury and arsenic were measurable in all tissue samples analyzed from both nondischarging and discharging platforms; arsenic being detected above a risk-based concentration set to measure human health concerns. Arsenic was measured at higher levels near platforms discharging produced water than at nondischarging platforms in 3 out of 12 cases; the same difference was found for polycyclic aromatic hydrocarbons in one instance. Since the new NPDES permit has not been developed as of the writing of this EIS, it is assumed that limits in the new permit will be set to restrict any bioaccumulation determined to be of concern and occurring from OCS discharges.

As industry moves into deeper waters, their operations are becoming different from those historically conducted. Because of the expense of drilling in deepwater, more wells will be drilled directionally or horizontally from the same production facility. The well stream coming from subsea completions may be carried by mixed pipelines to large, centralized processing facilities located in deep water or at the shelf break (DeepStar, 1994). Discharge volumes and rates for these centralized facilities and at deepwater production platforms are expected to be large and at maximum USEPA allowable discharge rates. Despite this increase in discharge loadings, wastes discharged at deepwater sites should be subject to ample dilution and dispersion, and it is uncertain how much of the discharge will reach deep-sea sediments.

A geophysical survey documented the extent of drilling discharges at several previously drilled oil and gas sites in about 400-m water depths (Nunez, personal communication, 1994). Accumulations of cuttings were still found extending from the well locations in finger-like projections to a maximum of about 610 m (the average being 450 m). Side-scan sonar records of these areas indicate that they were distributed in thin accumulations of less than 0.3 m thicknesses. It is assumed that discharges of drilling muds and cuttings will probably be distributed across broader areas of the seafloor at greater water depth and would generally be distributed in thinner accumulations than would occur in shallower areas on the continental shelf. Levels of contaminants in deep-sea sediments from drilling discharges will be extremely low or unmeasurable. Smothering and other physical effects from these thin accumulations of drilling wastes are expected to be much less than those documented at shallower sites. Because studies have yet to be conducted on how waste plumes impact sediments surrounding deepwater discharge sites under varying oceanographic conditions, there is no way to verify conclusively these assumptions.

Recent industry models of produced-water discharges of 7,000 and 11,000 bbl/day predicted that the plumes would not penetrate farther than 30 m into the water column, even under weak density stratification (Smith, written communication, 1995). The modeled produced-water plumes reached neutral buoyancy

rapidly, and further plume dispersion was horizontal. These models do not account for the fact that structures placed in deep water will likely discharge at the maximum allowable rate of 25,000 bbl/day. Also, the model examined only salinity changes, rather than all chemical components in a discharge plume, and focused on the axis of the plume transport so that the 30-m penetration depth may not represent the depth that all chemical components may reach. To account for these factors, it is assumed that under a worst-case scenario, the deepest that a surface produced-water plume can reach would be 100 m. More research and field verification is needed on this subject. In deeper waters, sediment contamination from a produced-water plume is more likely to occur only within a few hundred meters from the point that the plume reaches the seafloor, if it is detectable at all (Neff, 1997b). Since the plume from produced water discharged from surface facilities is not expected to reach the seafloor in water depths greater than 100 m, no seafloor sediment contamination is expected beyond this water depth.

Some operations fall between the traditional shallow type of operations and the projected deepwater operations. For these operations, the level of impact to marine waters would probably fall somewhere between the levels projected for shallow versus deepwater operations.

Metal and hydrocarbon contaminants that are discharged with produced water and drilling muds that enter the marine environment through oil-spill incidents could contribute to the long-term, regional degradation of offshore water quality. Averaging USEPA estimates on annual inputs (USEPA, 1993), the contribution of contaminants from drilling muds and cutting discharges from the proposed action would be about 23,000-45,000 metric tons/year (50-100 million lb/yr). Produced waters would contribute about 600-1,200 metric tons/year (1.3-2.6 million lb/yr). Any determination of long-term impacts should assess the residence times of the added compounds and the assimilative capacities of the receiving waters. Neither of these factors is known. Furthermore, to understand if the levels of these inputs would be consequential, these contaminant loadings should be compared with the level of all inputs of contaminants to offshore waters. Very little quantitative data exist on many sources. Some information is available on the contribution of petroleum from various inputs. Based on an analysis completed by MMS in 1995 of volumes from offshore oil spills (USDOI, MMS, 1995), the OCS industry contributes about 15 percent of the Gulf's regional, long-term contamination from offshore oil spills. Coastal inputs contribute an order of magnitude more petroleum to Gulf waters than offshore sources (NRC, 1985; Section IV.C.4.). Although a mass balance of all inputs is not available, given what is known about petroleum inputs, offshore operations from the OCS industry are contributing no more than a very minor amount to any low-level, long-term, regional contamination of Gulf waters and sediments. Based on the volume of oil projected to be produced, the proposed action would only be 0.5-1.0 percent of the contribution of future OCS operations in the Gulf.

Summary and Conclusion

Sediment disturbance from the emplacement and removal of platforms and associated pipelines and from the drilling of wells is expected to result in minor, localized, temporary increases in water-column turbidity in offshore waters. Given the low number and frequency of estimated explosive platform removals and blowouts, minimum, short-term changes in water quality conditions due to resuspension of sediments are expected from removal operations and accidental blowout events.

Oil spills related to the proposed action are assumed to be mostly very small events, and, for spills greater than 50 bbl, to occur very infrequently, if at all. These events are extremely unlikely to occur in the same area or in the same year. Water quality changes in the water column are limited to the area around and beneath the surface slick and is expected to last for only a short time following the removal of the slick from the surface of the water. Based on the above factors, loss of use of marine water from these spills will be of short-duration (from a few days to 3 months) and very localized.

Current and future limits on the levels of contaminants in drilling muds and cuttings and produced-water discharges, discharge-rate restrictions, and monitoring and toxicity testing requirements are expected to eliminate significant biological or ecological effects that were documented in the past. For shallow developments, elevated levels of some contaminants found in the plumes of produced-water discharges and drilling mud discharges are expected to be detected out to a few thousand meters downcurrent from the discharge point; however, no ecological effects to water-column organisms are expected. For deepwater

facilities, although levels of discharges per deepwater facility would be higher than shallower water facilities, there would be fewer locations where discharges would take place. Drilling discharges from facilities located in waters deeper than 400 m could reach the seafloor but would result in extremely low levels of sediment contamination, if any at all, and any cuttings would be distributed in very thin accumulations distributed somewhere within a broader area than they would be in shallower waters. The plume from produced-water discharges is not expected to reach the seafloor in water depths greater than 100 m. Despite any possible sediment accumulation of discharged chemicals, biological responses in soft-tissue benthic organisms are not expected to be detectable beyond a couple of hundred meters. Toxic effects to the benthos from OCS discharges are expected to be very localized, limited to within 100 m from the discharge, and will be of a relatively small magnitude. Given that the contaminants are exhibiting localized, low-level sediment retention and biological perturbation, regional water quality is not expected to be compromised by discharges related to the proposed action.

OCS discharges and spills associated with the proposed action could be contributing less than 1 percent of the metal and hydrocarbon contaminants that are measurable in regional offshore waters and may be accumulating in offshore sediments.

(4) Impacts on Air Quality

The following activities will potentially degrade air quality: platform construction and emplacement; platform operations; drilling activities; flaring; survey and support vessel operations; pipeline laying and burial operations; evaporation of volatile petroleum hydrocarbons during transfers and from surface oil slicks; and fugitive emissions. Supporting materials and discussions are presented in Sections III.A.2. and III.A.3. (descriptions of Gulf of Mexico meteorology and the coastal air quality status), IV.A.3.h.(2) and IV.B.2.d. (oil-spill assumptions), and IV.A.3.f. (air emissions). The parameters of this analysis are emission rates, surface winds, atmospheric stability, and the mixing height.

Emissions of certain air pollutants are known to be detrimental to public health and welfare. Some of these pollutants are directly emitted into the air, while others are formed in the atmosphere through chemical reactions. Nitric oxide and nitrogen dioxide constitute nitrogen oxide (NO_x) emissions. Nitrogen dioxide, a by-product of all combustion processes, is emitted from sources such as internal combustion engines, natural gas burners, and flares. Nitrogen dioxide is a precursor pollutant involved in photochemical reactions that yield ozone. Nitrogen dioxide is an irritating gas that may increase susceptibility to infection and may constrict the airways of people with respiratory problems. Further, nitrogen dioxide can react with water to form nitric acid, which is harmful to vegetation and materials, as a result of increased acidity in precipitation.

Carbon monoxide (CO) is a by-product of incomplete combustion, primarily contained in engine exhaust. Carbon monoxide is readily absorbed into the body through the lungs, where it reacts with hemoglobin in the blood reducing the transfer of oxygen within the body. CO particularly affects people with cardiovascular and chronic lung diseases.

Sulfur dioxide may cause constriction of the airways and particularly affects individuals with respiratory diseases. Sulfur dioxide can combine with water and oxygen, thus increasing the acidity in precipitation, which can be harmful to vegetation and materials. The flaring of hydrogen sulfide (H_2S), which is found naturally occurring in "sour"gas, and the burning of liquid hydrocarbons results in the formation of sulfur dioxide (SO_2). The amount of SO_2 produced is directly proportional to the sulfur content of the hydrocarbons being flared or burned. In the deepwater projects, the natural gas has been mainly sweet, but the oil is averaging between 1 and 4 percent sulfur content by weight. Flaring of sour production is of concern because it could significantly impact onshore areas, particularly when considering the short duration averaging periods (3 and 24 hr) for SO_2. The combustion of liquid fuels is the primary source of sulfur oxides (SO_x) when considering the annual averaging period.

Impacts from high-rate well cleanup operations can be significant. To prevent inadvertently exceeding established criteria for SO_2 for the 3-hour and 24-hour averaging periods, all incinerating events involving H_2S or liquid hydrocarbons are evaluated individually during the postlease process.

Volatile organic compounds (VOC's) are precursor pollutants involved in a complex photochemical reaction with NO_x in the atmosphere to produce ozone. The primary sources of VOC's result from venting and

evaporative losses that occur during the processing and transporting of natural gas and petroleum products. A more concentrated source of VOC's comes from glycol dehydrator still vents.

Particulate matter is comprised of finely divided solids or liquids such as dust, soot, fumes, and aerosols. PM_{10} and $PM_{2.5}$ particles are small enough to bypass the human body's natural filtration system and can be deeply inhaled into the lungs, affecting respiratory functions. PM_{10} can also affect visibility, primarily by particle scattering and by light absorption to a lesser extent. This analysis considers mainly total suspended particulate (TSP) matter.

Ozone is a nearly colorless gas with a faint but distinctive odor, somewhat similar to chlorine. It is formed in the atmosphere from complex chemical reactions involving hydrocarbons and nitrogen oxides in the presence of sunlight. At ground level, ozone can cause or aggravate respiratory problems, interfere with photosynthesis, and can damage vegetation and crack rubber. Children, the elderly, and healthy people who exercise strenuously outdoors are particularly sensitive to ozone concentrations. In the upper atmosphere, ozone is essential to life as we know it. The upper ozone layer shields the Earth's surface from harmful ultraviolet radiation. Depletion of the upper ozone layer is one of the most complex environmental issues facing the world today. This analysis will not include impacts on upper atmospheric ozone.

Emissions of air pollutants will occur during exploration, development, and production activities. Typical emissions for exploratory and development drilling activities presented in Section IV.A.3.f. show that emissions of NO_x are the primary pollutant of concern. These emission estimates are based on a drilling scenario of a 4,115-m hole during exploration activities and a 3,050-m hole during development activities. Emissions during exploration are higher than emissions during development due to power requirements for drilling a deeper hole.

Platform emission rates for the Gulf of Mexico region (Section IV.A.3.f.) are provided from the 1992 emission inventory of OCS sources compiled by MMS (Steiner et al., 1994). It states that there are a total of 1,857 OCS facilities with air-emitting equipment. The primary pollutants of concern are NO_x and VOC, both considered to be precursors to ozone. Emission factors for other activities such as support vessels, helicopters, tankers, and loading and transit operations were obtained from Jacobs Engineering Group, Inc. (1989) and USEPA AP-42 (1985).

Accidents, such as oil spills, blowouts and pipeline ruptures, are another source of emissions related to OCS operations. Typical emissions from OCS accidents consist of hydrocarbons; only fires produce a broad array of pollutants, including all NAAQS-regulated primary pollutants. Emissions from a 10,000-bbl spill cannot be sustained for long periods due to the rapid volatilization of the hydrocarbons, with emission rates decreasing to approximately 50 percent by the second hour for spills. Hydrogen sulfide may also be released during an accident. Hydrogen sulfide is a toxic gas; at lower concentrations it is readily recognized by the "rotten egg" smell. Accidents involving high concentrations of H_2S could result in deaths as well as environmental damage.

Once pollutants are released into the atmosphere, atmospheric transport and dispersion processes begin circulating the emissions. Transport processes are carried out by the prevailing net wind circulation. During summer, the wind regime in the WPA is predominantly onshore at mean speeds of 3-4 m/sec (6.7- 9.0 mph). Average winter winds are complex. The predominant winds blow from the north and south, averaging 4-8 m/sec (8.9-17.9 mph); the east and west winds are weaker and less frequent, although the easterly component is more common than the westerly component. Since the north and south winds nearly balance each other out, the resulting mean wind vector is from the northeast at about 2 m/sec (4.4 mph).

Dispersion depends on emission height, atmospheric stability, mixing height, exhaust gas temperature and velocity, and wind speed. For emissions inside the atmospheric boundary layer, the vertical heat flux, which includes effects from wind speed and atmospheric stability (via air-sea temperature differences), is a better indicator of turbulence available for dispersion (Lyons and Scott, 1990). Heat flux calculations in the WPA (USDOI, MMS, 1988) indicate an upward flux year-round, being highest during winter and lowest in summer.

The mixing height is very important because it determines the space available for spreading the pollutants. The mixing height is the height, above the surface, of the top of the layer through which vigorous vertical mixing occurs. Vertical mixing is most vigorous during unstable conditions. Vertical motion is suppressed during stable conditions and, hence, the mixing height for such times is undefined; these stagnant conditions generally result in the worst periods of air quality. Although mixing height information throughout the Gulf of Mexico is scarce, measurements near Panama City (Hsu, 1979) show that the mixing height can vary

between 400 and 1,300 m, with a mean of 900 m. The mixing height tends to be higher in the afternoon, more so over land than over water. Further, the mixing height tends to be lower in winter, with daily changes smaller than in summer.

Proposed Action Analysis

The total proposed action emissions (in tons over the 35-year life of the proposed action) for the criteria pollutants are indicated in Table IV-22. NO_x is the major emittent, while TSP is the least emitted pollutant. Combustion intensive operations such as platform operations, well drilling, and service-vessel activities contribute mostly NO_x; platform operations are also the major contributors of VOC emissions. Platform construction emissions contribute appreciable amounts of all pollutants over the life of the proposed action. These emissions are temporary in nature and generally occur for a period of 3-4 months. Typical construction emissions result from the derrick barge placing the jacket and various modular components and from various service vessels supporting this operation. Exploratory wells and development wells contribute considerable amounts of all pollutants. Well emissions are temporary in nature and typically occur over a 40-day drilling period. Support for OCS activities include crew and supply boats, helicopters, and pipeline vessels; emissions from these sources consist mainly of NO_x and CO. These emissions are directly proportional to the number and type of OCS operations requiring support activities. Most support emissions occur during transit between port and offshore oil and gas development activities, while a smaller percentage result from idling at the platform. Platform and well emissions were calculated using the integration of projected well and platform activities over time.

Table IV-22

Projected Total OCS Emissions Related to the Proposed Action in the WPA by Source
(tons over the 35-year life of the proposed action)

Activity/Pollutant	NO_x	CO	SO_x	VOC	TSP
Service Vessels	8,482 - 29,214	852 - 2,935	883 - 3,042	370 - 1,275	513 - 1,768
Pipeline Vessels	598 - 1,930	200 - 647	83 - 269	55 - 176	49 - 160
LTO Helicopters	7 - 48	6 - 39	1 - 7	0 - 2	0 - 2
Cruise Helicopters	12 - 83	34 - 237	3 - 18	2 - 18	3 - 24
Blowouts without Fire	0	0	0	11 - 11	0
Spills without Fire	0	0	0	0 - 255	0
Barge Loading	0	0	0	4 - 20	0
Tanker Loading	0	0	0	0	0
Transit Loss	0	0	0	5 - 27	0
Tanker Exhaust	0	0	0	0	0
Tug Exhaust	651 - 651	65 - 65	67 - 67	27 - 27	39 - 39
Platform Construction	1,685 - 5,687	333 - 1,123	96 - 324	99 - 334	104 - 349
Exploratory Wells	694 - 2,279	185 - 607	81 - 267	67 - 220	20 - 66
Development Wells	1,075 - 4,083	287 - 1,089	126 - 479	104 - 393	31 - 116
Platforms	4,477 - 8,700	1,042 - 2,025	752 - 1,462	3,395 - 6,597	82 - 159
Totals	17,679 - 52,676	3,003 - 8,767	2,093 - 5,935	4,138 - 9,354	841 - 2,682

Total emissions for each subarea in the WPA due to the proposed action are presented in Table IV-23. Activities projected for Subarea W0-60 would generate the greatest amounts of emissions, while the other three subareas are estimated to generate lower amounts of pollutants. Pollutants are distributed to subareas proportional to the projected number of production structure installations slated for those areas.

Table IV-23

Projected Total OCS Emissions Related to the Proposed Action by WPA Subarea
(tons over the 35-year life of the proposed action)

Pollutant Distribution	W0-60	W60-200	W200-900	W900-3000	Total
NO_x	11,050 - 37,069	2,210 - 5,853	2,210 - 3,901	2,210 - 5,853	17,679 - 52,676
CO	1,879 - 6,169	375 - 974	375 - 649	375 - 974	3,003 - 8,767
SO_x	1,308 - 4,176	262 - 659	262 - 440	262 - 659	2,093 - 5,935
VOC	2,586 - 6,583	517 - 1,039	517 - 693	517 -1,039	4,138 - 9,354
TSP	526 - 1,887	105 - 298	105 - 199	105 - 298	841 - 2,682

The total pollutant emissions per year are not uniform. During the early years of the proposed action, emissions would be small and would increase over time with full platform emplacements and production. After reaching a maximum, emissions would decrease as all platforms and wells are removed and service-vessel trips and other related activities are no longer needed.

The peak-year emissions in tons per year for the criteria pollutants are indicated in Table IV-24. The peak-year emissions for the WPA are projected to occur in the 2007 to 2008 timeframe. The peak emissions are calculated by combining peak-year activity total emissions for exploratory wells, development wells, and platforms over the life of the proposed action, and superimposing peak projected activity for support vessels and other emissions into that peak year. Well-drilling activities and platform peak emissions are not necessarily simultaneous. However, it is assumed for this analysis that total well and platform peak-year emissions combined with vessels and other emissions occur simultaneously. Use of the peak emissions shall provide the most conservative estimates of potential impacts to onshore air quality. NO_x is the main pollutant emitted, with service vessels being the primary source.

For conservative estimation, it is assumed that emissions from a potential oil spill and a potential blowout will both occur in the peak year.

Table IV-24

Projected Peak-Year OCS Emissions Related to the Proposed Action in the WPA by Source
(tons)

Activity/Pollutant	NO.	CO	SO.	VOC	TSP
Service Vessels	386 - 1,196	39 - 120	40 - 125	17 - 52	23 - 72
Pipeline Vessels	17 - 55	6 - 19	2 - 8	2 - 5	1 - 5
LTO Helicopters	0 - 2	0 - 2	0	0	0
Cruise Helicopters	1 - 3	2 - 10	0 -1	0 -1	0 - 1
Blowouts without Fire	0	0	0	11	0
Spills without Fire	0	0	0	0 - 255	0
Barge Loading	0	0	0	10 - 57	0
Tanker Loading	0	0	0	0	0
Transit Loss	0	0	0	14 - 77	0
Tanker Exhaust	0	0	0	0	0
Tug Exhaust	0	0	0	0	0
Platform Construction	843 - 1,474	166 - 291	48 - 84	49 - 87	52 - 91
Exploratory Wells	79 - 218	21 - 58	9 - 26	8 - 21	2 - 6
Development Wells	86 - 258	23 - 69	10 - 30	8 - 25	2 - 7
Platforms	204 - 407	47 - 95	34 - 68	154 - 309	4 - 7
Totals	1,615 - 3.614	304 - 663	144 - 341	274 - 899	85 - 190

Activities projected for Subarea W0-60 would generate the greatest amounts of emissions, while the other three subareas are estimated to generate lower amounts of pollutants (Table IV-25). Pollutants are distributed to subareas proportional to the projected number of production structure installations slated for those areas.

Table IV-25

Projected Peak-Year OCS Emissions Related to the Proposed Action by WPA Subarea
(tons)

Pollutant Distribution	W0-60	W60-200	W200-900	W900-3000	Total
NO_x	1,009 - 2,543	202 - 402	202 - 268	202 - 402	1,615 - 3,614
CO	190 - 466	38 - 74	38 - 49	38 - 74	304 - 663
So_x	90 - 240	18 - 38	18 - 25	18 - 38	144 - 341
VOC	171 - 633	34 - 100	34 - 67	34 - 100	273 - 899
TSP	53 - 133	11 - 21	11 - 14	11 - 21	85 - 190

The MMS regulations (30 CFR 250.44) do not establish annual significance levels for CO and VOC. For CO, a comparison of the projected emission rate to the MMS exemption level will be used to assess impacts. The formula to compute the emission rate in tons/yr for CO are $3,400 \cdot D^{2/3}$; D represents distance in statute miles from the shoreline to the source. This formula is applied to each facility. Offshore Texas the CO exempt emission level is 14,819 tons/yr at the State boundary line of 3 leagues, which is greater than CO peak emissions from the whole WPA.

The VOC emissions are best addressed as their corresponding ozone impacts, which were studied in the Gulf of Mexico Air Quality Study (GMAQS). The GMAQS indicated that OCS activities have little impact on ozone exceedance episodes in coastal nonattainment areas including the Houston/Galveston, Port Arthur/Lake Charles and Baton Rouge areas. Total OCS contributions to the exceedance (greater than 120 ppb) episodes studied were less than 2 ppb. In the GMAQS, the model was also run using double emissions from OCS petroleum development activities and the resulting attributable ozone concentrations, during modeling exceedance episodes, were still small, ranging 2-4 ppb. The activities under this proposed action will not result in a doubling of the emissions and because the proposed activities are substantially smaller than this worst-case scenario, it is logical to conclude that their impact would be substantially smaller as well (Systems Applications International et al., 1995). Additionally, 30 CFR 250.45(f)(2) requires that if a facility would significantly impact (defined as exceeding the MMS exemption level) an onshore nonattainment area that it would have to reduce its impact fully through the application of Best Available Control Technology (BACT) and possibly through offsets as well.

One to two blowouts are assumed to occur during the proposed action in the WPA. The air pollutant emissions from blowouts depend on the amount of oil and gas released, duration of the accident, and the occurrence or not of fire during the blowout. Because of technological advances, the duration of blowouts has decreased. Most blowouts occur without fire (MMS database). The amount of oil released during these accidents has been small. No statistics exist on the amount of gas released during a blowout; however, a rate of 1 billion cubic feet (Bcf) per day is assumed. Total blowout VOC emissions are estimated to be approximately 11 tons over the 35-year life of the proposed action. It must be remembered that these are conservative estimates and that the total amount of VOC may be less.

It is assumed that oil spills would result in low impacts on air quality because total emissions would be of short duration. Information from OCS accidents indicates emissions of fewer than 100 tons/hour by the second hour. A single spill of 6,500 bbl could occur and is used for this analysis. Within 4 hours 11 percent of the total mass of the spill will evaporate; within 24 hours 19 percent will be gone. Not all of the mass will evaporate, as a good portion of compounds have low boiling points. Air quality impacts from spills would be dependent on a variety of factors, including location, meteorological conditions at the time, and duration of the spill. Pollutant concentrations reaching onshore will generally be low due to dispersion of the emissions with distance over water and due to the fact that emissions decrease with time and become more diffuse as the spill spreads over a large area with time. Any potential air quality impacts from a large spill would be rare, very localized, and of short duration.

It is estimated that over approximately 99 percent of the gas and oil will be piped to shore terminals. Thus, fugitive emissions associated with tanker and barge loadings and transfer will be small, as will the resultant exhaust emissions. Safeguards to ensure minimum emissions from any offloading and loading operations of OCS crude oil production from surface vessels at ports have been adopted by the State of Louisiana (The Marine Vapor Recovery Act, 1989: LAC: III.2108). Current industry practice is to extend pipelines to new production facilities when feasible.

The MMS studied the impacts of offshore emissions using the Offshore and Coastal Dispersion (OCD) Model. Three large areas were modeled. The limiting factor on the size of the area was the run time needed to process the number of sources. The areas modeled were offshore Corpus Christi Bay, Matagorda Bay, and Galveston Bay. The receptors were set along the coastline and also a short distance inland in order to capture coastal fumigation. Circular areas were chosen to reduce edge effect. The areas were selected to best capture most of the offshore sources and to focus on the highly concentrated areas of development. The proposed action was modeled by comparing the proposed emissions to the emission inventory for the GMAQS. Ratios between these two sets of total emission rates were developed and applied to the GMAQS inventory; this modified inventory was then used as the database for the sources for the OCD modeling. Only the onshore maximum concentrations reported for all of the runs are discussed. The results of the runs are reported in the tables below and are compared with the federally allowable increases in emissions as regulated by 30 CFR 250.45(g) and 40 CFR 51.166(c).

The table below lists the highest predicted contributions to onshore pollutant concentrations from activities associated with the proposed lease sales and compares them with the maximum allowable increases over a baseline concentration established under the air quality regulations. While the table shows that the

proposed lease sales by themselves would result in concentration increases that are well within the maximum allowable limits for a Class II area, a direct comparison between the two sets of figures is not possible. This is because the actual maximum allowable increase depends on the net change in emissions from all other sources in the area, both offshore and onshore, since the date the baseline level was established. Sources that were already in place at the applicable baseline date are included in the establishment of the baseline and corresponding concentration and do not count in the determination of the maximum allowable increment. The TSP's are emitted at a substantially smaller rate than NO_2 and SO_2; hence, impacts from TSP's would be expected to be even smaller since chemical decay was not employed in this dispersion modeling.

Class II
OCS Modeling Results and the Corresponding Maximum Allowable Increases
(micrograms per cubic meter)

Pollutant	Averaging Period	Class II Maximum Allowable Increase	Class II Modeled Impact
SO_2			
	Annual Average	20.0	0.00
	24-hour Average	91.0	0.00
	3-hour Average	512.0	0.00
NO_2			
	Annual Average	25.0	0.01
TSP			
	Annual Average	19.0	*
	24-hour Average	37.0	*

*TSP emissions were not modeled because they are emitted in smaller quantities than NO_2 or SO_2; hence, their impacts would be even less than those modeled and presented above.

Suspended particulate matter is important because of its potential in degrading visibility and because of its potential health effects at high concentrations. The impact depends on emission rates and particle size. Particle size represents the equivalent diameter, which is the diameter of a sphere, that will have the same settling velocity as the particle. Particle distribution in the atmosphere has been characterized as being largely trimodal (Godish, 1991), with two peaks located at diameters smaller than 2 μm and a third peak with diameters larger than 2 μm. Particles with diameters of 2 μm or larger settle very close to the source (residence time of approximately ½ day, Lyons and Scott, 1990). For particles smaller than 2 μm, which do not settle fast, wind transport determines their impacts. Projected TSP concentrations are expected to have a low impact.

Summary and Conclusion

Emissions of pollutants into the atmosphere from the activities associated with the proposed action are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline. Emissions from proposed action activities are not expected to have concentrations that would change onshore air quality classifications. Increases in onshore annual average concentrations of NO_x, SO_x, and TSP are estimated to be less than the maximum increases allowed under the PSD Class II program.

(5) Impacts on Marine Mammals

The major impact-producing factors resulting from OCS oil and gas activities affecting marine mammals include degradation of water quality resulting from operational discharges; noise from helicopter and vessel traffic, operating platforms, and drillships; explosive platform removals; seismic surveys; oil spills; oil-spill response activities; and discarded debris from service vessels and OCS structures.

Produced waters, drill muds, and drill cuttings are routinely discharged into offshore marine waters and are regulated by the U.S. Environmental Protection Agency's NPDES permits. Most operational discharges are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (API, 1989; NRC, 1983; Henwood, personal communication, 1993; Kennicutt, 1995). Any potential impact from drilling fluids would be indirect, either as a result of impacts to prey items or possibly through ingestion via

the food chain (API, 1989). Contaminants in drilling muds or waste discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of marine mammals or species lower in the marine food web (for further information on bioaccumulation, see Section IV.A.3.d.). Marine mammals generally are inefficient assimilators of petroleum compounds in food (Neff, 1990). Analyses of samples from stranded Gulf of Mexico bottlenose dolphins carry high levels of organochlorides and heavy metals (e.g., Salata et al., 1995; Kuehl and Haebler, 1995). However, the significance of this cannot be determined because of the lack of baseline information with which to make comparisons. Many heavy metals presumably are acquired from food, but the ultimate sources are poorly known (API, 1989). It is known that coastal cetacean species tend to have higher levels of metals than those frequenting deeper water (Johnston et al., 1996). Cetaceans feeding on cephalopods have higher levels of cadmium in their tissues than comparable fish-eating species (Johnston et al., 1996). There also is in many cases a striking difference between the high mercury levels in the toothed whales and the lower values found in baleen whales, which is probably attributable to the lower position of baleen whale prey in the food chain and differences in the habitat (Johnston et al., 1996).

Aircraft overflights in proximity to cetaceans can elicit a startle response with sensitivity varying depending on the activity of the animals (Richardson et al., 1995). Whales often react to aircraft overflights by hasty dives, turns, or other changes in behavior. Whales engaged in feeding or social behavior are often insensitive to overflights. Whales in confined waters, or those with calves, sometimes seem more responsive. This behavioral response could be a result of noise and/or visual disturbance. The effects appear to be transient, and there is no indication that long-term displacement of whales would occur. Toothed whales (and baleen whales, to a lesser extent) show some tolerance of vessels, but may react at distances of several kilometers or more when confined by habitat features or when they learned to associate the vessel with harassment. Evidence suggests that certain whales have reduced their use of certain areas heavily utilized by ships (Richardson et al., 1995), possibly avoiding or abandoning important feeding areas, breeding areas, resting areas, or migratory routes. However, continued presence of various dolphin and whale species in areas with heavy boat traffic indicates a considerable degree of tolerance to ship noise and disturbance. Increased ship traffic from support vessels involved in survey, service, or shuttle functions could increase the probability of collisions between ships and marine mammals. These collisions can cause major wounds on cetaceans and/or be fatal (e.g., northern right whale, Kraus, 1990; bottlenose dolphin, Fertl, 1994; sperm whale, Slijper, 1962). Debilitating injuries may have negative effects on a population through impairment of reproductive output. Slow-moving cetaceans (e.g., northern right whale) or those which spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (sperm whale) might be expected to be the most vulnerable. Smaller delphinids often approach vessels that are in transit to bow-ride. The mobility of many marine mammals is such that it would appear that they can easily avoid encounters with vessels; however, there are many occasions that dolphins are either not attentive (due to behaviors they are engaged in, or perhaps because of their age/health), or there is too much vessel traffic around them, and they are struck by propellers. There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or productivity, unless they occur frequently. Long-term displacement of animals, in particular, baleen whales, from an area is also a consideration. It is not known whether toothed whales exposed to recurring vessel disturbance are stressed or otherwise affected in a negative, but inconspicuous way (Richardson et al., 1995). Stress or "alert" responses could occur quite early during an encounter. For example, Myrick and Perkins (1995) found stress responses occurring as early as the chase stage in purse-seine netting on dolphins. Though cetaceans should be able to avoid vessels, operators should take actions to avoid moving directly at a whale(s) or dolphin(s). In accordance with the Marine Mammal Protection Act, NMFS has guidelines for operators of boats with regard to proper maneuvering around cetaceans. It is suggested that operators in areas of heavy sperm whale concentration should take care to steer clear of these animals, since the whales must spend roughly 30 minutes resting at the water surface and are not able to perform deep dives at that time. It is possible, though unlikely, that manatees could occur in areas where they could be affected by vessels traveling to and from the lease sale areas. If a manatee should be present in an area where there is vessel traffic, they could be injured or killed by a boat colliding into them (Wright et al., 1995). It has been proposed that the manatee is poor at sound localization; this has been suggested to be important for understanding the substantial hazard

boat traffic represents (Ketten et al., 1992). Gerstein (1995) found no support for such a conclusion, and instead suggested that limited hearing sensitivity at lower frequencies may make it difficult for a manatee to detect, locate, and react to approaching boats from a safe distance.

Exploration, delineation, and production structures, as well as drillships, produce an acoustically wide range of sounds at frequencies and intensities that can be detected by cetaceans. Some of these sounds could mask cetaceans' reception of sounds produced for echolocation and communication. Odontocetes use sounds at frequencies that are generally higher than the dominant sounds generated by offshore drilling and production activities. Low-frequency hearing has not been studied in many species, but bottlenose dolphins can hear sounds at frequencies as low as 40-125 Hz. Below 1 kHz, where most industrial noise energy is concentrated, sensitivity seems poor (Richardson et al., 1995). Pilot whales and sperm whales changed their behavior (in particular, ceased vocalizations) during low frequency transmissions from the Heard Island Feasibility Test (Bowles et al., 1994); this throws doubt on the assumed insensitivity of odontocete hearing at low frequencies. Baleen whales mainly utter low-frequency sounds which overlap broadly with the dominant frequencies of many industrial sounds. There are indirect indications that baleen whales are sensitive to low- and moderate-frequency sounds (Richardson et al., 1995). Drilling noise from conventional metal-legged structures and semi-submersibles is not particularly intense and is strongest at low frequencies, averaging 5 Hz and 10-500 Hz, respectively (Richardson et al., 1995). There is particular concern for baleen whales that are apparently more dependent on low-frequency sounds than are other marine mammals; many industrial sounds are concentrated at low frequencies. Drillships produce higher levels of underwater noise than other types of platforms. There are few published data on underwater noise levels near production platforms and on the marine mammals near those facilities (Richardson et al., 1995). However, underwater strong noise levels may often be low, steady, and not very disturbing (Richardson et al., 1995). Stronger reactions would be expected when sound levels are elevated by support vessels or other noisy activities (Richardson et al., 1995).

Human-made sounds may affect the ability of marine mammals to communicate and to receive information about their environment (Richardson et al., 1995). Such noise may interfere with or mask the sounds used and produced by these animals and thereby interfere with their natural behavior. These sounds may frighten, annoy, or distract marine mammals and lead to physiological and behavioral disturbances. Response threshold may depend on whether habituation (gradual waning of behavioral responsiveness) or sensitization (increased behavioral responsiveness) occurs (Richardson et al., 1995). Sounds can cause reactions that might include disruption of marine mammals' normal activities (behavioral and/or social disruption), and, in some cases, short- or long-term displacement from areas important for feeding and reproduction (Richardson et al., 1995). The energetic consequences of one or more disturbance-induced periods of interrupted feeding or rapid swimming, or both, have not been evaluated quantitatively. Energetic consequences would depend on whether suitable food is readily available. Additionally, animals subject to a high energy drain, especially females in late pregnancy or lactation, probably would be most severely affected. Sounds may also disturb the species such as fishes, squids, and crustaceans upon which the marine mammals prey (NRC, 1994). Human-made noise may cause temporary or permanent hearing impairment in marine mammals. Such impairment would have the potential to diminish the individual's chance for survival. Tolerance of noise is often demonstrated, but this does not prove that the animals are unaffected by noise, for example, they may become stressed, making the animal(s) more vulnerable to parasites, disease, environmental contaminants, and/or predation. Noise-induced stress is little studied in marine mammals. Aversive levels of noise might cause animals to become irritable, affecting feed intake, social interactions, or parenting; all of these effects might eventually result in population declines (Bowles, 1995).

Little information is available on the effects of explosions on marine mammals (O'Keeffe and Young, 1984). The shock wave produced by explosions can cause physical damage to nearby animals. The potential for injury is associated with gas-containing internal organs, such as the lungs and intestines (Yelverton et al., 1973). The extent of potential injury is dependent upon the amount of explosive used, distance from the charge, and body mass of the cetacean. As explained in detail in the U.S. Dept. of Commerce, NMFS (1995), it may be assumed that marine mammals more than 3,000 ft (910 m) from structures to be removed would avoid injury caused by explosions. There is no evidence linking dolphin injuries or deaths in the Gulf to explosive removal of oil and gas structures (Klima et al., 1988). Odontocete cetaceans cannot hear well in

the frequencies emitted by explosive detonations (Richardson et al., 1995). The animals may not be able to hear the pulse generated from open-water detonations of explosive charges because it is very brief (*Federal Register*, 1995). Sublethal effects would be a startle response and physiological, behavioral, as well as pathological effects on the body due to the shockwave, as well as to the acoustic signature of the detonation. Even if dolphins are not capable of hearing the acoustic signature of the explosion, physiological or behavioral responses to detonations may still result. The U.S. Dept. of Commerce, NMFS (1995) cites such examples as detection of low-frequency sound by some mechanism other than conventional hearing and harassment due to tactile stings from the shockwave accompanying detonations. Data is limited regarding blast-induced auditory damage; however, two humpback whales were found with damage to their ear bones following an explosion in Newfoundland (Ketten et al., 1993). Explosions and shock wave and intense transient sound field have the ability to produce blast injury and acoustic trauma in marine mammals (Ketten, 1995). Cetaceans are liable to hearing loss from severe trauma or age (Ketten et al., 1995). Consequences of hearing damage may range from subtle, through modification of certain behaviors that require a modicum of hearing ability, to acute, where concussive effects may lead to death (Ketten, 1995). Humpback whales in Newfoundland, foraging in an area of explosive activity, showed little behavioral reaction to the detonations in terms of decreased residency, overall movements, or general behavior, though orientation ability appeared to be affected (Todd et al., 1996). Todd et al. (1996) suggested caution in interpretation of lack of visible reactions as indication that whales are not affected or harmed by an intense acoustic stimulus; both long- and short-term behavior as well as anatomical evidence should be examined. The researchers interpreted increased entrapment rate of humpback whales in nets as the whales being influenced by the long-term effects of exposure to deleterious levels of sound. Impacts resulting from resuspension of bottom sediments due to explosive detonation include increased water turbidity and mobilization of sediments containing hydrocarbon extraction waste (*Federal Register*, 1995). Because of its temporary effect, no impacts to higher life forms are expected, and, because of its temporary and localized nature, biomagnification is unlikely.

In October 1995, NMFS issued regulations authorizing and governing the taking of bottlenose and spotted dolphins incidental to the removal of oil and gas drilling and production structures in State waters and on the Gulf of Mexico OCS for a period of 5 years (*Federal Register*, 1995). Letters of Authorization must be requested from, and issued to, individual applicants (operators) to conduct the activities (platform removals) pursuant to the regulations.

In order to minimize the likelihood of removals occurring when cetaceans may be nearby, MMS has issued a series of guidelines (NTL 92-02) for explosive platform removal to offshore operators. These guidelines specify platform removal only during daylight hours, staggered detonation of charges, placement of charges 5 m below the seafloor, and extensive pre- and post-detonation 30-minute aerial surveys within one hour before and after detonation. Platform observers watch for sea turtles and marine mammals in the vicinity of the platform to be removed.

Seismic surveys produce a more intense noise than other nonexplosive methods. Baleen whales seem quite tolerant of low- and moderate-level noise pulses from distant seismic surveys but exhibit behavioral changes in the presence of nearby seismic activity (Richardson et al., 1995). Subtle effects on surfacing and respiration have been noted (Richardson et al., 1995). Bowhead and gray whales often show strong avoidance within 6-8 km of an airgun array. Whales exposed to noise from distant seismic ships may not be totally unaffected even if they remain in the area and continue their normal activities (Richardson et al., 1995). One report of sperm whales in the Gulf of Mexico indicated that the whales ceased vocalizations when seismic activity in the area was occurring (Davis et al., 1995) and that sperm whales may have moved 50+ km away (Mate et al., 1994). Goold (1996) found that acoustic contacts with common dolphins dropped sharply as soon as seismic activity began. Sperm whales during the Heard Island Feasibility Test were found to cease calling during some times when seismic pulses were received from an airgun array >300 km away (Bowles et al., 1994). No obvious behavior modifications relative to the seismic activity were recorded during the majority of the small odontocete observations made during marine mammal monitoring carried out by Impact Sciences during an Exxon 3D seismic survey offshore California in late 1995 (Arnold, 1996). There was also no observed obvious behavior modification or harassment of large whales attributable to the sound effects of the survey (Arnold, 1996). For baleen whales, in particular, it is not known (a) whether the

same individuals return to areas of previous seismic exposure, (b) whether seismic work has caused local changes in distribution or migration routes, or (c) whether whales that tolerate strong seismic pulses are stressed (Richardson et al., 1995). There are no data on auditory damage in marine mammals relative to received levels of underwater noise pulses (Richardson et al., 1995). Indirect "evidence" suggests that extended or repeated exposure to seismic pulses is unlikely to cause permanent hearing damage in marine mammals given a study of damage risk criteria; the transitory nature of seismic exploration; the presumed ability of marine mammals to tolerate exposure to strong calls from themselves or other nearby mammals; and the avoidance responses that occur in at least some baleen whales when exposed to certain levels of seismic pulses (Richardson et al., 1995).

Each major grouping of marine mammals confronts oil in different ways. Oil could affect marine mammals through various pathways: surface contact, oil inhalation, oil ingestion, and baleen fouling (Geraci, 1990). Much of the information on the effects of oil on marine mammals comes from studies of fur-bearing marine mammals. Sea otters exposed to the *Exxon Valdez* spill experienced high incidences of emphysema, petroleum hydrocarbon toxicosis, abortion, and stillbirths (Williams and Davis, 1995). Direct contact with oil and/or tar for cetaceans can lead to irritation and damage of skin and soft tissues (such as mucous membranes of the eyes), fouling of baleen plates so as to hinder the flow of water and interfere with feeding, and incidental ingestion of oil and/or tar. Studies by Geraci and St. Aubin (1982, 1985) have shown that the cetacean epidermis functions as an effective barrier to noxious substances found in petroleum. Unlike other mammals, penetration of such substances in cetacean skin is impeded by tight intercellular bridges, the vitality of the superficial cells, the thickness of the epidermis, and the lack of sweat glands and hair follicles (Geraci and St. Aubin, 1985). The cetacean epidermis is nearly impenetrable, even to the highly volatile compounds in oil, and when skin is breached, exposure to these fractions does not impede the progress of healing (Geraci and St. Aubin, 1985). Cetacean skin is free from hair or fur, which in other marine mammals, such as pinnipeds and otters, tends to collect oil and/or tar, which effectively reduces the insulating properties of the fur (Geraci, 1990). Dolphins maintained at a captive site in Sevastopol, Ukraine, that were exposed to petroleum products initially exhibited a sharp depression of food intake along with an excitement in behavior, eye inflammation, and changes in hemoglobin as well as erythrocyte content (Lukina et al., 1996). Prolonged exposure to oil led to a depression of those blood parameters, as well as changes in breathing patterns and gas metabolism, while nervous functions became depressed and skin injuries and burns appeared (Lukina et al., 1996). Experiments with harbor porpoise in similar conditions possibly resulted in aspiration pneumonia (Lukina et al., 1996). Dolphins exposed to oil at a Japanese aquarium that draws seawater from the ocean began developing cloudy eyes (Reuters, 1997).

Fresh crude oil or volatile distillates release toxic vapors that when inhaled can lead to irritation of respiratory membranes, lung congestion, and pneumonia; subsequent absorption of volatile hydrocarbons into the bloodstream may accumulate into such tissues as the brain and liver, causing neurological disorders and liver damage (Geraci and St. Aubin, 1982; Hansen, 1985; Geraci, 1990). Geraci and St. Aubin (1982) determined that toxic vapor concentrations just above the water's surface (where cetaceans draw breath) could reach critical levels for the first few hours after a spill, prior to evaporation of volatile aromatic hydrocarbons and other light fractions.

Trained, captive bottlenose dolphins exposed to oil could not detect light oil sheen but could detect thick dark oil based on visual, tactile, and presumably echolocation cues (Geraci et al., 1983; Smith et al., 1983). Captive studies also showed that dolphins completely avoided surfacing in or swimming beyond slick oil after a few brief, initial tactile encounters. Reactions of free-ranging cetaceans to spilled oil appears varied, ranging from avoidance to apparent indifference (reviewed by Geraci, 1990; Smultea and Würsig, 1991). In contrast to captive studies, bottlenose dolphins during the *Mega Borg* spill did not consistently avoid entering slick oil, which could increase their vulnerability to potentially harmful exposure to oil chemicals (Smultea and Würsig, 1991, 1995). As noted by Smultea and Würsig (1995), it is possible that some overriding behavioral motivations, such as feeding, induced dolphins to swim through oil, or that bottlenose dolphins have become accustomed to oil due to the extent of oil-related activity in the Gulf, or that slick areas were too large for dolphins to feasibly avoid. The latter could result in temporary displacement from migratory routes. After the *Exxon Valdez* spill, killer whales did not seem to attempt to avoid oil; however, none were observed in the presence of heavier slicks of oil (Matkin et al., 1994). It is unknown whether

animals in some cases are simply not affected by the presence of oil, or perhaps are even drawn to the area in search of prey organisms attracted to the oil's protective surface shadow (Geraci, 1990). The probable effects on cetaceans swimming through an oiled area would depend on a number of factors, including ease of escape from the vicinity, the health of the individual animal, and its immediate response to stress (Geraci and St. Aubin, 1985).

Spilled oil can also lead to the reduction or contamination of prey. Feeding strategies of cetaceans could lead to ingestion of oil-contaminated food or incidental ingestion of floating or submerged oil or tar. Zooplankton may become contaminated by direct contact and/or by ingesting oil droplets and tainted food. Marine fish also take up petroleum hydrocarbons from both water and food, though apparently do not accumulate high concentrations of hydrocarbons in tissues, and may transfer them to predators (Neff, 1990). Harmful hydrocarbon fractions might be swallowed or consumed through contaminated prey (Geraci, 1990) and by fouling of the feeding apparatus, in the case of baleen whales (though laboratory studies suggest that such fouling has only transient effects (Geraci and St. Aubin, 1985). In general, the potential for ingesting oil-contaminated prey organisms with petroleum-hydrocarbon body-burden content is highest for benthic feeding whales and pinnipeds. The potential is lower for plankton-feeding whales, and lowest for fish-eating whales and pinnipeds (Würsig, 1990). Baleen whales from the Gulf of Mexico feed on small pelagic fishes (such as herring, mackerel, and pilchard) and cephalopods (Cummings, 1985). An analysis of stomach contents from captured and stranded odontocetes suggest that they are deep-diving animals, feeding predominantly on mesopelagic fish and squid or deepwater benthic invertebrates (Heyning, 1989; Mead, 1989). Delphinids feed on fish and/or squid, depending upon the species (Mullin et al., 1991).

As noted by St. Aubin and Lounsbury (1990), there has been no experimental study, and only a handful of observations suggesting that oil has harmed any sirenian. Dugongs (relatives of the manatees) have been found dead on beaches after the Gulf War Oil Spill and the 1983 Nowruz Oil Spill caused by the Iran-Iraq War (Preen, 1991; Sadiq and McCain, 1993). Some dugongs were sighted in the oil sheen after the Gulf War (Pellew, 1991). Preen (1989) in Sadiq and McCain (1993) discusses four types of impacts to dugongs potentially caused by oil contact, including asphyxiation due to inhaled oil, acute poisoning due to contact with fresh oil, lowering of tolerance to other stress due to the incorporation of sublethal amounts of petroleum fractions into body tissues, and nutritional stress through damage to food sources. Manatees concentrate their activities in shallow water, often resting at or just below the surface, which should bring them in contact with spilled oil (St. Aubin and Lounsbury, 1990). Manatees are nonselective, generalized feeders that might consume tarballs along with their normal food; such occurrences have been rarely reported (review in St. Aubin and Lounsbury, 1990). A manatee might also ingest fresh petroleum, which some researchers have suggested might interfere with the manatee's secretory activity of their unique gastric glands or harm intestinal flora vital to digestion (Geraci and St. Aubin, 1980; Reynolds, 1980). Oil spills within the confines of preferred river systems and canals, particularly during winter (when the animals are most vulnerable physiologically), could endanger local populations. Manatees able to escape such areas might be forced into colder waters, where thermal stress could complicate the effects of even brief exposure to oil (St. Aubin and Lounsbury, 1990). This scenario is not one likely to be associated with offshore production or transportation of petroleum. The greater risk is from coastal accidents. For a population whose environment is already under great pressure, even a localized incident could be damaging (St. Aubin and Lounsbury, 1990). Spilled oil might affect the quality or availability of aquatic vegetation, including seagrasses, upon which manatees feed.

Indirect consequences of oil pollution on marine mammals are those effects that may be associated with changes in the availability or suitability of various food sources (Hansen, 1992a). No long-term oil-spill effects from bioaccumulation of hydrocarbons have been demonstrated; however, an oil spill may physiologically stress an animal (Geraci and St. Aubin, 1980), making them more vulnerable to disease, parasitism, environmental contaminants, and/or predation.

Oil-spill response activities include the application of dispersant chemicals to the affected area designed to break up oil on the water's surface into minute droplets, which then break down in seawater. Virtually nothing is known about the effects of oil dispersants on cetaceans, except that removal of the oil from the surface would reduce the risk of contact and render it less likely to adhere to skin, baleen plates, or other body surfaces (Neff, 1990). The acute toxicity of most oil dispersant chemicals is considered to be low when

compared to the constituents and fractions of crude oils and refined products, and studies have shown that the rate of biodegradation of dispersed oil is equal to or greater than that of undispersed oil (Wells, 1989). A variety of aquatic organisms readily accumulate and metabolize surfactants from oil dispersants. Enzymatic hydrolysis of the surfactant yields hydrophilic and hydrophobic components. The former probably are excreted via the gills and kidneys, whereas the latter accumulate in the gallbladders of fish and are excreted very slowly (Neff, 1990). Metabolism of surfactants is thought to be rapid enough that there is little likelihood of food chain transfer from marine invertebrates and fish to consumers, including marine mammals (Neff, 1990). Biodegradation is another process used for removing petroleum hydrocarbons from the marine environment, utilizing chemical fertilizers to augment the growth of naturally occurring hydrocarbon-degrading microorganisms. Toxic effects of these fertilizers on cetaceans are presently unknown.

In recent years, there has been increasing concern about man-made debris (discarded from offshore and coastal sources) and its impact on the marine environment (e.g., Shomura and Godfrey, 1990; Laist, 1987; Heneman and Center for Environmental Education, 1988). Both entanglement in and ingestion of debris has caused the death or serious injury of marine mammals (MMC, 1995). The debris items most often found entangling animals are net fragments and monofilament line from commercial and recreational fishing boats, as well as strapping bands and ropes probably from all types of vessels (MMC, 1995). Plastic bags and small plastic fragments are the most commonly reported debris items in the digestive tracts of cetaceans and manatees (e.g., Barros and Odell, 1990; Tarpley and Marwitz, 1993; MMC, 1995). Many types of plastic materials are used during drilling and production activities; the offshore oil and gas industry was shown to contribute 13 percent of the debris found at Padre Island National Seashore (Miller et al., 1995). The MMS prohibits the disposal of equipment, containers, and other materials into coastal and offshore waters by lessees (30 CFR 250.40). Prohibition of the discharge and disposal of vessel- and offshore structure-generated garbage and solid waste items into both offshore and coastal waters was established January 1, 1989, via the enactment of MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which the U.S. Coast Guard enforces.

Proposed Action Analysis

The major impact-producing factors resulting from OCS oil and gas activities affecting cetaceans include degradation of water quality resulting from operational discharges; noise from helicopter and vessel traffic, operating platforms, and drillships; explosive platform removals; seismic surveys; oil spills; oil-spill response activities; and discarded debris from service vessels and OCS structures.

Information on drilling fluids, drill cuttings and produced waters that would be discharged offshore as a result of the proposed action is provided in Section IV.A.3.d. These effluents are routinely discharged into offshore marine waters. It is expected that cetaceans may have some interaction with these discharges. Direct effects to cetaceans are expected to be sublethal. It should be noted, however, that any pollution in the effluent could poison and kill or debilitate marine mammals and adversely affect the food chains and other key elements of the Gulf ecosystem (Tucker and Associates, Inc., 1990).

Helicopter traffic will occur on a regular basis. The FAA Advisory Circular 91-36C encourages pilots to maintain higher than minimum altitudes over noise-sensitive areas. Corporate helicopter policy states that helicopters should maintain a minimum altitude of 700 ft while in transit offshore, and 500 ft while working between platforms. In addition, guidelines and regulations promulgated by the NMFS under the authority of the Marine Mammal Protection Act do include provisions specifying helicopter pilots to maintain an altitude of 1,000 ft within 100 yd (91 m) of marine mammals. It is unlikely that cetaceans will be affected by routine OCS helicopter traffic operating at these altitudes, provided pilots do not alter their flight patterns to more closely observe or photograph marine mammals that they see. It is also expected that 10 percent of helicopter trips will occur at altitudes below the specified minimums listed above as a result of inclement weather. Routine overflights may elicit a startle response from, and interrupt cetaceans nearby (depending on the activity of the animals) (Richardson et al., 1995). Occasional overflights probably have no long-term consequences on cetaceans; however, frequent overflights could have long-term consequences if they repeatedly disrupt vital functions, such as feeding and breeding.

About 550-1,000 OCS-related oil and gas service-vessel trips would occur annually as a result of the proposed action. Smaller delphinids may approach vessels that are in transit to bow-ride. Noise from service-vessel traffic may elicit a startle and/or avoidance reaction from cetaceans or mask their sound reception. There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or productivity, unless they occur frequently. Long-term displacement of animals from an area is also a consideration. It is not known whether toothed whales exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased ship traffic could increase the probability of collisions between ships and marine mammals, resulting in injury or death to some animals.

A total of 35-115 exploration and delineation wells and 50-190 development wells would be drilled and could produce sounds at intensities and frequencies that could be heard by cetaceans. It is estimated that noise from drilling activities will be relatively constant and last no longer than two months at each location. Odontocetes echolocate and communicate at higher frequencies than the dominant sounds generated by drilling platforms. Sound levels in this range are not estimated to be generated by drilling operations (Gales, 1982). Bottlenose dolphins, one of the few species in which low frequency sound detection has been studied, have been found to have poor sensitivity levels at the level where most industrial noise energy is concentrated. There is concern, however, for baleen whales since they are apparently more dependent on low-frequency sounds than other marine mammals. Potential effects on Gulf of Mexico marine mammals include disturbance (subtle changes in behavior, interruption of previous activities, or short- or long-term displacement); masking of calls from conspecifics, reverberations from own calls, and other natural sounds (e.g., surf, predators); stress (physiological); and hearing impairment (permanent or temporary) by explosions and strong nonexplosive sounds.

Potential impacts to marine mammals from the detonation of explosives include lethal and injurious incidental take, as well as physical or acoustic harassment. Injury to the lungs and intestines and/or auditory system could occur. Harrassment of marine mammals as a result of a noninjurious physiological response to the explosion-generated shockwave as well as to the acoustic signature of the detonation is also possible. It is estimated that 5-16 production platforms will be removed by explosives from the WPA as a result of the proposed action. It is expected that structure removals will cause primarily sublethal effects on cetaceans as a result of the implementation of the MMS guidelines for explosive removals (USDOI, MMS, 1990b, Appendix B).

Seismic surveys use airguns to generate sound pulses. It is assumed that only these methods will be used in seismic surveys as a result of the proposed action (Section IV.A.2.a.(1)). Although any one seismic survey is unlikely to have long-term adverse effects on any cetacean species or population, available information is insufficient to be confident that seismic activities, collectively, will not have significant adverse long-term effects on the size or productivity of any marine mammal species or population, with repeated disturbance of vital functions such as feeding, breeding, and nursing.

Oil spills and oil-spill response activities have the potential to adversely affect cetaceans, causing soft tissue irritation, fouling of baleen plates, respiratory stress from inhalation of toxic fumes, food reduction or contamination, the direct ingestion of oil and/or tar, and temporary displacement from preferred habitats or migration routes. Contact with oil, and consumption of oil and oil-contaminated prey, are unlikely to have more than temporary, nonlethal effects on cetaceans (Geraci, 1990). Some short-term (0-1 month) effects of oil may be (a) changes in cetacean distribution associated with avoidance of aromatic hydrocarbons and surface oil, changes in prey distribution, and human disturbance; (b) increased mortality rates from ingestion or inhalation of oil; (c) increased petroleum compounds in tissues; and (d) impaired health (e.g., immunosuppression) (Harvey and Dahlheim, 1994). Several mechanisms for long-term injury can be postulated: (a) initial sublethal exposure to oil causing pathological damage; (b) continued exposure to hydrocarbons persisting in the environment, either directly or through ingestion of contaminated prey; and (c) altered availability of prey as a result of the spill (Ballachey et al., 1994). While no conclusive evidence of an impact on cetaceans by the *Exxon Valdez* spill was uncovered (Dahlheim and Matkin, 1994; Harvey and Dahlheim, 1994; Loughlin, 1994), investigations on the effects on sea otters and harbor seals revealed pathological effects on the liver, kidney, brain (also evidenced by abnormal behavior) and lungs, as well as gastric erosions (Ballachey et al., 1994; Lipscomb et al., 1994a; Lowry et al., 1994; Spraker et al., 1994).

In addition, harbor seal pup production and survival appeared to be affected (Frost et al., 1994). A delayed effect of oil spills on river otters was strongly suggested in Bowyer et al. (1994). Oil spills have the potential to cause greater chronic (longer-term lethal or sublethal oil-related injuries) and acute (spill-related deaths occurring during a spill) effects on mammals than originally suggested. A few long-term effects include (a) change in distribution and abundance because of reduced prey resources or increased mortality rates; (b) change in age structure because certain year-classes were impacted more by oil; (c) decreased reproductive rate; and (d) increased rate of disease or neurological problems from exposure to oil (Harvey and Dahlheim, 1994). It has been speculated that new mortalities of killer whales may be linked to the *Exxon Valdez* spill (Matkin and Sheel, 1996). There was no evidence to directly link the Gulf War oil spill to marine mammal deaths that occurred during that time (Preen, 1991; Robineau and Fiquet, 1994). Effects of cleanup activities are unknown, but increased human presence (e.g., vessels) could add to changes in cetacean behavior and/or distribution, thereby additionally stressing animals, and perhaps making them more vulnerable to various physiologic and toxic effects.

Evidence gathered from the studies of the *Exxon Valdez* spill indicates that oil spills have the potential to cause chronic (long-term lethal or sublethal oil-related injuries) and acute (spill-related deaths) effects on marine mammals. Also, cetaceans do not always avoid contact with oil (e.g., Smultea and Würsig, 1995). Although an interaction with a spill could occur, primarily sublethal effects are expected due to avoidance and natural dispersion/weathering of the spill in the offshore environment. Sections IV.A.3.h.(2) and IV.B.2.d. provide discussions of offshore oil-spill modeling results and coastal spill projections for the proposed action.

Many types of plastic materials are used during drilling and production operations. Some of this material is accidentally lost overboard where cetaceans can consume it. The result of plastic ingestion could be lethal, and the probabilities of occurrence of ingestion and lethal effect are unknown.

Summary and Conclusion

The proposed action, by itself, is unlikely to have significant long-term adverse effects on the size and productivity of any marine mammal species or population stock in the northern Gulf of Mexico provided (a) previous and ongoing exploration and development activities have not increased the sensitivity of any marine mammal species to disturbance from seismic surveys, rig construction, drilling operations, or ship and helicopter support activities; (b) responses to disturbance do not increase as the level of disturbance increases or do not occur until a sensitivity threshold is reached; and (c) if oil spills occur, they occur at times and in places where significant numbers of marine mammals are not present, and individually and collectively do not adversely affect habitats or habitat components (e.g., important prey species) that are essential to the well-being of any marine mammal species or population stock in the northern Gulf. Small numbers of marine mammals could be killed or injured by chance collision with service vessels and by eating indigestible trash, particularly plastic items, lost from drill rigs and service vessels. Deaths due to structure removals are not expected due to mitigation measures (NMFS observer program). There is no conclusive evidence that anthropogenic noise has or has not caused long-term displacements of, or reductions in, marine mammal populations. Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain biomagnification; there is uncertainty concerning the possible effect. There is little likelihood of a well blowout or pipeline break resulting in a major oil spill and, if a major oil spill occurs, containment and cleanup capabilities are sufficient to ensure that significant numbers of marine mammals will not be affected. Lethal effects are most likely to be from chance collisions with OCS service vessels and ingestion of plastic materials, though few lethal impacts are expected. It should be noted that present distribution patterns of both large and small cetaceans may reflect displacements that have occurred as oil and gas exploration and developments in the northern Gulf expanded.

(6) Impacts on Sea Turtles

The major impact-producing factors that may affect loggerhead, Kemp's ridley, hawksbill, green, and leatherback turtles include water-quality degradation from operational discharges; structure installation;

noise from helicopter and vessel traffic, operating platforms, and drillships; seismic surveys; explosive platform removals; OCS-related debris; oil spills; and oil-spill response activities.

Produced waters, drill muds, and drill cuttings are routinely discharged into offshore marine waters and are regulated by the USEPA's NPDES permits. Most operational discharges, as regulated, are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (API, 1989; Henwood, personal communication, 1993; Kennicutt, 1995). Any potential that might exist for impact from drilling fluids would seem to be indirect, either by impact on prey items or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling muds or waste discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of sea turtles or species lower in the marine food web (for further information on bioaccumulation, see Section IV.A.3.d.). Sea turtles could potentially bioaccumulate chemicals such as heavy metals that occur in drilling mud. This might ultimately reduce reproductive fitness in the turtles, an impact that the already diminished population(s) cannot tolerate. Samples from stranded turtles in the Gulf of Mexico carry high levels of organochlorides and heavy metals (Sis et al., 1993).

Structure installation and removal, pipeline placement, dredging, and water quality degradation may adversely affect sea turtle habitat through destruction of seagrass beds and live-bottom communities used by sea turtles. Potential impacts on these habitats caused by the proposed action are discussed in detail in Sections IV.D.1.a.(1)-(3). The physical integrity, species diversity, and biological productivity of topographic features and live bottoms that sea turtles inhabit could be affected.

There have been no systematic studies of the reactions of sea turtles to aircraft overflights and even anecdotal reports are scarce; it would seem reasonable to expect that aircraft noise could be heard by a sea turtle at or near the surface and cause it to alter its normal behavior pattern (Advanced Research Projects Agency, 1995). Noise from service-vessel traffic may elicit a startle reaction from sea turtles and produce a temporary sublethal stress (NRC, 1990). Sea turtle hearing sensitivity is not well studied. A few preliminary investigations using adult green, loggerhead, and Kemp's ridley turtles suggest that they are most sensitive to low-frequency sounds (Ridgway et al., 1969; Lenhardt et al., 1983). It has been suggested that sea turtles use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Lenhardt et al., 1983). Bone-conducted hearing appears to be a reception mechanism for at least some of the sea turtle species, with the skull and shell acting as receiving structures (Lenhardt et al., 1983).

Exploration, delineation, and production structures, as well as drillships, produce an acoustically wide range of sounds at frequencies and intensities that could possibly be detected by turtles. Drilling noise from conventional metal-legged structures and semi-submersibles is not particularly intense and is strongest at low frequencies (Richardson et al., 1995). Captive loggerhead and Kemp's ridley turtles exposed to brief audio frequency vibrations initially showed startle responses of slight head retraction and limb extension (Lenhardt et al., 1983). Sound-induced swimming has been observed for captive loggerheads (O'Hara and Wilcox, 1990; Moein et al., 1993; Lenhardt, 1994); some loggerheads exposed to low-frequency sounds responded by swimming towards the surface at the onset of the sound, presumably to lessen the effects of the transmissions (Lenhardt, 1994). An anecdotal observation of a free-ranging leatherback's response to the sound of a boat motor suggests that leatherbacks may be sensitive to low-frequency sounds, but the response could have been to mid- or high-frequency components of the sound (Advanced Research Projects Agency, 1995). The potential direct and indirect impacts of sound on sea turtles includes physical auditory effects (temporary threshold shift), behavioral disruption, long-term effects, masking, and adverse impacts on the food chain. Based on conclusions of Lenhardt et al. (1983) and O'Hara and Wilcox (1990), low-frequency sound transmissions could potentially cause increased surfacing behavior and deterrence from the area near the sound source. The potential for increased surfacing behavior could place turtles at greater risk of vessel collisions and potentially greater vulnerability to natural predators. Vessel-related injuries were noted in 9 percent of stranded turtles examined in the Gulf of Mexico during 1988, but this figure includes those that may have been struck by boats post-mortem (USDOC, NMFS, 1989b). If sound affects any prey species, negative consequences to sea turtles would depend on the extent to which prey availability might be altered. Noise-induced stress has not been studied in sea turtles.

Seismic surveys produce a more intense sound than other nonexplosive sound sources. The limited data indicate that reactions of turtles to seismic pulses deserve detailed study. Seismic surveying activities are considered primarily sublethal and probably elicit a short-term behavioral response. There is limited data suggesting that seismic sounds would act as an acoustic repellent for turtles (Lenhardt, 1994).

Oil and gas structures serve as artificial reefs that have been shown to provide habitat for sea turtles (Gitschlag and Herczeg, 1994). The dominant species of turtle observed at explosive structure removals is the loggerhead, but leatherback, greens, Kemp's ridley and hawksbill have also been observed (Gitschlag and Herczeg, 1994). Loggerheads may reside at specific offshore structures for long periods of time (Rosman et al., 1987; Gitschlag and Renaud, 1989). The probability of occupation by sea turtles increases with the age of the structures (Rosman et al., 1987). Sea turtles probably use oil platforms as places to feed and rest. Offshore structures afford refuge from predators and stability in water currents, and loggerheads have been seen sleeping under platforms or next to support structures (Hastings et al., 1976; Rosman et al., 1987; Gitschlag and Renaud, 1989). Only near the Chandeleur and Breton Islands were sea turtles positively associated with platforms (Lohoefener et al., 1989, 1990).

Information about the effects of underwater explosions on sea turtles is extremely limited. O'Keeffe and Young (1984) assumed that shock waves would injure the lungs and other organs containing gas, expected that ear drums of turtles would be sensitive, and expected that smaller turtles would suffer greater injuries from the shock wave than larger turtles. The NMFS conducted several studies before and after an explosive platform removal to determine its effects on sea turtles in the immediate vicinity (Duronslet et al., 1986; Klima et al., 1988). Immediately after the explosion, the turtles closest to the vicinity were rendered unconscious (Klima et al., 1988), though they were active and resumed apparently normal behavior 5-15 minutes post-explosion (Duronslet et al., 1986). One of these turtles also sustained damage to the cloacal lining (it was everted) (Klima et al., 1988). Dilation of epidermal capillaries was a condition that continued for three weeks, after which time all turtles appeared normal. Effects on their hearing were not determined. Impacts of explosive removals on sea turtles are not easily assessed, primarily because turtle behavior makes observations difficult. Sea turtles in temperate latitudes generally spend less than 10 percent of their time at the surface, and dive durations can exceed one hour. Injured turtles that are capable of swimming return to the surface, while moribund turtles sink to the sea bottom. Unconsciousness may render a turtle more susceptible to predation; effects of submergence on stunned turtles is unknown (Klima et al., 1988). The number of documented sea turtles impacted by explosives was only two during 1986-1994 (Gitschlag and Herczeg, 1994; NRC, 1996). A dead or injured turtle drifting below the water surface was sighted 1.5 hours after the explosive removal of a structure in 1986 (Gitschlag and Renaud, 1989). Only one injured turtle has been observed since 1987 when monitoring became mandatory (NRC, 1996); in 1991, within one minute of detonation, a loggerhead with a fracture down the length of its carapace surfaced 15-100 ft from the detonation site. Five additional sea turtles were captured prior to detonation of explosives and saved from possible injury or death (Gitschlag and Herczeg, 1994). The low number of turtles affected by explosive removals of structures may be due to the small number of turtles that find themselves in harm's way at the time explosives are detonated, the effectiveness of the monitoring program in protecting sea turtles, and/or to the inability to adequately assess and detect impacted animals.

In 1987, in response to 51 dead sea turtles that washed ashore on Texas beaches (explosions were identified as the primary cause by Klima et al., 1988), the NMFS initiated an observer program at all explosive removal sites of oil and gas structures in State and Federal waters of the Gulf of Mexico. For at least 48 hours prior to detonation, NMFS observers watched for sea turtles from the surface. Helicopter aerial surveys within a mile radius of the removal site are conducted 30 minutes prior to and after detonation (Gitschlag and Herczeg, 1994). If sea turtles are observed, detonations are delayed until the sea turtles have been safely removed or have left the area. Monitoring the water's surface for sea turtles is not 100 percent effective. Once observed, there is currently no practical and efficient means of removing a sea turtle from the area that will be impacted by explosives (Gitschlag and Herczeg, 1994). Although divers have had some success in capturing sea turtles, this procedure is limited to animals resting or sleeping beneath platforms.

Even if turtles are not capable of hearing the acoustic signature of an explosion, physiological or behavioral responses (startle) to detonations may still result (USDOC, NMFS, 1995). Impacts resulting from resuspension of bottom sediments due to explosive detonation include increased water turbidity and

mobilization of sediments containing hydrocarbon extraction waste (*Federal Register*, 1995). Because of its temporary effect and localized nature, biomagnification is unlikely.

Brightly lit offshore drilling platforms present a potential danger to hatchlings (Owens, 1983). Hatchlings are known to be attracted to light (Raymond, 1984) and could be expected to orient toward lighted offshore platforms (Chan and Liew, 1988). If this occurs, hatchling predation would increase dramatically since large birds and predacious fish also congregate around the platforms (Owens, 1983).

A wide variety of debris is commonly observed in the Gulf. Marine debris comes from a variety of land-based and ocean sources (Cottingham, 1988). Some of this material is accidentally lost during drilling and production operations. The offshore oil and gas industry was shown to contribute 13 percent of the debris found at Padre Island National Seashore (Miller et al., 1995). Turtles may become physically entangled in drifting debris, and ingest small fragments of synthetic materials (Carr, 1987; USDOC, NOAA, 1988; Heneman and the Center for Environmental Education, 1988; USDOI, MMS, 1989). Entanglement usually involves fishing line or netting (Balazs, 1985). Once entangled, turtles may drown, suffer impaired ability to catch food or avoid predators, incur wounds and infections from the abrasive or cutting action of attached debris, or exhibit altered behavior patterns that place them at a survival disadvantage (Laist, 1987). Both entanglement and ingestion have caused the death or serious injury of individual sea turtles (Balazs, 1985). Balazs (1985) compiled dozens of records of sea turtle entanglement, ingestion, entanglement, and impaction of the alimentary canal by ingested plastics worldwide; tar was the most common item ingested. The marked tendency of leatherbacks to ingest plastic has been attributed to misidentification of the translucent films as jellyfish. Lutz (1990) concluded that turtles will actively seek out and consume plastic sheeting. Ingested debris may block the digestive tract or remain in the stomach for extended periods, thereby lessening the feeding drive, causing ulcerations and injury to the stomach lining, or perhaps even providing a source of toxic chemicals (Laist, 1987). Weakened animals may then be more susceptible to predators and disease and less fit to breed and nest successfully.

The initial developmental stages of all marine turtle species are passed in the open sea. Hatchlings spend their "lost years" in sargassum rafts; ocean currents concentrate or trap floating debris in sargassum (Carr, 1987). Witherington (1994) studied post-hatchling loggerheads in drift lines 8-35 nmi east of Cape Canaveral and Sebastian Inlet, Florida. Out of 103 turtles captured, 17 percent of the animals revealed plastic or other synthetic fibers in their stomachs or mouths. The southeastern U.S. had the highest number of turtle strandings affected by debris (49.1%), followed by the Gulf of Mexico (35.9%) (Witzell and Teas, 1994). Even though the Kemp's ridley is the second most commonly stranded turtle, for some unknown reason they are apparently less susceptible to the adverse impacts of debris than the other turtle species (Witzell and Teas, 1994). The MMS prohibits 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), prohibits the disposal of any plastics at sea or in coastal waters.

When an oil spill occurs, the severity of effects and the extent of damage to sea turtles are affected by geographic location; oil type, dosage, and weathering; impact area; oceanographic and meteorological conditions; season; and life history stage of the animal (NRC, 1985; USDOI, MMS, 1987b). All sea turtle species and life stages are vulnerable to the harmful effects of oil, through direct contact or by fouling of their habitats and food. Van Vleet and Pauly (1987) suggested that discharges of crude oil from tankers were having a significant effect on sea turtles in the eastern Gulf of Mexico. Experiments on the physiologic and clinicopathologic effects of oil have shown that major body systems in sea turtles are adversely affected by short exposure to weathered oil. Sea turtles accidentally exposed to petroleum products or tarballs may suffer inflammatory dermatitis, ventilatory disturbance, salt gland dysfunction or failure, red blood cell disturbances, immune responses, and digestive disorders or blockages (Vargo et al., 1986; Lutz and Lutcavage, 1989; Lutcavage et al., 1995). Although disturbances may be temporary, long-term effects remain unknown, and chronically ingested oil may accumulate in organs. Exposure to oil may be fatal, particularly to juvenile and hatchling sea turtles. Direct contact with oil may harm developing turtle embryos.

Oil can adhere to the body surface of marine turtles. Oil has been observed to cling to the nares, eyes, and upper esophagus, and even seal the mouth (Witham, 1978; Overton et al., 1983; Van Vleet and Pauly, 1987; Gramentz, 1988; Lutcavage et al., 1995). Turtles may become entrapped by tar and oil slicks and

rendered immobile (Witham, 1978; Plotkin and Amos, 1988; Gramentz, 1988). Periocular tissues and other mucous membranes would presumably be most sensitive to oil contact. Skin damage in turtles is in marked contrast to that observed in dolphins, where all structural and biochemical changes in the epidermis were minor and reversible. Changes in the skin are consistent with an acute, primary contact or irritant dermatitis. A break in the skin barrier could act as a portal of entry for pathogenic organisms, leading to infection, neoplastic conditions, and debilitation (Vargo et al., 1986).

Turtles surfacing in an oil spill will inhale petroleum vapors. Any interference with operation of the lungs would probably reduce a sea turtle's capacity for sustained activity (aerobic scope) and its dive time; both effects decreasing the turtle's chance of survival.

Lutcavage et al. (1995) found that operation of the salt gland in sea turtles was disrupted with exposure to oil, but the disturbance did not appear until several days after exposure. The salt glands did recover function when tested after two weeks of recovery. Prolonged interference with salt gland functioning could have serious consequences since it would interfere with both water balance and ion regulation.

Studies on the effect of oil on digestive efficiency are underway, but Lutcavage et al. (1995) report finding oil in the feces of turtles that had swallowed oil in experiments. Van Vleet and Pauly (1987) reported that oil ingested by turtles did not pass rapidly through the digestive tract, but was retained within the system for a period of several days, thus increasing the likelihood that toxic components of the oil could be passed on to other internal organs and tissues of the turtle.

Significant changes in blood chemistry following oiling have been reported (Lutcavage et al., 1995). Hematocrit and hemoglobin concentration decreased slightly during oiling; these parameters are critical components of the blood's oxygen transport system. The most striking hematologic finding was an elevation of white blood cell count, which may indicate a "stress" reaction related to oil exposure and/or toxicity.

Eggs, hatchlings, and small juveniles are particularly vulnerable to contact (Fritts and McGehee, 1982; Lutz and Lutcavage, 1989). Potential toxic impacts to embryos will depend on the type of oil and degree of weathering, type of beach substrate, and especially upon the developmental stage of the embryo. Turtle egg development may be altered or arrested by oiling, and hatchlings are especially vulnerable to impacts (Fritts and McGehee, 1982). Fresh oil was found to be highly toxic, especially during the last quarter of the incubation period, whereas aged oil produced no detectable effects. Fritts and McGehee (1982) concluded that oil contamination of nesting beaches would have its greatest impact on nests that were already constructed; nests made on fouled beaches are less likely to be affected, if at all. Hatchling and small juvenile turtles are particularly vulnerable to contacting or ingesting oil because the currents that concentrate oil spills also form the debris mats in which young turtles are sometimes found (Carr, 1980; Collard and Ogren, 1990). The result of sea turtles feeding selectively in surface convergence lines could be prolonged contact with viscous weathered oil (Witham, 1978; Hall et al., 1983). High rates of oiling in very young turtles suggest that bioaccumulation may occur over their potentially long lifespan. A female coming from the offshore waters to nest might be fouled with oil. During the nesting process, she might push oil mixed with sand into the nest and contaminate the eggs (Chan and Liew, 1988). Assuming olfaction is critical to the process, oil-fouling of a nesting area might disturb imprinting of hatchling turtles, or confuse the turtles on their return migration after a 6- to 8-year absence (Geraci and St. Aubin, 1985; Chan and Liew, 1988).

Some captive turtles exposed to oil either reduced the amount of time spent at the surface, possibly avoiding the oil, or became agitated and had short submergence levels (Lutcavage et al., 1995). Sea turtles pursue and swallow tar balls, and there is no concrete evidence that free-ranging turtles can detect and avoid oil (Odell and MacMurray, 1986). A loggerhead turtle sighted during an aerial survey in the Gulf of Mexico surfaced repeatedly within a surface oil slick for over an hour (Lohefener et al., 1989). Oil might have a more indirect effect on the behavior of marine turtles. The effect on reproductive success could therefore be significant.

Contact with oil may not cause direct or immediate death but cumulative sublethal effects, such as salt gland disruption or liver impairment, could impair the marine turtle's ability to function effectively in the marine environment (Vargo et al., 1986; Lutz and Lutcavage, 1989). Although many observed physiological insults are resolved in a 21-day recovery period, the impact of tissue oil intake on the long-term health and survival of sea turtles remains unknown (Lutcavage et al., 1995). There is evidence of bioacummulation in sea turtles exposed for longer periods of time. After the Gulf of Iraq war, a stranded green turtle did not

appear to have been oiled, but upon necropsy, was found to have large amounts of oil in its liver and stomach tissues (Greenpeace, 1992).

A study of turtles collected during the *Ixtoc* spill determined that the three animals found dead had petroleum hydrocarbons in all tissues examined and that there was selective elimination of portions of this oil, indicating that exposure to the oil was chronic; the turtles evidently did not encounter the oil shortly before death, but had been exposed to it for some time (Hall et al., 1983). The low metabolic rate of turtles may cause a limited capacity to metabolize hydrocarbons. Prolonged exposure to oil may have caused the poor body condition observed in the turtles, perhaps disrupting feeding activity. In such weakened condition, the turtles may have succumbed to some toxic component in the oil or some undiscovered agent.

The two primary feeding grounds for adult Kemp's ridley turtles in the northern and southern Gulf of Mexico are both near major areas of nearshore and offshore oil exploration and production (USDOC, NMFS, 1992a). The nesting beach at Rancho Nuevo, Mexico, is also vulnerable and was indeed affected by the *Ixtoc* spill. The spill reached the nesting beach after the nesting season when adults had returned or were returning to their feeding grounds. It is unknown how the adult turtles using the Bay of Campeche fared. It is possible that high hatchling mortality occurred that year in the open Gulf of Mexico as a result of the floating oil.

In addition to the impacts from oiling itself, oil-spill response activities could adversely affect sea turtle habitat and cause displacement from these preferred areas. Impacting factors might include artificial lighting from night operations; booms; machine and human activity; equipment on beaches and in intertidal areas; sand removal and cleaning; and changed beach landscape and composition. Some of the resulting impacts from cleanup could include interrupted or deterred nesting behavior; crushed nests; entanglement in booms; and increased mortality of hatchlings due to predation during the increased time required to reach the water (Newell, 1995; Lutcavage et al., 1997). The strategy for cleanup operations should vary, depending on the season, recognizing that disturbance to the nest may be more detrimental than the oil (Fritts and McGehee, 1982). As mandated by the Oil Pollution Act (OPA) of 1990, seagrass beds and live-bottom communities are expected to receive individual consideration during oil-spill cleanup. Required oil-spill contingency plans include special notices to minimize adverse effects from vehicular traffic during cleanup activities and to maximize protection efforts to prevent contact of these areas with spilled oil. Loggerhead turtle nesting areas in the Chandeleur Islands, Cape Breton National Seashore, and central Gulf States would also be expected to receive special cleanup considerations under these regulations. Studies are completely lacking regarding the effects of dispersants and coagulants on sea turtles (Tucker and Associates, Inc., 1990).

Proposed Action Analysis

Information on drilling fluids, drill cuttings, and produced waters that would be discharged offshore as a result of the proposed action is provided in Section IV.A.3.d. These effluents are routinely discharged into offshore marine waters. Turtles may have some interaction with these discharges. Very little information exists on the impact of drilling muds on Gulf sea turtles (Tucker and Associates, Inc., 1990).

Structure installation, pipeline placement, dredging, blowouts, and water quality degradation can impact seagrass bed and live-bottom sea turtle habitats. These impacts are analyzed in detail in Sections IV.D.1.a.(1)-(3). A discussion of the causes and magnitude of wetland loss as a result of the proposed action can be found in Section IV.D.1.a.(1)(b). The seagrass and high-salinity marsh components of this wetland loss will be the most important for sea turtles. Little or no damage is expected to the physical integrity, species diversity, or biological productivity of live-bottom marine turtle habitat as a result of the proposed action.

About 550-1,000 OCS-related offshore oil and gas service-vessel trips could occur annually. Noise from service-vessel traffic and helicopter overflights may elicit a startle reaction from marine turtles. The effect will probably be sublethal and constitutes a short-term and temporary impact. It is not known whether turtles exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased ship traffic could increase the probability of collisions between ships and turtles, resulting in injury or death to some animals. The contribution from OCS-related, service-vessel traffic is expected to vary according to locations of OCS operations and trends in OCS waterway use. Exploration, delineation, and development wells could produce sounds at intensities and frequencies that could possibly be heard by

turtles. There is some evidence suggesting that turtles may be receptive to low-frequency sounds, which is at the level where most industrial noise energy is concentrated. Potential effects on turtles include disturbance (subtle changes in behavior, interruption of behavior); masking of natural sounds (e.g., surf, predators); and stress (physiological).

Seismic surveys use airguns to generate sound pulses. It is assumed that only these nonexplosive methods will be used in seismic surveys as a result of the proposed action (Section IV.A.2.a.(1)). It is expected that effects of noise on sea turtles from seismic surveys will be sublethal, constituting a short-term startle response and avoidance behavior. There is limited data suggesting that seismic sounds would act as an acoustic repellent (Lenhardt, 1994).

It is estimated that 5-16 structures will be removed by explosives from the WPA as a result of the proposed action. Potential impacts to sea turtles from the detonation of explosives include lethal and injurious incidental take, as well as physical or acoustic harassment. Injury to the lungs and intestines, and/or auditory system could occur. It is expected that structure removals will cause primarily sublethal effects on sea turtles as a result of the implementation of the MMS guidelines for explosive removals (USDOI, MMS, 1990b, Appendix B). Sea turtles are widely distributed in the Gulf, and their densities would not be expected to be high near the vicinity of platform removals.

Sea turtles can become entangled in or ingest debris produced by operations resulting from the proposed action. Leatherback turtles that mistake plastics for jellyfish may be singularly more vulnerable to stomach blockage. The probability of plastic ingestion/entanglement is unknown.

Since sea turtle habitat in the Gulf includes both offshore and inshore areas, sea turtles could possibly be contacted by both offshore and coastal sale-related spills. Sections IV.A.3.h.(2) and IV.B.2.d provide discussions of offshore oil-spill modeling results and coastal spill projections for the proposed action. In general, on a yearly basis, about 1 percent of strandings identified by the U.S. Sea Turtle Stranding Network are associated with oil (e.g., Teas and Martinez, 1992). Oiling rates are higher in south Florida (3% of strandings), and oiled turtles strand regularly on South Padre Island. Turtles do not always avoid contact with oil (e.g., Loehefener et al., 1989). Contact with oil, and consumption of oil and oil-contaminated prey, may seriously impact turtles; there is direct evidence that turtles have been seriously harmed by oil spills. Oil spills have the potential to cause chronic (longer-term lethal or sublethal oil-related injuries) and acute (spill-related deaths occurring during a spill) effects on turtles. Several mechanisms for long-term injury can be postulated: sublethal initial exposure to oil causing pathological damage; continued exposure to hydrocarbons persisting in the environment, either directly or through ingestion of contaminated prey; and altered prey availability as a result of the spill. Few deaths are expected because of the small area of contact involved and the rapid dispersion and loss of oil.

The extent and severity of effects from any sale-related oil spills are expected to be lessened by coastal oil-spill contingency planning and by possible avoidance of oil spills by sea turtles. Oil spills and oil-spill response activities, such as beach sand removal, can negatively affect sea turtles. Although oil-spill response activities such as vehicular and vessel traffic during nesting season are assumed to contact sea turtle habitats, harm to sea turtles is expected to be minimized because of protection efforts to prevent contact of these areas with spilled oil as mandated by OPA. Increased human presence could add to changes in turtle behavior and/or distribution, thereby additionally stressing animals, and perhaps making them more vulnerable to various physiologic and toxic effects.

Summary and Conclusion

Activities resulting from the proposed action have the potential to cause detrimental effects to sea turtles. These animals could be impacted by the degradation of water quality resulting from operational discharges, helicopter and vessel traffic and noise, platform and drillship noise, seismic surveys, explosive platform removals, oil spills, oil-spill response activities, and discarded trash and debris from service vessels and OCS structures. Lethal effects are most likely to be from chance collisions with OCS service vessels and ingestion of plastic materials; few lethal impacts are expected. Deaths due to structure removals are not expected due to mitigation measures (NMFS observer program). Sale-related oil spills of any size are considered to rarely contact Gulf of Mexico sea turtles. Contact with oil, and consumption of oil and oil-contaminated prey, may

seriously impact turtles. There is direct evidence that turtles have been seriously harmed by oil spills. Most OCS activities are estimated to have sublethal effects (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or debris). Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification; there is uncertainty concerning the possible effect. 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, and result in either acute or gradual population declines. The proposed action, by itself, is unlikely to have significant long-term adverse effects on the size and productivity of any sea turtle species or population stock in the northern Gulf of Mexico.

(7) Impacts on Coastal and Marine Birds

This section discusses the possible effects of the proposed action on coastal and marine birds of the Gulf of Mexico and its contiguous waters and wetlands. Major impact-producing factors that could impact marine birds in the offshore environment include air emissions, oil and fuel spills, spill-response activities, and discarded trash and debris from service vessels and offshore structures. Impact-producing factors in the inshore and coastal environment include air emissions; oil, fuel, and other pollutant spills and spill-response activities; trash and debris discarded from service vessels, coastal infrastructure, and offshore structures; disturbances from OCS inshore and coastal service and transport operations; habitat loss, modification, and degradation from onshore infrastructure (both existing and planned); and degradation of water quality.

Air pollution is a documented health hazard for man and for both domestic animals and wildlife (Newman, 1979). Contamination of wildlife by air emissions can occur in three ways: inhalation, absorption, and ingestion. Inhalation is the most common mode of contamination for birds (Newman, 1980). The major effects of air pollution include direct mortality, debilitating injury, disease, physiological stress, anemia, hypocalcemic condition, bioaccumulation of air pollutants with associated decrease in resistance to debilitating factors, and population declines (Newman, 1979). Direct effects can be either acute, such as sudden mortality from hydrogen sulfide, or chronic, such as fluorosis from fluoride emissions. The magnitude of effect, acute or chronic, is a function of the pollutant, its ambient concentration, pathway of exposure, duration of exposure, and the age, sex, reproductive condition, nutritional status, and health of the animal at the time of exposure (Newman, 1980). For metals in air emissions, chemical composition as well as size of particulate compounds has been shown to influence the toxicity levels in animals. Particulate size affects retention time and clearance from and deposition in the respiratory tract (Newman, 1981).

Levels of sulphur oxide (mainly sulphur dioxide, SO_2) emissions from hydrocarbon combustion from OCS-related activities is the concern in relation to birds. Research specific to birds has elucidated both acute and chronic effects from SO_2 inhalation (Fedde and Kuhlmann, 1979; Okuyama et al., 1979). Due to their lack of tracheal submucosal glands, birds appear to have more tolerance for inhaled SO_2 than most mammals (Llacuna et al., 1993; Okuyama et al., 1979). This suggestion stems from laboratory investigations where the test subject was the domestic chicken and results from these studies are not necessarily applicable to wild bird species. Acute exposure of birds to 260 $\mu g/m^3$ SO_2 produced no alteration in heart rate, blood pressure, lung tidal volume, respiratory frequency, arterial blood gases, or blood pH. Exposure to 1,300 $\mu g/m^3$ SO_2 increased respiratory mucous secretion, and exposure to 13,000 $\mu g/m^3$ SO_2 caused rapid mortality (Fedde and Kuhlmann, 1979). Chronic (two weeks) exposure of birds to 8.8 $\mu g/m^3$ SO_2 produced no apparent impact and very little change at the cellular level. Chronic exposure to 48 $\mu g/m^3$ SO_2 resulted in cellular changes characteristic of persistent bronchitis (Okuyama et al., 1979).

The indirect effects of air emissions on wildlife include food web contamination and habitat degradation, as well as adverse synergistic effects of air emissions with natural and other manmade stresses. Air emissions can cause shifts in trophic structure that alter habitat structure and change local food supplies (Newman, 1980).

Air pollutants may cause a change in the distribution of certain bird species (e.g., Newman, 1977; Llacuna et al., 1993). Migratory bird species will avoid potentially suitable habitat in areas of heavy air pollution in favor of cleaner areas if available (Newman, 1979). The abundance and distribution of passerine birds, both active and sedentary, and migratory species, as well as nonpasserine and nonmigratory varieties,

are also greatly affected by natural factors such as weather and food supply. Therefore, any reduction in the numbers of birds within a given locale does not have a diagnostic certainty pointing to air emissions (Newman, 1980).

The general effects of oil on birds can be characterized as environmental, external, and internal. Environmental effects include, but are not limited to, contamination of food sources, reduction in food sources, contamination of nesting habitat, and reduction in reproductive success through contamination and reduced hatchability of eggs or temporary inhibition of ovarian function (Frink, 1994).

External effects are the most noticeable and most immediately debilitating. Direct oil contact is usually fatal to birds as a result of hypothermia, shock, drowning, and starvation (Knaus, 1990; Vermeer and Vermeer, 1975; Fry and Lowenstine, 1985). Oil and tar readily fouls and mats plumage, with subsequent loss of water repellency, thermal insulation, buoyancy, and the ability to fly and forage (Ambrose, 1990; Fry et al., 1985; Clark and Gregory, 1971). An oiled bird will preen its contaminated feathers and down in an effort to remove the oil and/or tar, often denuding areas of the body, which accelerates the loss of body heat. The usual reduction in food intake by oiled birds in conjunction with sharply increased metabolic rates can result in an "accelerated starvation" (Hartung, 1967). Preening also results in incidental ingestion and inhalation of oil with accompanying secondary toxic effects (Butler et al., 1988; Levy, 1983). Oil can also be directly transferred to incubating eggs or chicks by the adult. Consequential toxic effects of ingested oil can be highly variable, depending upon the type of oil and amount ingested. Very small quantities of oil have been found to produce mortality and developmental defects in avian embryos (Leighton, 1990). Toxicity can be acute, with resultant physiological changes and damage to internal organs, or it can produce long-term effects in exposed adults, chicks exposed to oil or fed contaminated food, and in chicks hatched from eggs of exposed birds (Fry et al., 1985). Deformities and mortality attributable to petroleum contamination are more common in the earlier stages of avian embryological development than during later stages of development. Birds contaminated during the nesting period typically exhibit a decrease in egg production, fertility, and hatchability in proportion to the concentration of oil (Butler et al., 1988; Lewis and Malecki, 1984; Vangilder and Peterle, 1981; Macko and King, 1980; Szaro et al., 1980; Miller et al., 1978; Albers, 1977; Hartung, 1965). Chicks often show reduced survival and growth rates, with some species-specific differences in sensitivity (Trivelpiece et al., 1986). Chick mortality during the brood phase can also result from temporary desertion by oil-contaminated adults (Butler et al., 1988). Ingestion of oil frequently results in ulceration and hemorrhaging of the lining of the gastrointestinal tract, inhibiting digestive and absorptive abilities (Hartung, 1995); the damaged digestive system cannot utilize food or water. A similar irritation of mucosal surfaces can lead to ulceration of the conjuctiva and corneal surfaces of the eyeball, and of the moist surfaces of the mouth. Oil aspiration pneumonia is not uncommon in oiled birds and can occur when birds, attempting to clean their feathers through preening, inhale droplets of oil. Severe and fatal kidney damage has been documented (reviewed by Frink, 1994). Ingestion of oils might reduce the function of the immune system and, thus, reduce resistance to infectious diseases (Leighton, 1990). Ingested oil can cause toxic destruction of red blood cells and varying degrees of anemia (Leighton, 1990). Stress and shock enhance the effects of exposure and poisoning. It is not clear which, if any, of the pathological conditions noted in autopsies are related to petroleum hydrocarbons rather than to generalized stress (Clark, 1984). Low levels of oil could stress birds by interfering with food detection, feeding impulses, predator avoidance, territory definition, homing of migratory species, susceptibility to physiological disorders, disease resistance, growth rates, reproduction, and respiration.

The magnitude of bird mortality following an oil spill would depend on the size of the local bird population (often a function of season), foraging behavior(s), whether or not the population is aggregated or dispersed into smaller subunits at the time of the spill, and the quantity of oil spilled and its persistence in the environment (NRC, 1985). The extent to which the oil affects a bird differs according to the species of bird, the time of the bird's life stage when this contact occurs, the type of petroleum product involved, the amount of time between the release of the oil and its contact with the bird (the degree of weathering of that oil), and the length of contact with that oil (Maccarone and Brzorad, 1994). The birds most vulnerable to direct effects include those species that spend most of their time swimming on and under the sea surface, and often aggregate in dense flocks (Piatt et al., 1990; Vauk et al., 1989). This group includes loons, grebes, sea ducks and pochards, and cormorants. Coastal birds, including shorebirds, waders, marsh birds, and certain

waterfowl, may be the hardest hit indirectly through destruction of their feeding habitat and/or food source (Hansen, 1981; Vermeer and Vermeer, 1975). Direct oiling of coastal birds and certain seabirds is usually minor; many of these birds are merely stained as a result of their foraging behaviors (Vermeer and Vermeer, 1975). Birds can ingest oil when feeding on contaminated food items or drinking contaminated water. Oil contamination will affect prey upon which birds depend. Prey populations after the Arthur Kill spill (January 1990, south coast of New York) have not returned to normal a year after the spill. Ducks and geese, both primarily herbivirous, feed at a lower trophic level than the other species of waterbirds and might not suffer the damaging effects of biomagnification to the same degree (Maccarone and Brzorad, 1994). However, they still may have encountered lower food availability, owing to the localized destruction of aquatic vegetation. Birds, such as ibises, that sift through mud and other sediments for small invertebrates may be exposed to high toxin levels in the invertebrates (Maccarone and Brzorad, 1994). Chapman (1981) noted that oil on the beach from the *Ixtoc* spill caused habitat shifts by the birds. Many birds were forced to feed in less productive feeding habitats. Similar observations were made for wading birds after the Arthur Kill spill (Maccarone and Brzorad, 1995); changes in composition of prey populations were noted after the spill. Shoreline vegetation may be killed after prolonged exposure to water contaminated with oil. Lush vegetation helps to conceal sparsely placed nests and their contents from potential predators. With destruction of vegetation, eggs and chicks are more exposed to aerial predators (Maccarone and Brzorad, 1994). Population recovery following destruction of a local breeding colony or a large group of wintering migrants would likely be slow for many species because of their inherently low reproductive potential and/or distance to neighboring colonies, which may act as refugia by attracting recruits (Cairns and Elliot, 1987; Trivelpiece et al., 1986; Samuels and Ladino, 1983/1984). Moreover, oil-induced decreases in reproductive success would probably be masked for at least several seasons as a result of delayed sexual maturity of many coastal and marine species (Butler et al., 1988). Disruption of pair-bonds and altered cycles of reproductive hormones might also be to blame (Leighton, 1990).

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 result in additional disturbance of coastal birds after a spill. Investigations have shown that oil-dispersant mixtures pose a threat similar to that of oil 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 would; 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 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; 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).

Coastal and marine birds are highly susceptible to entanglement in floating, submerged, and beached marine debris; specifically in plastics discarded from both offshore sources and land-derived litter and waste disposal (Heneman and the Center for Environmental Education, 1988). Studies in Florida reported that 80 percent of brown pelicans showed signs of injury from entanglement with fishing gear (Clapp and Buckley, 1984). In addition, seabirds ingest plastic particles and other marine debris more frequently than do any other taxon (Ryan, 1990). Ingested debris may have three basic effects on seabirds: irritation and blockage of the digestive tract, impairment of foraging efficiency, and release of toxic chemicals (Ryan, 1990; Sileo et al., 1990a). Long-term effects of plastic ingestion may include physical deterioration due to malnutrition; plastics often cause a distention of the stomach, thus preventing its contraction and simulating a sense of satiation (Ryan, 1988). Some birds also feed plastic debris to their young, which could result reduced survival rates. The chemical toxicity of some plastics can be high, posing a significant hazard in addition to obstruction and impaction of the gut (Fry et al., 1987). Sileo et al. (1990b) found that the prevalence of

ingested plastic found within the gut of examined birds varied greatly among species. Those species that seldom regurgitate indigestible stomach contents are most prone to the aforementioned adverse effects (Ryan, 1990). Within the Gulf of Mexico, these include the phalaropes, petrels, storm-petrels, and shearwaters. The MMS prohibits the disposal of equipment, containers, and other materials into coastal and offshore waters by operators (30 CFR 250.40). Prohibition of the discharge and disposal of vessel- and offshore structure-generated garbage and solid waste into either offshore or coastal waters was established January 1, 1989, via the enactment of MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which is enforced by the U.S. Coast Guard.

The transportation or exchange of supplies, materials, and personnel between coastal infrastructure and offshore oil and gas structures is accomplished with helicopters and a variety of service vessels. Disturbances from OCS-related traffic to coastal birds can result from the mechanical noise or physical presence (or wake) of the vehicle. The degree of disturbance exhibited by groups of coastal birds to the presence of air or vessel traffic is highly variable, depending upon the bird species in question, type of vehicle, altitude or distance of the vehicle, the frequency of occurrence of the disturbance, and the season. Encounters of this sort can often result in a temporary cessation of feeding, resting, breeding, or nesting activities. Disturbance can also lead to a permanent desertion of active nests or of critical or preferred habitat, which could contribute to the relocation of a species or group to less favorable areas or to a decline of species through reproductive failure. When birds are flushed prior to or during migration, the energy cost could be great enough that they might not make it to their destination, or they may be more susceptible to diseases (Anderson, 1995). Waterfowl are more overtly responsive to noise than other birds and seem particularly responsive to aircraft, possibly because they are frequently harassed by aerial predators (Bowles, 1995). Short-term behavioral responses by birds (mild and intense aversion triggered) as well as panic-induced losses (that can lead to egg losses, as well as frightening birds into colliding with human-made structures such as power-lines) are major concerns. Birds can lose eggs and young when predators attack nests after parents are startled into flight.

Pipeline landfalls and terminals, and other onshore OCS-related construction can destroy coastal bird feeding or nesting habitat and can displace coastal bird populations from affected areas. Onshore pipelines cross a wide variety of coastal environments, including freshwater marsh and canals, which can affect certain species generally not associated with marine or estuarine systems. These include certain waders, marsh birds, shorebirds, and waterfowl.

Degradation of coastal and estuarine water quality as a result of OCS-related activities can impact coastal birds directly by means of acute or chronic toxic effects from ingestion or contact, or indirectly through the contamination of food sources. Seabirds (e.g., laughing gulls), which remain and feed in the vicinity of offshore OCS structures and platforms, could also be impacted from operational discharges or runoff in the offshore environment. These impacts could also be both direct or indirect.

Proposed Action Analysis

Air emissions, oil spills, oil-spill response activities, degradation of water quality, OCS helicopter and service-vessel traffic and noise, habitat loss or modification resulting from pipeline landfalls and coastal facility construction, and discarded trash and debris from service-vessels and OCS structures are sources of potential adverse impacts. Any effects are 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 (Newman, 1980).

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. Emissions of pollutants into the atmosphere from the activities associated with the proposed action are projected to have negligible effects on onshore air quality because of the atmospheric regime, the emission rates, and the 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 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 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. Increases in onshore annual average concentrations of NO_x, SO_x, and TSP are estimated to be less than 1 $\mu g/m^3$ per the modeled steady state concentrations. These concentrations are less than the allowable Class I PSD increments for those particular pollutants and are far below concentrations that could harm coastal and marine birds. Indirect impacts on coastal and marine birds due to direct impacts on air quality from the proposed action will not affect coastal and marine birds in the CPA.

Sections IV.A.3.h.(2) and IV.B.2.d provide discussions of offshore oil-spill modeling results and coastal spill projections for the proposed action. Coastal spills that occur away from transfer facilities could result in some degradation of habitat (such as spoil banks that provide nesting and feeding habitats for congregations of pelicans and plovers, respectively). If physical oiling of individuals or local groups of birds occurs, some degree of both acute and chronic physiological stress associated with direct and secondary uptake of oil would be expected. Raptors, such as the bald eagle and peregrine falcon, feed upon weakened or dead birds (and fish, in the case of the eagle) and as a result may become physically oiled or affected by the ingestion of the oiled prey. Pelicans are active swimmers and plunge dive for prey. They are, therefore, very susceptible to both physical oiling and secondary effects via ingestion of oiled prey (i.e., fish). Plovers congregate and feed along tidally exposed banks and shorelines. They can be physically oiled while foraging on oiled shores or secondarily affected through ingestion of oiled intertidal sediments and prey. The least tern captures fish by means of shallow splash diving and surface dipping techniques. Some physical oiling could occur during these dives, as well as secondary toxic effects through the uptake of prey. It is possible that some death of endangered/threatened (as well as nonendangered and nonthreatened) species could occur, especially if the coastal spills occur during winter months when raptors and plovers are most common along the coastal Gulf or if spills occur within preferred or critical habitat for all representatives. Small coastal spills, pipeline spills, and spills resulting from accidents in navigation waterways can contact and affect many of the different groups of coastal and marine birds, most commonly marsh birds, waders, waterfowl, and certain shorebirds. Some bird death from these groups are to be expected; recruitment through successful reproduction is expected to take several years, depending upon the species and existing conditions.

Degradation of coastal and inshore water quality resulting from the proposed action is expected to impact coastal and marine birds in the WPA near the discharge sites. The effects of the proposed action on coastal water quality is analyzed in detail in Section IV.D.1.a.(3)(a). To summarize the effects on coastal and estuarine water quality, the proposed action is expected to result in minor, long-term declines in water quality within, or in the vicinity of, existing navigation channels, pipeline canals, and onshore support complexes primarily within the Texas and Louisiana coastal zone. Projected maintenance dredging operations will remove several million cubic meters of material, resulting in localized impacts (primarily increased turbidity and resuspended contaminants) during the duration of the operations (up to several months). Water clarity will decrease over time within navigation channels used for vessel operations and within pipeline canals due to continuous sediment influx from bank erosion, natural widening, and reintroduction of dredged material back into surrounding waters. Oil spills will cause localized, low-level petroleum hydrocarbon contamination. Coastal and marine birds that feed exclusively within these locations would likely experience chronic, nonfatal physiological stress. However, due to high activity levels at those locations, it is expected that few nonendangered and nonthreatened coastal and marine birds will actually be affected to that extent. The decrease in water quality due to spilled oil will degrade a small amount of coastal bird habitat and add some degree of chronic, nonfatal physiological stress to birds that feed and nest within those affected areas. It is expected that some coastal and marine birds would experience a decrease in viability and reproductive success that would be indistinguishable from natural population variations.

Helicopter and service-vessel traffic related to OCS activities could sporadically disturb feeding, resting, or nesting behavior of birds or cause abandonment of preferred habitat. This impact-producing factor could contribute to indirect population loss through reproductive failure resulting from nest abandonment. The FAA Advisory Circular 91-36C encourages pilots to maintain higher than minimum flight altitudes over

noise-sensitive areas. Corporate helicopter policy state that helicopters must maintain a minimum altitude of 700 ft while in transit offshore, and 500 ft while working between platforms. When flying over land, the specified minimum altitude is 1,000 ft over unpopulated areas or across coastlines, and 2,000 ft over populated areas and biologically sensitive areas such as wildlife refuges and national parks. Many undisturbed coastal areas and refuges provide preferred and/or critical habitat for feeding, resting (or staging), and nesting birds. The effects of low-flying aircraft within the vicinity of aggregations of birds on the ground or on the water typically results in mass disturbance and abandonment of the immediate area. Compliance to the specified minimum altitude requirements is expected to significantly reduce effects of aircraft disturbance on coastal and marine birds. It is expected, however, that approximately 10 percent of helicopter trips will 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. Birds in flight over water typically avoid helicopters; temporary disruption of feeding or flight paths is expected when encountering low-flying helicopters. It is expected that helicopter traffic will periodically disturb coastal and marine birds, but will maintain general adherence to FAA and corporate helicopter protocol on service altitudes.

It is projected that 550-1,000 service-vessel trips related to the proposed action would occur annually. Service vessels will use selected nearshore and coastal (inland) navigation waterways, or corridors, and adhere to protocol set forth by the U.S. Coast Guard for reduced vessel speeds within these inland areas. Routine presence and low speeds of service vessels within these waterways diminishes the effects of disturbance from service vessels on nearshore and inland populations of coastal and marine birds. For the purpose of this analysis, it is assumed that service-vessel traffic will seldom disturb populations of coastal and marine birds existing within these areas. The effects of service-vessel traffic on birds offshore are negligible.

The greatest negative impact to coastal and marine birds is the extent of preferred or critical habitat loss or degradation. The extent of bird displacement resulting from habitat loss is highly variable between different species, based upon specific habitat requirements and availability of similar habitat in the area. Generally, destruction of habitat from OCS pipeline landfalls and onshore construction displaces localized groups or populations of these species. As these birds move to undisturbed areas of similar habitat, their presence augments habitat utilization pressure on these selected areas as a result of intra- and interspecific competition for space and food. For the purpose of this analysis, it is estimated that OCS pipeline landfalls and onshore construction will not interact with feeding, resting, or nesting habitats of Gulf coastal and marine birds.

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 will seldom become entangled in or ingest OCS-related trash and debris as a result of MMS 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. For the purpose of this analysis, it is assumed that OCS oil- and gas-related plastic debris will seldom interact with coastal and marine birds, and therefore, the effect will be negligible.

Summary and Conclusion

Activities resulting from the proposed action are expected to affect endangered/threatened and nonendangered/nonthreatened coastal and marine birds of the WPA. It is expected that the majority of effects from the major impact-producing factors on coastal and marine birds are sublethal (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris), causing temporary disturbances and displacement of localized groups inshore. Chronic sublethal stress, 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. Lethal effects result primarily from coastal inshore oil spills and associated spill-response activities, and are especially serious for endangered/threatened species as any

reductions in population size represents a threat to their existence. Spills occurring in biologically sensitive areas are expected to kill a number of individuals from any or all groups of birds. The net effect will be the alteration of the species composition of the affected area(s) and possibly the reduction of the overall carrying capacity of these area(s) in general. Recovery of affected areas is expected to take up to several years.

(8) Impacts on Commercial Fisheries

Effects on commercial fisheries from activities associated with the proposed action could come from coastal environmental degradation, emplacement of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, oil spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters. Potential effects from these impact-producing factors are described below.

Since approximately 92 percent of commercially harvested species are estuary dependent, coastal environmental degradation resulting from proposed action activities, although indirect, has the potential to adversely affect commercial fisheries. The environmental deterioration and effects on commercial fisheries result from the loss of Gulf wetlands as nursery habitat and from the functional impairment of existing habitat through decreased water quality (Chambers, 1992; Stroud, 1992). The conversion of wetlands into open water may initially cause an appreciable increase called the "edge effect" in the population of a commercially harvested shellfish, such as shrimp (Keithly and Baron-Mounce, 1993; Louisiana Dept. of Wildlife and Fisheries, 1992).

Wetlands and estuaries within the WPA may be affected by OCS-related activities resulting from the proposed action. These include construction of new onshore facilities in wetland areas; pipeline placement in wetland areas; vessel usage of navigation channels and access canals; maintenance of navigation channels; inshore disposal of OCS-generated, oil-field wastes; and oil and chemical spills from both coastal and offshore OCS-support activities.

Water quality in coastal and estuarine areas adjacent to the WPA may be altered by OCS-related activities resulting from the proposed action. These activities include construction of new onshore support facilities; routine point- and nonpoint-source discharges from inshore facilities; discharges from associated support vessel traffic; canal maintenance dredging and pipeline emplacement actions; inshore disposal of OCS-generated, oil-field wastes; oil and chemical spills from both coastal and offshore OCS support activities; and OCS-related trash and debris.

Exploratory drilling rigs spend approximately 40-60 days on site and are a short-lived interference to commercial fishing. Production structures in all water depths have a life expectancy of 20-30 years. A bottom-founded production platform in water depths less than 450 m, with a surrounding 100-m navigational safety zone, requires approximately 6 ha of space. Production platforms such as TLP's, SPAR's, and FPS's in water depths greater than 450 m will be compliant structures (Figure IV-2). The use of tanker-based FPSO's is also being considered by operators in the Gulf. The U.S. Coast Guard has not yet determined what size of the navigational safety zone will be required during offloading operations. Factoring in navigational safety zones, these nonconventional structures will require 7-20 ha of space. The presence of these structures results in the loss of bottom trawling area to commercial fishermen and causes space-use conflicts.

Underwater OCS obstructions, such as pipelines, cause gear conflicts that result in losses of trawls and shrimp catch, business downtime, and vessel damage. Most of the shrimp trawl fishing off the Texas coast occurs in water depths less than 61 m (Texas Parks and Wildlife, personal communication, 1996). However, all pipelines in water depths less than 61 m will be buried, and their locations made public knowledge (Alpert, 1990). Although Gulf fishermen are experiencing some economic loss from gear conflicts, the economic loss for a fiscal year has historically been less than 0.1 percent of the value of that same fiscal year's commercial fisheries landings. In addition, most financial losses from gear conflicts are covered by the Fishermen's Contingency Fund (FCF).

Lessees are required to remove all structures and underwater obstructions from their leases in the Federal OCS within one year of the lease relinquishment or termination of production. Approximately 123 and 118 structures were removed from the Gulf of Mexico in 1994 and 1995, respectively. Seventy percent of multi-leg platforms in water depths less than 156 m are removed by severing their pilings with explosives placed

5 m below the seafloor. The concussive force is lethal to fish that have internal air chambers (swim bladders), are demersal, and are in close proximity to the platform being removed (Scarborough-Bull and Kendall, 1992; Young, 1991). Within the past decade, stocks of reef fish have declined in the Gulf. There is concern over a possible connection between this decline and the explosive removal of platforms. To examine this issue of concern, MMS entered into a formal Interagency Agreement with NOAA and NMFS and is investigating fish death associated with structure removal. This study attempts to relate the role of fish deaths from platform removals to the status of reef fish stocks in the Gulf of Mexico (USDOI, MMS, 1990b). Preliminary information suggests that less than 1 percent of the annual harvest of red snapper from the Gulf of Mexico can be attributed to explosive platform removals.

The acoustical pulses used in seismic surveys are generated by airguns. Airguns have little effect on even the most sensitive fish eggs at distances of 5 m from the airgun (Chamberlain, 1991; Falk and Lawrence, 1973). In general, the acoustical pulses from airguns have relatively little effect on marine invertebrates, presumably due to their lack of a swim bladder. Available scientific information concerning the effects of acoustic airgun sources on fish eggs and larvae indicates that commercial fishery resources are little disturbed by seismic surveys (Wingert, 1988).

Chronic low-level pollution is a persistent and recurring event resulting in frequent but nonfatal physiological irritation to those resources that lie within the range of impact and that are likely to be adversely affected by the pollution. The geographic range of the pollutant effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource to the pollutant in question (in the case of oil spills, hydrocarbons). 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). 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).

The direct effects of spilled oil on fish occur through the ingestion of oil or oiled prey, through the uptake of dissolved petroleum products through the gills and epithelium by adults and juveniles, and through death of eggs and decreased survival of larvae (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). 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). 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).

The effects on and the extent of damage from an oil spill to Gulf commercial fisheries is restricted by time and location. 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. Migratory species, such as mackerel, cobia, and crevalle, could be impacted if oil spills contact nearshore open waters. An oil spill contacting a low-energy inshore area would affect localized populations of commercial fishery resources, such as menhaden, shrimp, and blue crabs. Chronic oiling in an inshore area would affect all life stages of a localized population of a sessile fishery resource such as oysters.

For OCS-related oil spills to have an effect on a commercial fishery resource, whether estuary dependent or not, eggs and larvae would have to be abnormally concentrated in the immediate spill area. Oil components also would have to be present in highly toxic concentrations when both eggs and larvae are in the pelagic stage (Longwell, 1977). There is no evidence at this time that commercial fisheries in the Gulf have been adversely affected on a regional population level by spills or chronic oiling.

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 (Anon., 1991c; NRC, 1985). Fish swim away from spilled oil, and this behavior explains why there has never been a commercially important fish-kill on record following an oil spill. The only adult fish-kill on record following an oil spill was on the French coast when several tons of small rock-clinging fish (not commercially harvested) were killed at the site of the *Amoco Cadiz* wreck. In addition, concerns about the possible impact of spilled oil on the breeding cycle of commercial fishery resources have proved to be unfounded (Anon., 1991c; Baker et al., 1991).

Large numbers of fish eggs and larvae have been killed by oil spills. However, fish over-produce eggs on an enormous scale and the overwhelming majority of them die at an early stage, generally as food for predators. Even a heavy death toll from an oil spill has no detectable effect on the adult populations, which 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).

Development abnormalities in juveniles occur naturally in wild fish populations, and the frequency of these abnormalities is increased in populations chronically exposed to oil. These abnormal fish do not survive long in the struggle for existence. Such delayed death is likely to have an equally negligible impact on commercial fisheries as do the deaths immediately following an oil spill.

Benthic disturbance from subsurface blowouts of both oil and natural gas wells in water depths less than 152 m and trenching (burial) of pipelines in water depths less than 61 m may be detrimental to commercial fisheries. Trenching and blowouts can resuspend sediments, and the loss of oil-well control can release varying amounts of hydrocarbons into the water column (USDOI, MMS, 1987c). Resuspended sediments may clog gill epithelia of both finfish and shellfish with resultant smothering. Settlement of resuspended sediments may directly smother invertebrates or cover burrows of commercially important shellfish. However, sandy sediments are quickly redeposited within 400 m of the blowout site. Finer sediments are widely dispersed and redeposited over a period of 30 days or longer within a few thousand meters. Released hydrocarbons are diluted to background levels within a few thousand meters of the blowout site and degrade quickly without major biological effect. Gas-well blowouts are even less of an environmental risk, resulting in little resuspended sediments and increased levels of natural gas for a few days very near the source of the blowout. Natural gas consists mainly of nontoxic methane, which rapidly disperses upward into the air (Van Buuren, 1984). Loss of well control and resultant subsurface blowouts seldom occur on the Gulf of Mexico OCS. Only 0.7 percent of all wells experience an uncontrolled loss of pressure and no more than 14 percent of those result in the release of some oil (Fleury, 1983).

Drilling muds contain materials toxic to commercial fishery resources; however, the plume disperses rapidly and is usually undetectable at distances greater than 1,000 m (Section IV.A.3.d.). No effects beyond 100 m are expected.

In addition to toxic trace elements and hydrocarbons in produced waters, there are additional components and properties, such as hypersalinity and organic acids, that have a potential to adversely affect commercial fishery resources. Produced waters that are discharged offshore are diluted, dispersed, and undetectable at a distance of 1,000 m from the discharge point, and no detectable effects on water-column organisms are encountered (Harper, 1986; Rabalais et al., 1991).

Proposed Action Analysis

The major impact-producing factors analyzed below are related to the proposed action and include coastal environmental degradation, production platform emplacement, underwater OCS obstructions, production platform removal, seismic surveys, oil spills, subsurface blowouts, pipeline trenching, and OCS discharge of drilling muds and produced waters.

The effect of the proposed action on wetlands and coastal water quality in the WPA is analyzed in detail in Sections IV.D.1.a.(1) and (3), respectively. Collectively, the adverse impacts from these effects are termed coastal environmental degradation. The indirect effect from coastal environmental degradation on commercial fisheries is considered below.

To summarize the effects on wetlands, the proposed action is expected to result in minor, long-term changes near existing navigation channels and in the vicinity of existing and new pipeline canals. The widening of existing pipeline canals and erosion from vessel wakes will continue and result in the loss of wetlands. Dredging for new pipelines and concentrated oil from accidents will cause a long-term decrease in the vegetative productivity of wetlands within and immediately adjacent to the site and convert a small percentage of the affected area to open water. If seagrasses are contacted, oil concentrations will be very low, causing minor, short-term damage to the epifauna in those beds.

To summarize the effects on coastal and estuarine water quality, the proposed action is expected to result in minor, long-term declines in water quality within, or in the vicinity of, existing navigation channels, pipeline canals, and onshore support complexes spread out primarily within the eastern Texas and Louisiana coastal zones. Some produced waters will still be piped into coastal bays and rivers and discharged, at least until the year 2000. Some minor, localized degradation will occur. Projected maintenance dredging operations will remove several million cubic meters of material, resulting in localized impacts (primarily increased turbidity and resuspended contaminants) during the duration of the operations (up to several months). Water clarity will decrease over time within navigation channels used for vessel operations and within pipeline canals due to continuous sediment influx from projected bank erosion, natural widening, and reintroduction of dredged material back into surrounding waters. Oil spills will cause localized, low-level petroleum hydrocarbon contamination.

It is expected that coastal environmental degradation from the proposed action will affect commercial fishery resources. The impact of coastal degradation is expected to cause less than a 1 percent decrease in commercial fishery populations, in essential habitats, or in commercial fishing. Recovery of commercial fishery resources can occur from more than 90 percent, but not all, of the expected coastal environmental degradation. However, at the expected level of effect the resultant influence on Western Gulf fisheries is negligible and will be indistinguishable from natural population variations.

Based on a maximum expected number of 23 bottom-founded and 4 compliant structures, 218 ha (539 ac) will be lost to commercial fishing in the WPA as a result of a proposed action. This represents less than 0.1 percent of the total area available (14.5 million ha or 35 million ac) to commercial fishing in the WPA. It is assumed that space-use conflicts will rarely occur. The effect of space loss to trawl fishing in the Gulf from the construction of platforms is negligible because the extent of the area lost to commercial trawling is less than 0.1 percent of the available trawl fishing area.

Underwater OCS obstructions such as pipelines cause gear conflicts. It is expected that several hundred kilometers of pipeline will be installed in the area of concentrated bottom trawl fishing. Gear conflicts are mitigated by the FCF. During FY 95, 82 claims were processed, with 73 percent being approved for a total of $264 thousand (Jackson, written communication, 1996). This economic loss from gear conflicts for FY 95 was less than 0.1 percent of the value ($787 million) of Gulf commercial fisheries landings for 1995 (Davenport, written communication, 1996). It is assumed that installed pipelines will seldom conflict with bottom trawl fishing, and they are expected to have a negligible effect on Western Gulf fisheries.

Structure removal results in artificial habitat loss and causes fish kills when explosives are used. It is estimated that 5-16 structure removals using explosives will occur. It is assumed that these removals will begin about 2011 and continue during the last 25 years of the proposed action. It is expected that structure removals will have a negligible effect on Western Gulf fisheries because of the inconsequential number of removals and the consideration that removals kill only those fish proximate to the removal site.

Seismic surveys will occur in both coastal and offshore areas of the WPA. Usually, only airguns would be used, and it is expected that seismic surveys will have a negligible effect on Gulf commercial fisheries.

Oil spills that contact coastal bays, estuaries, and waters of the OCS when pelagic eggs and larvae are present have the greatest potential to affect commercial fishery resources. 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 damage is 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.

It is estimated that 35-70 oil spills $\leq$ 1 bbl would occur in inland waters. Spills of this volume would affect little area and dissipate rapidly. Between 2 and 16 small offshore spills (> 1 bbl and < 1,000 bbl) and between 11 and 17 small inland oil spills (> 1 bbl and < 1,000 bbl) are estimated to occur. The spills in inland waters will originate in the coastal zone of Texas and will affect a highly localized area. It is assumed that small oil spills will seldom contact and affect the coastal bays and marshes critical to the well-being of commercial fisheries.

There is a 2-15 percent probability of one or more large offshore oil spills ($\geq$ 1,000 bbl) occurring somewhere in the WPA within the next 35 years. If such a spill occurs from a pipeline directly offshore

Texas, there is a 57 percent probability that the spill will contact Espiritu Santos Bay within 10 days; a 54 percent probability that the spill will contact Galveston Bay within 10 days; and a 42 percent probability that the spill will contact Matagorda Bay within 10 days. It is estimated that a large spill ($\geq$ 1,000 bbl) will seldom contact and affect the coastal bays and marshes critical to the well-being of commercial fisheries.

Although the quantity of commercial landings of migratory species in the WPA is comparatively small, these species are of high value. Migratory species could be affected by oil spills reaching nearshore and coastal waters. If a spill occurs from an OCS pipeline directly offshore Texas, there is as high as a 56-98 percent probability that the spill will contact nearshore and coastal waters along the Western Gulf. It is assumed that a large spill ($\geq$ 1,000 bbl) will occasionally contact and affect nearshore and coastal waters of migratory Gulf fisheries.

The effect of sale-related oil spills on commercial fisheries is expected to cause less than a 1 percent decrease in commercial populations or in commercial fishing. At the expected level of effect, the resultant influence on Western Gulf fisheries is negligible and will be indistinguishable from natural population variations.

Subsurface blowouts of both oil and natural gas wells and pipeline trenching have the potential to adversely affect commercial fishery resources. Loss of well control and resultant blowouts seldom occur on the Gulf OCS (7 blowouts per 1,000 well starts; 14% will result in some spilled oil). It is assumed that there will be 1-2 blowouts resulting in the resuspension of several hundred thousand m^3 of sediments. In addition, it is assumed that no more than 0.2 million m^3 of sediments will be resuspended during the installation of no more than 290 km of pipelines in water depths less than 60 m. Sandy sediments will be quickly redeposited within 400 m of the trench or blowout site, and finer sediments will be widely dispersed and redeposited over a period of 30 days or longer within a few thousand meters. It is expected that the infrequent subsurface blowout that may occur on the Gulf OCS will have a negligible effect on Gulf commercial fisheries. The effect on commercial fisheries from pipeline trenching is expected to cause less than a 1 percent decrease in commercial fishery populations or in commercial fishing. Any affected population is expected to recover to predisturbance condition in one generation. At the expected level of effect, the resultant influence on Western Gulf fisheries is negligible and will be indistinguishable from natural population variations.

Drilling mud discharges contain chemicals toxic to marine fishes; however, based on recent restrictions of toxic contaminates in drilling muds, this is only at concentrations a few orders of magnitude higher than those found more than a few meters from the discharge point. Offshore discharges of drilling muds will dilute to background levels within 1,000 m of the discharge point and have a negligible effect on Western Gulf fisheries.

Produced-water discharges contain components and properties detrimental to commercial fishery resources. Given recent NPDES permit restrictions, it is projected that moderate petroleum and metal contamination of sediments and the water column will occur out to several hundred meters downcurrent from the discharge point. Offshore discharges of produced water will disperse and dilute to background levels within 1,000 m of the discharge point and have a negligible effect on Western Gulf fisheries.

Summary and Conclusion

Operations resulting from the proposed action have the potential to cause detrimental effects on WPA commercial fisheries. Activities such as seismic surveys, subsurface blowouts, pipeline trenching, and OCS discharge of drilling muds and produced water will cause negligible impacts and will not deleteriously affect WPA commercial fisheries. Operations such as production platform emplacement, underwater OCS impediments, explosive platform removal, oil spills, and activities that result in coastal environmental degradation will cause greater impacts on WPA commercial fisheries. The proposed action is expected to result in less than a 1 percent decrease in commercial fishery populations, in essential habitat, or in commercial fishing. It will require less than six months for fishing activity and one generation for fishery resources to recover from 99 percent of the impacts.

(9) Impacts on Recreational Resources and Beach Use

Major recreational beaches are defined as those frequently visited sandy areas along the shoreline that are exposed to the Gulf of Mexico and that support a multiplicity of recreational activity, most of which is focused at the land and water interface. Included are Padre Island National Seashore, State park and recreational areas, county and local parks, urban beaches, private resort areas, and State and private environmental preservation and conservation areas. The general locations of these beaches are indicated on Visual 2.

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, 1990b). 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 exploration and development, and most widely recognized as major threats to the enjoyment and use of recreational beaches, are oil spills and trash and debris. Additional factors such as the physical presence of platforms and drilling rigs can affect the aesthetics of beach appreciation (Section IV.A.3.b.(3)), and noise from OCS-related aircraft can adversely affect a beach-related recreation experience (Sections IV.A.2.b.(5) and IV.A.3.g.). All these factors, either individually or collectively, may adversely affect the number and value of recreational beach visits.

Oil spills can be associated with the exploration, production, or transportation phases of OCS operations. Major oil spills contacting recreational beaches can cause short-term displacement of recreational activity from the areas directly affected and will lead to closure of beaches directly impacted for periods of 2-6 weeks, or until the cleanup operations are complete. When an oil spill occurs, other factors such as season, extent of pollution, beach type and location, condition and type of oil washing ashore, tidal action, cleanup methods (if any), and publicity can have a bearing on the severity of effects a spill may have on a recreational beach and its use.

Widely publicized and investigated oil-spill events, such as the Santa Barbara spill of 1969, the *Ixtoc* spill in 1979 (Restrepo and Associates, 1982), the *Alvenus* tanker spill of 1984, and the 1989 *Exxon Valdez* tanker spill in Prince William Sound, Alaska, have demonstrated that large oil spills (greater than 1,000 bbl) can severely impact beaches and their recreational use. However, findings from an in-depth study of the *Ixtoc* oil-spill impact on three south Texas shoreline beach parks indicated no significant decrease in park visitations as a result of the oil spill (Freeman et al., 1985). Sorensen (1990) reviewed the economic effects of several historic major oil spills on beaches and concluded a spill near a coastal recreation area would reduce visitation in the area by 5-15 percent over one season, but would have no long-term effect on tourism.

Most oil spills occurring in the Gulf are assumed to dissipate rapidly (Table IV-11). Because of the chemical properties of the light crude oils typically produced from fields on the continental shelf of the northern Gulf , it is assumed that only relatively small fractions are subject to tarball formation. Oil from deepwater fields may prove to be more prone to tarball formation. (Tarballs are known to persist as long as 1-2 years in the marine environment.) Investigations and reports from Texas A&M and Padre Island National Seashore on the sources of tarballs on Texas beaches conclude the tarballs are primarily related to marine transportation and natural seeps. A large oil spill would acutely threaten shoreline recreational resources for up to 10 days, after which natural processes significantly change the nature and form of the pollutant to the point that it is unlikely to be a major threat to beach recreational resources and activities.

Trash, debris, and tarballs from OCS operations can wash ashore on Gulf of Mexico recreational beaches and reduce their attractiveness as recreational resources (Section IV.A.3.e.). Some trash items, such as glass, pieces of steel, and drums with chemical residues, can also be a health threat to users of recreational beaches. Cleanup of OCS trash and debris from coastal beaches adds to operation and maintenance costs for coastal beach and park administrators.

The physical presence of platforms and drilling rigs, when visible from shore (Section IV.A.3.b.(3)), and noise associated with vessels and aircraft (Section IV.A.3.g.) traveling between coastal shore bases and

offshore operation sites can also adversely affect the natural ambience of primitive coastal beaches. Although these factors may affect the quality of recreational experiences, they are unlikely to reduce the number of recreation visits to coastal beaches in the Central and Western Gulf.

Proposed Action Analysis

Exploration and production on blocks leased in the Western Gulf of Mexico and transportation of produced oil and gas could lead to large oil spills. Wind, waves, and currents could result in spills reaching major shoreline recreational beaches throughout the coastal area.

Based on estimated production volumes and historical spill rates, there is as high as a 98 percent chance that no large offshore spills will occur from the proposed action and a 2-13 percent probability that one large spill will occur. If a large spill does occur, the likelihood of contact to recreational beaches is dependent on its origin point and its trajectory (as determined by oceanographic and wind movements). The OSRA model provides the percent chance that a hypothetical large spill starting at a particular location will contact a resource in 3, 10, or 30 days. For Texas recreational beaches, for example, the highest probability of contact within 3 days is 51 percent of a hypothetical spill occurring from a pipeline and its associated production facility located directly off of Mustang Island State Park (Nueces County). For most other hypothetical spill locations examined by the OSRA model, the probability is much smaller, most being less than 0.5 percent.

Small offshore and coastal spills will also occur more frequently as a result of the proposed action. Although small (1 bbl or less) offshore spills are projected to occur throughout the life of the proposal (Section IV.A.3.h.(2)), they are assumed to be mostly very small events, with spills greater than 50 bbl occurring very infrequently. Only the larger of these small spills occurring in nearshore waters are any threat to coastal recreational beaches. Should any of these spills interact with recreational beaches, the portions impacted could be closed for a short time during cleanup and temporarily inconvenience recreational users of the impacted beach areas.

Some litter from OCS accidents, carelessness, and noncompliance with OCS antipollution regulations and directives is likely to come ashore on recreational beaches. New industry waste management practices, in addition to training and awareness programs focused on the beach litter problem, are expected to minimize the level of indiscriminate and irresponsible trash disposal and accidental loss of solid wastes from OCS oil and gas operations. Recreational beaches in Louisiana and Texas are most likely to be impacted by this waterborne trash. Incremental effects from the proposed action on litter are unlikely to be perceptible by beach users or administrators because the activity from the proposal will constitute only a small percentage of the total OCS Program activity in the WPA. Impacts from litter associated with proposed action activities are likely to be offset by platform removals and by industry's continuing efforts to minimize, track, and control offshore waste. Litter on recreational beaches from OCS operations will adversely affect the ambience of the beach environment, will detract from the enjoyment of beach activities, and can increase administrative costs on maintained beaches.

Drilling rigs and platforms placed within the first tier of OCS blocks off Texas will be no closer than 10 mi from Texas coastal beaches and are unlikely to be recognizable from shore under the best of weather conditions. Therefore, no adverse visual impacts from OCS structures on recreational beach users will result from the proposed action.

The proposed action may also stimulate and redirect additional vessel and helicopter traffic. Some additional vessel trips and helicopter coastal crossings are projected to result from additional offshore leasing. Therefore, some new traffic around and above the Padre Island National Seashore and a few State and local beach parks is likely to occur. On the assumption that vessels use established nearshore traffic lanes and helicopters comply with areal clearance restrictions 90 percent of the time, boats and aircraft servicing offshore oil and gas operations may still be seen and heard by some recreational beach users, but the intermittent detection should not seriously affect the quality and amount of recreational beach use.

Summary and Conclusion

A few small onshore and offshore spills may affect portions of Texas or Louisiana beaches with little disruption of recreational activities. Marine debris will be lost from time to time from OCS operations associated with drilling 85-305 new wells and producing oil and gas from 8-27 new production locations throughout the WPA. However, the impact from the resulting intermittent pollution washup on Texas and Louisiana beaches should be minimal. Helicopter and vessel traffic will add very little additional noise pollution likely to affect beach users.

The proposed action is expected to result in pollution events and nearshore operations that may adversely affect the enjoyment of some beach uses on Texas and Louisiana beaches. However, these will have little effect on the number of beach users.

(10) Impacts on Archaeological Resources

Blocks with a high probability for the occurrence of prehistoric, prehistoric and historic, or historic archaeological resources are found in the Western Gulf. Blocks with a high probability for prehistoric archaeological resources are found landward of a line that roughly follows the 45-m bathymetric contour.

The areas of the northern Gulf of Mexico that are considered to have a high probability for historic period shipwrecks were redefined as a result of an MMS-funded study (Garrison et al., 1989; LTL's dated November 30, 1990, and September 5, 1995). 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 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 (cf. Visual 3, Offshore Regulatory Features). The historic archaeological high probability areas are under in-house review at the time of this writing. NTL 91-02 mandates a 50-m remote-sensing, survey linespacing density for historic shipwreck surveys. The NTL also requires submission of an increased amount of magnetometer data to facilitate MMS analysis. Survey and report requirements for prehistoric sites have not been changed.

An Archaeological Resources Stipulation was included in all Gulf of Mexico lease sales from 1974 through 1994. The stipulation was incorporated into operational regulations effective 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.

Sections that provide additional supportive material for the archaeological resources analysis include Sections III.C.4. (archaeological resources), IV.A.2.a. (offshore infrastructure), IV.B.1. (coastal infrastructure), and IV.A.3.h.(2) and IV.B.2.d. (oil spills).

Several OCS-related, impact-producing factors may cause adverse impacts to archaeological resources. Offshore development could result in a drilling rig, platform, pipeline, dredging activity, or anchors having an impact on a historic shipwreck. Direct physical contact with a wreck 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 placement of drilling rigs and production platforms has the potential to cause physical impact to prehistoric and/or historic archaeological resources. It is assumed that the standard drilling rig in less than 750 m of water will directly disturb 1.5 ha of soft bottom; the average platform in less than 450 m of water, 2 ha. Pile driving associated with platform emplacement may also cause sediment liquefaction an unknown distance from the piling, disrupting stratigraphy in the area of liquefaction.

Pipeline placement has the potential to cause a physical impact to prehistoric and historic archaeological resources. Pipelines placed in water depths of less than 61 m must be buried. Burial depths of 1 m are required with the exception of shipping fairways and anchorage areas, where the requirements are 3.0 m and 4.6 m, respectively.

The dredging of new channels, as well as maintenance dredging of existing channels, has the potential to cause a physical impact to historic shipwrecks (Espey, Huston, & Associates, 1990a). There are many navigation channels that provide OCS access to onshore facilities. Most of these facilities are located in the Central Gulf.

Anchoring associated with platform and pipeline emplacement, as well as with service vessel and shuttle tanker activities, may also physically impact prehistoric and/or historic archaeological resources. It is assumed that, during pipeline emplacement, an array of eight 20,000-lb anchors is continually repositioned around the pipelaying barge.

Oil spills have the potential to affect both prehistoric and historic archaeological resources. Impacts to historic resources would be limited to visual impacts and, possibly, physical impacts associated with spill cleanup operations. Impacts to prehistoric archaeological sites would be the result of hydrocarbon contamination of organic materials, which have the potential to date site occupation through radiocarbon dating techniques, as well as possible physical disturbance associated with spill cleanup operations.

The OCS oil and gas activities will also generate tons of ferromagnetic structures and debris, which will tend to mask magnetic signatures of significant historic archaeological resources. The task of locating historic resources through an archaeological survey is, therefore, made more difficult as a result of leasing activity.

(a) Historic

Proposed Action Analysis

Since the likely locations of archaeological sites cannot be delineated without first conducting a remote-sensing survey of the seabed and near-surface sediments, MMS, by virtue of new 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. Generally, in the western part of the WPA, where unconsolidated sediments are thick, it is likely that side-scan sonar will not detect shipwrecks buried beneath the mud. In this area, the effectiveness of the survey for detecting historic shipwrecks of composite and wooden construction would depend on the capability of a magnetometer to detect ferromagnetic masses of the size characteristically associated with shipwrecks. Conservatively, it is assumed that an initial survey at a 50-m linespacing (as specified in NTL 91-02) will be 90 percent effective at locating historic shipwrecks. The survey would therefore reduce the potential for an impact to occur by an estimated 90 percent.

Estimates of the ranges of exploration, delineation, and development wells, and production platforms are presented in Table IV-2. The majority of blocks in the WPA with a high probability for the occurrence of historic shipwrecks fall in water depths under 200 m. Under current survey requirements, as much as 10 percent of this activity would occur without accurate information about the proximity of the activity to a historic resource. The location of any proposed activity within a lease that has a high probability for historic shipwrecks requires archaeological clearance prior to operations. Considering that there are a limited number of historic period shipwrecks in the entire Western Gulf OCS, the probability of an OCS activity contacting and damaging a shipwreck is very low. If an oil and gas structure contacted a historic resource, however, there could be a loss of significant or unique archaeological information.

In the eastern part of the WPA and the western part of the CPA , where shipwrecks are more likely to be detected by side-scan sonar because there is only a thin Holocene sediment veneer overlying an indurated Pleistocene surface, the increased survey linespacing density (50 m) will reduce the potential for a direct physical contact between an impact-producing factor and a shipwreck by an estimated 95 percent. The effectiveness of the survey would reduce the potential impacts of OCS activities to historic shipwrecks in this area by 95 percent. There is a very small possibility that a historic shipwreck could be impacted by OCS activities. Should such an impact occur, however, significant or unique archaeological information could be lost.

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 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 could result in the direct physical contact between the construction of new onshore facilities or pipeline canals and 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. It is assumed that 0.5-1.0 percent of OCS Program use of projected onshore facilities will occur as a result of the proposed action. Table IV-12 shows the projected coastal infrastructure related to OCS Program activities. Each facility projected to be 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 in the WPA from onshore development.

Maintenance dredging associated with the proposed action has the potential to impact a historic shipwreck. For instance, maintenance dredging in the Port Mansfield Entrance Channel is believed to impact the *Santa Maria de Yciar*, which sank on April 29, 1554 (Espey, Huston & Associates, 1990a) and is expected to impact the *SS Mary*, which sank on November 30, 1876, in Aransas Pass (Espey, Huston & Associates, 1990b). Impacts from maintenance dredging can be attributed proportionally to the users of the navigation channels. In-house assessment indicates that, under the proposed action, less than 1 percent of the ship traffic through the Port Mansfield Cut is related to OCS use. Therefore, the impact to the *Santa Maria de Yciar* and *SS Mary* directly attributable to traffic and maintenance dredging as a result of the OCS Program is negligible. As these shipwrecks are unique historic archaeological resources, maintenance dredging, in general, is responsible for impacts to historic shipwrecks. According to Table IV-14, the percentage of use of the major navigation channels for the Western and Central Gulf by proposed action activities is approximately 1 percent.

The loss or toss of ferromagnetic debris during exploration and production activities has the potential to mask the magnetic signatures of historic shipwrecks. Under the proposed action, it is expected that hundreds of tons of ferromagnetic debris will be lost or tossed as a result of OCS activities. It is expected that most ferromagnetic debris associated with emplaced structures will be removed from the seafloor during site clearance activities. Site clearance, however, takes place after the useful life of the structure is complete. It has been noted that such debris has the potential to be moved from the area of initial deposition as a result of trawling activities (Garrison et al., 1989). Also, no site clearance activities occur in association with pipeline emplacement. Therefore, there remains the potential for masking the signatures of historic shipwrecks as a result of ferromagnetic debris from OCS oil and gas activities.

Since all platform locations within the high probability areas for the occurrence of offshore historic and prehistoric archaeological resources are given archaeological clearance prior to setting the structure, removal of the structure should not result in any adverse impact to archaeological resources. This is consistent with the findings of the *Programmatic Environmental Assessment: Structure Removal Activities, Central and Western Gulf of Mexico Planning Areas* (USDOI, MMS, 1987a).

Should an oil spill contact a coastal historic site, such as a fort or a lighthouse, the major impact would be visual because of oil contamination of the site and its environment. The percent chance (probabilities) that a hypothetical spill starting at a particular location offshore will contact land segments is listed in Appendix C. Impacts to coastal historic sites are expected to be temporary and reversible. It is assumed that inshore spills will occur as a result of OCS oil being transported to shore. The coastal oil-spill scenario numbers are presented in IV.B.2.d. Should such an oil spill contact a historic site, the effects would be temporary and reversible.

Summary and Conclusion

The greatest potential impact to a historic archaeological resource as a result of the proposed action would result from a contact between an OCS offshore activity (platform installation, drilling rig emplacement, dredging or pipeline project) and a historic shipwreck. An MMS-funded study (Garrison et

al., 1989) resulted in the redefinition of the high probability areas for the location of historic period shipwrecks. An in-house review of the historic high probability areas is occurring at the time of this writing. An NTL for archaeological resource surveys in the Gulf of Mexico Region (NTL 91-02) has mandated a 50-m linespacing density for remote-sensing surveys for historic shipwreck surveys.

Most other activities associated with the proposed action are not expected to impact historic archaeological resources. It is conservatively assumed that 0.5-1.0 percent of OCS Program use of projected onshore facilities will occur as a result of the proposed action (Table IV-12). It is expected that archaeological resources will be protected through the review and approval processes of the various Federal, State, and local agencies involved in permitting onshore activities. Ferromagnetic debris has the potential to mask the magnetic signatures of historic shipwrecks. There is a small chance of contact from an oil spill associated with the proposed action. Furthermore, the major impact from an oil-spill contact on a historic coastal site, such as a fort or lighthouse, would be visual due to oil contamination. These impacts would be temporary and reversible. Maintenance dredging of navigation channels may result in impacts to historic shipwrecks; however, the percentage of OCS use of these channels under the proposed action is less than 1 percent.

OCS activities could contact 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.

(b) Prehistoric

Offshore development as a result of the proposed action could result in an interaction between a drilling rig, a platform, a pipeline, dredging, or anchors and an inundated prehistoric site. This direct physical contact with a site could destroy fragile artifacts or site features and could disturb artifact provenience and site stratigraphy. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts for North America, Central America, South America, and the Caribbean.

Proposed Action Analysis

Estimates of the ranges of exploration, delineation, and development wells, and production platforms are presented in Table IV-2. Only those potential activities that are estimated to occur in water depths less than 60 m are considered to have the potential to impact prehistoric archaeological sites. This is based upon a projected 12,000 B.P. shoreline that, due to a post-glacial rise in sea level, occurs between 45 and 60 m below present sea level. The 12,000 B.P. date is a generally accepted date for the advent of man in the Gulf of Mexico region (cf. Aten, 1983). The limited amount of impact to the seafloor throughout the WPA, the required archaeological survey, and archaeological clearance are sufficient to assume a low potential for interaction between an impact-producing factor and a prehistoric archaeological site. Should such an impact occur, damage to or loss of significant or unique prehistoric archaeological information could occur.

Onshore prehistoric archaeological resources include sites, structures, and objects such as shell middens, earth middens, campsites, kill sites, tool manufacturing areas, ceremonial complexes, and earthworks. Currently unidentified onshore prehistoric sites would have to be assessed after discovery to determine the uniqueness or significance of the information that they contain. Sites already listed in the National Register of Historic Places and those considered eligible for the Register have already been evaluated as having the potential for making a unique or significant contribution to science. Of the unidentified coastal prehistoric sites that could be impacted by onshore development, some may contain unique information.

Onshore development as a result of the proposed action could result in direct physical contact between construction of new onshore facilities or a pipeline landfall and a previously unidentified prehistoric site. Direct physical contact with a prehistoric site could destroy fragile artifacts or site features and could disturb the site context. The result would be the loss of information on the prehistory of North America and the Gulf Coast region. It is assumed that 0.5-1.0 percent of OCS Program use of projected onshore facilities will

occur as a result of the proposed action. Table IV-12 shows the projected coastal infrastructure related to OCS Program activities. Each facility projected to be 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 should, therefore, be no impact to onshore WPA prehistoric sites from onshore development related to the proposed action.

Should an oil spill contact a coastal prehistoric site, the potential for dating the site using C-14 could be destroyed. This loss of information might be ameliorated by ceramic or lithic seriation or other relative dating techniques. Recent investigations into oil-spill archaeological damage associated with the *Exxon Valdez* oil spill in the Gulf of Alaska revealed that oil did not penetrate the subsoil, or into wooden artifacts, in the intertidal zone, apparently because of hydrostatic pressure (Federal Archaeology, 1994). However, it is premature to extrapolate the results from this study into the Gulf coastal environment. Previously unrecorded coastal sites could experience an impact from oil-spill cleanup operations, including possible site looting. Cleanup equipment could destroy fragile artifacts or site features and could disturb the site context. The result would be the loss of information on the prehistory of North America and the Gulf Coast region. Some of the coastal prehistoric sites that might be impacted by beach cleanup operations may contain unique information. In Texas, Louisiana, Mississippi, and Alabama, prehistoric sites occur frequently along the barrier islands and mainland coast and the margins of bays and bayous. Numerous prehistoric artifacts, as well as Pleistocene mega-faunal fossils, have been recovered from the MacFaddin Beach site in eastern Texas. The percentage of shoreline having prehistoric sites is a very small portion of the total shoreline area. Thus, any spill that contacts the land would involve a low probability of potential impact to a prehistoric site. The conditional probabilities that a hypothetical spill starting at a particular location offshore will contact land segments is listed in Appendix C. The probabilities for occurrence and contact of an offshore spill are less than the conditional probabilities for contact.

It is assumed that onshore spills will occur as a result of OCS oil being transported to shore. As most of these spills will occur within navigation channels or at support facilities, there is a very low probability of these spills contacting a prehistoric archaeological site. However, should such oil spills contact a prehistoric site, impacts identical to those discussed for offshore oil spills would be possible.

Each platform location within the high probability areas for the occurrence of historic and prehistoric archaeological resources requires archaeological clearance prior to setting the structure, so removal of the structure should not result in any adverse impact to archaeological resources. This is consistent with the findings of the *Programmatic Environmental Assessment: Structural Removal Activities, Central and Western Gulf of Mexico Planning Areas* (USDOI, MMS, 1987a).

Summary and Conclusion

Several impact-producing factors may threaten the prehistoric archaeological resources of the Western Gulf. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric site located on the continental shelf. The archaeological survey and archaeological clearance of sites required prior to an operator beginning oil and gas activities on a lease block are estimated to be 90 percent effective at identifying possible prehistoric sites. Since the survey and clearance provide a significant reduction in the potential for a damaging interaction between an impact-producing factor and a prehistoric site, there is a very small possibility of an OCS activity contacting a prehistoric site. Should such contact occur, there would be damage to or loss of significant or unique archaeological information.

Onshore development as a result of the proposed action could result in the direct physical contact from new facility construction, pipeline trenching, and new navigation canal dredging. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes of the Federal, State, and local agencies involved.

Should an oil spill contact a coastal prehistoric site, the potential for dating the site using radiocarbon methods could be destroyed. Oil-spill cleanup operations could physically impact coastal prehistoric sites. Previously unrecorded sites could also experience an impact from oil-spill cleanup operations on beaches. Should a spill contact an archaeological site, damage might include loss of C-14 dating potential, direct

impact from oil-spill cleanup equipment, and/or looting. There is a small possibility of onshore oil spills contacting a prehistoric site; should such contact occur, impacts identical to those described for offshore spills could occur.

The proposed action is not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost.

(11) Impacts on Socioeconomic Conditions

(a) Employment and Population

The importance of the oil and gas industry to the coastal communities of the Gulf of Mexico is significant, particularly in Louisiana, Texas, and coastal Alabama. Dramatic changes in the level of OCS oil and gas activity over recent years have brought forth similar fluctuations in employment and population in the Gulf of Mexico region. State government and citizen concern over the Gulf Coast's economic dependence on the oil and gas industry has made clear the need for an analysis of the impact of the OCS Program on the social and economic well-being of affected communities.

This section focuses on an analysis of the direct, indirect, and induced impacts of the OCS oil and gas industry on the employment and population of the counties and parishes within the coastal impact area of the Western and Central Gulf Region caused by the proposed action in the Western Gulf. There would also be other economic impacts, both direct and indirect, associated with the proposed actions because of their effect on other industries, such as commercial fishing, tourism, and recreational fishing. The direct benefit or loss in these industries is addressed in the sections of this EIS related specifically to those topics. The OCS Program's indirect and induced effect on these associated industries is much more difficult to quantify. Nevertheless, it will generally constitute a fraction of the magnitude of the direct impact.

Section III.C.1.a. provides an historical perspective of the oil and gas industry, as well as a brief description of recent events that have significantly affected the level of OCS activity in the Gulf of Mexico. A detailed discussion of historical trends in population and employment within the coastal impact area of the Western and Central Gulf can be found in Section III.C.1.b. Included in that section are current statistics and future projections of population and employment levels for coastal subareas in the region. These projections will serve as a baseline against which impacts will be measured. A listing of counties and parishes in the Western and Central Gulf of Mexico coastal impact area is included with Figure IV-1.

The methodology developed to quantify these impacts on population and employment takes into account changes in OCS-related employment, along with population and labor impacts resulting from these employment changes within each individual coastal subarea. The projections of OCS-related employment are classified into three categories: direct, indirect, and induced employment.

Direct employment associated with the oil and gas industry consists of those workers involved in oil and gas exploration, development, and production operations, including geophysical and seismic surveying, exploratory drilling, well operation, maintenance, and other contract support services. These activities are covered under the Standard Industrial Classification (SIC) Code 13--Oil and Gas Extraction. To facilitate the analysis, several assumptions were made regarding the employment associated with SIC 13 activity projected to result from the proposed action. These assumptions are estimates of typical levels of activity and employment based on an informal survey of oil and gas companies and drilling organizations.

Exploration Activity -	One jack-up rig can drill an average of eight wells per year providing approximately 127 person-years of employment.
	One semisubmersible can drill an average of eight wells per year providing approximately 147 person-years of employment.

	One drillship can drill an average of six wells per year providing approximately 187 person-years of employment.
Development Activity -	One platform rig can drill an average of six to nine wells per year providing approximately 115 person-years of employment.
Deepwater Development Activity -	One drilling rig can drill an average of six wells per year providing approximately 187 person-years of employment.
Production Activity -	One offshore platform can operate with an average crew of 25 workers in water depths up to 900 m. In water depths 900 m and greater, one offshore platform can operate with an average crew of 100 workers.

A computerized population and employment spreadsheet developed at MMS uses these and other assumptions to translate estimates of exploration, development, and production activities associated with the proposed action into annual projections of direct employment for each planning area. Planning area level employment projections are apportioned to offshore subareas on the basis of each subarea's hydrocarbon resource potential and projected share of the offshore infrastructure. Employment within each offshore subarea is then allocated to coastal subareas on the basis of an allocation matrix developed at MMS. This matrix allocates direct employment offshore to those coastal subareas where the onshore support facilities for that particular offshore site are expected to be located. The matrix was derived from an analysis of the historical and proposed location of onshore support facilities for the different actual or planned drilling sites offshore. The allocation matrix also accounts for the fact that employment impacts from offshore activity are not constrained by planning area or subarea boundaries. In other words, oil and gas development in the WPA can and does impact the coastal communities of the Central Gulf and vice versa. This is particularly true for the deepwater areas offshore the Western Gulf of Mexico. Indeed, about one-third of the rigs currently drilling in water depths greater than 200 m in the WPA (offshore Subarea W-3) are being serviced from coastal Subarea LA-2.

Indirect employment resulting from activities in the primary oil and gas extraction industry occurs in secondary or supporting oil- and gas-related industries. Section III.C.1.b. provides a listing of those industries considered in the projection of indirect employment. Employment in the Sanitary Service Industry, which supports oil-spill cleanup activities (SIC 4959), was not included as part of indirect employment in the model because the manpower requirements for oil-spill clean-up activities are highly unpredictable. The level of employment involved in any given clean-up effort is influenced by a variety of factors, such as whether or not the oil comes ashore, the coastal environment, weather conditions at the time of the incident, type and quantity of oil spilled, as well as the extent and duration of the oiling. Nevertheless, employment in oil-spill, cleanup activities has been included in the proposed action analysis as an external adjustment to the population and employment model, using assumptions regarding the size of potential oil spills presented in Sections IV.A.3.h.(2), IV.B.2.d., and IV.C.4.

Based on an analysis of actual industry-specific employment levels in the counties and parishes of the coastal impact area, a multiplier was determined to estimate indirect employment from direct employment projections for the oil and gas extraction industry. The indirect employment multiplier determined for this analysis was 1.22. It is important to note that the indirect employment multiplier only captures indirect employment within the Gulf of Mexico impact area. Indirect employment, particularly associated with deepwater development, outside the Gulf of Mexico coastal subareas can be significant. Because this employment is widespread (across the United States and even abroad), it is considered negligible for any given area.

Indirect employment is allocated to coastal subareas on the basis of the current and projected distribution employment in indirect industries within the impact area as well as an analyses of onshore oil- and gas-related

infrastructure locations and capacities. The distribution of indirect employment is also not constrained by planning area or subarea boundaries.

Induced employment in tertiary industries is generated from both direct and indirect employment and consists of jobs that are created or supported by the expenditures of employees in primary and secondary industries. Induced employment results from the demand for consumer goods and services such as food, clothing, housing, and entertainment. Based on a previous MMS analysis of employment impacts, the induced employment multiplier for this analysis was estimated to be 0.33.

The total employment impact to each coastal subarea resulting from the proposed action is the sum of its direct, indirect, and induced employment impact projections. The population dependent on the income from oil- and gas-related employment for their subsistence was derived from total employment estimates based on the current ratio of population to employment in the coastal subareas. Labor impacts were addressed using both population and employment data to assess the supply and demand for workers trained in oil- and gas-related trades.

To arrive at a bottom-line level of impact for population and employment, the population and employment model is used to convert the projections to a format that facilitates analysis and comparison. This conversion involves the estimation of annual changes in population and employment projections for the proposed action as a percent of the population and employment levels expected in absence of the proposal for each coastal subarea. To derive population and employment levels in absence of the proposal, the population and employment impacts estimated for the proposed actions were subtracted from a set of baseline projections that, inherently, included impacts from the proposal. The baseline projections of population and employment used in the analysis are described in Section III.C.1.b. 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 leasing activity.

Proposed Action Analysis

A total of about 10,000-33,000 person-years of employment (direct, indirect, and induced) are required in the Western and Central Gulf coastal subareas in support of a typical proposed sale in the WPA. About 33 percent of the total employment resulting from the proposed action is expected to affect the coastal subareas of the Central Gulf. Peak impacts of approximately 1,800 workers involved in primary, secondary, and tertiary industries occur throughout the years 2005-2010. This represents a mild peak with steady employment supporting a typical Western Gulf of Mexico sale proposed for 1998 through 2001 expected through the year 2030. "In the past several years a combination of events has resulted in a surge in the amount of drilling in the Gulf [of Mexico]. . . . In part, the Gulf became more attractive as the alternatives proved disappointing. . . . As geologists continued to study the Gulf, they discovered that vast quantities of oil lay undisturbed beneath subterranean sheets of salt. . . . [And] Before anybody drilled below salt or began producing oil from deep water, 3-D seismic technology created a modest rally in old oil fields in the shallow parts of the Gulf" (*Texas Monthly*, 1996). Additionally, the OCS Deepwater Royalty Relief Act has promoted leasing in water depths greater than 200 m. Recent OCS lease sales in the Central and Western Gulf of Mexico have been setting records in terms of the number of leases issued. This surge in drilling in the Gulf of Mexico is expected to continue, and the steady drilling efforts and the employment that supports that effort is reflected in the relatively steady numbers of employment with a mild peak.

Direct employment in the primary oil and gas extraction industry (SIC 13) accounts for about 34 percent of the total employment impact projected for the coastal subareas of the Western and Central Gulf over the life of the proposed action. Production activity is the largest contributor to peak direct employment impacts. Steady state SIC 13 employment is projected through the year 2026.

Table IV-26 displays the model projections of total OCS-related employment impacts (direct, indirect, and induced) from a proposed sale in the Western Gulf to the coastal subareas of the CPA and WPA throughout the life of the proposed action. Table IV-27 provides estimates of annual impacts to the population and employment of each coastal subarea as a percent of levels expected in absence of the proposal. These impact estimates represent changes in the new share of the existing population and employment that will be dependent on activities resulting from the proposed action. These impact estimates alone do not provide enough information to determine whether employment needs will be met with the population and labor force in the area or with immigrants and new labor force from other areas.

Table IV-26

OCS-Related Employment Projections (Direct+Indirect+Induced) for a Proposed Action in the Western Planning Area
(person-years)

Year	TX-1	TX-2	LA-1	LA-2	LA-3	MA-1	WGOM	CGOM	Total
1998	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0
1999	4 - 5	28 - 41	4 - 5	4 - 5	3 - 4	5 - 6	32 - 46	15 - 21	48 - 67
2000	15 - 28	127 - 279	17 - 34	17 - 34	14 - 29	20 - 43	142 - 307	69 - 141	211 - 448
2001	22 - 78	146 - 739	26 - 99	19 - 90	16 - 78	25 - 116	168 - 818	86 - 383	253 - 1,201
2002	26 - 88	175 - 835	30 - 111	23 - 102	19 - 88	29 - 131	201 - 923	101 - 432	302 - 1,355
2003	27 - 88	187 - 815	31 - 108	24 - 100	21 - 86	31 - 128	214 - 903	108 - 422	322 - 1,325
2004	29 - 96	187 - 884	31 - 117	24 - 108	21 - 93	31 - 139	216 - 980	107 - 457	323 - 1,437
2005	30 - 114	199 - 1,027	33 - 142	26 - 126	22 - 109	33 - 163	229 - 1,141	114 - 540	343 - 1,681
2006	35 - 126	240 - 1,147	38 - 157	31 - 141	27 - 122	40 - 182	276 - 1,274	136 - 601	412 - 1,875
2007	41 - 124	282 - 1,086	44 - 149	37 - 134	31 - 115	47 - 172	323 - 1,210	159 - 570	482 - 1,780
2008	35 - 120	226 - 1,029	36 - 142	29 - 127	25 - 109	38 - 164	262 - 1,150	129 - 542	390 - 1,692
2009	36 - 119	228 - 925	37 - 138	30 - 113	25 - 99	38 - 150	264 - 1,045	130 - 499	394 - 1,544
2010	36 - 123	230 - 954	37 - 141	30 - 117	26 - 102	39 - 154	267 - 1,077	131 - 514	397 - 1,592
2011	35 - 114	234 - 831	37 - 126	31 - 101	26 - 89	39 - 135	269 - 945	133 - 452	403 - 1,397
2012	33 - 111	207 - 847	34 - 128	27 - 104	23 - 91	35 - 137	240 - 957	118 - 460	358 - 1,418
2013	34 - 106	209 - 811	34 - 124	27 - 100	23 - 87	35 - 132	242 - 917	119 - 443	362 - 1,360
2014	30 - 106	182 - 817	30 - 124	24 - 101	20 - 88	31 - 133	213 - 923	105 - 445	318 - 1,368
2015	28 - 103	176 - 774	30 - 119	23 - 95	20 - 83	30 - 126	205 - 878	102 - 424	307 - 1,301
2016	27 - 102	173 - 752	29 - 118	23 - 94	19 - 81	29 - 123	200 - 853	100 - 416	301 - 1,270
2017	25 - 100	144 - 706	25 - 114	19 - 88	16 - 77	25 - 116	170 - 806	85 - 395	255 - 1,201
2018	23 - 97	115 - 661	21 - 108	15 - 82	13 - 72	20 - 110	139 - 758	69 - 372	208 - 1,130
2019	21 - 95	108 - 670	21 - 109	14 - 84	12 - 73	19 - 111	129 - 765	65 - 377	195 - 1,141
2020	20 - 87	103 - 584	20 - 99	13 - 73	12 - 64	18 - 97	123 - 671	63 - 333	186 - 1,004
2021	18 - 83	96 - 538	19 - 93	12 - 67	11 - 59	17 - 90	113 - 621	59 - 310	173 - 931
2022	14 - 83	61 - 539	15 - 94	7 - 67	7 - 59	11 - 90	74 - 621	40 - 310	115 - 932
2023	12 - 74	53 - 454	14 - 85	7 - 58	6 - 51	10 - 77	64 - 528	36 - 271	100 - 799
2024	10 - 66	47 - 420	13 - 82	6 - 54	6 - 47	9 - 72	57 - 486	33 - 255	90 - 742
2025	6 - 47	29 - 280	5 - 57	4 - 37	3 - 32	5 - 49	35 - 327	17 - 175	52 - 502
2026	4 - 35	25 - 197	3 - 37	3 - 27	3 - 23	4 - 34	29 - 232	13 - 121	42 - 354
2027	2 - 24	17 - 153	2 - 20	2 - 19	2 - 16	3 - 25	19 - 177	9 - 80	28 - 258
2028	0 - 11	11 - 71	1 - 8	2 - 9	1 - 8	2 - 12	12 - 83	6 - 36	18 - 119
2029	0 - 4	11 - 46	1 - 5	2 - 6	1 - 5	2 - 7	12 - 50	6 - 23	18 - 73
2030	0 - 1	9 - 13	1 - 3	1 - 3	1 - 2	1 - 2	9 - 14	5 - 11	14 - 25
2031	0 - 0	3 - 4	2 - 3	2 - 3	1 - 2	1 - 1	4 - 5	6 - 9	10 - 13
2032	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0	0 - 0
Total	681 - 2,559	4,271 - 19,932	722 - 3,001	557 - 2,470	478 - 2,142	720 - 3,229	4,952 - 22,491	2,477 - 10,843	7,428 - 33,334

Table IV-27

Employment and Population Percentage Impact Levels for a Proposed Action in the Western Planning Area

Employment Impacts

Year	TX-1	TX-2	LA-1	LA-2	LA-3	MA-1	WGOM	CGOM	TOTAL
1998	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%
1999	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%
2000	0.00% - 0.01%	0.01% - 0.01%	0.01% - 0.01%	0.00% - 0.01%	0.00% - 0.00%	0.01% - 0.01%	0.01% - 0.01%	0.01% - 0.01%	0.01% - 0.01%
2001	0.01% - 0.02%	0.01% - 0.03%	0.01% - 0.04%	0.00% - 0.02%	0.00% - 0.01%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.02%
2002	0.01% - 0.02%	0.01% - 0.03%	0.02% - 0.04%	0.01% - 0.02%	0.00% - 0.01%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.03%
2003	0.01% - 0.02%	0.01% - 0.03%	0.02% - 0.04%	0.01% - 0.02%	0.00% - 0.01%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.03%
2004	0.01% - 0.02%	0.01% - 0.03%	0.02% - 0.05%	0.01% - 0.02%	0.00% - 0.02%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.03%
2005	0.01% - 0.03%	0.01% - 0.04%	0.02% - 0.06%	0.01% - 0.02%	0.00% - 0.02%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.03%
2006	0.01% - 0.03%	0.01% - 0.04%	0.02% - 0.06%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.04%	0.01% - 0.04%	0.01% - 0.03%	0.01% - 0.04%
2007	0.01% - 0.03%	0.01% - 0.04%	0.02% - 0.06%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.04%	0.01% - 0.04%	0.01% - 0.03%	0.01% - 0.03%
2008	0.01% - 0.03%	0.01% - 0.03%	0.02% - 0.05%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.03%
2009	0.01% - 0.03%	0.01% - 0.03%	0.02% - 0.05%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.03%
2010	0.01% - 0.03%	0.01% - 0.03%	0.02% - 0.05%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.03%
2011	0.01% - 0.02%	0.01% - 0.03%	0.02% - 0.05%	0.01% - 0.02%	0.01% - 0.01%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.02%
2012	0.01% - 0.02%	0.01% - 0.03%	0.02% - 0.05%	0.01% - 0.02%	0.00% - 0.01%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.03%
2013	0.01% - 0.02%	0.01% - 0.03%	0.02% - 0.05%	0.01% - 0.02%	0.00% - 0.01%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.02%
2014	0.01% - 0.02%	0.01% - 0.03%	0.01% - 0.05%	0.01% - 0.02%	0.00% - 0.01%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.02%
2015	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.04%	0.00% - 0.02%	0.00% - 0.01%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.02%
2016	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.04%	0.00% - 0.01%	0.00% - 0.01%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.02%
2017	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.04%	0.00% - 0.01%	0.00% - 0.01%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.02%
2018	0.01% - 0.02%	0.00% - 0.02%	0.01% - 0.04%	0.00% - 0.01%	0.00% - 0.01%	0.01% - 0.02%	0.00% - 0.02%	0.00% - 0.02%	0.00% - 0.02%
2019	0.01% - 0.02%	0.00% - 0.02%	0.01% - 0.04%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.02%	0.00% - 0.02%	0.00% - 0.02%	0.00% - 0.02%
2020	0.01% - 0.02%	0.00% - 0.02%	0.01% - 0.04%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.02%	0.00% - 0.02%	0.00% - 0.02%	0.00% - 0.02%
2021	0.00% - 0.02%	0.00% - 0.02%	0.01% - 0.03%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.02%	0.00% - 0.02%	0.00% - 0.01%	0.00% - 0.02%
2022	0.00% - 0.02%	0.00% - 0.02%	0.01% - 0.03%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.02%	0.00% - 0.02%	0.00% - 0.01%	0.00% - 0.02%
2023	0.00% - 0.01%	0.00% - 0.01%	0.01% - 0.03%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.02%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%
2024	0.00% - 0.01%	0.00% - 0.01%	0.01% - 0.03%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%
2025	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.02%	0.00% - 0.01%	0.00% - 0.00%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%
2026	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%
2027	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.01%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%
2028	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%
2029	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%
2030	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%
2031	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%
2032	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%

Population Impacts

Year	TX-1	TX-2	LA-1	LA-2	LA-3	MA-1	WGOM	CGOM	TOTAL
1998	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%
1999	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%
2000	0.00% - 0.00%	0.01% - 0.01%	0.01% - 0.01%	0.00% - 0.01%	0.00% - 0.01%	0.01% - 0.01%	0.01% - 0.01%	0.01% - 0.01%	0.01% - 0.01%
2001	0.00% - 0.01%	0.01% - 0.03%	0.01% - 0.04%	0.01% - 0.02%	0.00% - 0.01%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.02%
2002	0.00% - 0.01%	0.01% - 0.03%	0.02% - 0.04%	0.01% - 0.02%	0.00% - 0.02%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.03%
2003	0.00% - 0.01%	0.01% - 0.03%	0.02% - 0.04%	0.01% - 0.02%	0.00% - 0.02%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.03%
2004	0.01% - 0.01%	0.01% - 0.04%	0.02% - 0.04%	0.01% - 0.02%	0.00% - 0.02%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.03%
2005	0.01% - 0.01%	0.01% - 0.04%	0.02% - 0.05%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.04%	0.01% - 0.04%	0.01% - 0.03%	0.01% - 0.03%
2006	0.01% - 0.02%	0.01% - 0.05%	0.02% - 0.06%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.04%	0.01% - 0.04%	0.01% - 0.03%	0.01% - 0.04%
2007	0.01% - 0.02%	0.01% - 0.04%	0.02% - 0.06%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.04%	0.01% - 0.04%	0.01% - 0.03%	0.01% - 0.03%
2008	0.01% - 0.02%	0.01% - 0.04%	0.02% - 0.05%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.04%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.03%
2009	0.01% - 0.01%	0.01% - 0.04%	0.02% - 0.05%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.03%
2010	0.01% - 0.02%	0.01% - 0.04%	0.02% - 0.05%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.03%
2011	0.01% - 0.01%	0.01% - 0.03%	0.02% - 0.05%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.03%
2012	0.01% - 0.01%	0.01% - 0.03%	0.02% - 0.05%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.03%
2013	0.01% - 0.01%	0.01% - 0.03%	0.02% - 0.05%	0.01% - 0.02%	0.01% - 0.01%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.03%
2014	0.00% - 0.01%	0.01% - 0.03%	0.01% - 0.05%	0.01% - 0.02%	0.00% - 0.01%	0.01% - 0.03%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.03%
2015	0.00% - 0.01%	0.01% - 0.03%	0.01% - 0.04%	0.01% - 0.02%	0.00% - 0.01%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.02%
2016	0.00% - 0.01%	0.01% - 0.03%	0.01% - 0.04%	0.01% - 0.02%	0.00% - 0.01%	0.01% - 0.03%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.02%
2017	0.00% - 0.01%	0.01% - 0.03%	0.01% - 0.04%	0.00% - 0.02%	0.00% - 0.01%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.02%	0.01% - 0.02%
2018	0.00% - 0.01%	0.01% - 0.02%	0.01% - 0.04%	0.00% - 0.02%	0.00% - 0.01%	0.01% - 0.02%	0.01% - 0.02%	0.00% - 0.02%	0.00% - 0.02%
2019	0.00% - 0.01%	0.01% - 0.02%	0.01% - 0.04%	0.00% - 0.02%	0.00% - 0.01%	0.01% - 0.02%	0.00% - 0.02%	0.00% - 0.02%	0.00% - 0.02%
2020	0.00% - 0.01%	0.00% - 0.02%	0.01% - 0.03%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.02%	0.00% - 0.02%	0.00% - 0.02%	0.00% - 0.02%
2021	0.00% - 0.01%	0.00% - 0.02%	0.01% - 0.03%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.02%	0.00% - 0.02%	0.00% - 0.02%	0.00% - 0.02%
2022	0.00% - 0.01%	0.00% - 0.02%	0.01% - 0.03%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.02%	0.00% - 0.02%	0.00% - 0.02%	0.00% - 0.02%
2023	0.00% - 0.01%	0.00% - 0.02%	0.01% - 0.03%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.02%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%
2024	0.00% - 0.01%	0.00% - 0.01%	0.01% - 0.03%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%
2025	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.02%	0.00% - 0.01%	0.00% - 0.00%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%
2026	0.00% - 0.00%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.01%
2027	0.00% - 0.00%	0.00% - 0.01%	0.00% - 0.01%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%
2028	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%
2029	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%
2030	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%
2031	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%
2032	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%	0.00% - 0.00%

The impact to employment from a typical OCS sale in the Western Gulf is expected to be negligible in all coastal subareas. Coastal Subarea TX-2 (eastern Texas) provides for almost 60 percent of the total employment required in support of a proposed sale in the Western Gulf of Mexico. Coastal Subarea TX-1 is expected to provide approximately 8 percent of the employment for a typical sale in the Western Gulf proposed for 1998-2001. Coastal Subareas LA-1, LA-2, and LA-3 provide for about 9 percent, 7 percent, and 6 percent of the total employment required in support of the proposed action in the Central Gulf, respectively. Coastal Subarea MA-1 accounts for almost 10 percent of the employment related to the proposed action and projected for the Gulf coastal impact area. In addition, the coastal communities of the Gulf of Mexico are expected to have no noticeable peak population impacts as a result of proposed action activities (Table IV-27).

Employment impacts resulting from oil-spill cleanup activities, because of their highly unpredictable nature, were handled apart from the population and employment model. The level of employment associated with any given cleanup operation is dependent on numerous variables, which, in themselves, are also difficult to predict. Nevertheless, the most labor-intensive cleanup operations are those from spills that contact the coastline, particularly recreational beaches. For the purpose of this analysis, it is assumed that only those spills contacting land will involve significant manpower requirements in their cleanup efforts. Based on employment statistics from recent spill cleanup operations along the coast, the assumption is that, for every kilometer of coastline subjected to heavy oiling, approximately 100 temporary workers will be employed for a maximum of 6 weeks.

Section IV.A.3.h.(2) presents estimates of the mean number of offshore spills assumed to result from the proposed action in the WPA. Probabilities of contact are also provided in Appendix C. Employment associated with oil-spill cleanup activities is expected to be temporary and of short duration, thereby resulting in a negligible impact to overall OCS-related employment for a proposed sale in the Central Gulf of Mexico.

The level of OCS-related employment expected to result from the proposed action in the Western Gulf is not significant enough to attract new residents and labor force to the area. However, as previously mentioned in Section III, some employment is expected to be met through in-migration due to the shadow effect and a labor force lacking requisite skills for the oil and gas and supporting industries. The presence of some in-migrants has been reported for southern Lafourche Parish, including workers from Mexico and India. This temporary importation of labor, particularly in the South Lafourche area of Louisiana, is expected to continue in the near future This is a unique situation exacerbated by the shadow effect. The unusual work schedules in the oil and gas extraction industry also support employment outside of the impact area because long-distance commuting can be reasonably accomplished on such an infrequent basis. So, while employment opportunities are growing in the oil and gas extraction and supporting industries within the Gulf of Mexico impact area, some of that employment will be met outside of the area. As previously mentioned, the computerized model used in this analysis only reflects (permanent) employment within the coastal impact area. Analysis of historical trends has shown that only population impacts greater than 1 percent typically result in positive net migration to any given area. None of the coastal subareas is projected to experience population impacts greater than 1 percent because of the proposed action. Labor force impacts will parallel population and employment impacts. Jobs are expected to be primarily filled by currently unemployed or underemployed workers or by future entrants into the labor force already living in the area. Therefore, most of the permanent employment demands in support of the proposed action primarily will be met with the existing population and available labor force.

Summary and Conclusion

Peak annual changes in the employment and population of all coastal subareas in the Western and Central Gulf resulting from the proposed action in the Western Gulf represent less than 1 percent of the levels expected in absence of the proposal in the Western Gulf. About 33 percent of the total employment resulting from the proposed action is expected to affect the coastal subareas of the Central Gulf. Employment resulting from oil-spill clean-up activities due to the proposed action is expected to be negligible. For the most part, it is expected that employment demands in support of the proposed action will be met with the existing population and available labor force. Some employment is expected to be met through in-migration due to the shadow effect and a labor force lacking requisite skills for the oil and gas and supporting industries.

(b) Public Services, Infrastructure, and Land Use Plans

Public services and infrastructure, as used in this analysis, include commonly provided public, semipublic, and private services and facilities, such as education, police and fire protection, sewage treatment, solid-waste disposal, water supply, recreation, transportation, health care, other utilities, and housing. Changes in demands for and usage of public services and infrastructure could result from OCS activities. Adverse effects could arise if the amount or rate of increase or decrease in the usage significantly exceeded or fell far below the capability of a local area to provide a satisfactory level of service.

Sections providing supportive material for this analysis include Sections III.C.1. (description of socioeconomic issues), IV.A.2.a. (offshore infrastructure), IV.B.1.a. (onshore infrastructure), IV.A.3.h.(2) and IV.B.2.d. (oil spills), and IV.D.1.a.(11)(a) (impacts on employment and population).

For the purpose of this analysis, OCS-related, impact-producing factors to public services and community infrastructure will include workforce fluctuations, migration (both in-migration and out-migration), and the effect of relative income. These impact-producing factors are interrelated and derive from or result in increased or decreased population. It should be noted that these impact-producing factors also pertain to social patterns and will be analyzed in Section IV.D.1.a.(11)(c).

Impacts to land use planning include sitings of coastal infrastructure or OCS-related materials in areas proscribed for such sitings by State, regional, and/or local ordinances, regulations, etc., or submittal of applications for sitings of coastal infrastructure which could result in stresses placed on regulatory agencies to review all applications in a timely, efficient, and effective manner. It is assumed that both existing and projected pipeline shore facilities would be used to some extent to support a typical proposed action. Disposal of nonhazardous OCS waste in unlined pits is now banned in the Gulf States because of potential impacts to wildlife, wetlands, water supplies, and humans. Regulatory restrictions that provide for management of oil-field wastes have been passed by all Gulf States. Storage and disposal of nonhazardous oil-field waste are taken to commercial oil-field waste disposal facility sites. In addition to drilling and production wastes, trash and debris from the offshore oil industry are shipped onshore for disposal at municipal landfills. Such landfills must undergo approval from regulatory bodies prior to becoming operational.

Greater details on other matters pertinent to an analysis on land use plans (disposal of offshore waste, coastal infrastructure, etc.) may be found in Section IV.B.1. and are incorporated by reference.

Proposed Action Analysis

Baseline employment projections and information relating to the model analysis used to arrive at these projections are presented in Section IV.D.1.a.(11)(a). This information is incorporated by reference. Unexpected events (such as the 1973 Arab Oil Embargo) may influence oil and gas activity within the Gulf of Mexico Region. These events cannot be predicted and cannot be presumed for this analysis.

Approximately 10,000-33,000 person-years of employment (direct, indirect, and induced) are required to sustain a typical proposed action (Table IV-26). About 68 percent of total employment in support of a typical proposed action is expected to affect the Texas coastal area (almost entirely within Subarea TX-2). The remaining employment is expected to lie within coastal Subareas LA-1 (9%), LA-2 (7%), LA-3 (6%), and MA-1 (10%). In the peak year of 2007, approximately 1,800 person-years of total employment will be required to support a typical proposed action. A steady stream of employment supporting a typical Western Gulf of Mexico sale proposed for 1998-2002 is expected through the year 2030. The greatest population and employment impacts associated with a typical proposed action would fall in western Louisiana and Texas. The impact to employment is expected to be negligible in all coastal subareas. The expected population and employment impacts for the coastal subareas as a result of a typical proposed action are shown in Table IV-27. The greatest impact to employment is expected to occur in coastal Subareas LA-1 and TX-2, with peak-year exploration impact estimates in 2005-2007 of 0.06 and 0.04 percent, respectively. The greatest impact to population is expected to occur in Subareas LA-1 and TX-2, with peak-year impacts in 2006-2007 of between 0.04 and 0.06 percent.

A major impact of OCS-generated activities, new population associated with increased service demands, will be significantly mitigated by planning and other measures undertaken at the Federal, State, regional, and local levels. All the potential onshore development areas either have or participate in local and/or regional planning programs. The objectives of these programs include orderly and efficient growth management that minimizes fiscal, social, and environmental impacts.

Short-term fluctuations in the workforce as a result of changing levels of OCS-related oil and gas activity could impact social services and community infrastructure in several ways. Large, short-term layoffs of oil and gas industry personnel could stress the abilities (both in terms of work load and available funding) of public and private agencies whose mission is to aid persons with severe financial difficulties (cf. Laska et al., 1993). Such layoffs would not only affect those directly employed by the industry, but also those in secondary and tertiary jobs. According to Applied Technology Research Corporation (1994), there were 6,617 unique OCS vendors and contractors serving production companies in the Gulf of Mexico region. Louisiana vendors employed approximately 55,000 persons. The need for public or private assistance could force the diversion of funds needed for the maintenance of community infrastructure, such as schools and roads. Large, short-term increases in the workforce could result in net positive migration and cause a scarcity of housing, a shortage of municipal personnel (i.e., policemen, firemen, engineers, etc.), stresses on the capabilities of available infrastructure, and an increase in the cost of living. This could result in significant detrimental impacts in affected communities, and particularly, on those living on fixed incomes (Laska et al., 1993).

Recent technological advances have allowed exploration (3D seismic surveying technology) and production (nonconventional drilling and production platforms for deepwater operations) to move into deeper water areas of the Gulf (for operations this is greater than 1,000 ft or 305 m). These projects, of necessity, are much larger and more complex than production activities in shallow water areas (Cranswick and Regg, 1997). In addition, the passage of the Deep Water Royalty Relief Act has stimulated deepwater leasing, and subsequent exploration and development activities, beyond expectations. The models used to predict employment associated with a typical proposed action take the larger and more complex nature of these operations into account. However, needs specific to these deepwater projects may result in more focused stresses placed on areas that are capable of supporting these large-scale development projects (e.g., ports that can handle deeper draft service vessels).

This focusing of activity could result in stresses to infrastructure servicing these focal points (particularly highways and ports), as well as stresses placed on the infrastructure associated with the focal point. Testimony provided at a Central Gulf Multisale Draft EIS public hearing in Houma, Louisiana, on June 23, 1997, highlighted Port Fourchon as one area that has recently seen a large increase in OCS-related activity, with concomitant stresses placed on local infrastructure (particularly La. Highway 1, the only road into the area). The major reason for the increase in activity at Port Fourchon lies in the use of the port for support of deepwater activity in the Gulf. Examination of recent rig locator reports indicate that coastal Subarea LA-2 (which includes Port Fourchon) supports about one-third of the deepwater activity in the WPA. The size and complexity of these deepwater projects, coupled with the limited number of service bases capable of handling their unique needs, will likely result in continued stresses on port infrastructure and associated stresses placed on local infrastructure (including highways) at Port Fourchon and at other ports used to service the needs of deepwater projects. Stresses placed on local infrastructure at these bases will continue as a result of the typical proposed action to the extent that deepwater tracts are leased, explored, and developed. Scoping for the present EIS suggests that the ports of Corpus Christi and Galveston do not anticipate the degree of stresses to port and local infrastructure that has been encountered by Port Fourchon. The MMS's Gulf of Mexico OCS Region sponsored a workshop in April 1997 to identify information needs related to deepwater environmental resources and potential impacts of deepwater activities, including socioeconomic impacts. Information needs identified in the socioeconomic session of the workshop included an infrastructure inventory of the Gulf Region and identification of stresses on the infrastructure resulting from deepwater activity; an examination of port facilities across the Gulf (an MMS-funded study is currently underway to examine the impacts of deepwater activity on Port Fourchon, Louisiana); and an examination of employment and commuting patterns. Scoping performed in Texas for this EIS indicated that there is a use conflict in the Corpus Christi area. The conflict results from the need to block usage of the Gulf

Intracoastal Waterway several times during construction of tension leg platforms (TLP's) at the facilities in Ingleside, Texas. At present, a working agreement exists between the USCG and the operators of the construction facility to ensure that potential users of the GIWW are notified in advance of blockage of the waterway. However, there have been instances where advance notification was not provided and vessel traffic in the GIWW was blocked. At the Texas scoping meeting, the USCG indicated that continued construction of TLP's in the facility may cause more use conflicts and result in the need for more active management of waterway usage.

None of the coastal subareas are expected to experience population impacts greater than 0.06 percent (peak years 2006-2007) as a result of a typical proposed action. It is expected that employment related to a typical proposed action will not require importation of labor and that the existing labor pool will be adequate to supply the majority of labor needs, with the possible exception of some skilled positions (Section IV.D.1.a.(11)(a); Krapf, 1997, pp. 24-28). A typical proposed action is expected to provide jobs for unemployed, underemployed, and new employees already living in the area. Excess labor capacity of the coastal subareas is also expected to provide sufficient human resources to maintain adequate levels of public services and infrastructure.

Migration into a coastal subarea (in-migration) as a response to increased levels of OCS-related oil and gas activity could result in increased stress on both public and private agencies in assisting newly relocated persons and in providing basic services to an expanding population, particularly if the increase occurs at a rapid rate (Laska et al., 1993). In addition, not all persons who migrate to an area seeking employment will find it. This failure causes additional stress on social service agencies. In-migration into an area may result in dramatic population increases, with resulting stress on community schools, roads, law enforcement agencies, and other community infrastructure (cf. McKenzie et al., 1993). Migration out of a coastal subarea (out-migration), in response to lowered levels of OCS-related oil and gas activity, could jeopardize the numerous secondary and tertiary jobs that were created during periods of increased population, stressing social service agencies (cf. Applied Technology Research Corporation, 1994). Community infrastructure created in response to a larger population could become a redundant expense as a result of out-migration. An analysis of historical trends indicates that population impacts of greater than 1 percent result in positive net migration into a given area. Table IV-27 indicates that population impacts as a result of the proposed action are not expected to exceed this figure. Therefore, it is expected that the proposed action will not produce in-migration into the coastal subareas of the Gulf of Mexico, with the possible exception of some migration of persons involved in skilled labor positions. The recent upsurge in oil and gas activity in both Federal and State areas of jurisdiction may have revealed a shadow effect of the previous bust. In this phenomenon, workers are reluctant to engage in oil- and gas-related employment due to a fear of future unemployment during times of industry downturn. At present, the quantitative and temporal extent of this phenomenon is uncertain; however, it may impact the amount of in-migration into a specific area. A typical proposed action will result in the need for approximately 10,000-33,000 person-years of total employment. The majority of these jobs are expected to be filled by unemployed, underemployed, and newly employed persons already living in the area. By providing these jobs, a typical proposed action will reduce the amount of out-migration compared to that which might occur without a typical proposed action.

The relatively high wages paid to OCS-related oil and gas industry personnel may result in a reduction in the degree of income inequality in those counties and parishes that are involved in OCS oil and gas activity. Income inequality, which measures the distribution of income throughout a population, increased in selected parishes of Louisiana during the bust period of the 1980's (cf. Tolbert, 1995b). Conversely, family income inequality significantly diminished between 1970 and 1980, which is when the majority of the boom period occurred. The estimated average salary of OCS-related employees in 1992 was about $52,000 (Applied Technology Research Corporation, 1994). It is reasonable to assume that the degree of income inequality, as well as impacts to public services and community infrastructure, would be less with the proposed action than without the proposed action. Impacts to social services could come from the need for assistance of those living on fixed incomes, as well as those unemployed as a result of the decline of businesses unable to operate in an environment of high wage scale. Impacts to community infrastructure could come from workers in the community moving from infrastructure-related activities to higher paying jobs in the oil and gas industry. The employment needs of a typical proposed action are not expected to

exceed the labor capacity of the Gulf coastal subareas. As mentioned above, an analysis of historical trends indicates that in-migration is not expected as a result of a typical proposed action, with the possible exception of some in-migration associated with the importation of skilled labor. In addition, jobs created by the proposal would likely reduce the amount of migration out of the coastal subareas as compared to scenarios without the proposal. Revenues generated by Federal, State, and local taxes from employment related to a typical proposed action are expected to mitigate any increased needs for public services.

Appendix C presents the conditional probabilities for hypothetical offshore oil-spill contacts to land and resources. Based on employment statistics from recent spill cleanup operations along the coast, the assumption is that, for every kilometer of coastline subjected to heavy oiling, approximately 100 temporary workers will be employed for a maximum of 6 weeks. As it is not possible to predict exactly if, or where, the assumed oil-spill contact would occur, the identity and number of communities that could be impacted by an influx of oil-spill cleanup workers is also impossible to predict. Potential impacts could include temporary stresses on local infrastructure including housing, recreation, transportation, and water supply. The duration of these possible impacts would be limited to the amount of time necessary to clean up the spill (a maximum of 6 weeks based on the estimates above).

It is assumed that 0.5-1.0 percent of OCS Program use of projected onshore facilities will occur as a result of a typical proposed action. Table IV-12 shows the projected coastal infrastructure related to OCS Program activities. Each facility projected to be constructed must receive approval from the pertinent Federal, State, county/parish, and/or community involved. In addition, such facilities must be in concurrence with the State's approved CZM plan. All onshore pipelines must obtain similar permit approval and concurrence. It is assumed that projected construction will be approved only if it is consistent with the regulatory mechanisms of the involved parties. Should a conflict exist between those mechanisms and the projected construction, it is assumed that approval will either not be granted or that appropriate mitigating measures will be enforced by the political entities. Projected construction is therefore anticipated to be in accordance with appropriate land use plans, zoning regulations, and other State/regional/local regulatory mechanisms. Only a minimal percentage of onshore infrastructure is anticipated to be required to support a typical proposed action. This minimal amount of new construction is not anticipated to stress the capacity of State, county/parish, or local regulatory mechanisms to ensure compliance with local and regional land use plans.

Summary and Conclusion

Impacts to public services and infrastructure would be related to dramatic increases or decreases in OCS activities resulting in rapid increases or decreases in population, migration, employment, etc., which are not projected in the WPA as a result of a typical proposed action. Specific impact-producing factors examined in this analysis include workforce fluctuations, migration into or out of the coastal subareas, and the relatively high wages made by personnel involved in the oil and gas industry. The greatest population and employment impacts associated with a typical proposed action would fall within western Louisiana and Texas. An analysis of historical trends indicates that population impacts of greater than 1 percent result in positive net migration into a given area. Population impacts are not expected to exceed the peak-year impacts of 0.6 percent. It is expected that most employment needs will be met by those currently employed in the oil and gas industry as well as by the unemployed, underemployed, and new employees already living in the area. In addition, jobs created by the proposal would likely reduce the amount of migration out of the coastal subareas as compared to scenarios without the proposal. The need for some skilled labor may result in some in-migration. The amount of in-migration may be increased by a shadow effect resulting from the previous oil bust. An increasing focus on deepwater activity may result in some stress placed on local infrastructure at or near focal points associated with support of deepwater exploration and development activities. Some use conflicts involving the GIWW near Corpus Christi, Texas, may be exacerbated by activities resulting from the proposed action. Potential impacts of oil spills could include temporary stresses on local infrastructure including housing, recreation, transportation, and water supply. The duration of these possible impacts would be limited to the amount of time necessary to clean up the spill. Projected

construction is anticipated to be in accordance with appropriate land use plans, zoning regulations, and other State/regional/local regulatory mechanisms.

Population, employment, and land use impacts that result from a typical proposed action will not result in disruptions to community infrastructure and public services beyond what is anticipated by in-place planning, development, and regulatory agencies. Temporary (6 weeks maximum) stresses to local infrastructure could occur as a result of oil spills.

(c) Sociocultural Issues and Environmental Justice

This impact analysis is for the coastal counties and parishes of the Western and Central Gulf of Mexico. Sociocultural issues, as used in this analysis, include traditional occupations, folkways, social structure, language, family life, and other forms of cultural adaptation to the natural and human environment. It should be noted that impacts unrelated to OCS oil and gas activity (such as technological improvements in communications and transportation) have caused, and will continue to cause, sociocultural changes within the analysis area. This analysis will consider only the effects of oil and gas activities related to the proposed action on the social and cultural patterns of the Western and Central Gulf coastal subareas.

Sections providing supportive material for this analysis include Sections III.C.1. (description of socioeconomic issues), IV.A.2.a. (offshore infrastructure), IV.A.3.h.(2) (oil spills), IV.D.1.a.(1) (impacts on sensitive coastal environments), IV.D.1.a.(8) (impacts on commercial fisheries), IV.D.1.a.(11)(a) (impacts on employment and population), and IV.D.1.a.(11)(b) (impacts on public services, infrastructure, and land use plans).

The OCS-related, impact-producing factors to sociocultural issues include OCS-related employment and workforce fluctuations, population and demographic change, relative income, wetlands loss, oil spills, and work scheduling. Adverse effects to social and cultural patterns could arise if disruption of these patterns occurred and resulted in changes in traditional occupations, disruption in the viability of extant subcultures, social and community dysfunction, and detrimental effects on individual or family life. A recently completed study of stakeholders in the Central Gulf of Mexico and their issues and concerns suggests that major social issues relate to the cyclic, or "boom/bust," aspects of oil and gas activity. This was noted particularly in the Louisiana sample (cf. Gramling et al., 1995; pp. 59-60). Aesthetic impacts and concerns about the impacts of oil spills on local economies were mentioned by those residing in areas of beach-focused tourism (e.g., portions of Mississippi and Alabama). A similar study for the Western Gulf of Mexico is currently underway. Aesthetic impacts are discussed in Section IV.D.1.a.(9), and impacts of oil spills are discussed below.

The OCS-related employment and workforce fluctuations may result in positive and/or negative effects on social and cultural patterns. The OCS-related employment may occur from exploration, delineation and development of reservoirs, from secondary and tertiary industries serving OCS activities, and from construction of infrastructure necessary to service OCS activities. The obvious positive benefit of OCS oil and gas activity lies in the availability of jobs (or continuity of existing jobs) for persons in the analysis area. This can allow for the economic stability of those persons who are already working in OCS-related positions and for the incorporation of persons into OCS-related jobs who are unemployed or underemployed. According to Applied Technology Research Corporation (1994), the 1992 estimated payroll from producing companies to OCS-related employees was about $500 million. Large numbers of short-term layoffs in OCS oil and gas industry personnel could result in large numbers of persons engaging in alternative methods of earning income that are traditional to the area (i.e., fishing, trapping, farming, etc.). This could stress the carrying capacity of local ecosystems and diminish the various resources that would be exploited, which, in turn, would have economic impacts on resource exploiters as the ability to sustain the activity decreased. An additional effect could be increased economic stress placed on families and individuals with concomitant social problems. A large increase in the hiring of oil and gas industry personnel could result in increases in populations of small communities highly involved in the OCS oil and gas industry with attendant social and cultural effects (cf. Seydlitz, 1994; Laska et al., 1993).

In-migration and out-migration may be considered resultants of rapid increases and decreases in the rate of OCS activity. During periods of rapid increases in OCS activity, it is reasonable to assume that persons

move into the coastal areas to take part in the increased opportunity for employment in the OCS oil and gas industry. The rapid influx of persons into coastal communities could effect community function and cohesion, quality of life, and cultural identity. During periods of rapid decreases in OCS activity, out-migration of persons from coastal communities could occur. This could result in fiscal and sociocultural effects. Adverse impacts could include effects on stress in individuals and families as a result of the departure of family members, and the departure of persons who are engaged in traditional occupations (cf. Laska et al., 1993; McKenzie et al., 1993; Seydlitz and Laska, 1994).

Jobs associated with the OCS oil and gas industry in the Gulf of Mexico have generally been viewed as higher paying jobs. This is true at both the professional and blue collar levels. The average salary of an OCS-related employee in Louisiana in 1992 was about $52,000 (Applied Technology Research Corporation, 1994). It is assumed that a similar average would apply to OCS-related employees in Texas. A recent MMS-funded study suggest that OCS-related jobs may have served to reduce the amount of income inequality in coastal parishes in Louisiana, particularly during the industry "boom" (Tolbert, 1995b), and similar effects are assumed for Texas. Deleterious impacts associated with the higher paying jobs in the OCS oil and gas industry include possible destabilization of small businesses that cannot compete with salaries and benefit packages of larger OCS-related companies, possible lack of incentives for increased business efficiency (particularly during "boom" times), and dependency on these relatively higher wages that can lead to individual and family economic stress (particularly if layoffs occur and the wage-earner cannot find work at comparable pay). Another impact associated in the literature with OCS activity (in Louisiana) has been the impact on human capital (e.g., the educational attainment of persons in the area). According to Seydlitz and Laska (1993), basic level educational attainment temporarily improves and educational strain temporarily worsens during increases in petroleum activity, especially in highly involved and extraction parishes. In addition, a smaller percentage of high school graduates seek college degrees during upswings in OCS activity. It is reasonable to assume similar impacts on human capital in Texas.

The loss of wetlands has the potential to impact many traditional occupations associated with the coastal counties and parishes of the analysis area. Wetlands loss could result in the loss of productivity of the estuarine marshes. This loss could diminish the availability of biological resources and have an adverse economic effect on individuals engaged in fishing, trapping, and other exploitative efforts. This could eventually result in a loss of or diminution of traditional occupations.

Oil spills have the potential to damage wetlands and adversely affect persons engaged in fishing, trapping, etc. Aesthetic enjoyment and recreational use of those areas impacted by an oil spill would be adversely affected. Cleanup of oil spills could result in short-term, adverse effects on communities. The problems would be similar to those associated with a large and rapid influx of strangers into small, coastal communities.

Distance to site and type of transportation needed for personnel in OCS-related oil and gas activities results in the normal work schedule occurring as a large block of time on duty (or at site) followed by a large block of time off duty. The schedule may range from 7 days on followed by 7 days off to a 30 day-on/30 day-off schedule. This extended work schedule necessitates adjustment by the family and the working family member to changes in traditional roles (i.e., when the family member, usually the husband, is away, other members must perform those duties that would ordinarily be done by the absent person). Several different types of adaptive familial structures have been identified as responses to the extended work schedule (Laska et al., 1993). The most frequent adaptive response is a father/husband centered, traditional structure in which both parents actively participate in family life, with the wife relaxing her authority during the husband's presence. This was found to occur in approximately 55 percent of the families examined. In those families that could not adapt without conflict, adverse effects (such as divorce or habitual conflict) were found to occur in about 10 percent of the families examined.

Proposed Action Analysis

Baseline employment projections and information related to the model analysis used to arrive at these projections are presented in Section IV.D.1.a.(11)(a). This information is incorporated by reference. Unexpected events (such as the 1973 Arab Oil Embargo) may influence oil and gas activity on the OCS

within the Gulf of Mexico Region. These events cannot be predicted and cannot be presumed for this analysis.

A typical proposed action will result in 10,000-33,000 person-years of direct, indirect, and induced employment (Table IV-26). The coastal subareas of Texas are projected to provide the greatest support and, hence, potential impacts for a typical proposed action. The expected population and employment impacts for the coastal subareas as a result of a typical proposed action are shown in Table IV-27. About 68 percent of total employment in support of a typical proposed action is expected to affect the Texas coastal area (almost entirely within Subarea TX-2). The remaining employment is expected to lie within coastal Subareas LA-1 (9%), LA-2 (7%), LA-3 (6%), and MA-1 (10%). In the peak years of 2006-2007, approximately 1,800-1,900 person-years of total employment will be required to support a typical proposed action. A steady stream of employment supporting a typical Western Gulf of Mexico sale proposed for 1998-2002 is expected through the year 2030. The greatest impact to employment is expected to occur in coastal Subareas LA-1 and TX-2, with peak-year impact estimates in 2005-2007 of between 0.04 and 0.06 percent. The greatest impact to population is expected to occur in Subareas LA-1 and TX-2 with peak-year impact estimates in 2006-2007 of between 0.04 and 0.06 percent. The majority of employment projected to occur in association with a typical proposed action is expected to be filled by persons already engaged in OCS oil- and gas-related employment, unemployed persons living in the area, and underemployed persons living in the area. Some need for importation of skilled labor may be necessary to support a typical proposed action (cf. Krapf, 1997, pp. 24-28). Inasmuch as jobs will be provided for persons living in the coastal subareas, some positive impact is expected.

Given the present amount of OCS-related jobs in the coastal subareas, a typical proposed action is not expected to result in workforce fluctuations. The creation of jobs associated with a typical proposed action (i.e., between about 10,000 and 33,000 person-years of employment over the life of a typical proposed action) is expected to reduce the amount of workforce fluctuations, which would occur without a typical proposed action. It is therefore expected that a typical proposed action will not result in large increases or decreases in OCS-related employment within the Western and Central Gulf coastal subareas.

Projected population impacts in the Western and Central Gulf coastal subareas are presented in Table IV-26. Peak impacts are expected to occur in 2006-2007 at between 0.04 and 0.06 percent in coastal Subareas LA-1 and TX-2. An analysis of historical trends indicates that only population impacts greater than 1 percent typically involve positive net migration into a given area. None of the coastal subareas are projected to experience population impacts greater than 0.06 percent as a result of a typical proposed action. However, it is possible that some in-migration will occur in association with the importation of skilled labor. The recent upsurge in oil and gas activity in both Federal and State areas of jurisdiction may have revealed a shadow effect of the previous bust. In this phenomenon, workers are reluctant to engage in oil- and gas-related employment due to a fear of future unemployment during times of industry downturn. At present, the quantitative and temporal extent of this phenomenon is uncertain; however, it may impact the amount of in-migration into a specific area. It is assumed that employment as a result of a typical proposed action will decrease the amount of out-migration compared to that which would occur without a typical proposed action. Social and cultural problems typically associated with in-migration and out-migration are not expected to occur generally as a result of a typical proposed action (e.g., loss of community cohesion, social dysfunction, educational strain, etc.). However, it is possible that some of the communities heavily involved in supporting OCS activity may experience problems associated with in-migration in support of the proposed action.

It is reasonable to expect that some persons engaged in lower-paying occupations will seek employment in OCS-related oil and gas activities. It is also reasonable to expect that some persons engaged in traditional occupations will seek employment in OCS-related activities. Employment projections for the life of a typical proposed action indicate that peak-year employment will occur in 2006 and will total up to approximately 1,900 person-years. The relatively small amount of employment associated with a typical proposed action, in comparison with the total employment in the affected Western and Central Gulf coastal subareas, is not expected to result in deleterious impacts to small businesses. Given the total employment associated with the proposal, impacts to educational attainment are expected to occur to a minimal extent. In some

individual cases, it is possible that persons will forgo pursuit of higher education in order to avail themselves of the relatively high wages of OCS-related employment.

A typical proposed action is assumed to result in an impact to wetlands (Section IV.D.1.a.(1)(b)). The projected amount of wetlands loss is not sufficient to affect the practice of traditional occupations in the WPA, given the total amount of coastal marsh available for exploitation.

Section IV.A.3.h.(2) presents estimates of the mean number of offshore spills assumed to result from a typical proposed action in the WPA. The conditional probabilities of a hypothetical spill contacting land are provided in Appendix C. An analysis of historical data relating length of coastline affected to spill volumes and the oil-spill cleanup employment assumptions cited above is presented in Section IV.D.1.a.(11)(a). Potential impacts could include a loss of community cohesion, social disorganization associated with a rapid influx of strangers into a tightly-knit community, and an increased cost of living associated with increased demand for housing. The duration of these possible impacts would be limited to the amount of time necessary to clean up the spill (an estimated maximum of 6 weeks). The level of cleanup action associated with these spills will be minimal. Therefore, the practice of traditional occupations will not be impacted given the total amount of coastal marsh available for exploitation.

Up to approximately 1,200 person-years of direct, annual offshore employment in OCS activities will be required to support a typical proposed action. These persons will likely encounter the extended work schedule typically associated with OCS offshore activities. The extended work schedule will allow for part-time participation in more traditional occupations (fishing, trapping, etc.). The relationship between OCS oil and gas activities and traditional culture in the coastal subareas of Louisiana has been mostly positive (Laska et al., 1993). It is reasonable to assume that the relationship has been mostly positive in Texas as well, given Texas' long history of involvement with both onshore and offshore oil and gas activity. The extended work schedule changes the practice of traditional familial roles, in an adaptive response to absence. In the majority of cases, it is expected that the familial adaptations to the extended work schedule will be successful (cf. Storey et al., 1989). However, it is expected that in a small number of cases, successful adaptation of the family to the extended work schedule will not occur. In these cases, some deleterious impacts to family are expected.

It is assumed that 0.5-1.0 percent of OCS Program use of projected onshore facilities will occur as a result of a typical proposed action. Table IV-12 shows the projected coastal infrastructure related to OCS Program activities. Several different possible scenarios may result in the siting of facilities, with their concomitant economic and environmental implications, proximal to low-income or minority communities or populations. Most facilities that support OCS exploration and production activities require multiple acres of contiguous land. Economic and logistic decisions, as well as local zoning and permitting requirements, drive the choice of where to locate these facilities. In some cases, the facilities will be located some distance away from populated areas. Through time, land adjacent to the facility may be purchased and a community may grow up around the facility. In many cases, the land adjacent to such a facility will be deflated in value with respect to land farther from an OCS-support facility. Conversely, if an OCS-support facility is to be built in a populated area, there is the likelihood that it would be built in a low-income community, based on economic factors. There may be subsequent impacts to these communities' environment (e.g., impacts to air and water quality) based on the type of facility that is constructed; however, there is no projected oil refinery construction (which would likely have the greatest potential impact to air and water quality). Low-income communities, which can be found across the Gulf Coastal Plain, would include multi-ethnic as well as homogenous communities and neighborhoods. Minority communities subject to Executive Order 12898 and within the potential impact area analyzed in this document would include primarily Hispanic communities and neighborhoods found in Texas, African-American communities, and neighborhoods found across the northern Gulf rim; two federally recognized American Indian tribal lands found in Louisiana; and Asian-American communities and neighborhoods found primarily in Texas, Louisiana, and Alabama. The location of any new onshore infrastructure is based on economic and logistic considerations outside of the purview and regulatory authority of MMS. It is possible that new onshore infrastructure could be located proximal to minority or low-income populations or communities. To the extent that this occurs, a typical proposed action is responsible for 0.5-1.0 percent of the impacts associated with siting new onshore facilities proximal to minority or low-income populations or communities. It is not expected to cause disproportionately

high and adverse human health or environmental effects on minority populations or low-income populations; however, the lack of information on the location of potential construction of onshore infrastructure over the life of the proposed actions makes it impossible to dismiss potential disproportionate impacts. Each facility projected to be constructed must receive approval from the pertinent Federal, State, county/parish, and/or community involved. All onshore pipelines must obtain similar permit approval and concurrence. It is assumed that projected construction will be approved only if it is consistent with the regulatory mechanisms of the involved parties. Should a conflict exist between those mechanisms and the projected construction, it is assumed that approval will either not be granted or that appropriate mitigating measures will be enforced by the political entities. Projected construction is therefore anticipated to be in accordance with appropriate land use plans, zoning regulations, and other State/regional/local regulatory mechanisms.

Summary and Conclusion

The employment projected to occur in association with a typical proposed action is expected to be filled primarily by persons already engaged in OCS oil- and gas-related employment, unemployed persons living in the area, and underemployed persons living in the area. The coastal subareas of Texas are projected to provide the greatest support and, hence, incur the greatest potential impacts associated with the proposal. Inasmuch as jobs (including high-paying jobs) will be provided for persons living in the coastal subareas, some positive impact is expected. Given the present amount of OCS-related jobs in the coastal subareas, a typical proposed action is not expected to result in workforce fluctuations. None of the coastal subareas are projected to experience population impacts greater than 0.06 percent as a result of a typical proposed action. Some importation of skilled labor may be required to support a typical proposed action. In addition, the shadow effect may exacerbate the need for importation of skilled labor. It is assumed that employment as a result of a typical proposed action will decrease the amount of out-migration compared to that which would occur without a typical proposed action. Social and cultural problems typically associated with in-migration and out-migration are not expected to generally occur as a result of a typical proposed action. However, it is possible that some of the communities heavily involved in supporting OCS activity may experience problems associated with in-migration in support of the proposed action. The relatively small amount of employment associated with a typical proposed action, in comparison with the total employment in the affected Western and Central Gulf coastal subareas, is expected to result in no deleterious impacts to small businesses. The projected amount of wetlands loss is not sufficient to affect the practice of traditional occupations in the WPA, given the total amount of coastal marsh available for exploitation. Potential offshore oil-spill impacts could include a loss of community cohesion, social disorganization associated with a rapid influx of strangers into a tightly-knit community, and an increased cost of living associated with increased demand for housing. The duration of these possible impacts would be limited to the amount of time necessary to clean up the spill (6 weeks estimated). Employment requirements for cleanup of onshore spills is expected to be minimal. Impacts to educational attainment are expected to be minimal. It is expected that in a small number of cases, successful adaptation of the family to the extended work schedule will not occur. In these cases, some deleterious impacts to family are expected. Several different possible scenarios may result in the siting of facilities, with their concomitant economic and environmental implications, proximal to low-income or minority communities or populations. The siting of onshore infrastructure is not regulated by the MMS. Economic and logistic considerations, as well as local zoning and permitting requirements, drive the choice of where to locate these facilities. A typical proposed action could be attributed with 0.5-1.0 percent of the impacts associated with the siting of any new onshore facilities proximal to minority or low-income populations or communities. The proposed action is not expected to cause disproportionately high or adverse human health or environmental effects on minority or low-income populations; however, the lack of information on the location of potential construction of onshore infrastructure over the life of the proposed actions makes it impossible to dismiss potential disproportionate impacts.

b. Alternative B - The Proposed Action Excluding the Blocks Near Biologically Sensitive Topographic Features

Description of the Alternative

Alternative B differs from Alternative A (the proposed action) by not offering the 61 unleased blocks of the 200 total blocks that are possibly affected by the proposed Topographic Features Stipulation (Section II.C.1.c.(1)). All the assumptions (including the two other potential mitigating measures) and estimates are the same as in the proposed action (Alternative A).

Effects of the Alternatives

The analyses of impacts are based on the proposed action scenario of Alternative A. The scenario provides assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major, related impact-producing factors is included in Sections IV.A. and IV.B.

It should be emphasized that the analyses of impacts to the various resources under Alternative B are very similar to those for Alternative A. The reader should refer to the appropriate discussions under Alternative A for additional and more detailed information regarding impact-producing factors and their expected effects on the various resources. Impacts are expected to be the same as those estimated under the proposed action (Section IV.D.1.a.) for the following resources:

- Sensitive Coastal Environments
- Sensitive Offshore Resources
  Deepwater Benthic Communities
- Water Quality
- Air Quality
- Marine Mammals
- Coastal and Marine Birds
- Commercial Fisheries
- Recreational Resources and Beach Use
- Socioeconomic Conditions

However, the impacts to some Gulf of Mexico resources under Alternative B would be different from the impacts expected under the proposed action. These impacts are described below.

The Federal offshore area is divided into subareas based on water depths in meters (W0-60, W60-200, W200-900, W900-3,000, and W3000+), and the adjacent coastal region is divided into two coastal subareas (TX-1 and TX-1). These subareas are delineated on Figure IV-1.

(1) Impacts on Sensitive Offshore Resources

Topographic Features

The sources and severity of impacts associated with this alternative are those sale-related activities discussed for the proposed action. As noted in Section IV.D.1.a.(2)(b), the potential impact-producing factors to the topographic features of the Western Gulf are anchoring and structure emplacement, effluent discharge, blowouts, oil spills, and structure removal. A more detailed examination of these potential impact-producing factors is presented in that section.

All of the 23 topographic features of the Western Gulf are located within water depths less than 200 m. These features occupy a very small portion of the entire area. Of the potential impact-producing factors to the topographic features, anchoring, structure emplacement, and structure removal will be eliminated by the adoption of this alternative. Effluent discharge and blowouts will not be a threat because blocks near enough to the banks for these events to have an impact on the biota of the banks will have been excluded from leasing. Thus, the only impact-producing factor remaining from operations in blocks included in this alternative (i.e., those blocks not excluded by this alternative) is an oil spill.

The chances of one or more subsurface oil spills greater than or equal to 1,000 bbl occurring from operations resulting from Alternative B is between 1 and 11 percent. A subsurface spill would have to come into contact with a biologically sensitive feature to have an impact. A subsurface spill is expected to rise to the surface, and any oil remaining at depth will be swept clear of the banks by currents moving around the banks (Rezak et al., 1983). Deepwater subsurface spills may travel along the sea bottom or in the water column for some distance before rising to the surface. The currents that move around the banks are expected to steer any oil around the banks rather than directly upon them, lessening impact severity. The fact that the topographic features are widely dispersed in the Western Gulf, combined with the probable random nature of spill locations, would serve to limit the extent of damage from any given spill to only one of the sensitive areas. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for most of the adult sessile biota. Lethal effects would probably be limited to a few coral colonies (in the case of the Flower Garden Banks) (CSA, 1992; 1994). It is anticipated that recovery from a mostly sublethal exposure would occur within a period of 2 years. In the unlikely event that oil from a subsurface spill could reach a coral covered area (in the case of the Flower Garden Banks), the areal extent of coral mortality would be limited to a few incidences, but long-lasting sublethal effects may be incurred by organisms surviving the initial effects of a spill (Jackson et al., 1989). Indeed, the stress resulting from the oiling of reef coral colonies could affect their resilience to natural disturbances (e.g., elevated water temperature, diseases) and may hamper their ability to reproduce. A complete recovery of such an affected area could take in excess of 10 years. Furthermore, Alternative B would prevent oil and gas leaseholders from constructing pipelines and other sources of subsurface spills in those areas near the banks.

Conclusion: Alternative B is expected to cause little or no damage to the physical integrity, species diversity, or biological productivity of the habitats of the topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be localized and primarily sublethal for most of the adult sessile biota. Lethal effects would probably be limited to a few coral colonies (in the case of the Flower Garden Banks). It is anticipated that recovery for such an event would occur within a period of 2 years.

(2) Impacts on Sea Turtles

The level of activity associated with Alternative B is the same that described for the proposed action in Table IV-2. The sources and severity of impacts for sea turtles under Alternative B are the same as those discussed for the proposed action (Section IV.D.1.a.(6)). However, the major impact-producing factors related to Alternative B that may affect Gulf sea turtles, including structure installation, dredging, operational discharges, and explosive platform removals, would not occur within the excluded area. The effects of these activities would remain in the rest of the WPA and are expected to be primarily nonlethal and to result in few lethal impacts; the probability of an interaction is low.

Conclusion: Alternative B is expected to temporarily disturb some sea turtles and their habitats; however, it is unlikely to have significant long-term adverse effects on the size and productivity of any turtle species or population stock in the northern Gulf of Mexico.

c. Alternative C - No Action

Description of the Alternative

Alternative C is equivalent to cancellation of a sale scheduled for a specific time period on the approved *Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002*. Sales in the Western Gulf are scheduled on an annual basis. By canceling a proposed Western Gulf sale, the opportunity is postponed or foregone for development of the estimated 0.01-0.09 BBO and 0.57-1.93 tcf of gas.

Effects of the Alternative

Under Alternative C, the U.S. Dept. of the Interior cancels a planned Western Gulf of Mexico sale. Therefore, the oil expected from this sale will remain undiscovered and undeveloped. The environmental effects of Alternative A (the proposed action) also will not occur. Energy from alternative sources for the lost production. Canceling a sale would eliminate the effects described for Alternative A (the proposed action). Other sources of energy would substitute for the lost production. Principal substitutes would be additional imports, conservation, additional domestic production, and switching to other fuels. These alternatives, except conservation, have significant negative environmental impacts of their own.

This section briefly discusses the most likely alternative sources, the quantities of each expected to be consumed, and the environmental impacts associated with production of the alternatives. The discussion is based on material from the following Minerals Management Service publications: *Proposed Final Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002, Decision Document,* August 1996; *Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002, Final Environmental Impact Statement* (OCS EIS/EA MMS 96-0043, August 1996); and *Energy Alternatives and the Environment* (OCS Report MMS 96-0049, August 1996). These sources are incorporated into this document by reference.

Most Important Substitutes for Production Lost Through No Lease Sale

Energy Alternatives and the Environment discusses a long list of potential alternatives to natural gas and oil. However, most substitutes for the natural gas and oil from the proposed action will come from four sources:

- additional imports
- conservation
- additional domestic production
- fuel switching

Additional domestic production and imports will augment supply, while conservation and switching to alternative fuels shift demand downward. Table IV-28 shows the percentage and range of quantities we expect will substitute for the lost natural gas and oil production. The quantities for conservation and fuel switching are in equivalent energy units.

Table IV-28

Substitutes for Natural Gas and Oil Lost Because of No Lease Sale

Source	% of Lost Oil Production	Range of Oil Quantity (MMbbl)	% of Lost Gas Production	Range of Gas Quantity (Bcf)
Additional Imports	88%	134-385	12%	184-527
Conservation	5%	8-22	14%	214-615
Additional Domestic Production	4%	6-18	41%	627-1,800
Fuel Switching	3%	5-13	33%	505-1,449
Total Production Lost Through No Sale	100%	153-438	100%	1,530-4,391

Environmental Impacts from the Most Important Substitutes

Additional Imports: Significant environmental impacts from an increase in oil imports include the following:

- generating greenhouse gases and air pollutants from both transport and dockside activities (emissions of NO_x, SO_x, and VOC's have an impact on acid rain, tropospheric ozone formation, and stratospheric ozone depletion);
- water quality degradation due to oil spills from either accidental discharges or during tanker casualties;
- oil spill contact with flora and fauna and with recreational and scenic land and water areas; and
- increasing public concern about tanker spills (see Section IV.C.4. for discussion of oil spill rates associated with tankering).

Imported oil may also impose negative environmental impacts in producing countries and in countries along trade routes. Additional imports of natural gas would require construction of new pipelines from the most likely sources, which are Canada and Mexico. Pipeline construction can disrupt wildlife habitat, lead to increased erosion, and add to the siltation of streams and rivers.

Conservation: Conservation is composed of two major components:

- substituting energy-saving technology, often embodied in new capital equipment, for energy resources (e.g., adding to home insulation)
- consuming less of an energy-using service (e.g., turning down the thermostat in an office during the winter)

Consuming less of an energy service is positive from an environmental perspective. Substituting energy-saving technology will tend to result in positive net gains to the environment. The amount of gain will depend on the extent of negative impacts from capital equipment fabrication.

Additional Domestic Production: Onshore oil and gas production has notable negative impacts on surface water, groundwater, and wildlife. It can also cause negative impacts on soils, air pollution, vegetation, noise, and odor. Offshore oil and gas production imposes the risk of oil spills affecting water quality, localized degradation of air quality, potential impacts on coastal wetlands dependent wildlife, and shoreline erosion from additional supply boat traffic. Offshore activities may also have negative impacts on social, cultural, and economic measures such as recreation and tourism.

Fuel Switching: The most likely substitutes for natural gas are oil, which will further increase imports, and coal for use in electricity generation. Coal mining causes severe damage to land and wildlife habitat. It also is a major contributor to water quality deterioration through acid drainage and siltation. Alternative transportation fuels may constitute part of the oil substitution mix. The mix depends on future technical and economic advances. No single alternative fuel appears to have an advantage at this time. Every fuel alternative imposes its own negative environmental effects.

Other Substitutes

Government could also impose other substitutes for natural gas and oil. The most likely sectors to target would be transportation, electricity generation, or various chemical processes. *Energy Alternatives and the Environment* discusses many of the alternatives at a level of detail impossible here.

d. Major Cumulative Actions

(1) Impacts on Sensitive Coastal Environments

(a) Coastal Barrier Beaches and Associated Dunes

This cumulative analysis considers the effects of impact-producing factors related to the proposed action; prior and future OCS sales in the WPA, CPA and EPA; State oil and gas activities; other governmental and private projects and activities; recreational activities; and pertinent natural processes that may affect barrier beaches and dunes. Specific impact-producing factors considered in this cumulative analysis include reduced sedimentation, pipeline landfalls, canal and onshore facility construction, oil spills, beach protection and stabilization projects, and recreational activities.

As discussed in Section III.B.1.a., under biological resources, erosion of barrier islands in coastal Louisiana and easternmost Texas is related to the stages of construction and destruction of nearby deltaic landmasses. The Mississippi River is the most influential direct and indirect source of sand-sized and other sediments to the shoreline of the Chenier Plain in both states. Under natural circumstances, the location of the river determined which areas of the deltaic plain were forming and which were deteriorating. Over the last 150 years, river control activities have also had a significant impact upon land building processes.

Within a decade after the Civil War, Louisiana connected the Mississippi, Red, and Atchafalaya Rivers for navigational purposes, which began the diversion of the more sediment laden waters of the Mississippi River to the Atchafalaya River. By the early 1930's, levees and channelization of the lower Mississippi River ended the once significant land building in Louisiana. The completely leveed and channelized river directed the vast majority of land-building sediments to the end of the bird-foot delta (coastal Subarea LA-3), from where they are still distributed to deepwater areas of the continental slope. River control set circumstances toward deltaic degradation, as if the river had abandoned this area of the coast. By 1962, the Federal Government constructed the Old River control structure, which controls diversion of approximately 30 percent of the Mississippi River flow to the Atchafalaya River. Since the 1950's, the suspended sediment load of the Mississippi River has decreased more than 50 percent, largely as a result of dam and reservoir construction (Turner and Cahoon, 1988) and soil conservation measures within the drainage basin. Sediment loads in the Atchafalaya River also decreased as a result. As result of these actions, the only significant delta formation is found at the mouths of the Atchafalaya River in Atchafalaya Bay, Louisiana (coastal Subarea LA-2). Reduced sediment supply to the Louisiana coast has contributed to erosional forces becoming dominant. The resulting reworking of the deltaic sediments winnows away the lighter sediments and retains the heavier, sand-sized materials that build barrier beaches. Unfortunately, very little of these coarser materials are present in the deltaic deposits of these regions. Consequently, these beaches are retreating rapidly landward and will continue to do so into the foreseeable future. One of the least stable beach and dune systems is at Port Fourchon in Lafourche Parish, where tank farms and other businesses have been forced to move inland, away from the rapidly eroding beach.

The barrier landforms to the east of the Mississippi River delta are not dependent on a fluvial source of sand. Rather, these islands appear to be nourished by the sandy barrier platforms beneath them (Otvos, 1980). Reduced discharges of fluvial sediment into the coastal zone will not affect these barriers.

The Texas coast has experienced a natural decrease in sediment supply as a result of climatic changes that have occurred during the past few thousand years (Morton, 1982). Coastal regions of Texas are experiencing less dramatic subsidence and erosion than that found in Louisiana. Dam construction upstream on coastal rivers has trapped sand-sized sediments. The Texas coast east of Galveston Island is influenced by sediment discharged by the Mississippi River, which has decreased by more than 50 percent since the 1950's.

Large numbers of stabilization techniques utilizing seawalls, groins, bulkheads, revetments, jetties and other hard structures have been applied along the Louisiana and Texas coasts. Undoubtedly, efforts to stabilize the beach within Texas have contributed to coastal erosion (Morton, 1982). Usually, efforts employing hard structures on the beach to stabilize segments of Gulf shoreline have adversely impacted

barrier landscapes, around the Gulf. These structures trap sediments on their updrift sides thereby depriving downdrift beaches of sediments where erosion is caused or accelerated.

Reductions in sediment supply along the Texas coast will continue to have a significant adverse impact on barrier landform. During this century, the annual rate of coastal landloss in Texas has increased from 13 ha at the turn of the century to nearly 65 ha in 1980 (Morton, 1982).

According to Wicker et al. (1989), approximately 280 km of the Texas coast are experiencing erosion. The weighted average erosion rate along these stretches of coast is 5.9 m/yr. Another 212 km of coast are experiencing loss at an average rate of 2.9 m/yr. The average change over the entire Texas coast has been erosional at a rate of 2.1 m/yr.

Table IV-3 contains estimates of future offshore spills resulting from the OCS Program. The great majority of these are less than 50 bbl crude oil spills.

Oil slick weathering and dissipation (Section IV.A.3.h.) are projected to significantly reduce slick volume and resulting concentration on beaches (Table IV-9). The only significant land contact projected to occur will result from offshore oil spills greater than 1,000 bbl. The large majority of oil slicks that contact land will come ashore on barrier landforms. As discussed in Section IV.D.1.a.(1)(a) and Table IV-9, if such contacts occur within 10 days of the spill, 46 percent of oil from such a spill would likely contact a 16-km stretch of coastal barrier beach. For spills less than 1,000 bbl, beach cleanup crews are directed by coastal states to remove oil manually with minimal sand removal from the littoral environment.

Considering Appendix C and as a result of the OCS Program, 12-17 offshore oil spills greater than 1,000 bbl are projected to occur and contact the U.S. shoreline. According to Table C-2, land segments 4, 7, 8, and 10 in the WPA and 17, 20, and 23 in the CPA have the highest probabilities of OCS-related, oil-spill landfall depending upon where a spill occurs. Table C-1 largely concurs with Table C-2 in that it identifies that oil spills are most likely to occur and then contact land segments 6-10 in the WPA and land segments 15-17 in the CPA. As discussed in Section IV.D.1.a.(1), the two OSRA analyses reflect that (1) regions with higher concentrations of oil handling facilities have the highest risk of having an oil spill and (2) spills occurring within 50 mi of land have the highest probabilities of contacting land. For projected sizes of different classes and sources of oil spills, see Section IV.A.3.h.(2).

The average size for spills greater than 1,000 bbl is 6,500 bbl. Assuming a 54 percent volume loss from weathering and 10 percent removal by offshore cleanup efforts, an average spill that makes barrier-beach contact in 10 days is projected to retain 2,340 bbl of oil. Assuming that the percentage of the oil that contacts a barrier feature is proportional to the overall ratio of barrier beach to barrier passes along the coast for some areas, two-thirds or more of the oil would contact a barrier beach. Therefore, approximately 16 km of beach would be contacted with 1,700-2,340 bbl of oil from each average spill. As discussed in Section IV.D.1.a.(1), the probability that tide levels could reach or exceed the elevations of sand dune vegetation on barrier beaches ranges from 0 to 16 percent, depending on the particular coastal setting and the elevation of the vegetation. Weather conditions would most probably be very stormy, if contact with sand dune vegetation were to occur. The combined probabilities of spill occurrence and contact, barrier beach contact, and sand-dune vegetation contact is considered very low. Hence, contact of sand-dune vegetation with spilled oil is not assumed to occur. Furthermore, the strong onshore winds that would be needed to produce unusually high tide levels would also disperse and spread the slick over a larger area than is being considered in the current analysis. The spreading and dispersion would reduce oil concentrations contacting the beach and vegetation, greatly reducing impacts on vegetation. Even repeated spill contacts under these conditions are not anticipated to have significant, long-term impacts.

The barrier beaches of the land segments with the greatest risks of oil-spill contact, land segments 15-21, have the greatest rates of erosion and landward retreat of any known in the Western Hemisphere, and among the greatest rates on earth. Above, land segments 15-17 were identified as having one of the highest probabilities of being contacted by spilled OCS oil. Long-term impacts to contacted beaches from spills could occur if significant volumes of sand were removed during cleanup operations. Removing sand from the coastal littoral environment, particularly in the sand-starved transgressive setting of coastal Louisiana, could result in accelerated coastal erosion. Spill cleanup is difficult in the inaccessible setting of coastal Louisiana.

This analysis assumes that each state would require the responsible party to clean the beach without removing significant volumes of sand or to replace the sand removed. Hence, cleanup operations are assumed to cause no permanent effects on barrier beach stability. Within a few months, adjustments in beach configuration may result from the disturbance and movement of sand during cleanup. Some of the oil that penetrated to depths beneath the reach of the cleanup methods would persist in beach sands, periodically being released when storms and high tides resuspend or flush through beach sediments. During hot, sunny days, tarballs buried near the surface of the beach sand may liquefy and seep to the sand surface.

Coastal oil spills in State offshore waters that contact coastal barriers could also result from imported OCS and State coastal oil operations. Based on historical information, the 69 percent of coastal accidents that occur inland of barrier beaches and dunes would be unlikely to contact a barrier feature. Instead, inland spills are most likely to contact the landward side of a barrier beach. Hence, no inland spills are assumed to significantly contact barrier beaches (USDOI, MMS, 1996c).

Table IV-18 estimates that 885-962 inland coastal oil spills are projected to occur per year for the period 1998-2036 as a result of non-OCS petroleum operations. Another 76-101 spills per year are projected for the OCS Program. Applying the historical information, it is estimated that 398-432 non-OCS spills and 34-45 OCS spills may occur in offshore State waters.

The remaining 31 percent of coastal spills are anticipated to occur in State offshore waters. Very few of these smaller spills would contact the beach due to their size and rates of dispersion. Because of their size and proximity to the shore, many of the larger spills in this number should be expected to contact barrier beaches. Also because of their proximity to shore, they cannot be analyzed like the larger spills occurring in OCS waters, and their impacts upon beaches are assumed to be comparably greater per volume spilled (USDOI, MMS, 1996c). Because of the comparably heavier and more frequent oilings of beaches by non-OCS spills, their resulting cleanup operations will likely disturb and remove significantly more sand, which could result in short-term (up to 2 years), landward adjustments in beach configuration if the sand is not replaced and regraded as a mitigation measure. As discussed above, significant impact upon dunes and dune vegetation is unlikely.

Considering the results of an investigation on the effects of the disposal of oiled sand on dune vegetation in Texas, where disposal showed no deleterious impacts on existing vegetation or colonization of the sand by new vegetation (Webb, 1988), it is assumed that contacts to small areas of lower elevation sand dunes would not result in destabilization of the sand dune area or the barrier landform.

An area of special concern along the south Texas coast is the Padre Island National Seashore. This area is projected to have no significant contact with an oil spill because of limited opportunities for a spill to occur near that national seashore. One oil pipeline landfall crosses the northern end of Padre Island. No oil has been developed in the OCS areas offshore the seashore, although 1-4 pipelines have been projected for the TX-1 coastal region.

Many of the existing 214 OCS-related pipeline landfalls have occurred on barrier landforms. Construction of another 128-261 new OCS-related pipelines is expected for the period 1998-2032, as described in Sections IV.A.2.b., IV.B.1., IV.B.2., and IV.D.1.a.(1).

Presently, only the Texas state database of pipelines is available and reasonably complete. Its 1996 data set indicated another 33 non-OCS-related pipeline landfalls exist in that state. If the ratio of OCS pipeline landfalls to non-OCS pipeline landfalls is similar in the other Gulf planning areas, about 460 pipeline landfalls may exist in total. Hence, 270-560 landfalls are cumulatively projected for installation between 1998-2036.

An MMS study and other studies (Wicker et al., 1989; LeBlanc, 1985; Mendelssohn and Hester, 1988) have investigated the geological, hydrological, and botanical impacts of pipeline emplacement on barrier landforms in the Gulf (Wicker et al., 1989). In general, the impacts of pipeline landfalls installed since 1975 were minor to nonexistent. In most of these cases, no evidence of accelerated erosion was noted in the vicinity of landfalls if no shore protection for the pipeline was installed on the beach because of the new installation methods.

Aside from landfalls, Wicker et al. (1989) warn, however, that the potential for future breaching of barrier shorelines remains at sites of flotation canal crossings where island width is small or diminishing because of Gulf and bay erosion or where sediments beneath the sand-shell beach plugs are unconsolidated

and susceptible to erosion. As have been seen, several pipelines from State and OCS fields were cut through barrier islands, parallel to the barrier shores of most of Louisiana's barrier islands, leaving canals. Also, a variety of rig access canals were dredged into barrier islands from the landward bays. As these islands have eroded and were overwashed, these canals have proven to be effective sediment sinks that have hastened the breakup and deterioration of many of Louisiana's barrier islands. This type of pipeline placement was quite common in Louisiana prior to the late 1970's, but has been discontinued. The numbers and locations of OCS-related pipelines that fall into this category are being compiled.

No new navigation canals between the Gulf and inland regions are expected to be installed. The basis of this assumption is the large number of existing navigation channels that can accommodate additional navigation needs and a set of interviews with COE waterway planners that occurred in 1995. Many new inland navigation canals will be dredged to accommodate the inland oil and gas industry, developers, and transportation interests.

Some existing channels may be deepened or widened to accommodate projected increases in deeper-draft petroleum-production and cargo vessels. The project in Port Fourchon, Louisiana (Belle Pass), is described in Sections IV.B.1.j. and IV.D.1.a. and b. Beneficial use of the dredged material should be considered to mitigate adverse impacts of the project as well as adverse impacts of the existing jetties and channel. The channel to Corpus Christi, Texas (coastal Subarea TX-1), is projected to be deepened to provide access for larger cargo vessels. Early descriptions indicate that existing jetties will not be modified and that channel deepening will occur in waterways behind barrier islands to provide access to support-base locations. Deepening the channel may not affect barrier beaches if beneficial use of the dredged material is used to mitigate adverse impacts of the project as well as adverse impacts of the existing jetties.

In subsiding coastal areas, such as in Texas and Louisiana, existing tidal channels will also deepen and widen naturally to accommodate continually increasing tidal prisms.

Navigation-related impacts and mitigative techniques are described in Section IV.B.2.a. Such mitigative measures are assumed to occur, where practicable and increasingly in accordance with Executive Order 11990 and the Clean Water Act. The contribution of the OCS Program to vessel traffic in navigation canals is estimated at 12 percent for the CPA and WPA. Correspondingly, 12 percent of impacts attributable to maintenance dredging and wake erosion of those channels is also accredited to the OCS Program. A corresponding percentage of beneficial use of dredged material would be attributed to the OCS Program. During the life of the proposed action, beneficial use of dredged material should increase, thereby reducing the continuing impacts of navigation channels and jetties upon barrier beaches.

Most barrier beaches in Texas and Florida are accessible to people for recreation use because of road access. The Texas Open Beaches Act (1959) guarantees the public's right to unimpeded use of the State's beaches. It also provides public acquisition of private beachfront property. Public recreation along the Texas coast is thus encouraged by the State. Recreational use of barrier beaches and dunes can have impacts on the stability of the landform. Vehicle and pedestrian traffic on sand dunes can stress and reduce the density of vegetation that binds the sediment and stabilizes the dune. Destabilized dunes are more easily eroded by wind and wave forces. Judd et al. (1988) documented that as much as 18 percent of the total dune area along parts of South Padre Island had experienced damage from vehicular traffic. Recreational vehicles, and even hikers, have principally been a problem where road access is available and where the beach is wide enough to support vehicle use, as in Texas and Florida and a few places in Louisiana. Areas without road access will have very limited impacts by recreational vehicles.

Most barrier beaches in the CPA are relatively inaccessible for recreational use either because they are located at a substantial distance offshore, as in Mississippi, or are in coastal areas with limited road access, as in Louisiana. Few beaches in the CPA have been, or are likely to be, substantially altered to accommodate recreational or industrial construction projects.

A variety of beach and barrier island restorative measures have been brought about as the population has become more aware of barrier island and beach problems. Since about 1980, dune and beach stabilization have been better accomplished by using more natural applications such as sand dunes, beach nourishment, and vegetative plantings. During the mid-1980's the U.S. Army Corps of Engineers contracted with Louisiana and Jefferson Parish governments to replenish beach sand on Grand Isle, Louisiana. During the 1990's, the State of Louisiana and Federal Government joined in a partnership through the Coastal Wetlands

Protection, Planning and Restoration Act (CWPPRA) to address and, where possible, correct the deterioration of wetlands and barrier islands along Louisiana's Gulf Coast and elsewhere. Most of the CWPPRA's attention for barrier beaches has been focused on the Cameron Parish coast, Isles Dernieres chain, Grand Isle, and the Timbalier Islands.

Summary and Conclusion

The Texas coast has experienced landloss because of a decrease in the volume of sediment delivered to the coast due to dams on coastal rivers, a natural decrease in sediment supply as a result of climatic changes during the past several thousand years, subsidence and hard, beach-stabilization structures. Sediment deprivation, poor sediment quality in coastal headlands, and rapid submergence have resulted in severe, rapid erosion of most of the barrier landform along the Louisiana coast. The barrier systems of coastal Mississippi, Alabama, and Florida are well supported on a fairly stable coastal barrier platform of sand.

Several oil spills are assumed to contact coastal barriers from State and OCS offshore sources, as well as from the transportation of oil originating from other sources. The sand-starved barrier beaches of the Louisiana coast are the most susceptible to damage by contact with an oil spill. Because of very high rates of coastal erosion and the high concentrations of oil production facilities within 50 km of that coast, the coastal region of Louisiana marked as land segments 15, 16, 17, and 18 (Figure IV-2) have the greatest risks of sustaining significant impacts from oil-spill landfalls. The impacts of these spills should not result in long-term alteration of landform if the beaches are cleaned using techniques that do not significantly remove sand from the beach or dunes, as prescribed by State laws and regulations. Otherwise, the impacts of a spill and subsequent cleanup could result in short-term (up to 2 years) adjustment in beach profiles and configurations. Some contact to lower areas of sand dunes may occur but would not result in significant destabilization of the dunes.

Under the cumulative scenario, 128-261 new OCS-related pipeline landfalls and possibly another 50 or more major non-OCS pipeline landfalls are projected. As mitigation, these are expected to be installed using modern techniques, which cause little to no impacts to the barrier islands and beaches. Pipeline installations that left canals, ponds, or swales on barrier islands have caused and will continue to cause barrier beaches to narrow and breach.

Beach stabilization projects, such as groins, jetties, and seawalls, as well as artificially-maintained channels and jetties installed to stabilize navigation channels, are considered by coastal geomorphologists and engineers to generally accelerate coastal erosion. Beneficial use of maintenance dredged materials could be required to mitigate some of these impacts.

Recreational use of many barrier beaches in the WPA and EPA is intense because of their accessibility by road. Because of the inaccessibility of most of the Central Gulf barrier coast to humans, recreational use is not expected to result in significant impacts to most beaches.

Federal, State, and local governments have made efforts over the last 10 years to slow the landward retreat of Louisiana's Gulf shorelines. Some of these efforts have been effective in the short term. Assessment of long-term effectiveness awaits the passage of time.

In conclusion, coastal barrier beaches have experienced severe adverse cumulative impacts from natural processes and human activities. Natural processes are considered the major contributor to these impacts, whereas human activities cause both direct impacts as well as significant accelerations of natural processes that deteriorate coastal barriers. Human activities that have caused the greatest adverse impacts upon barrier beaches and dunes are pipeline canals, channel stabilization structures, beach stabilization structures, and recreational use of vehicles on dunes and beaches. 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 the landward retreat of Gulf shorelines. The contribution of the proposed action compared to cumulative impacts on coastal barrier beaches and dunes impacts is expected to be very small.

(b) Wetlands

This cumulative analysis considers the effects of impact-producing factors related to the proposed action; prior and future OCS sales; State and private oil and gas activities; other governmental and private projects and activities; and pertinent natural processes and events that may occur and adversely affect wetlands around the northern Gulf of Mexico.

Development of wetlands for agricultural, residential, and commercial uses has generally been the major cause of wetland loss. Of these, the greatest loss was to agriculture. A notable exception to this trend was the loss of three-quarters of Louisiana's estuarine wetlands to open-water habitat, due to deltaic subsidence and dredging. During the period of the mid-1970's and mid-1980's, the following states lost the associated approximate acres of their total statewide wetlands; the percentage represents the percent of the entire State's area that was considered wetlands: Alabama, 42,000 ac (8%); Florida, 260,000 ac (30%); Louisiana, 518,000 ac (28%); and Mississippi, 209,000 ac (14%) (Hefner et al., 1994). Statewide losses for Texas were not available.

In the coastal zone of Texas between 1955 and 1992, about 210,600 ac of wetlands were lost, amounting to about 5,700 ac per year; another 1.7 million ac of freshwater wetlands (52%) were classified as farmed wetlands (Moulton et al., 1997). During the period 1952-1974 in the Chenier Plain area of southwestern Louisiana, an estimated 1,233 ha of wetlands were converted to urban use (Gosselink et al., 1979). During the period 1956-1978, an estimated 21,642 ha of urban or industrial development occurred in the Mississippi Deltaic Plain region of southern Louisiana (Bahr and Wascom, 1984). For the period between 1972 and 1990, the landloss rate in coastal Louisiana was an estimated 6,475 ha per year (Louisiana Coastal Wetlands Conservation and Restoration Task Force, 1993). Land-use impacts on wetlands in coastal Alabama have been high in recent decades due to industrial, residential, and commercial development. Alabama's loss of fresh coastal marsh was mainly attributable to commercial and residential development and silviculture. Between 1955 and 1979, fresh and estuarine marshes in Alabama declined by 69 and 29 percent, respectively (Roach et al., 1987). Coastal marshes in Mississippi are assumed to have declined by rates similar to those in Alabama. Due to changes in regulatory actions, wetland destruction for agricultural, commercial, and residential purposes may be reduced over the life of the proposed action. Assuming that these latest landloss rate continue for the period 1998-2036, about 776,000 ha wetlands will be lost in the coastal regions. Given the apparent slowing trend, if the loss rate slows by 20 percent for that period, the loss would be about 621,000 ha.

Submergence rates in coastal Louisiana have ranged from 0.48 to 1.3 cm (Baumann, 1980; Ramsey et al., 1991). This submergence is primarily due to subsidence and the elimination of river flooding. Flooding normally deposited sediment over the deltas and flood plains, which either slowed subsidence, maintained land elevations, or built higher land elevations, depending upon the distances from the river and the regularity of flooding for each region of interest. A secondary cause of land submergence is sea-level rise. To a smaller extent, the Texas Gulf Coast also suffers from submergence due to subsidence, sea-level rise, and flood control.

Many of man's activities cause landloss either directly or indirectly by accelerating natural processes. Until the Mississippi River was channelized and leveed during the early 1900's, flood waters layered sediment over the active deltaic plain, building new land and countering ongoing submergence. Areas that did not receive sediment-laden flood waters continually lost elevation. Human intervention interrupted this natural process of renewal and wetland creation. Further compounding this impact, the suspended sediment load in the Mississippi River has decreased more than 50 percent since the 1950's, largely as a result of dam and reservoir construction (Turner and Cahoon, 1988) and soil conservation practices in the drainage basin. On a smaller scale, similar flood control projects in Texas have caused similar problems.

Leveeing and deepening the Mississippi and other rivers also affect seagrass beds in Mississippi and Chandeleur Sounds, causing them to move farther inland where salinities are increased and regular flooding is reduced. In turn, seagrasses in regions around the mouths of flood-controlled rivers are moved farther out or away from the "active deltas" due to increased freshwater flow there. During particularly high water stages in the Mississippi River, the Bonnet Carre' Spillway is sometimes opened to divert flood waters into Lake Pontchartrain. This freshwater eventually flows into Mississippi and Chandeleur Sounds. In the past,

spillway openings have been associated with loss of up to 16 percent of seagrass acreage (Eleuterius, 1987). As is seen with the Carnarveron Freshwater Diversion, more regular flooding events reduced such large impacts and induced the growth of freshwater, submerged vegetation. Submerged estuarine vegetation may then reestablish in regions where salinities were previously unsuitable.

Wetland contacts by spills of crude oil, diesel, petroleum products, and similar substances can occur from activities of the OCS Program, imports, State production, transportation of crude oil from other sources, and petroleum products production and transportation. The circumstances of projected oil spills and their projected effects on wetlands are described in Sections IV.A.3.h.(2), IV.B.2.d., and IV.D.1.a.(1). Appendix C shows projected numbers of OCS-related spills occurring in Federal offshore waters and the volumes of oil spilled. The large majority of these oil slicks that contact land are projected to come ashore on barrier shores. Because of their size and nature, non-OCS spill dispersion and weathering characteristics for crude oil spills originating in Federal waters are assumed to be similar to that of the OCS-related spills discussed.

Flood tides may bring some oil slicks through tidal inlets into areas landward of barrier beaches. The turbulence of tidal water passing through most tidal passes would break up the slick, thereby accelerating dispersion and weathering. For the majority of these situations, light oiling of vegetated wetlands may occur, contributing less than 0.1 l/m^2 on wetland surfaces. Any adverse impacts that may occur to wetland plants are expected to be very short lived, less than a year. No oil spilled in Federal offshore waters is expected to significantly contact inland seagrass beds (Section IV.D.1.a.(1)).

Coastal OCS spills could occur as a result of pipeline accidents and barge or shuttle tanker accidents during transit or off-loading. Section IV.D.1.a.(1) acknowledges that 69 percent of coastal oil spills occur inland. The size, distribution, and impacts of OCS spills are also discussed in Section IV.D.1.a.(1). Non-OCS spills also occur in coastal regions as a result of accidents during coastal crude oil production and transportation, and petroleum product production and transportation. Their distribution is believed to be similar to that described in Section IV.D.1.a.(1). OCS-related spills are projected to impact approximately 740-20,000 ha of wetlands. Within 4 and 10 years, 220-6,000 and 640-17,000 ha will recover, respectively. About 120-3,000 ha of wetlands would be converted to open water. Given that coastal oil production over the last 10 years has been approximately 35 percent, and declining, of the total produced around the Gulf (Table IV-14), and that it is in much closer proximity to wetlands, wetland losses due to spills from State oil production are assumed to be about twice as high as for OCS production. Cumulatively, spills associated with the OCS Program, State oil production, and inland coastal oil barges and import tankers (Table IV-18) are projected to impact about 141,500-204,000 ha of wetlands. Of that area, 42,000-61,200 ha and 122,400-173,400 ha are projected to recover within 4 and 10 years, respectively. About 22,900-30,600 ha of wetlands would be converted to open water.

Under this scenario, any spills that occur in Chandeleur or Mississippi Sounds or in Laguna Madre could potentially contact seagrass beds, the Gulf Islands National Seashore, the Breton National Wildlife Refuge and Wilderness Area, Padre Island National Park, and Laguna Madre National Wildlife Refuge. Because of their natural history, these areas are considered areas of special importance, and they support endangered and threatened species. Although the seagrass acreage on these islands is small, compared to that in Florida, they make up an important element in the habitat complex of the islands.

Circumstances of oil-spill impacts to seagrasses are discussed in Section IV.D.1.a.(1)(b). Given the large number of oil wells and pipelines in and near Chandeleur Sound and the designation by the OSRA analysis that land segment 20 has one of the highest probabilities that given volumes of spilled oil will make landfall (Table C-2), the risk of several contacts to seagrass beds in this vicinity seems rather high. Such contacts will result in die back to the seagrass vegetation and supported epifauna, which will be replaced for the most part within one to two growing seasons, depending upon the season in which the spill occurs and the nature of the tides while the spilled oil is over the beds of submerged vegetation. No to little, permanent mortality of seagrass beds is expected as a result of oil-spill occurrences, unless tides are unusually low when a spill slick is located over particularly shallow beds. Contact of seagrasses with crude and refined oil has been implicated as a causative factor in the decline of seagrass beds and in the observed changes in species composition within them (Eleuterius, 1987).

More than 2.4 billion bbl of produced waters will be disposed of in coastal Louisiana alone. Although much of this volume is still discharged to surface waters away from seagrass beds, by 2000, produced waters

from petroleum producing operations will either be reinjected or discharged into offshore OCS waters. Field studies have documented no impacts to wetland vegetation under these disposal conditions (Boesch and Rabalais, 1989). Future produced-water discharges are therefore assumed to not affect wetland or seagrass vegetation.

Projected new onshore facilities for the OCS are described in Section IV.B.1. and Table IV-12. Federal and State permitting programs are assumed to discourage constructing them in wetlands, to the maximum extent practicable. If facility placement in a wetland is unavoidable, adequate mitigation of unavoidable adverse impacts will be required. Therefore, no significant impacts to wetlands are expected from construction of new facilities, other than pipelines.

Inshore pipeline construction projects affect wetland and seagrass habitats in a number of ways. Pipeline installation methods and impacts are described in Sections IV.B.2.a., IV.D.1.a.(1), and IV.C.1.b. The State oil and gas industry is generally described in Section IV.C.1. In Table IV-12, the OCS Program represents 214 existing landfalls and about 5,660 km of related pipelines. Projected new OCS-related landfalls and related inshore pipeline construction for the period of 1998-2036 are 131-260 landfalls and 2,760-6,800 km, respectively. Installation of this pipe is projected to convert about 3,100-4,000 ha of wetlands.

At present, only the Texas state database of pipelines is available and reasonably complete. Its 1996 data set indicated another 33 non-OCS-related pipeline landfalls exist in that state. If the ratio of OCS pipeline landfalls to non-OCS pipeline landfalls is similar in the other Gulf States, a total of about 460 pipeline landfalls may exist and would be associated with about 13,900 km of associated inshore pipelines. If the ratio between OCS and non-OCS pipeline landfalls is applied to their installation, about 270-560 landfalls are projected for installation between 1998 and 2036. Correspondingly, about 7,410-14,730 km of inshore pipelines would be constructed during that period. Cumulatively, these pipeline landfalls are projected to impact 24,000-29,400 ha, converting 6,800-8,400 ha to open water.

Secondary impacts of pipeline canals are considered more damaging to coastal wetlands and associated habitats than primary construction impacts (Tabberer et al., 1985). Secondary impacts include expansion of tidal influence, saltwater intrusion, hydrodynamic alterations, erosion, sediment export, and habitat conversion (Gosselink, 1984). Section IV.D.1.a.(1)(b) and Table IV-21 describe wetland loss due to OCS-related, pipeline canal widening. The combined length of non-OCS pipelines through wetlands and their impacts are believed to about twice that of the Gulf OCS Program, indicating the related cumulative loss of about 27,100-33,300 ha. Note that these estimations are to be replaced with data presently being developed on geographic information systems.

Pipeline maintenance activities that disturb wetlands are very infrequent and are considered insignificant. During reviews of pipeline projects for Federal and State permits, agencies consistently comment with concern upon the extent of secondary impacts. As a result, structures engineered to mitigate secondary adverse impacts are included as permit requirements for canal and pipeline construction through wetlands. Maintenance of mitigation structures on pipeline canals is only required for 5 years, a rarely enforced stipulation. Structures constructed for the purpose of mitigating adverse impacts of pipeline construction fail very frequently (Gosselink, 1984). Where mitigation structures are not maintained, secondary impacts significantly accelerate. Decisions to not maintain mitigative structures allow deterioration and eventual failure. Significant indirect and adverse impacts on wetlands that the structures were designed to prevent or mitigate then proceed. These adverse impacts include saltwater intrusion, reduction of freshwater head, sediment erosion and export, expansion of tidal influence, and habitat conversion. The number of pipeline-related mitigative structures throughout coastal areas around the Gulf is unknown. Although the extent of impacts caused by failure to maintain mitigation structures is unknown, such impacts are believed to be significant (Gosselink, 1984; Tabberer et al., 1985; Turner and Cahoon, 1988).

Most canal dredging in coastal Louisiana has occurred as a result of onshore oil and gas activities. Approximately 41,190 wells had been completed in coastal Louisiana as of 1984 (USDOI, GS, 1984). Drilling and production activity at most coastal well sites require rig access canals. Access canals and pipelines to service onshore development are pervasive throughout the coastal area; 15,285 km of pipeline canals have been installed there to carry onshore production. Typical dimensions of an access canal, as indicated on permits during 1988, were 366-m long by 20-m wide with a 0.5-ha drill slip at the end.

Assuming that 1.3 wells were drilled per drill slip, these figures represent the conversion of approximately 46,000 ha to open water. Another 75 percent of that figure, about 33,700 ha, were buried under spoil banks.

In 1988, the COE, New Orleans District, received applications for the installation of 123 km of pipelines and for dredging more than 11 km of new oil-well access canals through wetland areas. This survey took place for a period (1984 through 1990, approximately) of suppressed oil and gas activities. Assuming that this level of activity persists for the period 1998-2036, the direct impacts from the COE-permitted dredging will be the conversion of more than 9,600 ha of wetlands to open water. In addition, another 75 percent of that wetland acreage will be buried by spoil banks along the channel margins, converting a projected 7,200 ha of wetlands to bottom land or shrub-scrub habitat. In areas where soils are poorly consolidated, the weight of a spoil bank will often cause flank subsidence, and about another 5 percent of the spoilbank and a varying but larger area of adjacent marsh would correspondingly be converted to open water (more than 350 ha). Estimates are not available for other COE Districts.

As discussed in Section IV.A.2.c., emphasis of OCS activities is being directed towards deeper water in the future, which may require some larger service vessels for efficient operations. At present, OCS-related service bases in Port Isabel, Corpus Christi, Harbor Island, Freeport, Pelican Island (Galveston), Sabine Pass, and Port Arthur in Texas, and Lake Charles, Berwick, Port Fourchon, and Venice in Louisiana are accessible to the larger vessels; canals to Empire and Cameron, Louisiana, are considered marginally useable for OCS-related shallow water traffic. Typically, channels greater than 6-7 m deep will not be needed to accommodate the deepwater needs of the OCS Program. Channels deeper than 6-7 m accommodate increasing numbers of ocean-going ships.

The Port Authority of Lafourche Parish and the COE are deepening access and interior channels of Port Fourchon to greater than 7 m NGVD. The number of cargo vessels not related to petroleum or fishing using Port Fourchon is projected to increase. From an early report, dredged material is expected to be placed for the creation of at least 192 ha of saline marsh. The abandoned feasibility report did not anticipate significant saltwater intrusion effects on wetlands as a result of the deepening project, probably because the project will only extend approximately 8.5 km inland and will be performed in a saline environment where the existing vegetation is salt tolerant. The COE estimated that 90 percent of the need for deepening the Fourchon Navigational Channel is attributed to OCS activities. Impoundment sites adjacent to Louisiana Highway 3090 may later be further filled to provide additional commercial sites for this developing port facility. In this event, accredited wetland gains will be lost. (See Section IV.D.1.b. for details.) In addition, that portion of La. Highway 1 between Golden Meadow, Port Fourchon, and Grand Isle in Louisiana is being considered for improvements. If the road is widened, wetland impacts will be inevitable. The significance of those impacts will be dependent upon the design and techniques yet to be decided upon.

Vessel traffic within navigation channels can cause channel bank erosion in wetland areas. An idea of the magnitude of OCS vessel traffic is provided in Table IV-13, which shows the projected numbers of barge, service vessel, and shuttle tanker landings and dockings at various ports. The OCS-related vessels use approximately 3,650 km of the 7,866 km of federally maintained Gulf Coast navigation routes. Channels associated with OCS activities are listed in Table IV-13. Approximately 12 percent of the traffic using OCS-related channels is related to the OCS Program. Of the OCS-related length, approximately 2,020 km are through eroding canals, rivers, and bayous. Vessel wakes cause erosion of wetlands along channel margins. For analytical purposes, erosion rates were established in Section IV.D.1.a.(1)(b). Hence, approximately 6,100-7,000 ha of wetlands during the period 1998-2036 will be lost along the banks of OCS-related channels. The non-OCS-related navigation channels conduct lower traffic volumes and, hence, are assumed to widen at a lower rate of 0.95 m/yr. Assuming that the remaining 5,728 km of non-OCS-related navigation channels around the Gulf have a similar percentage through erodible channels, another 4,350 km of eroding channels may represent loss of another 16,000-16,500 ha of land to channel erosion.

Maintenance dredging of existing channels will occur and could harm wetlands if the dredged material is deposited onto wetlands, resulting in burial or impoundment of marsh areas. Twelve percent of associated maintenance dredging of OCS-related channels and related impacts are attributed to the OCS Program. On average, the four COE Districts survey each navigation channel for which they are responsible every two years to determine the need for maintenance dredging. Schedules for maintenance dredging of OCS-related

navigation channels vary broadly from annually to once every 17 years. Each navigation channel is usually divided into "reaches," each of which may have an entirely independent maintenance schedule. The COE data indicate that an approximate average of 14,059,500 m^3 of dredged material per year or 492,082,500 m^3 per 35 years are displaced by maintenance dredging activities on OCS-related navigation channels in the Gulf area. The navigation channels not used by OCS navigation traffic are generally smaller, less-used channels with less frequent maintenance dredging. These channels are assumed to produce 50 percent less maintenance-dredged materials per kilometer. Hence, maintenance dredging of non-OCS-related channels are estimated to produce approximately 36,576,500 m^3 of dredged material during the period 1998-2036. This dredged material should be increasingly used to enhance or reestablish marsh growth in deteriorating wetland areas. If this mitigation is implemented, the damaging effects of maintenance dredging of navigation channels would be reduced.

Significant volumes of OCS-related produced sands and drilling fluids will be transported to shore for disposal. According to USEPA information, sufficient disposal capacity exists at operating and proposed disposal sites. Economic and political opportunities exist that may support construction of new disposal sites. Because of current regulatory policies, no wetland areas will be disturbed as a result of the establishment of new disposal sites or expansions of existing sites, without adequate mitigation. Some seepage from waste sites may occur into adjacent wetland areas and result in damage to wetland vegetation.

Miscellaneous factors that impact coastal wetlands include marsh burning, marsh buggy traffic, onshore oil and gas activities, and well-site construction. Bahr and Wascom (1984) report major marsh burns that have resulted in permanent wetland loss. Sikora et al. (1983) reported that in one 16-km^2 wetland area in coastal Louisiana, 18.5 percent of the area was covered with marsh-buggy tracks. Tracks left by marsh buggies have been known to open new routes of water flow through relatively unbroken marsh, thereby inducing and accelerating erosion and sediment export. Marsh-buggy tracks are known to persist in Louisiana intermediate, brackish, and saline marshes for 15-30 years. Well-site construction activities include board roads and ring levees. Ring levees are approximately 1.6-ha impoundments constructed around a well site. In oil and gas fields, access canal spoil banks impound large areas of wetlands. With 41,000 onshore coastal wells drilled in Louisiana as of 1984, the total acreage of impounded, dredged, and filled wetlands is substantial and would amount to 32,800 ha, if there were two wells per ring levee in 1984.

Summary and Conclusion

On the North American continent, the highest rates of total landloss are found in coastal Louisiana. If existing trends continue as expected for the period 1998-2036, about 202,000-252,500 ha would be lost in Louisiana alone. Texas, Alabama, Mississippi, and Florida's fresh and estuarine marshes are expected to continue to decline significantly during the same period. Total marsh loss in the coastal regions around the northern Gulf are projected to be roughly between 621,000 and 776,000 ha for the same period.

Wetland loss in coastal Louisiana is principally due to subsidence, erosion, and reduced sediment input from the Mississippi River, each of which has been accelerated significantly by human activities. Coastal wetlands in Texas are also disappearing for similar reasons. Together, impacts from residential, commercial, and agricultural developments are expected to continue to be primary causes of wetland losses in coastal regions around the Gulf, except in Louisiana where separation of manmade and natural causes can be difficult.

The OCS-related oil spills are estimated to adversely impact approximately 740-20,000 ha of wetlands during the life of the proposed action. Productivity of approximately 640-17,000 ha of wetlands is expected to recover over a period of up to 10 years. About 120-3,000 ha of wetlands would be converted to open water. Cumulatively, spills are estimated to adversely impact approximately 141,500-204,000 ha of wetlands. Productivity of approximately 122,400-173,400 ha wetlands is expected to recover by 10 years. About 22,900-30,600 ha of wetlands would be converted to open water.

Some seagrass beds around the Gulf could be contacted by crude and refined oil. These contacts will result in some short-term die back of the vegetation and faunal and floral communities among seagrass. No impacts to wetlands and seagrasses from produced-water discharges into coastal waterbodies are expected to occur due to disposal methods.

Impacts from State onshore oil and gas activities are expected to occur as a result of dredging for new canals and for maintenance; usage of existing rig access canals and drill slips; and preparation of new well sites. Indirect impacts from dredging new canals for inshore oil and gas development and from maintenance of the existing canal network are expected to continue.

Secondary adverse impacts of canals can be much more significant than initial impacts, depending upon the region where they are found. Destruction of wetlands along all OCS-related navigation channels as a result of vessel wake erosion is expected to result in approximately 6,100-7,000 ha of wetlands loss, of which approximately 12 percent are accredited to the OCS Program. Cumulatively, widening navigation channels is projected to cause the loss of about 22,100-24,000 ha of wetlands. Widening of OCS and non-OCS pipeline canals is estimated to cause the loss of approximately 9,060-11,100 and 18,100-22,200 ha, respectively. Additional wetland losses generated by the secondary impacts of salt water intrusion, flank subsidence, and deeper tidal penetration have not been calculated due to a lack of quantitative documentation. Decisions to not maintain structures built to mitigate adverse impacts of canal construction is a significant source of adverse impacts upon wetlands, an impact that needs study and quantification.

Maintenance dredging of OCS-related navigation channels displaces approximately 492,082,500 m^3 of dredged material, of which 12 percent is attributed to the OCS Program. Federally maintained, non-OCS-related navigation channels are estimated to account for another estimated 36,576,500 m^3 of dredged material. Maintenance dredging of inshore, well-access canals is estimated to result in the displacement of another 5,014,300 m^3 of materials. Insignificant adverse impacts upon wetlands from maintenance dredging are expected because the large majority of the material would be disposed of upon existing disposal areas. Alternative, dredged-material disposal methods can be used to enhance and create coastal wetlands.

New onshore OCS-infrastructure construction, other than pipelines, is projected to be constructed on non-wetlands, given the regulatory difficulties involved in construction projects on wetlands.

Projected construction of 131-260 OCS pipeline landfalls would generate construction of 2,760-6,800 km of associated inland pipelines and the loss of about 3,100-4,000 ha of wetlands during the period of 1998-2036. Cumulatively, the offshore, oil and gas industry is projected to cause another 270-560 pipeline landfalls and 7,410-14,730 km of associated pipelines during that period. Cumulatively, these pipeline landfalls are projected to impact 24,000-29,400 ha, converting 6,800-8,400 ha to open water.

Deepening Fourchon Channel to accommodate larger, OCS-related service vessels is expected to occur within a saline marsh environment and may afford the opportunity for the creation of 192 ha wetlands, 173 ha of which would be attributed to the OCS Program. Deepening the Corpus Christi Channel is non-OCS-related and should afford the opportunity to create wetlands with the dredged materials.

In conclusion, a significant area of wetlands is projected to be lost around the Gulf during the period 1998-2036. Deltaic Louisiana will continue to experience the greatest losses. Wetland loss is also expected to continue in coastal Texas, Mississippi, Alabama, and Florida, but at slower rates. The OCS Program seems to represent 2.1-2.4 percent of the total projected coastal wetland losses described and calculated in this document for the period 1998-2036. The proposed action represents about 0.5-1.0 percent of the OCS impacts that will occur during the period 1998-2032.

(2) Impacts on Sensitive Offshore Coastal Environments

(a) Deepwater Benthic Communities

Cumulative factors considered to impact the deepwater benthic communities of the Western Gulf include both oil- and gas-related and non-oil- and gas-related activities. The latter type of impacts includes activities such as fishing, trawling, and anchoring. However, fishing and trawling in the deeper waters of the Western Gulf are minimal, and the impacts are minimal. Oil- and gas-related activities include pipeline and platform emplacement activities, anchoring, accidental seafloor blowouts, drilling discharges, and explosive structure removals. This analysis considers the effects of these factors related to the proposed action and to prior and future OCS sales.

The greatest potential for adverse impacts to occur to the deepwater chemosynthetic communities would come from those OCS-related, bottom-disturbing activities associated with pipeline and platform emplacement, associated anchoring activities, and seafloor blowout accidents. The potential impacts to deepwater benthic communities from these activities are discussed in detail in Section IV.D.1.a.(2)(b).

Routine discharges of drilling muds and cuttings have been documented to reach the seafloor in water depths greater than 400 m, but these discharges are distributed across wider areas and in thinner accumulations than those found in shallower water depths. Any impacts that resulted from these discharges were likely to be minor and sublethal. As discussed in Section IV.A.3.d., restrictions resulting from the new USEPA NPDES discharge permits and regulations will prevent sediments from being contacted by discharges that previously would have accumulated on the seafloor. Due to the great water depths in which chemosynthetic communities are found, sanitary wastes and produced waters are not expected to have adverse impacts to chemosynthetic communities. These effluents would undergo a great deal of dilution and dispersion before contacting these benthic communities.

A blowout at the seafloor could resuspend large quantities of bottom sediments and even create a large crater, destroying any organisms in the area. Structure removals and other bottom-disturbing activities could resuspend bottom sediments, but not at magnitudes as great as blowout events.

Oil spills would not impact chemosynthetic communities because the communities are often seen growing among oil-saturated sediments and natural gas bubbles, using these hydrocarbons as an energy source.

As exploration and development continue on the Federal OCS, activities in the Western and Central Gulf have moved into the deeper water areas of the Gulf of Mexico. With this trend comes the certainty that increased development will occur in these areas, accompanied by stress to the deepwater benthos from bottom disturbances and disruption of the seafloor from associated activities. The extent of this disturbance will be determined by the intensity of development in these deepwater regions, as well as by the types of structures and mooring systems utilized. Activity levels for the cumulative OCS Program are shown in Table IV-5. In offshore Subareas W200-900 and W900-3000 (no activities are projected for Subarea W3000+), an estimated 689-1,568 exploration and delineation wells and 644-1,652 development wells will be drilled and 41-100 production structures and several tens of thousands of kilometers of pipelines could be installed. Approximately 9-23 blowout accidents are estimated. Annually, no more than 1 million bbl of drilling fluids and cuttings will be discharged. As noted in Section IV.D.1.a.(2)(b), NTL 88-11 operates to protect high-density chemosynthetic communities.

The majority of these deepwater communities are of low density and are widespread throughout the deepwater areas of the Gulf. Physical disturbance to a small area would not result in a major impact to the ecosystem. The frequency of such impact is expected to be low. Such impacts are expected to result in minor disturbance to the ecological function of the community, with no alteration of ecological relationships with the surrounding benthos.

High-density communities are, as noted above, largely protected from direct physical impacts by the provisions of NTL 88-11. Small impacts are expected to occur infrequently. The impacts from bottom-disturbing activities could be quite severe to the immediate area affected, with recovery time as high as 200 years for mature tube worm communities. The severity of such an impact is such that there may be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

Low-density communities may occasionally sustain minor impacts from discharges of drill muds and cuttings or resuspended sediments. As discussed in Section IV.A.3.d., the new USEPA discharge regulations and permits will prevent further impacts from discharges on leases resulting from this proposed lease sale. These impacts are most likely to be sublethal in nature and would be limited in areal extent. The consequences of these impacts to these widely distributed low-density communities are considered to be minor with no change to ecological relationships with the surrounding benthos.

High-density chemosynthetic communities would be largely protected from discharges of drill muds and cuttings and resuspended sediments by the provisions of NTL 88-11. The NTL is designed to prohibit oil and gas activities in the vicinity of these communities. Beginning with the proposed lease sale, no further benthic impacts from oil- and gas-related discharges are anticipated in water depths less than 200 m (Section

IV.A.3.d.). In cases where these communities are subjected to these discharges or resuspended sediments, however, the impacts are most likely to be sublethal in nature and limited in aerial extent. High-density communities are widely distributed, but few in number and limited in size. They have a high standing biomass and productivity. The impacts to ecological function of high-density communities would be minor with recovery occurring within 2 years, but minor impacts to ecological relationships with the surrounding benthos would also be likely.

Summary and Conclusion

The most serious impact-producing factor threatening the chemosynthetic communities is physical disturbance of the seafloor, which would destroy the organisms of these communities. Such disturbance would come from those OCS-related activities associated with pipelaying, anchoring, structure emplacement, and seafloor blowouts. Drilling discharges and resuspended sediments have a potential to cause minor, mostly sublethal impacts to chemosynthetic communities. Seafloor disturbance is considered to be a threat only to the high-density (Bush Hill-type) communities; the widely distributed low-density communities would not be at risk. The provisions of NTL 88-11 (currently in effect), requiring surveys and avoidance prior to drilling, will greatly reduce the risk. Activities unrelated to the OCS Program include fishing, trawling, and anchoring. Because of the water depths in these areas, these activities are not expected to impact chemosynthetic communities.

The activities considered under the cumulative scenario are expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities could experience minor impacts from drilling discharges or resuspended sediments, with recovery expected within 2 years. If physical disturbance (such as anchor damage) to high-density, Bush Hill-type communities were to occur, impacts could be severe over a limited area, with recovery time as long as 200 years for mature tube worm communities. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

The incremental contribution of the proposed action (as analyzed in Section IV.D.1.a.(2)(b)) to the cumulative impact is expected to be slight, due to the effects of the possible impacts caused by physical disturbance of the seafloor and minor impacts from sediment resuspension. Negative impacts will be limited but not completely eliminated by adherence to NTL 88-11 (currently in effect).

(b) Topographic Features

The Topographic Features Stipulation is assumed to be in effect for this cumulative analysis. The continued application of this stipulation would prevent any direct adverse impacts on the biota of the topographic features potentially generated by oil and gas operations. The cumulative impact from routine oil and gas operations includes effects resulting from the proposed action (Section IV.D.1.a.(2)(b)) as well as those resulting from past and future OCS leasing. These operations include anchoring, structure emplacement, effluent discharge, blowouts, oil spills, and structure removal. Potential non-OCS-related factors include vessel anchoring, treasure hunting activities, ocean dumping, tankering of imported oil, heavy storms and hurricanes, the collapse of the tops of the features due to dissolution of the underlying salt structure, fishing, and recreational scuba diving.

Mechanical damage, including anchoring, is considered to be a definite threat to the biota of topographic features. The proposed biological stipulation prohibits oil and gas leaseholders from anchoring vessels and placing structures in the No Activity Zones; the stipulation does not affect other non-OCS activities such as anchoring, fishing, or recreational scuba diving. No data are available on the extent to which non-OCS activities may take place; however, these activities are known to occur in proximity of the topographic features. Nearly all the topographic features are found near established shipping fairways and are apparently well-known fishing areas. Also, several of the shallower topographic features are frequently visited by scuba divers. Anchoring at a topographic feature by a vessel involved in any of these activities could damage the

biota. The degree of damage would depend on the size of the anchor and chain (Gittings and Bright, 1986). Anchor damages incurred by live bottom may necessitate more than 10 years to recover.

The use of explosives in treasure hunting operations is rather infrequent on topographic features. The blasting of large areas of Bright Bank by treasure hunters resulted in the loss of extensive live coral cover (Bright, 1985). The recovery from such destruction may take in excess of 10 years, while part of the resource loss may be irreversible. Recovery of the system to pre-interference conditions would depend on the type and extent of damage incurred by structure of the topographic feature.

Ocean dumping activities are regulated by the USEPA. It is unlikely that the USEPA would approve a disposal site in the vicinity of a topographic feature.

Impacts on the topographic features could occur as a result of spills or operational discharges from import tankering. Due to dilution and the depths of the crests of the topographic features, discharges should reach topographic features in insufficient concentrations to cause impacts.

Impacts from natural occurrences such as hurricanes occasionally result in damage to the biota of the topographic features. Coral colonies can be toppled, resuspended sand can scar live coral tissue, and the structure of the reef can be changed. The collapse of the crest of the topographic features by the dissolution of the underlying salt structure is possible, but unlikely and certainly uncontrollable by human activity.

Depending on the levels of fishing pressure exerted, fishing activities that occur at the topographic features may impact local fish populations. The collecting activities by scuba divers on shallow topographic features may have an adverse impact on the local biota. Anchoring during recreational and fishing activities, however, should be the source of the majority of any of the severe impacts incurred by the topographic features.

Anchoring on the topographic features during oil- and gas-related operations could have even greater impacts (Bright and Rezak, 1978; Rezak et al., 1985). The continued application of the biological stipulation should preclude anchoring of pipeline barges, drilling rigs, or service vessels, and structure emplacement (pipeline, drilling rig, or platform emplacement) by oil and gas leaseholders in the No Activity Zone, thus preventing adverse impacts on benthic communities of topographic communities.

The routine discharge of drilling muds and cuttings probably is significant under the cumulative scenario; it is assumed that several million barrels of drilling fluids and cuttings would be discharged in water depths less than 200 m. The areal extent of the topographic features relative to the area of the entire WPA is small, so the actual amounts of these discharges in the vicinity of the topographic features would be a fraction of this total. Continued application of the Topographic Features Stipulation would require lease operators to comply with measures, such as shunting, that would keep discharged materials at depths below sensitive biota. The USEPA, through its new NPDES discharge permit, also cite further mitigating measures. As noted above under the proposed action, drilling fluids can be moderately toxic to marine organisms (the more toxic effluents are not allowed to be discharged under the new NPDES permit), and their effects are restricted to areas closest to the discharge point, thus preventing contact with the biota of topographic features. Small amounts of drilling effluent may reach a bank from wells outside the No Activity Zone; however, these amounts, where measurable, would be extremely small and would be restricted to small areas and have sublethal effects on the biota. Such impacts would occur infrequently. The severity of the impacts is assumed to be such that only a few elements at the regional or local scale would be disrupted or impaired, and that no interference to the ecosystem performance would be incurred. Recovery of the system to pre-interference conditions would take place within 2 years.

With the inclusion of the proposed Topographic Features Stipulation, no discharges of effluents, including produced water, would take place within the No Activity Zones. Discharges in areas around the No Activity Zone would be shunted to within 10 m of the bottom. This procedure, combined with the new USEPA discharge regulations and permits, should eliminate the threat of discharges reaching and affecting the biota of a topographic high. The impacts that these discharges could cause would be primarily sublethal damages that could lead to a possible disruption or impairment of a few elements at the regional or local scale, but no interference to the general system performance should occur. Recovery of the impacted area to pre-interference conditions would take place within 2 years.

Blowouts outside the No Activity Zones are unlikely to impact the biota of the topographic features. A total of 50-73 blowouts could occur in Subarea W0-60, and 24-33 blowouts could occur in Subarea W60-

200. Few, if any, would occur in the immediate vicinity of the topographic features. It is assumed that a resuspension of sediments or a subsurface oil spill following a blowout could reach the biota of a topographic feature. If this were to occur, the impacts would be primarily sublethal with the disruption or impairment of a few elements at the local scale, but no interference to the general system performance would occur, and recovery of the impacted area to pre-interference conditions would take place within 2 years.

Oil-spill occurrence and contact probabilities for the OCS Program are presented in Appendix C and are discussed in Section IV.A.3.h.(2). However, because of the water depths in which topographic features are found, no oil from surface spills would reach the biota of concern at concentrations likely to cause impacts. A subsurface oil spill could, however, reach the biota of a topographic feature. Such spills are assumed to rise to the surface would initially adhere to the sediments surrounding the buried pipeline or well site until the sediment reached its maximum capacity to retain the oil before rising (typically 100 m/hr; Guinasso, personal communication, 1997) in discrete droplets toward the sea surface. Any oil remaining at depth would be swept clear by currents moving around the topographic features (Rezak et al., 1983).

If a seafloor oil spill (e.g., pipeline) were to occur, the spill would have to come into contact with a biologically sensitive feature to have an impact. The extent of damage from any given spill would probably be concentrated on only one of the sensitive areas given that topographic features are widely spread out in the Western Gulf, and given the random nature of spill locations, the potential impacts of oil spills on biological resources of the topographic features would probably be restricted to discrete locations. The currents should steer any spilled oil around the topographic features rather than directly upon them, lessening impact severity. Furthermore, the No Activity Zones established by the proposed Topographic Features Stipulation would serve to keep OCS sources of spills away from the topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for corals and much of the other adult reef biota. It is anticipated that recovery for such an event would occur within a period of 2 years. In the highly unlikely event that oil from a subsurface spill could reach a coral covered area in lethal concentrations, the area so impacted would be small, but recovery of this area could take in excess of 10 years.

Many platforms will be removed from the OCS Program each year in the vicinity of topographic features (95-145 in Subarea W0-60 and 17-27 in Subarea W60-200). However, the proposed Topographic Features Stipulation would prevent the installation of platforms in the No Activity Zones, thus reducing the potential for impact from platform removal. The explosive removals of platforms should not impact the biota of the topographic features. Similarly, other activities that resuspend bottom sediments are unlikely to impact the topographic features

Summary and Conclusion

Activities causing mechanical disturbance represent the greatest threat to the topographic features. This would, however, be prevented by the continued application of the Topographic Features Stipulation. Potential OCS-related impacts include anchoring of vessels and structure emplacement, operational discharges (drilling muds and cuttings, and produced waters), blowouts, oil spills, and structure removal.

The proposed Topographic Features Stipulation would preclude mechanical damage caused by oil and gas leaseholders from impacting the live-bottom communities of the topographic features and would protect them from operational discharges. As such, little impact would be incurred by the biota of the topographic features. The likelihood of any discharge-related impacts would be even further reduced by the new USEPA discharge regulations and permits (Section IV.D.1.a.(3)). Recovery from any discharge-related impacts would take place within 2 years.

Blowouts could potentially cause damage to benthic biota, but due to the application of the proposed Topographic Features Stipulation, they would not occur in the immediate vicinity of the live bottom communities; therefore, they would have little impact on the biota of the topographic features. Recovery from any impact would take place within 2 years.

Oil spills can cause damage to benthic organisms when the oil contacts the organisms. The proposed Topographic Features Stipulation would keep sources of OCS spills away from the immediate biota of the topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a

topographic feature, the effects would be primarily sublethal for corals (in the case of the Flower Garden Banks) and much of the other adult biota. It is anticipated that recovery for such an event would occur within a period of 2 years. In the highly unlikely event that oil from a subsurface spill reached an area containing coral cover (e.g., Flower Garden Banks) in lethal concentrations, the impacted area would be small, but its recovery could take in excess of 10 years.

Non-OCS activities are thought to have the greatest potential of impacting the topographic features, particularly those that could mechanically disrupt the bottom (such as anchoring and treasure-hunting activities, as described above). Natural events such as hurricanes or the collapse of the tops of the topographic features (through dissolution of the underlying salt structure) could cause severe impacts. The collapsing of topographic features is unlikely and would, at the most, impact a single topographic feature. Impacts from scuba diving, fishing, ocean dumping, and discharges or spills from tankering of imported oil are likely to have little or no impact on the topographic features.

The incremental contribution of the proposed action (as analyzed in Section IV.D.1.a.(2)(b)) to the cumulative impact is slight because of the implementation of the Topographic Features Stipulation, which would limit mechanical impacts and operational discharges. Furthermore, there is a low probability and low risk of accidental OCS-related events such as blowouts and oil spills occurring in the immediate vicinity of a topographic feature.

(3) Impacts on Water Quality

(a) Coastal Waters

This cumulative analysis assesses future coastal water quality within the Gulf's coastal zone from the U.S./Mexico border through the northeastern Gulf Coast off the Florida Panhandle. Degradation of water quality conditions is expected to continue because of point- and nonpoint-source pollution and frequent spills. Section III.A.5. provides an overview of existing degradation problems and activities affecting the water quality of the Gulf of Mexico. The Gulf Coast has been heavily used and is now showing some signs of environmental stress. Large areas experience nutrient overenrichment, low-dissolved oxygen, toxin and pesticide contamination, shellfish ground closures, and wetland loss.

Water quality is based on a waterbody's ability to support designated uses and the extent to which the waterbody attains water quality standards. When possible, an assessment of the impact to water quality includes determining the nature and amount of contaminant inputs and comparing these levels with Federal and State water quality criteria. When this is not possible, the level of impact from an activity can be projected based on the likely percentage contribution the activity makes to the contamination. In general, the major designated uses of coastal waters include aquatic life support, contact and noncontact recreation, fish consumption, and shellfishing.

Point-source discharges are numerous along the Gulf of Mexico. In a comprehensive report by the USEPA (1990) on the environmental quality of the Gulf, 113 municipalities and 347 major industrial facilities were reported to discharge pollutants directly into coastal waters of the Gulf in 1990. The greatest contamination came from the discharge of sewage wastes by municipalities. Sewage effluents discharged into Gulf waters are estimated at 3.8 million m^3/day (USEPA, 1990). Major industrial sources of wastewater discharges include petroleum refineries and petrochemical plants; fish processing and forest product industries; coastal oil and gas development operators; large, commercial waste disposal facilities; the manufacturing industry; nuclear power plants; and pulp and paper mills. In 1990, Texas accounted for 192 of the major industrial dischargers, Louisiana for 79, Mississippi for 30, Alabama for 29, and Florida for 17. By 1996, the State of Texas Water Quality Inventory (TNRCC, 1996) shows a significant increase in the number of point sources in Texas. There are 159 municipal discharges and 234 industrial discharges into the coastal bays and Gulf waters of Texas. The Houston Ship Channel is heavily impacted by point sources from both municipal and industrial facilities, especially from oil, steel, and petrochemical industries (Crocker and Koska, 1996). The number of industrial and municipal point sources in the Gulf area is expected to continue to grow because of growth both in the coastal population and in the major industry of the Texas coastal zone--the oil and gas industry. The coastal population is projected to grow and increase

approximately 35 percent from the year 1998 over the next 35 years (Section IV.D.1.d.(11)(a)). Peak impacts related to expansion of the oil and gas industry are expected to occur within the first 7 years of the life of the proposed action and gradually decline through 2036. Municipal discharges are already resulting in 26 of the 45 bays of Texas being unable to support one or more designated uses (66% of the bays' areas) (Texas Water Commission, 1996). Although there are likely to be improvements in limiting contaminants in point sources in the future, the impact from point sources, especially from municipalities, will increase, resulting in further degradation of coastal water quality.

Facilities in the coastal zone that support the OCS oil and gas industry are industrial point sources discharging their wastewater directly into coastal waters. Service bases and marine terminals contaminate coastal waters with antifouling marine paint components, chronic spills, domestic wastewater, and contaminated sludge, containing heavy metals, and oil and grease. Pipecoating yards, platform-construction facilities, and repair and maintenance yards contaminate surrounding waters by releasing thermal effluents, radioactive substances, antifouling paint chemicals, heavy metals, and a variety of process waters, as well as solid waste such as packaging materials, metal scraps, and other debris. Gas processing plants and refineries discharge a number of types of wastewater, including cooling and boiler waters, sanitary and domestic wastewater, and process waters. These waters may be contaminated with dissolved hydrocarbons, sulfuric acid, chromium, zinc, phosphates, alkaline substances, and suspended solids.

Of all these OCS support facilities, the USEPA (1990) identified refineries as major sources of point-source discharge contamination to the coastal zone. Cooling water represents a significant portion (70-100%) of the wastewater effluent originating from an oil refinery or a gas processing plant. Chemicals added to the cooling water stream to reduce corrosion and fouling within the tower and the condenser system (including chromium and chlorine) could be greatly toxic to aquatic organisms. Process water used in refining operations may be the most contaminated of wastewater discharges from OCS support facilities due to its anaerobic and highly reduced character and to the presence of numerous heavy metals (primarily three toxic metals--mercury, cadmium, and cyanide), sulfides, and ammonia, which are produced together with the oil and gas. The processing chemicals are added during crude-oil desalting, steam distillation, and steam stripping.

The existing oil and gas infrastructure service bases (352 facilities) found along the Gulf Coast between Corpus Christi, Texas, and Alabama, is assumed to support most future OCS and State oil and gas operations (Table IV-12). Most of the facilities are concentrated between the Galveston/Houston area and the Mississippi Delta area in Louisiana. Besides the existing facilities, between 21 and 140 new facilities are projected to be built. As long as these onshore support facilities are in operation, routine point-source discharges and chronic spillages from them are expected to continue to contribute, to some degree, to coastal water quality degradation.

It is not known how many of the industrial point sources are facilities supporting the OCS oil and gas industry. Section IV.D.1.d.(11)(a) recognizes that as high as 7-9 percent of Gulf Coast employees work with service companies associated with the OCS oil industry. If one assumes that employment can be directly correlated with the number of point sources (the more employment the more point-source discharges), then the percentage of total Gulf Coast workers employed by OCS service companies represents the percentage of the point sources that are related to OCS service companies, i.e., the contribution of the OCS onshore infrastructure to point-source industrial discharges is likely to be less than 10 percent of all point-source industrial discharges.

Point-source discharges can also originate from vessel discharges. In the Gulf area, the commercial maritime industry, tanker transport of crude oil and petroleum products, recreational and commercial fishing, and crew and supply vessels for the OCS oil industry dump galley wastes, sewage and sanitary wastes, and at times bilge and ballast waters into coastal waters. Point-source discharges of vessel traffic are likely to be most problematic when discharged within the Gulf's coastal waterways; the Gulf Intracoastal Waterway (GIWW); and within bays, bayous, and coastal rivers, particularly the Mississippi River. Bilge waters from vessel traffic can contain petroleum and metallic compounds leaked from machinery. Recent regulations severely restrict the levels of oil and grease in bilge water discharges in coastal areas (40 CFR 110). For the 39 channels used by the OCS oil industry, it has been estimated that the average usage by OCS-related vessels is about 12 percent (Turner and Cahoon, 1988, Appendix B), although the same report estimates that

Texas channels are never used more than 10 percent by the OCS oil and gas industry. Between 400,000 and 500,000 service-vessel trips and about 120 barge trips, carrying crews, supplies, and crude oil between offshore facilities, shorebases, and terminals are estimated to occur annually in support of future OCS operations in the Gulf. Bilge water and sanitary and domestic wastewater discharged from these vessel trips along the 400 km of Texas channels during the life of the proposed action is estimated to be less than 2,000 liters per km per day on average. These levels are not large when compared with the total volume of water that they are entering and, thus, would be quickly diluted and assimilated.

For vessels that harbor or anchor in congested or highly populated areas, such as recreational boats, sewage disposal from marine sanitation devices is a primary pollution concern. The discharge of sewage and wastes from vessels in confined, coastal waters can result in a local increase of the biological oxygen demand (BOD) and in the introduction of pathogens. Regulations promulgated under the Federal Water Pollution Control Act require all vessels to be equipped with approved marine sanitation devices; however, both treated and untreated wastes are currently discharged into coastal waterbodies. Although the wastewater generated by each boat is small, the organic compounds are concentrated and, therefore, the BOD levels are much higher than that of raw or treated municipal sewage. When this occurs in poorly flushed waters, the dissolved oxygen concentration of the water usually decreases. The addition of disease-carrying pathogens from fecal matter in boat sewage poses an obvious threat to human health; contaminated waters could be harmful should humans contact or ingest pathogens while swimming, or should humans consume a pathogen-infected shellfish. Bacteria, viruses, and other waterborne diseases can be attributed to vessel sewage pollution.

Vessel discharges are of a long-term, continuous nature. Discharges from OCS-related commercial vessel traffic in the Gulf Coast are expected to result in low-level, regional degradation of water quality within the waterbodies used most frequently. Discharges from all vessel traffic, especially at marinas and in areas with substantial vessel traffic such as Galveston Bay, are expected to be great enough to affect some uses of some waterbodies in the next 40 years.

Although many contamination problems have been documented in the past from the point-source discharge of used drilling muds and cuttings and produced water, the direct discharges of these oil and gas industry wastes into estuarine waters is now prohibited by all states along the Gulf Coast except for some produced water discharged in Louisiana. Oil-field wastes will no longer be discharged directly into coastal waters but will be disposed of at commercial land farms, landfills, and injection pits. Produced-water discharges to open bays and major deltaic passes of the Mississippi River and the Atchafalaya River will continue at least until the year 2000. Impacts from these discharges are not expected to be significant because of the assimilative capacity of the waterbodies receiving the wastes.

Despite these numerous point sources, nonpoint-source pollution remains the leading cause of water quality impairment in the Gulf's rivers and estuaries (USDOC, NOAA, 1996; Louisiana Dept. of Environmental Quality, 1990; TNRCC, 1996). Activities contributing significant levels of nonpoint-source contamination to Gulf coastal waters include river runoff, agriculture, livestock farming, forestry, urban expansion, general construction in the coastal zone, septic tank leakage from municipal and camp sewerage treatment processes, and hydrologic modifications. Vessels contribute nonpoint-source contaminants while docked at marinas or marine terminals through the deterioration of antifouling marine paints used on their hulls. River runoff is often contaminated by both point- and nonpoint-source discharges brought down river from sources outside the Gulf coastal area. Waterways draining over two-thirds of the United States enter the Gulf, transporting wastes from three-fourths of the farms and ranches of the United States, 80 percent of the U.S. cropland, hundreds of cities, and thousands of industries not located in the Gulf's coastal zone.

Urban runoff is a substantial source of oil and grease, lead, and chromium found in the Gulf coastal zone, although decreases in lead inputs have been documented since the 1970's (USEPA, 1990). Urban runoff is a major contributor of petroleum hydrocarbons originating from discarded oils; asphaltic coatings used for roofs and pipes; oil used in two-cycle engines, especially outboard boat motors; gas station runoff; and unburned hydrocarbons in car exhaust. These hydrocarbons are either directly flushed by rainfall and runoff into storm drains and into coastal waters or rivers, or they are weathered, broken down, and then dispersed.

Agricultural runoff along the Gulf Coast is contributing large quantities of nutrients, herbicides, pesticides, and fecal coliform bacteria. More than 4,500 metric tons (mt) (10 million lb) of pesticides were

applied in 1987 within the Gulf of Mexico coastal area, making it then the top user of pesticides in the country (USDOC, NOAA, 1992a).

Excess nutrients entering coastal waters from agricultural and municipal runoff brought into the Gulf Coast by major river systems are one of the greatest causes of water problems in the Gulf Coast. These excess nutrients can lead to noxious algal blooms, turbidity blooms, decreased seagrasses, fish kills, and hypoxia events. The nitrogen and phosphorus contents in the Mississippi River and the entire Gulf Coast have risen substantially over the last three decades (Rabalais, 1992). More than 172 mt (379,000 lb) of phosphorus and more than 848 mt (1.87 million lb) of Kjeldahl nitrogen is discharged into the Gulf on an average day. Ninety percent of this nutrient input originates from the Mississippi River system (Lovejoy, 1992). Nutrient overenrichment has recently been a water quality problem for the Lower and Upper Laguna Madre, Texas; Lake Pontchartrain, the Mississippi River, and Barataria Bay, Louisiana; Mississippi Sound, Pascagoula Bay, and Biloxi Bay, Mississippi; and Perdido, Pensacola, Choctawhatchee, and St. Andrews Bays, Florida (Rabalais, 1992). Currently in Texas, 14 of 45 bays show elevated levels of inorganic nitrogen, total phosphorus, and/or orthophosphorus, probably as a result of runoff. Although efforts to limit nutrient overenrichment by both States and the Federal Government are underway, water quality problems resulting from excess nutrients are expected to continue.

These nonpoint sources of pollution are related to population growth and development. As with point sources, because the Gulf Coast population is projected to continue to grow, the contaminant loadings will continue to increase. These sources will cause nonattainment of some water quality standards and preclude some designated uses of the affected waterbodies.

Another major type of nonpoint-source pollution in Gulf coastal waters is sediment loading resulting from dredging operations. Hydromodification dredging operations include channelization; maintenance and modification of existing channels; dam construction; and stream bank and shoreline changes. Dredging also occurs to provide access to well sites located in the wetlands and for pipeline emplacement. Dredged sediments can enter coastal waters either directly by open-water dumping or indirectly when the sediments originally dredged and emplaced onto spoil banks and into wetlands are washed and eroded away. Analysis of historical data shows that maintenance dredging, the dominant dredging activity in the Gulf area, will continue to increase each year. Maintenance dredging will displace approximately 4 billion m^3 of sediment in the next 35 years, with about 55 million m^3 of dredged materials being disposed of directly into Gulf estuarine waters every year at USEPA-designated dredged material disposal areas (Section IV.B.1.j.); most of the areas are located at channel and river mouths. Dredged materials are often contaminated with toxic heavy metals, organic chemicals, pesticides, oil and grease, and other pollutants originating from municipal and industrial discharges and nonpoint sources. Dredged-material disposal can result in changes in the natural flow or circulation of surface waters, causing secondary water quality effects. The addition of pollutants to the water in excess quantities can cause degradation of surrounding waters. This can result in contamination of areas formerly isolated from major anthropogenic sources (USEPA, 1979). Because dredging operations are short-term activities, it is assumed that they will result in localized impacts, primarily increased turbidity, occurring over the duration of the operations (up to several months). These operations are expected to alter water quality to a level that would preclude recreational and commercial uses. The periods between projected dredging operations should generally allow for the recovery of affected areas. Impacts from dredging are assumed to be somewhat higher near the mouths of major rivers where greater sediment quantities are found.

Even when channels and pipeline canals are not maintenance dredged, their banks slowly erode and widen with time, resulting in increased turbidity in the surrounding waters as well as possible inputs of contaminant compounds found in the levee sediments. Saltwater intrusion into fresher water habitats through channel and pipeline canals could result in vegetation die-off and soil erosion, which further degrades water quality. Erosion of dredged material from spoil banks, bank erosion due to vessel usage, and the natural widening of pipeline canals provide continuous low-level and long-term sediment suspensions in surrounding waters, adversely affecting water clarity, especially in small, confined portions of navigation channels.

OCS support facilities contribute to the nonpoint-source discharges occurring in the Gulf Coast. Much of the channel dredging occurs to provide access to the coastal area for the OCS oil industry, as well as to install new OCS pipelines coming ashore from offshore. New dredging is projected to occur for construction

of 128-261 new pipeline landfalls and for 3,471-6,884 km of new onshore pipe needed to support future OCS operations. To meet future OCS support needs over the next 40 years, 21-140 more onshore facilities of various types are projected to be built (Table IV-12), plus one landfill for OCS trash. Also, existing onshore facilities are projected to be modified or expanded to accommodate new pipeline networks. Ten pipeyards in Texas are assumed to be expanded due to projected increased activity off South Texas. Also, a number of gas processing plants are projected to be expanded (Section IV.B.1.d.(2)). In particular, Port Fourchon in Louisiana is being extensively modified to develop deepwater port capabilities. Construction associated with these projects, along with the construction or modification of associated access routes, alters the natural hydrology and geography of the area, which can result in increased runoff from the land. Saltwater intrusion may occur if the facility is built through wetlands. If existing vegetation is modified, increased erosion and landloss around the facility may take place.

Runoff from oil and gas support facilities is expected to contribute to nonpoint-source contamination by adding oil, particulate matter, heavy metals, petroleum products, process chemicals, and soluble inorganic and organic compounds leached from the soil surface. In Mississippi Sound, hydrocarbons originating from the Pascagoula refinery were the most significant pollutants found in the sediments (Delfino et al., 1984). Besides adding contaminants to coastal waters, runoff from oil and gas facilities may alter circulation in wetland areas and may affect flushing rates and salinity gradients.

Locations where oil-field wastes were disposed of in the past will continue contributing to the nonpoint-source pollution problems of the Gulf Coast. Historically, oil-field wastes transported into the Gulf coastal area have contaminated groundwater and coastal water quality because they were improperly transported, stored, treated, and disposed of. Up until a few years ago, oil-field wastes generated during State oil and gas drilling and production in the coastal zone were usually disposed of onsite, either directly into coastal waters or into pits located near the well sites. Some of these pits were used by the OCS oil industry. In 1989, the State of Louisiana's Department of Natural Resources, Conservation Division, estimated that there were between 10,000 and 20,000 open, unlined oil-field waste pits existing in Louisiana, many located in wetlands. A large number of open pits also existed in Texas at this time. There are documented cases of environmental damage to oyster beds and to water quality from this practice (USEPA, 1987). In 1990, the State of Louisiana passed comprehensive oil-field waste management regulations that require the cleanup of these pits as well as establishing strict future disposal practices (LAC Title 43: Part XIX Amendment to Statewide Order No. 29-B). Revised State regulations and new USEPA NPDES permit restrictions have, for the most part, eliminated historical disposal practices that caused such problems. Given this, future contamination is expected to occur only around the old unlined pits, which are taking years to clean up, or due to human errors during a few onshore disposal operations.

The Gulf Coast is particularly susceptible to spills from crude oil, petroleum products, and hazardous wastes. Table IV-18 provides the number of oil spills from various activities projected to occur annually about 15-20 years from now within the Gulf. An average year for oil spills is difficult to choose because, while the trend for domestic production is for a decline in annual production, the trend for importing oil indicates increasing annual imports. Section IV.C. provides more information regarding non-OCS oil spills. Section IV.A.3.h.(2) provides information regarding OCS-related oil spills.

Most of the hazardous wastes produced in the United States are transported into the Gulf area for disposal, and the risk of spills of hazardous substances during transportation is considerable. In 1986, almost 20 percent of all hazardous, and other substances, spills occurred in the Gulf area (U.S. Dept. of Transportation, Coast Guard, 1989).

An even larger portion of crude oil and petroleum product spills occur in the Gulf each year. Approximately 44 percent of all oil spills occur in the Gulf area according to USCG statistics (Oil Spill Intelligence Report, 1992). This is primarily due to the extensive petroleum industry that exists in the Gulf. About 65 percent of the Nation's imported crude comes into the Gulf. The Gulf and surrounding areas produce most of the Nation's domestic crude oil. Much of this oil makes landfall in Louisiana or Texas and is then further barged or tankered within the coastal zone. Section IV.C.2.c. discusses marine transportation of oils in more detail. According to Table IV-18, about 950-1,050 spills could be occurring annually 15-20 years from now within Gulf coastal waters. Of these, about 8-11 percent are assumed to be associated with

OCS operations in the coastal zone. Of the total number of all coastal spills, about 10-15 are projected to be greater than 1,000 bbl.

Offshore spills may also impact coastal water quality if the spill is large enough and is transported into coastal waters by the prevailing currents and winds. About 1,275-2,000 spills are projected to be occurring annually 15-20 years from now in offshore waters from all sources. Of the offshore spills projected (Table IV-18), 3-4 spills per year would be large (greater than 1,000 bbl) non-OCS-related spills. Because these large spills are from vessel transport (Section IV.C.4.) and because most vessel spills occur in nearshore waters (Anderson and LaBelle, 1994), all of the large non-OCS-related spills are assumed to reach coastal waters. About 200-250 of the projected offshore spills less than 1,000 bbl would be small non-OCS-related spills; of these, it is projected that 4-5 spills would be large enough to reach coastal waters. About 80 percent of the offshore spills projected in Table IV-18 would likely be from OCS oil and gas activities. Of these, only one per year is projected to be greater than 1,000 bbl. The results of the OSRA model show that there is a 100 percent probability that one or more of the OCS-related large spills will occur and contact coastal waters within 30 days (mean number being 9-13 spills) over the 39-year analysis period. For Texas, the model shows that there is also as high as a 100 percent chance of occurrence and contact of one or more large spills reaching Texas coastal waters within 30 days (mean number being 4-5 spills) over the 39-year period. For Mississippi and Alabama, there is as high as a 28 percent probability that an offshore OCS large spill will occur and contact their coastal waters (mean number being 1 spill) over the next 39 years. Of the 2-3 spills less than 1,000 bbl (average size being 150 bbl) projected to reach coastal waters (Section IV.A.3.h.(2)), it is assumed one of these spills would reach land during the typical year analyzed below. Spills less than 50 bbl occurring in offshore waters would weather quickly and none are likely to reach coastal waters.

Adding the annual numbers of spills estimated to occur offshore and reach coastal waters to the number of spills estimated to occur in the coastal zone, about 14-20 spills greater than 1,000 bbl, about 25-30 spills between 50 and 1,000 bbl, about 190-210 spills between 1 and 50 bbl, and about 740-820 spills of 1 bbl or less are expected to impact coastal waters annually 15-20 years from now. The following discussion provides long- and short-term impacts expected from such numerous spill occurrences.

The level of contamination in coastal waters from all these oil spills is dependent on the amount of petroleum hydrocarbons that enter the water column and the length of time that these hydrocarbons remain within the water column. These two factors, in turn, are dependent on the type of environment contacted by the slick, the size of the water surface covered by the slick, and the time that the slick remains on the surface of the water (residence time). The area of potential contact and the residence time are very different if a spill reaches marshes or remains in open waters. Section IV.B.2.d. provides assumptions regarding the fate and potential area affected for each spill size category for open water versus marsh areas, as well as assumptions regarding contact.

In open water, the majority of the spilled oil floats on the surface as a slick because hydrocarbons are relatively insoluble in water. The amount of oil dispersed and dissolved under an oil slick in nearshore or open bays is not likely to cause prolonged (more than a few months) adverse water quality conditions once the source of the oil, that is, the slick, is removed by cleanup or naturally degrades by weathering. Oceanographic processes, bacterial action, and dilution of the oil should disperse oil remaining in the water column after the surface slick is removed or moves away from the contaminated water column, dependent on the energy of the system being impacted. Longer-lasting deterioration of coastal water may occur should the water mass be proximate to a continuous source of oil, such as an oiled shoreline.

When an oil spill occurs in protected waters, such as within a marsh, this oil would weather at a slower rate than oil spread out on the surface of an open waterbody. Part of the slick may be pushed into clumps of marsh vegetation or into protected pools. Weathering and natural removal processes would be slowed because of the low energy of such areas and the thickness of the oil layer, and the oil would act as a continuous source of hydrocarbon contamination to the surrounding waters. No cleanup of the spilled oil is expected to occur in wetland areas.

Because the expected impact from spills is very different depending upon whether the spill reaches low-energy, wetland areas versus higher energy nearshore waters, open bays, or channels, the estimated number of spills is further divided based on their likelihood to occur in the two types of environments.

Offshore spills are assumed to affect only open coastal waters because spill response efforts are assumed to prevent a significant quantity of the slick reaching inland, protected wetlands. The USCG data show that about 85 percent of spills occurring in coastal waters are within open waters (harbors, ports, channels, or rivers). Adding the number of offshore spills projected to reach coastal waters to 85 percent of projected coastal spills, about 12-18 spills greater than or equal to 1,000 bbl, 20-25 spills greater than 50 bbl and less than 1,000 bbl, and 160-180 spills greater than 1 bbl and less than or equal to 50 bbl are projected to impact open coastal waters in a typical year. For open waters, the area of potential contact is the maximum area covered if oil remained together and spread out to 1 mm in thickness; this is assumed to be about 0.8 ha for each 50 bbl spilled. It is also assumed that most slicks would normally dissipate within 10 days and that all sheen would be gone within six weeks after the cleanup. Hydrocarbon contamination from the numbers and sizes of spills projected to reach or occur in open coastal waters in a typical year would be gone within six months in 1,400 ha of open waters, within one year in another 60 ha of open water, and within two years in about 12 ha of open waters for spills.

About 15 percent of projected coastal spills is assumed to reach protected, low-energy waters within wetlands. Estimates of the area of potential contact and residence times for the number and size of spills projected are based on the assumptions described in Section IV.B.2.d. The areal extent of this contamination is assumed to decrease significantly over time and is dependent on the proximity of water to oiled vegetation and sediments. Given the above, projected oil spills reaching or occurring in low-energy, protected areas annually in a typical year could impact up to 350 ha of wetland waters. Contaminants from the spills estimated to reach or occur in low-energy, protected waters in a typical year would be detected for up to 6 months in 7 ha, up to 5 years in another 24 ha, and for as long as 10 years in 325 ha of wetlands.

For the 740-820 spills of 1 bbl or less per year, the primary concern is the frequency of occurrence because their residence time is so temporary and the area impacted is so small. Areas subjected to chronic spills may incur greater impacts.

Summary and Conclusion

Contaminant inputs to coastal waters bordering the Gulf of Mexico will continue to be the result of large volumes of water entering the Gulf from rivers draining over two-thirds of the contiguous U.S., from both municipal and industrial point- and nonpoint-source discharges, and from numerous spill events. Major sources expected to contribute to the contamination of Gulf coastal waters include the petrochemical industry (inclusive of oil and gas development and processing), agriculture, urban expansion, municipal and camp sewerage treatment processes, marinas, commercial fishing, maritime shipping, and hydromodification activities. Lesser sources of contaminants are likely to be forestry, recreational boating, livestock farming, manufacturing industry activities, nuclear power plant operations, and pulp and paper mills. Runoff and wastewater discharge from these sources will cause water quality changes that will result in a significant percentage of coastal waters not attaining Federal water quality standards. The onshore service industry supporting the OCS oil and gas industry will contribute to a minor extent (less than 10%) to cumulative water quality degradation.

Vessel traffic will degrade coastal water quality through routine releases of bilge and ballast waters, chronic fuel and tank spills, trash, and domestic and sanitary discharges. The greatest impacts from commercial vessel traffic will occur along navigation channels from elevated levels of hydrocarbons and tributyltin compounds found in bilge waters and marine paints, and within highly populated, confined harbors and anchorages from increased BOD and pathogens from sanitary and domestic waste discharges.

Increased turbidity from extensive dredging operations projected to continue within the Gulf coastal zone constitutes another considerable type of nonpoint-source pollution in the Gulf coastal waters. Analysis of historical data shows that maintenance dredging, the dominant dredging activity in the Gulf area, will continue to increase each year and is likely to displace approximately 4 billion m^3 of sediment in the next 35 years, with about 55 million m^3 of dredged materials being disposed of directly into Gulf estuarine waters annually at USEPA-designated dredged material disposal areas. Dredging will also take place for pipeline emplacement, State oil and gas well access, and commercial developments, many in support of the OCS oil and gas industry. Dredged sediments will enter coastal waters either directly by open-water dumping or

indirectly, if the sediments originally dredged and emplaced onto spoil banks and into wetlands wash and erode away.

Considering the frequency, large number, and widespread locations of anticipated spills, a large percentage of coastal waters could be affected by petroleum inputs. The contamination should be primarily localized and not long term enough to preclude designated uses of the waters. In the areas where oil spills are most likely to be a recurring problem, coastal waters could be subject to low-level and chronic regional petroleum contamination. Spill events from OCS-support operations constitute about 10 percent of the total spill events estimated to occur during a typical future year.

(b) Marine Waters

This cumulative analysis considers the effects on offshore water quality from the OCS oil and gas leasing program, OCS sulfur mining program, oil tankering and other vessel traffic, and coastal water quality conditions. Contamination of the Gulf of Mexico is occurring from offshore, coastal, and land-based sources. Atmospheric and riverine inputs transport contaminants from sources outside of the Gulf coastal zone into Gulf waters. Most offshore sources of contaminants result from man's activities in the Gulf and include discharges of oil and gas drilling and production wastes, discharges from vessels, bottom disturbances from oil and gas structure and pipeline emplacement and removal, and from anchoring, dredged material disposal, and spills of oil and hazardous substances. A major offshore source of petroleum hydrocarbons into Gulf waters is natural seepage.

Offshore sulphur operations Gulfwide started in 1954 and were well established along the Louisiana and Texas coasts since the 1920's. Sulphur mining operations generate wastewater discharges including mostly bleed water discharged directly into surface waters. Dissolved solids in bleed water closely approximate those found in seawater. Data from years of testing by Freeport McMoRan at its Grand Isle Mine show that bleed water is not detectable at a distance greater than 90 m away from the source. Accidental spills of molten sulphur would have an inconsequential impact on offshore water quality. Impacts on northern Gulf of Mexico water quality resulting from sulphur operations are assumed to be immeasurable.

Historically, changes in offshore water quality from oil spills have only been detected during the life of the spill and for a short time afterwards. 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. Overall, the relative amount of oil that resides in the water column depends on the depth at which the oil is spilled, the point of release (surface versus subsurface), the hydrographic conditions affecting the surface slick, and the amount of particulate matter in the water. Once oil is spilled, it weathers and its chemistry is altered. Table IV-11 provides the results of the MMS weathering model that predicts the changes in time in chemical and physical characteristics and volume for a slick resulting from a typical large OCS oil spill. About 1-5 percent of the surface slick volume dissolves into the water column. By 10 days, another 17 percent disperses into the water column. A larger percentage could be measured in the water column at any time but would have a very short residence time as the oil is absorbed onto particulate matter then deposited on the seafloor or taken up by organisms. Elevated hydrocarbons measurable under a slick are not expected to penetrate below about 30 m from the surface. The amount of oil dispersed and dissolved from an oil slick is not likely to cause prolonged (more than a few months) adverse water quality conditions. Oceanographic processes and natural weathering should disperse the oil remaining in the water. It is assumed that any oiling of offshore waters would occur only to the water column that comes in direct contact with a moving slick, and changes in water-column chemistry resulting from this oiling would be of short duration (2-3 months). Water quality changes in the water column are limited to the area around and beneath the surface slick and is expected to last for only a short time following the removal of the slick from the surface of the water. Given this, the frequency of occurrence and the size of the spills are the major factors determining water quality degradation. Future spills are assumed to be quite numerous; Table IV-18 provides projections on spill occurrence, probabilities for assumed occurrences, and the average size of many large offshore spill categories. Oil spills may occur from vessels that are importing and exporting crude oil and petroleum products, from vessels that are transporting oil and its products through Gulf waters between U.S. ports, from damaged fuel tanks in any vessels transiting the Gulf, from LOOP, and from OCS oil and

gas production operations. Section IV.C.2.c. provides further information on LOOP and the extensive marine transportation projected to occur in the Gulf of Mexico in the future.

As many as 3-4 spills greater than 1,000 bbl could occur annually in the Gulf of Mexico from tanker and barge traffic during a typical future year. About one spill greater than 1,000 bbl is estimated to occur annually from OCS operations (Table IV-18). Spills greater than 1,000 bbl are assumed to result in localized, short-term changes to offshore water quality conditions in the area affected by the spill for up to three months from the time of the spill.

Smaller size spills would occur much more frequently. About 1,270-1,950 small spills, less than 1,000 bbl, are estimated to occur in Federal offshore waters during a typical future year. About 80 percent of the these are calculated to occur from OCS oil and gas activities, 95.4 percent of which would be 1 bbl or less (Anderson, 1997). These numerous spills could add to the regional petroleum contamination of Gulf waters. A comparison of the major sources of oil contamination in the Gulf can be found in Section IV.C.4. Although not complete, the comparison shows that offshore spills account for less than 10 percent of the petroleum hydrocarbon loadings of Gulf waters.

Spills of hazardous materials may, in many cases, pose a more serious threat to marine ecosystems than oil spills. Substantial amounts of hazardous materials enter the marine environment from accidental spills. Although the focus in the past has been on the cleanup and mitigation of spilled oil, national attention has been shifting toward the spills of hazardous materials. Much has been learned in the past 10 years about how to respond to oil spills; far less is known about spills of hazardous material, which are complicated by their wide variety of physical and chemical forms, which in turn makes their cleanup and disposal much more difficult.

Routine offshore oil and gas development operations affect marine waters through bottom disturbance during construction and removal operations, bottom disturbance during anchoring, and the discharge of operational wastes. Blowouts or spills of oil and hazardous substances also have the potential to alter offshore water quality.

Vessels disturb the bottom when they anchor, resuspending sediments. The frequency and extent of anchoring activities that occur offshore is not known. At some of the locations where lightering operations take place, large supertankers anchor while offloading their cargo.

Tables IV-4, IV-5, and IV-6 present the estimated number of exploration and delineation wells, production platforms, development wells, and the length of offshore pipelines needed to develop, produce, and transport the estimated resources for the OCS Program. To develop existing reserves, about 4,000 active platforms, with about 13,000 development wells and 37,200 km of associated pipelines, would be in place at the time of the proposed sale (Table IV-8). At present, 250-350 exploration or delineation wells are drilled annually in the Gulf. By far, most of these are in the CPA. The overall annual rate is expected to decline over time as the hydrocarbon potential of more areas is tested through drilling. By the year 2036, Gulfwide exploratory drilling may be as low as 55-80 wells annually. At present, 90-150 platforms are installed annually in the Gulf. The majority of these, more than 80 percent, are conventional fixed platforms in water depths less than 60 m. Although the rate of platform installation in deeper water areas (greater than 200 m) is expected to increase over the next decade, the overall annual platform installation rate is expected to decrease. At present, 300-575 development wells are drilled annually in the Gulf. Most of these development wells are being drilled in the CPA. The overall annual rate is expected to decline over time as more areas reach peak development. Development drilling is projected to be at its peak in the CPA through the next seven years, in the WPA in 2002-2009, and in the EPA in 2005-2013. By the year 2036, development drilling in the Gulf of Mexico may be as low as 70-100 wells annually. Section IV.A. provides assumptions regarding the levels of major impact-producing factors associated with the assumed exploration, development, and production activities resulting from the proposed action.

Bottom area disturbances resulting from the emplacement of drill rigs, the drilling of wells, and the installation of platforms and pipelines would increase water-column turbidity in the overlying offshore waters. Section IV.A.3.a. provides the areal extent of disturbance for each of these activities. In water depths shallower than 61 m, pipelines would be buried below the seafloor, as required by MMS regulations, resulting in additional resuspension of sediment. Besides resulting in turbidity, sediment disturbance can result in the resuspension of any accumulated pollutants, such as trace metals, chlorinated hydrocarbons, and

excess nutrients. As discussed in the general introduction to the marine water quality analysis, bottom disturbances resulting from platform installation on the OCS have produced short-lived impacts on water quality conditions in the immediate vicinity of the emplacement operation (Arthur D. Little, Inc., 1985). Should operations occur frequently and in proximity of each other, there would be any increased risk of water quality degradation. The OCS operations, such as the drilling of wells, are assumed to occur over a widespread schedule and have a widespread distribution. Pipelaying operations would probably be spread out relative to production. Therefore, it is assumed that combined effects from OCS operations would not occur. Individual operations would result in short-lived and local impacts on water quality.

Blowouts also can disturb the bottom and increase water-column turbidity, dependent upon whether they occur subsurface and upon their severity. If sediments are resuspended, the sands generally settle within 400 m for a 30-m water depth and 25 cms^{-1} blowout. During a large blowout, sands would also settle within 400 m, but finer sediments could remain in suspension for periods of 30 days or longer and thus be dispersed over larger distances. Based on historical trends, about seven blowouts per thousand wells drilled is estimated to occur in the Gulf. No more than 1,000 wells are projected to be drilled in any one year; thus, no more than seven blowout events are projected each year. It is assumed that only some of these blowouts would disturb surrounding sediments. Given this, blowout events are expected to result in localized, short-term changes in water quality that may affect the uses of the waters disturbed, but would not be of consequence to regional water quality.

In addition to increasing water-column turbidity due to bottom sediment resuspension, explosive platform removal may adversely impact water quality by releasing explosive by-products into the water column. This resuspension of sediments would only have a short-term local effect. At present, platforms are being removed at a rate of 45-65 annually. This rate is expected to decrease over time. The number removed explosively would be a subset of the total number removed. Given these numbers and the fact that the platforms would be widespread, such operations would not affect regional water quality.

Daily operational discharges to offshore waters occur from vessels moving through Gulf waters and from most oil and gas operations. The discharge of drilling fluids and cuttings and produced waters accounts for the bulk of effluent discharge volumes from oil and gas development and production facilities. Major contaminants in oil-field wastes can include high salinity, low pH, high biological and chemical oxygen demand, suspended solids, heavy metals, crude oil compounds, organic acids, priority pollutants, hazardous wastes, and radionuclides. The discharge of treated sanitary and domestic wastes from rigs, platforms, and vessels may increase suspended solids, nutrients, chlorine, and biological oxygen demand (BOD) in a small area near the point of discharge. Deck drainage from OCS structures and vessels can be contaminated. Bilge waters and ballast waters may be routinely discharged from vessels and rigs and can contain petroleum and metallic compounds leaked from machinery. Tributyltin (TBT) has been used since the 1960's as an antifouling agent in marine paints and enters the marine environment slowly through deterioration of the painted surfaces. Since 1989, the use of TBT has been banned in paints applied to boats less than 25 m, but it is still being used on larger vessels such as aluminum-hulled service boats. Monitoring studies have shown that TBT levels have decreased in the Gulf of Mexico since this ban. However, data have also shown that marine life in the Gulf may be continuing to be exposed to butyltin compounds (Kannan et al., 1997).

Section IV.A.3.d. provides detailed descriptions of expected characteristics and levels of offshore oil and gas operational discharges. It also summarizes both laboratory and field research on the transport of these wastes in the water column, their incorporation into bottom sediments, water column and benthic organism effects, toxicity of components, water quality exceedances, and bioaccumulation. The total level of contaminants estimated by the USEPA (1993) to be discharged annually in drilling muds and cuttings in the future is 1.65 billion pounds per year and in produced water is 44 million pounds per year. It is assumed that existing and future limitations on the levels of various contaminants in drilling muds and cuttings and produced-water discharges, discharge-rate restrictions, and toxicity testing requirements contained in NPDES permits are expected to continue to eliminate significant biological or ecological effects that were documented in the past. All other minor waste discharges will be rapidly assimilated and dispersed.

Plumes of drilling fluids and produced water mix rapidly with ambient seawater. Beyond 100 m from the discharge point, none of the contaminants are expected to be at concentrations great enough in the water column to produce adverse effects to water-column organisms. Biofouling organisms on submerged

platform structures may be exposed to harmful concentrations of some contaminants in the discharge plumes. Contaminants in produced water and drilling discharges should be undetectable in the water column by 1,000 m from the discharge point.

Sediment contamination is dependent on the water depth and current speed. In shallow waters, elevated levels of petroleum hydrocarbons and metals from produced water, drilling fluids, and drill cuttings may be measurable in sediments out as far as 2,000-3,000 m downcurrent from the discharge. In general, for operations occurring in water depths less than 100 m, retention within the sediments of chemicals found in OCS discharges is likely to occur from several hundred to several thousand meters from the discharge point. Despite any possible sediment accumulation of these discharged chemicals, biological responses to levels retained by the sediments are not expected to be detectable beyond a couple hundred meters, and toxic effects to the benthos are expected to be very localized, limited to within 100 m from the discharge, and of a relatively small magnitude. Toxic effects beyond 100 m should be controlled through the NPDES permit requirements.

There is some evidence that bioaccumulation of a few chemicals found in OCS discharges may be occurring in fish and benthic organisms to a small extent. Two recently completed studies (Kennicutt, 1995; CSA, 1997b) found some long-lasting effects existed in the sedimentary environment around gas platforms. Both studies identified a few stations where higher levels of contaminants in benthic organisms were correlated with discharge inputs. Peterson et al. (1996) concluded that the heavy metals in barite, the release of produced waters, and the organic shedding from the platforms appear to be the major determinants of observed biological response patterns that extend to a distance of 100-200 m away from the gas production platforms on the Gulf of Mexico shelf. Industry just completed a large monitoring study (CSA, 1997b) that was conducted to provide information on possible bioaccumulation specifically associated with produced-water discharges. The results are expected to assist the USEPA in the development of the 1997-2002 general NPDES permit. The authors concluded that there was little evidence of bioaccumulation of produced-water contaminants. Although most contaminants were detectable in soft-tissue organisms, concentrations were below levels that would represent a hazard to marine animals or man. Mercury and arsenic were measurable in all tissue samples analyzed from both nondischarging and discharging platforms; arsenic being detected above a risk-based concentration set to measure human health concerns. Arsenic was measured at higher levels near platforms discharging produced water than at nondischarging platforms in 3 out of 12 cases; the same difference was found for polycyclic aromatic hydrocarbons in one instance. Since the new NPDES permit has not been developed as of the writing of this EIS, it is assumed that limits in the new permit will be set to restrict any bioaccumulation determined to be of concern and occurring from OCS discharges.

As industry moves into deeper waters, their operations are becoming different from those historically conducted. Because of the expense of drilling in deep water, more wells will be drilled directionally or horizontally from the same production facility. The well stream coming from subsea completions may be carried by mixed pipelines to large, centralized processing facilities located in deep water or at the shelf break (DeepStar, 1994). Discharge volumes and rates for these centralized facilities and at deepwater production platforms are expected to be large and at maximum USEPA allowable discharge rates. Despite this increase in discharge loadings, wastes discharged at deepwater sites should be subject to ample dilution and dispersion, and it is uncertain how much of the discharge will reach deep-sea sediments. Levels of discharges per deepwater facility would be higher than shallower water facilities, but there would be fewer locations. Drilling discharges from facilities in waters deeper than 400 m could reach the seafloor, but any cuttings would probably be distributed across broader areas of the seafloor at greater water depth and would generally be distributed in thinner accumulations than would occur in shallower areas on the continental shelf. Levels of contaminants in deep-sea sediments from drilling discharges will be extremely low or unmeasurable. Smothering and other physical effects from these thin accumulations of drilling wastes are expected to be much less than those documented at shallower sites. In deeper waters, sediment contamination from a produced-water plume is more likely to occur only within a few hundred meters from the point that the plume reaches the seafloor, if it is detectable at all (Neff, 1997b). Since the plume from produced water discharged from surface facilities is not expected to reach the seafloor in water depths greater than 100 m, no seafloor sediment contamination is expected beyond this water depth.

Some operations fall between the traditional shallow type of operations and the projected deepwater operations. For these operations, the level of impact to marine waters would probably fall somewhere between the levels projected for shallow versus deepwater operations.

Vessel traffic associated with the extensive maritime industry, the oil and gas support operations, and recreational and commercial fishing operations routinely discharge contaminants in domestic and sanitary wastes and in bilge and ballast waters into offshore waters. New regulations promulgated under the international protocols provided by MARPOL 73/78 (33 CFR 157) have significantly limited petroleum hydrocarbon levels in bilge and ballast water discharges from oil tankers and other large vessels. No total volume is calculable for bilge and ballast water discharges from all offshore vessel traffic. In general, bilge water discharges are dependent on the size and tonnage of a vessel. For a 200-ft vessel weighing 100 tons, about 2,000 liters of bilge water is discharged in a 24-hour period (NERBC, 1976). About 400,000-500,000 service-vessel trips and about 120 barge trips are assumed to occur annually in connection with OCS offshore operations. For each person working or traveling in Gulf waters on a vessel, about 227 l/day of sanitary wastes are discharged. Although diluted and discharged slowly over large areas, vessel wastes, both OCS-related and others, are assumed to contribute in a very small way to the long-term, regional degradation of water quality.

Very little quantitative data exist on many sources of contamination. Some information is available on the volumes of petroleum hydrocarbon compounds entering Gulf waters from various sources (Section IV.C.4.). Based on the analysis of inputs from various sources found in Section IV.C.4., the OCS oil and gas industry contributes about 4 percent of the Gulf's regional, long-term contamination by petroleum hydrocarbons. Natural seepage accounts for 27 percent of the total input. Although the Gulf comprises one of the world's most prolific offshore oil-producing provinces, onshore sources of hydrocarbons to Gulf waters far outweigh the contributions from offshore domestic production of oil (NRC, 1985; Section IV.C.4.); coastal sources contribute an order of magnitude more petroleum hydrocarbons to Gulf waters than offshore anthropogenic sources.

Coastal sources have also been implicated as the primary source of other contaminants, especially elevated nutrients. These elevated nutrients are periodically not supporting the designated uses of the waterbodies being affected. Contaminants and high levels of nutrients found in land-based effluents and runoff have been identified as potential causes of hypoxia and, possibly, more frequent red tide outbreaks. It is believed that hypoxia occurring in bottom waters in some areas of the open Gulf is caused by nutrient loading coming from the Mississippi River, combined with high summer temperatures and/or phytoplankton blooms in surface waters (Rabalais, 1992). A hypoxic zone about 48-km wide has been identified in the summer on the central Louisiana shelf extending from the Mississippi Delta to offshore Galveston. Mass mortalities of the benthic communities have been documented in the zone (Rabalais, 1992). There are ongoing studies to determine whether human activity that continues to increase nutrient loadings to Gulf waters will increase the intensity and frequency of red tides outbreaks in the future.

Information on elevated levels of organic compounds of environmental concern measured in northern Gulf offshore waters was summarized by Kennicutt et al. (1988). Volatile organic compounds (VOC's) were generally present in the highest levels in coastal and nearshore waters, were highest near known onshore point-source discharges, and generally decreased with distance from shore. Chlorinated VOC's were generally restricted to nearshore waters, whereas petroleum-related VOC's were detected at offshore locations. The highest levels of petroleum hydrocarbons were measured near point sources in coastal environments and near natural seeps. Large areas of the Gulf appear to be relatively pristine (off Florida and southern Texas) and other areas show significant contamination (northern Texas coast, Louisiana, and Alabama). Organochlorine residues appear to exist in many marine species. Higher concentrations of pollutants were generally found in organisms from the Mississippi Delta in comparison to offshore biota (Kennicutt et al., 1988). In a recently completed study that measured metals in fish and benthic organisms in the CPA, fish tissue was often found contaminated with elevated heavy metals, some above human health standards (CSA, 1997b). Studies have identified the Mississippi River, which drains two-thirds of the United States, as the major source of contamination for Gulf waters (e.g., Bedinger, 1981; Brooks and Giammona, 1988).

The Mississippi River will continue to be the major source of contamination of the Gulf. Municipalities, industries, and agriculture enterprises located upriver and in the Gulf's coastal zone will continue being the primary source of contaminants to coastal and offshore waters. Over time, continuing coastal water quality contamination will degrade offshore water quality. As the assimilative capacity of coastal waters is exceeded, there will be a subsequent, gradual movement of the area of degraded waters farther offshore over time. This degradation will cause short-term loss of uses of large areas of shallow, offshore waters due to hypoxic and red tide impacts and to levels of contaminants in some fish exceeding human health standards.

Summary and Conclusion

Sediment disturbances caused by maximum annual emplacement of 90-150 new platforms and associated pipeline systems and the removal of, at most, 65 platforms annually along with some associated pipelines, from the drilling of a maximum of 250-350 exploratory wells and a maximum of about 600 development wells, and from commercial fishing trawler operations and vessel anchoring are assumed to result in localized, short-term increases in water-column turbidity in offshore waters. The risk of water quality degradation would be heightened if these operations occur frequently in proximity to each other. Given the few number of projected explosive platform removals and blowouts projected to occur in a typical year, resuspension of sediments is assumed to have minimal impacts on water quality.

Future waste discharges from OCS operations are assumed not to degrade offshore water or sediment quality great enough to cause any acute, toxic effects to any living organism beyond 100 m from the discharge. Some bioaccumulation may be occurring. The effect to the food web is unknown but unlikely because of the extremely low levels of uptake and the low bioavailability of these compounds. In the long term, contaminant inputs from OCS discharges, combined with spill incidents related to OCS operations, could be adding to the regional degradation of Gulf waters and sediments.

Municipal, agricultural, and industrial coastal discharges and land runoff would continue to impact the long-term health of marine waters of the Gulf of Mexico. Coastal sources are assumed to exceed all other sources, with the Mississippi River continuing to be the major source of contaminants to marine waters. Offshore vessel traffic would contribute, in a small way, to regional degradation of offshore waters through spills and waste discharges.

All spill incidents (OCS and others) are assumed to cause local, water quality changes for up to three months for each incident and to make a small addition to the regional petroleum contamination of Gulf waters.

As the assimilative capacity of coastal waters is exceeded, there will be a subsequent, gradual movement of the area of degraded waters farther offshore over time. This degradation will cause short-term loss of the designated uses of large areas of shallow offshore waters due to hypoxic and red tide impacts and to levels of contaminants in some fish exceeding human health standards.

(4) Impacts on Air Quality

The Gulf of Mexico has been subdivided into subareas based on water depth (0-60, 60-200, 200-900, 900-3000, and 3000+) (Figure IV-1). Table IV-3 presents the numbers of exploration, delineation, and development wells; platforms installed; and service-vessel trips for the cumulative scenario in each subarea. The types of sources and their usage do not really change from the proposed action (lease sales in the WPA) to the cumulative scenario. Rather, the main differences between these two analyses are that the proposed action considered only the emissions associated with one lease sale and the area analyzed was restricted to the WPA of the Gulf of Mexico. In the cumulative analysis, the cumulative emissions from existing sources, the proposed sale, and potential future sales are combined and the area analyzed is the entire Gulf of Mexico. The cumulative Gulfwide emissions for the 39-year period under consideration are estimated in Table IV-29.

Table IV-29

Projected Total Cumulative Gulfwide OCS Program Emissions by Source
(tons over the 35-year life of the proposed action)

Activity/Pollutant	NO$_x$	CO	SO$_x$	VOC	TSP
Service Vessels	4,865,580 - 5,909,753	488,853 - 593,763	506,694 - 615,433	212,294 - 257,853	294,382 - 357,558
Pipeline Vessels	135,352 - 189,079	45,353 - 63,356	18,848 - 26,330	12,369 - 17,279	11,191-15,633
LTO Helicopters	3,241 - 4,675	2,618 - 3,776	499 - 719	112 - 162	125 - 180
Cruise Helicopters	5,585 - 8,055	15,958 - 23,016	1,197 - 1,726	1,197 - 1,726	1,596 - 2,302
Blowouts without Fire	0	0	0	2,851 - 4,597	0
Spills without Fire	0	0	0	4,358 - 6,717	0
Barge Loading	0	0	0	2,134 - 2,878	0
Tanker Loading	0	0	0	6,476 - 1,0663	0
Transit Loss	0	0	0	15,168 - 24,091	0
Tanker Exhaust	2,115 - 3,525	231 - 385	2,627 - 4,378	3.1 - 5.2	760 - 1,267
Tug Exhaust	17,353 - 17,353	1,729 - 1,729	1,791 - 1,791	721 - 721	1,041 - 1,041
Platform Construction	207,465 - 392,814	40,976 - 77,584	11,810 - 22,361	12,175 - 23,051	12,746 - 24,133
Exploration Wells	107,523 - 168,272	28,644 - 44,827	12,586 - 19,697	10,362 - 16,216	3,092 - 4,839
Development Wells	140,974 - 282,378	37,589 - 75,292	16,531 - 33,113	13,579 - 27,200	4,002 - 8,015
Platforms	3,748,381 - 4,037,684	872,264 - 939,587	629,887 - 678,503	2,842,227 - 3,061,593	68,514 - 73,802
Totals	9,233,570 - 11,013,589	1,534,215 - 1,823,314	1,202,471 - 1,404,051	3,186,026 - 3,454,731	397,449 - 488,770

Total OCS emissions for each WPA subarea in the Gulf of Mexico for the cumulative scenario are presented in Table IV-30. Pollutants are distributed to subareas proportional to the projected number of production structure installations identified for those areas.

Table IV-30

Projected Total Cumulative Gulfwide OCS Program Emissions by Water Depth in Meters
(tons over the 35-year life of the proposed action)

Pollutant Distribution	0-60	60-200	200-900	900-3000	Total
NO$_x$	6,149,464 - 7,098,302	1,452,998 - 1,683,042	853,051 - 1,122,028	778,057 - 1,110,217	9,233,570 - 11,013,589
CO	1,021,772 - 1,175,133	241,425 - 278,630	141,740 - 185,753	129,279 - 183,798	1,534,215 - 1,823,314
SO$_x$	800,833 - 904,916	189,221 - 214,560	111,091 - 143,040	101,325 - 141,534	1,202,471 - 1,404,051
VOC	2,088,562 - 2,226,588	493.486 - 527,935	289,724 - 351,957	264,254 - 348,252	3,136,026 - 3,454,731
TSP	264,697 - 315,014	62,543 - 74,691	36,719 - 49,794	33,491 - 49270	397,448 - 488,770

Emission rates for the cumulative scenario are not uniform but do not vary greatly from year to year. The deviation is on the order of 10 percent or less for the entire 35 years. This is in contrast to the distinctive peak in activities; hence, emissions associated with a single sale are analyzed in the proposed action. This smoothing is caused by the overlapping of successive peaks from individual sales.

Peak-year emissions for the entire 35 years of Gulfwide activities are presented in Table IV-31. The peak year is expected to occur between 2005 and 2013.

The peak-year emissions are calculated by combining peak-year activity total emissions for exploratory wells, development wells, and platforms over 35 years, and superimposing peak projected activity for support vessels and other emissions into that peak year. It is important to note that well-drilling activities and platform peak-year emissions are not necessarily simultaneous. However, it is assumed for this analysis that total well and platform peak-year emissions combined with vessels and other emissions occur simultaneously. Use of the peak emissions shall provide the most conservative estimates of potential impacts to onshore air quality.

Table IV-31

Projected Peak-Year Gulfwide OCS Program Emissions by Source
(tons)

Activity/Pollutant	NO$_x$	CO	SO$_x$	VOC	TSP
Service Vessels	139,017-168,850	13,967-16,965	14,477-17,584	6,066-7,367	8,411-10,216
Pipeline Vessels	3,867 - 5,402	1,296 - 1810	539 - 752	353 - 494	320 - 447
LTO Helicopters	93-134	75-108	14-20	3-5	4-5
Cruise Helicopters	160-230	456-658	34-49	34-49	46-66
Blowouts without Fire	0	0	0	2,851-4,597	0
Spills without Fire	0	0	0	4,358-6,717	0
Barge Loading	0	0	0	61- 82	0
Tanker Loading	0	0	0	185 -305	0
Transit Loss	0	0	0	433 - 688	0
Tanker Exhaust	60-101	7-11	75-125	0-0	22-36
Tug Exhaust	0	0	0	0	0
Platform Construction	5,928-11,223	1,171-2,217	337-639	348-659	364-689
Exploration Wells	4,995-6,818	1,331-1,816	585-798	481-657	144-196
Development Wells	6,597-12,249	1,759-3,266	774-1,436	636-1,180	187-348
Platforms	98,097-107,815	22,828-25,089	16,484-18,118	74,382-81,751	1,793-1,970
Totals	258,813 - 312,822	42,888 - 51,939	33,319 - 39,522	90,192 - 104,549	11,290 - 13,974

For conservative estimation, it is assumed that emissions from potential oil spills and potential blowouts will occur in the peak year. Yet, platforms remain the primary source of VOC emissions.

Peak-year emissions for each subarea for the cumulative scenario are presented in Table IV-32. Pollutants are distributed to subareas proportional to the projected number of production structure installations identified for those areas.

Table IV-32

Projected Peak-Year Gulfwide OCS Program Emissions by Water Depth in Meters
(tons)

Pollutant Distribution	0-60	60-200	200-900	900-3000	Total
NO$_x$	172,367 - 201,615	40,727 - 47,804	23,911 - 31,869	21,809 - 31,534	258,813 - 312,822
CO	28,563 - 33,475	6,749 - 7,937	3,911 - 5,291	3,614 - 5,236	42,888 - 51,939
SO$_x$	22,190 - 25,472	5,243 - 6,040	3,078 - 4,026	2,808 - 3,984	33,319 - 39,522
VOC	60,067 - 67,383	14,193 - 15,977	8,332 - 10,651	7,600 - 10,539	90,192 - 104,549
TSP	7,519 - 9.006	1,777 - 2,135	1,043 - 1,424	951 - 1,409	11,290 - 13,974

The VOC emissions are best addressed as their corresponding ozone impacts, which were studied in the Gulf of Mexico Air Quality Study (GMAQS). The GMAQS indicated that OCS activities have little impact on ozone exceedance episodes in coastal nonattainment areas, including the Houston/Galveston, Port Arthur/Lake Charles, and Baton Rouge areas. Total OCS contributions to the exceedance (greater than 120 ppb) episodes studied were less than 2 ppb. In the GMAQS, the model was also run using double emissions from OCS petroleum development activities; the resulting attributable ozone concentrations, during modeling exceedance episodes, were still small, ranging 2-4 ppb. The cumulative activities under consideration will not result in a doubling of the emissions, and because they are substantially smaller than this worst-case scenario, it is logical to conclude that their impact would be substantially smaller as well (Systems Applications International et al., 1995). Additionally, 30 CFR 250.45(f)(2) requires that, if a facility would significantly impact (defined as exceeding the MMS significance level) an onshore nonattainment area, it would have to reduce its impact fully through the application of Best Available Control Technology (BACT) and possibly through offsets as well.

It is assumed that oil spills would result in low impacts on air quality because the emission rate of pollutants would be low and of short duration (it is assumed that 30% of the spill evaporates in 3 days). Information from OCS accidents indicates emissions of fewer than 100 tons/hr by the second hour. Air quality impacts from spills would be dependent on a variety of factors including location, meteorological conditions at the time, and duration of the spill. Pollution concentrations reaching shore will generally be

low due to dispersion of the emissions with distance over water and the fact that emissions decrease with time and become more diffuse as the spill spreads over a larger area with time. Any potential air quality impacts from a large spill would be rare, very localized, and of short duration.

Approximately 3-4 percent of OCS crude-oil production is offloaded from surface vessels at shore terminals. The fugitive emissions from these offloading operations are estimated as 3,635 tons of VOC. This represents about 0.22 percent of the total VOC emissions in the WPA. Safeguards to ensure minimum emissions from the offloading and loading operations have been adopted by the State of Louisiana (The Marine Vapor Recovery Act, 1989: LAC: III.2108).

Blowouts are accidents related to OCS and State oil and gas activities and are defined as an uncontrolled flow of fluids from a wellhead or wellbore. The air pollutant emissions from blowouts depend on the amount of oil and gas released, the duration of the accident, and the occurrence or not of fire during the blowout. Because of technological advances, blowout duration has decreased. Also, most blowouts occur without fire (MMS database), and the amount of oil released during these accidents has been small. The total emissions of VOC attributable to blowouts is between 2,851 and 4,597 tons during the cumulative scenario, which projects between 108 and 177 blowouts. It must be remembered that these are conservative estimates and that the total amount of VOC may be less.

Recent MMS modeling runs were conducted using the Offshore and Coastal Dispersion (OCD) Model to determine potential cumulative NO_2 and SO_2 impacts on onshore areas. Three large areas were modeled. The limiting factor on the size of the area was the run time needed to process the number of sources. The areas were selected to best capture most of the offshore sources and to focus on the highly concentrated areas of development. The cumulative action was modeled by comparing the projected Gulfwide cumulative emissions with the emission inventory for the GMAQS. Ratios between these two sets of total emission rates were developed and applied to the GMAQS inventory; this modified inventory was then used as the database for the sources for the OCD modeling. The emissions inventory included structures in existence prior to the PSD baseline dates. Emissions from such preexisting structures do not count toward increment consumption. Only the maximum concentrations for all of the runs are reported in the table below and are compared with the federally allowable increases in emissions, as regulated by 30 CFR 250.45(g) and 40 CFR 51.166(c).

Class II
OCS Modeling Results and the Corresponding Maximum Allowable Increases
(micrograms per cubic meter)

Pollutant	Averaging Period	Class II Maximum Allowable Increase	Class II Modeled Impact
SO_2			
	Annual Average	20.0	0.00
	24-hour Average	91.0	0.03
	3-hour Average	512.0	0.19
NO_2			
	Annual Average	25.0	1.06
TSP			
	Annual Average	19.0	*
	24-hour Average	37.0	*

*TSP emissions were not modeled because they are emitted in smaller quantities than NO_2 or SO_2; hence, their impacts would be even less than those modeled and presented above.

The above table lists the highest predicted contributions to onshore pollutant concentrations from activities associated with the proposed lease sales and compares them with the maximum allowable increases over a baseline concentration established under the air quality regulations. While the table shows that the OCS Program by itself would result in concentration increases that are well within the maximum allowable limits, a direct comparison between the two sets of figures is not possible. This is because the actual maximum allowable increase depends on the net change in emissions from all other sources in the area, both offshore and onshore, since the date the baseline level was established. Sources that were already in place at the applicable baseline date are included in the establishment of the baseline and the corresponding concentration and do not count in the determination of the maximum allowable increment. The increment is an additional amount of deterioration of air quality allowed under the PSD program above the baseline

concentration. The baseline concentration was required to be established when the first PSD application was submitted after the trigger date for the individual pollutants.

For CO, a comparison of emission rates to the MMS exemption levels will be used to assess impact. The formula to compute the emission rates in tons/yr for CO are $3,400 \cdot D^{2/3}$; D represents distance in statute miles from the shoreline to the source. This formula is applied to each facility. Offshore Texas, the CO exemption level is 14,819 tons/yr for a facility at the Federal/State boundary line, which is the nearest point to shore of any facility in Federal waters. The average emission rate for a production platform is 11.84 tons/yr, but some vessels have a higher emission rate. Nonetheless, if the peak CO emissions for the entire Gulf of Mexico (at the high end of the range) were taken and assigned to the current number of production platforms (1,820), this would still only result in an emissions rate of approximately 29 tons/yr. Not all platforms are located at the 3 league line; therefore, most platforms have even larger exemption levels than the one used in this example.

Suspended particulate matter is important because of its potential in degrading visibility and because of its potential health effects at high concentrations. The impact depends on emission rates, particle size, and chemical composition. Particle size used in this analysis represents the equivalent diameter, which is the diameter of a sphere, that will have the same settling velocity as the particle. Particle distribution in the atmosphere has been characterized as being largely trimodal (Godish, 1991) with two peaks located at diameters smaller than 2 μm and a third peak with a diameter larger than 2 μm. Particles with diameters of 2 μm or larger settle very close to the source (residence time of approximately ½ day; Lyons and Scott, 1990). For particles smaller than 2 μm, which do not settle fast, wind transport determines their impacts. The TSP's are emitted at a substantially smaller rate than the two pollutants modeled with OCD; hence, impacts from TSP's would be expected to be even smaller because chemical decay was not employed in this dispersion modeling. A straight ratio can be employed to give an impact of 0.05 ug/m^3 for the annual average and 0.01 ug/m^3 for the 24-hr average, which are below the Class II increments.

The amount of power generation that occurs during the period 1997-2031 is very difficult to predict because it depends on many nonquantifiable factors. Therefore, different sets of assumptions result in different estimates. The envelope of predictions shows that energy consumption should increase up to the year 2010; after this, predictions show more variation but generally indicate an increase of energy consumption. Because energy production is the largest single pollutant generator, one would suspect emissions would also increase (USDOE, 1990). However, advances in control technology and use of alternative energy sources can change the correlation between energy production and emissions. The available information (USDOE, 1990) indicates that SO_x emissions from energy generation decreased 16.4 percent between 1970 and 1987. Other pollutants that showed a decrease over the 1970-1987 period are particulate matter and NO_x. Although CO and VOC increased over the same period, the overall amount of emitted pollutants decreased.

Emissions of the criteria pollutants related to industrial activities decreased over the 1970-1987 period. The reduction in the total amount of pollutants was 51 percent (Godish, 1991). The projected increase in employment (Section III.C.2.) can be interpreted as an increase of industrial activities. However, if the decreasing trend of emissions holds during the next 35 years, it is reasonable to estimate that industrial emissions would not increase; at worst, they would remain at present levels.

Even though oil and gas production in State waters is known to be taking place, the States have not provided MMS with information regarding the actual number of production facilities in their jurisdiction. Without this information, MMS cannot estimate emissions from these facilities.

Summary and Conclusion

Based on the cumulative scenario discussed in Section IV.A. (Table IV-3), it is assumed that OCS emissions will maintain present levels with projected decreases in future years in relation to projected declining trends in OCS activity in the Gulf of Mexico and advances in control technology. Future impacts are intrinsically related to the continuation of trends in energy consumption and technological developments in fuel and engine efficiency.

Emissions of pollutants into the atmosphere from the activities associated with the cumulative scenario are not projected to have significant effects on onshore air quality because of the prevailing atmospheric conditions, emission rates and heights, and the resulting pollutant concentrations. Onshore impacts on air quality from emissions from cumulative OCS activities are estimated to be within Class II PSD allowable increments. The incremental contribution of the proposed action (as analyzed in Section IV.D.1.a.(4)) to the cumulative impacts are not significant nor expected to alter onshore air quality classifications.

(5) Impacts on Marine Mammals

This cumulative analysis considers how the combination of potential impacts resulting from the proposed action in addition to past, present, and future OCS activities, incidental take in fisheries, live captures and removals, anomalous mortality events, habitat alteration, and pollution may affect all marine mammals (endangered, threatened, and/or protected) in the region. The major impact-producing factors relative to the proposed action are described in Section IV.D.1.a.(5).

Sections providing supportive material for the marine mammals analysis include Sections III.B.3. (description of marine mammals), IV.A.2.a.(1) (seismic surveying operations), IV.A.2.a.(4) (structure removal), IV.A.2.c. (support activities), IV.A.3.d. (offshore discharges), and IV.A.3.h.(2) (oil spills).

Information on drilling fluids and drill cuttings and produced waters that would be discharged offshore are discussed in Section IV.A.3.d. Effluents are routinely discharged into offshore marine waters and are regulated by the U.S. Environmental Protection Agency's NPDES permits. Cetaceans could periodically interact with these discharges. Direct effects to cetaceans are expected to be sublethal. Indirect effects via food sources are not expected due to offshore dilution and dispersion of operational discharges. It should be noted, however, that any pollution in the effluent could potentially poison and kill or debilitate marine mammals and adversely affect the food chains and other key elements of the Gulf of Mexico ecosystem (Tucker & Associates, Inc., 1990). Operational discharges could periodically contact and/or affect marine mammals.

It is assumed that helicopter traffic will occur on a regular basis. The FAA (Advisory Circular 91-36C) and corporate helicopter policy state that helicopters must maintain a minimum altitude of 700 ft while in transit offshore, and 500 ft while working between platforms. In addition, guidelines and regulations promulgated by the NMFS under the authority of the Marine Mammal Protection Act do include provisions specifying helicopter pilots to maintain an altitude of 1,000 ft within 100 yd (91 m) of marine mammals. It is unlikely that cetaceans will be affected by routine OCS helicopter traffic at these altitudes, provided pilots do not alter their flight patterns to more closely observe or photograph marine mammals that they see. It is also expected that 10 percent of helicopter trips will occur at altitudes below the specified minimums listed above as a result of inclement weather. Routine overflights may elicit a startle response from, and interrupt cetaceans nearby (depending on the activity of the animals) (Richardson et al., 1995). Occasional overflights probably have no long-term consequences on cetaceans; however, frequent overflights could have long-term consequences, if they occur repeatedly and disrupt vital functions, such as feeding and breeding.

It is projected that about 65,000-77,000 OCS-related service-vessel trips will occur annually as a result of the proposed action, plus prior and future OCS sales in the WPA. Noise from service-vessel traffic may elicit a startle and/or avoidance reaction from cetaceans and mask their sound reception. It is expected that the extent of service-vessel traffic predicted in the cumulative scenario could affect cetaceans either through active avoidance behavior or displacement of individuals or groups (reaction will most likely vary with species, age, sex, and psychological status; the most vulnerable might be perinatal females and nursing calves, and those animals stressed by parasitism and disease). The presence of multiple noise sources is expected to cause more frequent masking, behavioral disruption, and short-term displacement (Richardson et al., 1995). Although the proportion of a marine mammal population exposed to noise from any one source may be small, the proportion exposed to at least one noise source may be much higher (Richardson et al., 1995). The net result of any disturbance would be dependent upon the size and percentage of the population likely to be affected; ecological importance of the disturbed area; environmental and biological parameters that influence an animal's sensitivity to disturbance and stress; or the accommodation time in response to a prolonged disturbance (Geraci and St. Aubin, 1980).

The probability of collisions is higher within these waters. It is expected that the extent of service-vessel traffic in the cumulative scenario could affect cetaceans either through avoidance behavior or displacement of individuals or groups. Smaller delphinids may approach vessels that are in transit to bow-ride. There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or productivity, unless they occur frequently. Long-term displacement of animals from an area is also a possibility. It is not known whether toothed whales exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased ship traffic will increase the probability of collisions between ships and marine mammals, resulting in injury or death to some animals.

It is projected that about 250-350 exploration and delineation wells and 300-575 development wells will be drilled annually as a result of the proposed action, plus prior and future OCS sales Gulfwide and will produce sounds at intensities and frequencies that could be heard by cetaceans. It is estimated that noise from drilling activities will be relatively constant and last no longer than two months at each location. Sound levels generated by drilling operations are generally low frequency (Gales, 1982). Odontocetes echolocate and communicate at higher frequencies than the dominant sounds generated by drilling platforms. The bottlenose dolphins is sensitive to high-frequency sounds and is able to hear low-frequency sounds; however, where most industrial noise energy is concentrated, sensitivity appears to be poor (Richardson et al., 1995). Baleen whales appear to be sensitive to low- and moderate- frequency sounds, but as mentioned by Richardson et al. (1995), the lack of specific data on hearing abilities of baleen whales is of special concern since baleen whales apparently are more dependent on low-frequency sounds than are other marine mammals. The effects on cetaceans from platform noise are expected to be sublethal and may elicit some degree of avoidance behavior and temporary displacement; interference with ability to detect calls from conspecifics, echolocation pulses, or other important natural sounds; or might cause temporary reduction in hearing sensitivity. It is expected that drilling noise will periodically disturb and affect cetaceans in the Gulf of Mexico.

Potential impacts to marine mammals from the detonation of explosives include lethal and injurious incidental take, as well as physical or acoustic harassment. Injury to the lungs and intestines and/or auditory system could occur. Harassment of marine mammals as a result of a noninjurious physiological response to the explosion-generated shockwave as well as to the acoustic signature of the detonation is also possible. Resuspension of bottom sediments and increased water turbidity and mobilization of bottom sediments due to explosive detonation is considered to be a temporary effect. At present, explosive platform removals are occurring at a rate of 35-50 platforms annually in water depths less than 60 m. Few platforms to date have been removed in greater water depths. It is expected that structure removals will cause only sublethal effects on cetaceans as a result of the implementation of the MMS guidelines for explosive removals (USDOI, MMS, 1990b, Appendix B).

Seismic surveys use airguns to generate sound pulses. It is assumed that only this method will be used in seismic surveys as a result of the proposed action, plus prior and future OCS sales (Section IV.A.2.a.(1)). Although any one seismic survey is unlikely to have long-term adverse effects on any cetacean species or population, available information is insufficient to be confident that seismic activities, collectively, will not have significant adverse long-term effects on the size or productivity of any marine mammal species or population, with repeated disturbance of vital functions such as feeding, breeding, and nursing.

Oil spills and oil-spill response activities can adversely affect cetaceans, causing skin and soft tissue irritation, fouling of baleen plates, respiratory stress from inhalation of toxic fumes, food reduction or contamination, the direct ingestion of oil and/or tar, and temporary displacement from preferred habitats or migration routes. Earlier studies have suggested that contact with oil, and consumption of oil and oil-contaminated prey, are unlikely to have more than temporary, nonlethal effects on cetaceans (Geraci, 1990). However, evidence from the *Exxon Valdez* spill indicates that oil spills have the potential to cause greater chronic (longer-term lethal or sublethal oil-related injuries) and acute (spill-related deaths occurring during a spill) effects on mammals than originally suggested. Some short-term (0-1 month) effects of oil may be (a) changes in cetacean distribution associated with avoidance of aromatic hydrocarbons and surface oil, changes in prey distribution, and human disturbance; (b) increased mortality rates from ingestion or inhalation of oil; (c) increased petroleum compounds in tissues; and (d) impaired health (e.g.,

immunosuppression) (Harvey and Dahlheim, 1994). Several mechanisms for long-term injury can be postulated: (a) sublethal initial exposure to oil causing pathological damage; (b) continued exposure to hydrocarbons persisting in the environment, either directly or through ingestion of contaminated prey; and (c) altered availability of prey as a result of the spill (Ballachey et al., 1994). A few long-term effects include (a) change in distribution and abundance because of reduced prey resources or increased mortality rates; (b) change in age structure because certain year-classes were impacted more by oil; (c) decreased reproductive rate; and (d) increased rate of disease or neurological problems from exposure to oil (Harvey and Dahlheim, 1994). Effects of cleanup activities are unknown, but increased human presence (e.g., vessels) could add to changes in cetacean behavior and/or distribution, thereby additionally stressing animals, and perhaps making them more vulnerable to various physiologic and toxic effects. In the event that oiling of cetaceans should occur from Size 3 oil spills, the effects would probably be sublethal; few immediate deaths are expected; long-term impacts might be more lethal. Offshore oil spills >1 bbl and < 1,000 bbl are likely to affect only small numbers of animals; the effects would likely have virtually no effect on the range, size, or productivity of any marine mammal population.

It is assumed that 1,270-1,950 (offshore waters) and 950-1,050 (inland waters) spills less than 1,000 bbl could occur each year in the Gulf area. One or more of these could reach nearshore areas and resident dolphin populations. Although an interaction with small spills may occur, few animals likely would be affected due to possible avoidance by the animals and natural dispersion/weathering of a spill in the offshore environment; the effects would likely have virtually no effect on the range, size, or productivity of any marine mammal population.

About 4-5 offshore and 10-15 inland spills $\geq$ 1,000 bbl could occur annually in the Gulf area. Although an interaction with spills $\geq$ 1,000 bbl may occur, few deaths are expected, due to possible avoidance by the animals and natural dispersion/weathering of a spill in the offshore environment; the effects would likely have virtually no effect on the range, size, or productivity of any marine mammal population.

A wide variety of debris is commonly observed in the Gulf. Marine debris comes from a variety of land-based and ocean sources (Cottingham, 1988). Some of this material is accidentally lost during drilling and production operations. The offshore oil and gas industry was shown to contribute 13 percent of the debris found at Padre Island National Seashore (Miller et al., 1995). Both entanglement in and ingestion of debris has caused the death or serious injury of individual marine mammals (MMC, 1995). The probability of this occurrence is unknown, but thought to be low.

Stock structure is completely unknown for all species in the Gulf, except the bottlenose dolphin (Blaylock et al., 1995). Stock definition for bottlenose dolphins is problematic; there are a variety of possible stock structures (Blaylock and Hoggard, 1994). Inshore and offshore forms of bottlenose dolphins are commonly recognized based on morphological and ecological evidence (Hersh and Duffield, 1990). Recent work has confirmed significant genetic differences between inshore and offshore bottlenose dolphins in the Gulf of Mexico (Curry et al., 1995). There has also been speculation that the population of bottlenose dolphins along the southeastern coast of the United States is structured such that there are local, resident stocks in certain embayments and transient stocks that migrate into and out of these embayments seasonally (Scott, 1990). There is reason to believe that some genetic exchange may occur between bottlenose dolphins inhabiting nearshore waters and dolphins from bays and sounds in the Gulf (Blaylock and Hoggard, 1994). Life history parameters have not been estimated for cetacean stocks in the Gulf, except for some coastal bottlenose dolphin stocks (Odell, 1975).

Since the inception of the Marine Mammal Protection Act (1972), over 500 bottlenose dolphins have been live-captured and removed from southeastern U.S. waters for public display and scientific research purposes (USDOC, NMFS, 1989c). The live-capture fishery is managed under the 2 percent quota rule and based on the best available information relating to the bottlenose dolphin population abundance, stock structure, and productivity in the region (Scott and Hansen, 1989). Almost half of these dolphins were caught in the Mississippi Sound area (Tucker & Associates, Inc., 1990). Captures in the past had concentrated on the female portion of the stock, which in turn could significantly lower the potential for future recruitment (Scott, 1990). Capture activities may also stress and affect the survival and productivity of animals that are chased and captured, but not removed (Tucker & Associates, Inc., 1990; Young et al.,

1995; Myrick, 1988). Anomalous mortality events resulted in a temporary, if not permanent, cessation of the live-capture fishery for bottlenose dolphins in the southeastern United States (USDOC, NOAA, 1996).

Several anomalous mortality events (die-offs) have been reported for cetaceans (Marine Mammal Commission, 1995). One of the largest die-offs of bottlenose dolphins occurred along the mid-Atlantic coast of the United States in 1987-1988 (Marine Mammal Commission, 1995). Geraci (1989) concluded that the most likely cause of the mortality was brevetoxin, a "red tide" toxin, though this hypothesis has been criticized (U.S. Congress, 1989 reported in Lipscomb et al., 1994b). Retrospective analyses of tissues indicate that mortality may have been caused by a morbilli virus (Lipscomb et al., 1994b). Dolphins with disease symptoms appeared to have elevated levels of PCB's in their tissues (Kuehl et al., 1991; 1994) leading researchers to conclude that contamination may have played an important part in the event.

Gulf of Mexico bottlenose dolphins have been involved in several unusual mortality events in recent years: 1990, 1992, and 1994. The death of 26 bottlenose dolphins in Matagorda Bay in January 1990 was attributed to cold weather (Miller, 1992a). No conclusive evidence for a single or multiple causal agent(s) was provided for the other 300+ animals on the Gulf Coast that were part of the 1990 die-off (Hansen, 1992b). A localized die-off of dolphins in East Matagorda Bay in 1992 was suggested to be due to agricultural run-off (trace amounts of Aldecarb were found in the water) (Worthy, personal communication, 1995). Evidence of morbilli virus infection was recently found in Gulf of Mexico bottlenose dolphins (Lipscomb et al., 1994c). In 1994, 67 percent of tested samples of a die-off of bottlenose dolphins in East Texas/Louisiana revealed that morbilli virus was present (Worthy, personal communication, 1995). A period of increased stranding of bottlenose dolphins from October 1993 through April 1994 in Alabama, Mississippi, and Texas was determined to have been caused by a morbilliviral epizootic (Lipscomb et al., 1996). A die-off of bottlenose dolphins occurred in 1995 on the west coast of Florida (Hansen, personal communication, 1997) and on the Mississippi coast in November 1996 (Rowles, personal communication, 1996). Propagation of the morbilliviral epizootic along the coast is probably determined by contact between adjacent communities and seasonal movements of transient dolphins (Duignan et al., 1995a).

Concentrations of die-offs appear to not be widespread, with deaths appearing to occur in localized populations. To understand the impact and long-term effects, large-scale surveys are needed to assess possible impacts on the offshore dolphin distribution, while localized, small-scale surveys are required to further quantify "before and after" effects of the disease (Scott and Hansen, 1989). Blaylock and Hoggard (1994) noted that bottlenose dolphins living in enclosed systems (bays) in the U.S. might be subject to increased anthropogenic mortality due to their proximity to humans. Such dolphins would also be at increased risk of being affected by catastrophic events or by chronic, cumulative exposure to anthropogenic activities or compounds.

In Spring 1996, a die-off of manatees occurred. There were an estimated 150 individual manatees involved in this unusual mortality event. At a regional level, 20 percent of the population was involved, while at the State level, it was 6 percent (Wright, personal communication, 1996). Brevotoxin (red tide) was determined to be the cause of the die-off (Suzik, 1997). Deaths of manatees in November 1997 indicated exposure to red tide (Anonymous, 1997). The first well-documented manatee mortality event associated with a red tide was in 1982 (O'Shea et al., 1991). Free-ranging manatee exposure to a morbilli virus was reported by Duignan et al. (1995b). The authors suggested that the infection in Florida manatees is sporadic rather than enzootic (as in cetaceans); however, Florida manatees may be at risk nonetheless for disease transmission between cows and their calves, between "estrus herds," and during aggregations in warm water refuges (which is also the most stressful time of year energetically for these animals). Morbilli virus could then affect manatees either directly or through immunosuppression or abortion (Duignan et al., 1995b). Papillomavirus has recently been found in Florida manatees (Bossart, personal communication, 1997).

A variety of environmental contaminants have been found in Gulf of Mexico bottlenose dolphins (e.g., Haubold et al., 1993; Davis et al., 1993; Meador et al., 1995) and manatees (O'Shea et al., 1984; Ames and van Vleet, 1996). Atlantic spotted dolphins from the Gulf have lower contaminant levels than Gulf bottlenose dolphins (Hansen, personal communication, 1997). Marine mammals include high-order marine predators that may be affected by the bioaccumulation of contaminants (Reijnders, 1986a). Manatees, as herbivores, are exposed to pesticides through ingestion of aquatic vegetation containing concentrations of these compounds. The reliance of manatees on inshore habitats and their attraction to industrial and

municipal outfalls has the potential to expose them to relatively high levels of contaminants (USDOI, FWS, 1995). Contaminants, siltation, and modified deliveries of freshwater to the estuary can indirectly impact manatees by causing a decline in submerged vegetation on which manatees depend (USDOI, FWS, 1995). Manatees do not appear to accumulate large quantities of chlorinated pesticides (O'Shea et al., 1984; Ames and van Vleet, 1996). Manatees, as herbivores, occupy a lower position in the food chain than most other marine mammals. Most marine mammal species have large stores of fat, acting both as insulation and an energy reserve. Lipophilic contaminants can accumulate in this tissue and may be released at high concentrations when the energy reserves are mobilized (UNEP, 1991). Recently, significant accumulation of butyltin compounds (tributyltin is an antifouling agent to prevent attachment of barnacles on boat hulls) has been implicated for immune suppression and consequent disease outbreak (Kannan et al., 1997). High butyltin concentrations in liver and kidney were found in bottlenose dolphins stranded along the Atlantic and Gulf Coasts of Florida (Kannan et al., 1997). Butyltin concentrations in the livers of spotted dolphin and pygmy sperm whale were found to be 3-4 times lower than in bottlenose dolphins; it was suggested that since these are offshore species, the exposure to butyltins is expected to be minimal (Kannan et al., 1997). Butyltins tend to magnify less in cetaceans as compared to organochlorines, which exert chronic toxic effects in marine mammals. Laboratory studies demonstrate that butyltin compounds are potent inhibitors of energy production in cells, followed by lymphocyte depletion and decreased phagocytic activity resulting in immunotoxicity. Kannan et al. (1997) suggested that butyltin compounds in addition to PCB's have contributed to the immune suppression in bottlenose dolphins. Insufficient information is available to determine how, or at what levels and in what combinations, environmental contaminants may affect marine mammals (MMC, 1995). There is growing evidence that high contaminant burdens are associated with several physiological abnormalities, including skeletal deformations, developmental effects, reproductive and immunological disorders, and hormonal alterations (e.g., Reijnders, 1986b; Addison, 1989; Brouwer et al., 1989; Colborn et al., 1993; De Swart et al., 1994; Reijnders, 1994; Lahvis et al., 1995; Smolen and Colborn, 1995). It is possible that anthropogenic chemical contaminants initially cause immunosuppression, rendering dolphins susceptible to opportunistic bacterial, viral, and parasitic infection (De Swart et al., 1995). Studies indicate an inverse relationship between hydrocarbon contaminant levels and certain bacterial and viral antigen titers in *Tursiops* from Matagorda Bay (in Blaylock et al., 1995). Contaminant loads were also associated with decreased levels of testosterone (Rowles, personal communication, 1996). Debilitating viruses such as morbilli virus may result in further immunosuppression and death. A study by Ross et al. (1996) indicated that present levels of PCB's in the aquatic food chain are immunotoxic to mammals. It should also be noted that emaciated animals that have mobilized their lipid stores (which accumulate high concentrations of toxic chemicals) may be more susceptible to toxic effects as a result of remobilization of the pollutants. Air pollution may also be a health factor for cetaceans. Anthracosis has been identified in the lungs of a sample of stranded dolphins in the Sarasota Bay, Florida area, but the implications of this finding are not yet clear (Rawson et al., 1991). Participants in a workshop convened by the MMS in August 1989 recommended that levels of environmental contaminants and natural biotoxins should be determined and monitored in representative marine mammals that occur in the northern Gulf of Mexico (Tucker & Associates, Inc., 1990). Collectively, the National Marine Mammal Tissue Bank, the quality assurance and contaminant monitoring programs, and the regional marine mammal stranding networks constitute NMFS's marine mammal health and stranding response program (MMC, 1995).

Commercial fisheries may accidentally entangle and drown or injure marine mammals during fishing operations or by lost and discarded fishing gear, or compete with marine mammals for the same fishery resources (Tucker & Associates, Inc., 1990). There is very little information on cetacean/fishery interactions in Gulf of Mexico waters. Bottlenose dolphins are often seen feeding in association with shrimp fishery operations (e.g., Fertl, 1994). Dolphins in nearshore and continental shelf waters have been caught and killed in shrimp trawls, as well as experimental trawling for butterfish (Burn and Scott, 1988). While the catch rate may be low, fisheries such as the shrimp trawl fishery with very large fleets may be having significant impacts. Marine mammals may be caught and killed occasionally in the menhaden purse seine fishery (Tucker & Associates, Inc., 1990). Dolphins have been stranded with evidence of gillnet entanglement on the west coast of Florida and Louisiana (Burn and Scott, 1988); recent legislation banning the use of gillnets will hopefully ensure no further mortality for Gulf dolphins in these types of nets. Adequate conservation

strategies for marine mammals must take into account the natural history and ecology of important prey species; this is something that is currently underemphasized in research and conservation efforts (Heithaus and Connor, 1995; Trites et al., 1995). For example, Trites et al. (1995) suggested that fisheries may indirectly compete with marine mammals by reducing the amount of primary production accessible to marine mammals, thereby negatively affecting marine mammal numbers.

There are also several pelagic fisheries that have the potential for incidental take problems. From 1957 to 1982, the Japanese fished for tuna with longlines in the Gulf of Mexico (Russell, 1993, in Jefferson, 1995). There is no information on incidental catch of cetaceans in this fishery, but cetaceans have been taken on longlines off the U.S. east coast (Burn and Scott, 1988). The most likely major pelagic fishery in the Gulf is the domestic tuna/swordfish longline fishery started in the offshore Gulf of Mexico in the early 1970's, and it continues today (Russell, 1993, in Jefferson, 1995). There is no marine mammal observer program for this fishery, though there are anecdotal reports of pilot whales and possibly Risso's dolphins taking fish off the longlines. The level of take in most, if not all, of these fisheries may be small, but the effects could be causing, or contributing to, significant population declines when taking in account other cumulative effects. Available information is insufficient to assess the nature and extent of incidental take, its effect on the affected species and populations, or how it might be reduced or avoided.

The level of take in Gulf fisheries may be small (e.g., Reynolds, 1985; Burn and Scott, 1988), but as iterated by Tucker & Associates, Inc. (1990), the effects could be causing, or contributing to, significant population declines if the affected populations also are subject to other human-produced impacts. Available information continues to be insufficient to assess the nature and extent of incidental take, its impact on the affected species and populations, or how it might be reduced or avoided. In addition, shooting of bottlenose dolphins occurs infrequently. These few cases may be simple vandalism or may be fisheries-related (Burn and Scott, 1988) (in response to real or perceived damage to gear and/or catch). Although the extent of incidental take and death during "ghost" fishing is largely undocumented, it has been noted as an activity of concern by the NMFS and the MMC. Fishermen have been reported to shoot at dolphins to scare them away from their gear (e.g., Reynolds, 1985; Fertl, 1994). It is expected that commercial fishing equipment will periodically contact and affect cetaceans in the Gulf of Mexico.

Habitat loss and degradation is now acknowledged to be a significant threat to cetacean populations. The impact of coastal development on Gulf of Mexico cetaceans has not been thoroughly investigated. Apparent declines in bottlenose dolphin abundance in some areas has been suggested to be contributed to pollution and heavy boat traffic (e.g., Odell, 1976). Bottlenose dolphins in Sarasota Bay, Florida, appear to use less-altered areas more frequently, but specific effects are uncertain (Wells, 1992). On the other hand, habitat alteration in the form of artificial passes in southern Texas has been suggested to have opened up new habitat for bottlenose dolphins (Leatherwood and Reeves, 1983). Habitat alteration has the potential to disrupt the social behavior, food supply, and health of cetaceans that occur in the Gulf of Mexico. Such activities may stress the animals and cause them to avoid traditional feeding and breeding areas, or migratory routes. The most serious threat to cetacean populations from habitat destruction may ultimately prove to be its impact on the lower trophic levels in their food chains (Kemp, 1996). Intensive coastal development is degrading important manatee habitat and poses perhaps the greatest long-term threat to the Florida manatee (USDOI, FWS, 1995).

Coastal bottlenose dolphin populations in the southeastern United States have the potential to be impacted by commercial dolphin-watching trips that feed dolphins as part of their tours. Feeding wild dolphins is likely to disrupt normal behavior, particularly feeding and migration patterns (USDOC, NMFS, 1994; MMC, 1995). This activity could make dolphins dependent upon nonnatural food sources and more vulnerable to being hit by boats, malicious shooting, and accidental or deliberate food poisoning (Tucker & Associates, Inc., 1990). While such activities are classified as "harassment" by the Marine Mammal Protection Act (MMC, 1995), this activity continues due to lack of enforcement. Migrating baleen whales may be affected by whale-watching activities on the East Coast, as well as in the Caribbean. Impacts of whale watching on cetaceans may be measured in a short time-scale (i.e., startle reaction) or as a long-term effect on reproduction or survivability (IFAW, 1995). There is little evidence to show that short-term impacts have any relation to possible long-term impacts on cetacean individuals, groups, or populations (IFAW, 1995).

Marine mammals can exhibit some of the same stress symptoms as found in terrestrial mammals, but perhaps to a lesser extent (Thomson and Geraci, 1986). Stress often is associated with release of adrenocroticotrophic hormones or cortisol. Thomas et al. (1990) examined the effect of playbacks of drilling platform noise on captive belugas. They found no behavioral (swim patterns, social group interactions and dive/respiration rates) or physiological (blood catecholamines) indications of stress from drilling noises. It is important to recognize that disturbance from ship traffic, noise from ships, aircraft, and drilling rigs and/or exposure to sublethal levels of biotoxins and anthropogenic contaminants may stress animals, weakening their immune systems, making them more vulnerable to parasites and diseases that normally would not be fatal. Stressed animals may also fail to reproduce at normal rates or have been found with significantly high fetotoxicity and malformations in the young, as evidenced in some small laboratory mammals. For example, a heavily fished population of spotted dolphins in the eastern tropical Pacific was found to have a substantially lower pregnancy rate and a significantly higher (i.e., delayed) age at sexual maturity than nearby, sporadically fished, spotted dolphins; chronic stress is one possibility (Myrick and Perkins, 1995). Marine mammals may stay in an area despite disturbance (such as noise) if no alternative areas meet the requirements of the animals.

With regard to the incremental contribution of the proposed action, impacts are expected to be primarily sublethal (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris); however, combined effects may be deleterious to cetaceans occurring in the Gulf of Mexico. Biological significance of any mortality would depend, in part, on the size and reproductive rates of the affected stocks, as well as the number, age, and sex of animals affected.

Summary and Conclusion

Activities considered under the cumulative scenario will affect nonendangered and nonthreatened cetaceans. These cetaceans could be impacted by the degradation of water quality resulting from operational discharges, helicopter and vessel traffic and noise, platform and drillship noise, explosive platform 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 (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris) 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 greater than or equal to 1,000 bbl, chance collisions with OCS service vessels, ingestion of plastic material, commercial fishing, and pathogens. Oil spills of any size, are estimated to be recurring events that will periodically contact cetaceans. Deaths as a result of structure removals are not expected to occur due to mitigation measures (NMFS observer program). Disturbance (noise from ship traffic and drilling operations, etc.) and/or exposure to sub-lethal levels of biotoxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them more vulnerable to parasites and diseases which normally would not be fatal. The net result of any disturbance would be dependent upon the size and percentage of the population likely to be affected; ecological importance of the disturbed area; environmental and biological parameters which influence an animal's sensitivity to disturbance and stress; or the accommodation time in response to prolonged disturbance (Geraci and St. Aubin, 1980). Collisions between cetaceans and ships, though expected to be rare events, could cause serious injury or even be fatal.

The proposed action, by itself, is unlikely to have significant long-term adverse effects on the size and productivity of any marine mammal species or population stock in the northern Gulf of Mexico provided (a) previous and ongoing exploration and development activities have not increased the sensitivity of any marine mammal species to disturbance from seismic surveys, rig construction, drilling operations, or ship and helicopter support activities; (b) responses to disturbance do not increase as the level of disturbance increases or do not occur until a sensitivity threshold is reached; and (c) if oil spills occur, they occur at times and in places where significant numbers of marine mammals are not present, and individually and collectively do not adversely affect habitats or habitat components (e.g., important prey species) that are essential to the well-being of any marine mammal species or population stock in the northern Gulf. It should be noted that

present distribution patterns of both large and small cetaceans may reflect displacements that have occurred as oil and gas exploration and developments in the northern Gulf expanded.

(6) Impacts on Sea Turtles

This cumulative analysis considers the combination of potential impacts resulting from the proposed action in addition to prior and future OCS sales, State oil and gas activity, dredge-and-fill operations, water quality degradation, natural catastrophes, pollution, recreational and commercial fishing, dredges, vessel traffic, beach nourishment, beach lighting, power plant entrainment, and human consumption affect the loggerhead, Kemp's ridley, hawksbill, green, and leatherback turtles found in the Gulf of Mexico.

Major impact-producing factors related to the proposed action that may occur are reviewed in detail in Section IV.D.1.a.(6). Sections providing supportive material for the sea turtle analysis include Sections III.A.2. (meteorological conditions), III.B.5. (description of sea turtles), IV.A.2.a.(4) (structure removal), IV.A.3.(d) (offshore discharges), IV.C.3. (other major onshore/coastal activities), and IV.A.3.h.(2) (oil spills).

Effluents are routinely discharged into offshore marine waters and are regulated by the USEPA NPDES permits. Most operational discharges are diluted and dispersed when released in offshore areas and, given the current permit restrictions, are considered to have sublethal effects (API, 1989; Henwood, personal communication, 1993; Kennicutt, 1995). Any potential that might exist for impact from drilling fluids would seem to be indirect, either by impact on prey items or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling mud discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of sea turtles or species lower in the marine food web (for further information on bioaccumulation, see Section IV.A.3.d.). This might ultimately reduce reproductive fitness in the turtles, an impact that the already diminished population(s) cannot tolerate.

Structure installation and removal, pipeline placement, dredging, and water quality degradation may adversely affect sea turtle habitat through destruction of seagrass beds and live-bottom communities used by sea turtles. Potential impacts on these habitats caused by the OCS Program are discussed in detail in Sections IV.D.1.a.(1)-(3).

Noise from service-vessel and helicopter traffic may elicit a startle reaction from sea turtles and produce a temporary, sublethal stress (NRC, 1990). It is assumed that about 400,000-500,000 OCS-related oil and gas service-vessel trips could occur annually, Gulfwide. The FAA Advisory Circular 91-36C encourages pilots to maintain greater than minimum altitudes near noise-sensitive areas. Corporate helicopter policy states that helicopters should maintain a minimum altitude of 700 ft while in transit offshore, and 500 ft while working between platforms. The potential direct and indirect impacts of sound on sea turtles includes physical auditory effects (temporary threshold shift), behavioral disruption, long-term effects, masking, and adverse impacts on the food chain. Noise-induced stress has not been studied in sea turtles. It is expected that drilling noise will periodically disturb and affect turtles in the Gulf of Mexico. Based on conclusions of Lenhardt et al. (1983) and O'Hara and Wilcox (1990), low-frequency sound transmissions (such as those produced by operating platforms) could potentially cause increased surfacing behavior and deterrence from the area near the sound source. The potential for increased surfacing behavior could place turtles at greater risk of vessel collision and potentially greater vulnerability to natural predators. Collisions between service vessels or barges and sea turtles would likely cause fatal injuries. Vessel traffic in general is estimated to cause about 9 percent of all sea turtle deaths in the southeastern United States, and this mortality most probably will increase if fishing, recreational, and OCS Program vessel traffic continue to increase. The regions of greatest concern are those with high concentrations of recreational boat traffic, such as the many shallow coastal bays in the Gulf.

Explosive discharges such as those used for platform removals can cause capillary damage, disorientation, and loss of motor control in sea turtles (Duronslet et al., 1986). Although sea turtles far from the site may suffer only disorientation, those near detonation sites would likely sustain fatal injuries. Injury to the lungs and intestines and/or auditory system could occur. Other potential impacts include physical or acoustic harassment. To minimize the likelihood of removals occurring when sea turtles may be nearby, MMS has issued guidelines for explosive platform removal to offshore operators. These guidelines include

daylight-limited detonation, staggered charges, placement of charges 5 m below the seafloor, and pre- and post-detonation surveys of surrounding waters. At present, explosive platform removals are occurring at a rate of 35-50 platforms annually in water depths less than 60 m. Few platforms to date have been removed in greater water depths. Resuspension of bottom sediments, increased water turbidity, and mobilization of bottom sediments due to explosive detonation are considered to be temporary effects. It is expected that structure removals will cause only sublethal effects on turtles as a result of the implementation of the MMS guidelines for explosive removals (USDOI, MMS, 1990b, Appendix B).

Seismic surveys produce a more intense sound than other nonexplosive sound sources. Data are limited but show that reactions of turtles to seismic pulses deserve detailed study. Seismic activities would be considered primarily sublethal and probably elicit a short-term behavioral response. There is limited data suggesting that seismic sounds would act as an acoustic repellent for turtles (Lenhardt, 1994).

Sea turtles may be the animals most seriously affected by marine debris. In addition to the incremental amount of trash and debris generated by the OCS Program and other users of the Gulf (Miller et al., 1995), marine debris is carried into the Gulf and Atlantic via oceanic currents from other parts of the world (Plotkin and Amos, 1988; Hutchinson and Simmonds, 1992). Turtles that consume or become entangled in debris may die or become debilitated (O'Hara, 1989; USDOC, NMFS, 1989a; Heneman and the Center for Environmental Education, 1988). Monofilament line is the most common type of debris to entangle turtles (NRC, 1990). Fishing related-debris is involved in about 68 percent of all cases of sea turtle entanglement (O'Hara and Iudicello, 1987). Floating plastics and other debris, such as petroleum residues drifting on the sea surface, accumulate in sargassum drift lines commonly inhabited by hatchling sea turtles during their pelagic stage; these materials could be toxic. In a review of sea turtle debris ingestion and entanglement worldwide, Balazs (1985) found that tar was the most common item ingested. High rates of oiling of hatchlings netted from sargassum rafts suggest that bioaccumulation may occur over their potentially long lifespan. Sea turtles, particularly leatherbacks, are known to be attracted to floating plastic debris because it resembles their preferred food, the jellyfish. Ingestion of plastics could interfere with food passage, respiration, and buoyancy and could reduce the fitness of a turtle or kill it (Carr, 1987; USDOC, NOAA, 1988; Heneman and the Center for Environmental Education, 1988; USDOI, MMS, 1989; Lutz and Alfaro-Shulman, 1992). The MMS prohibits 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), prohibits the disposal of any plastics at sea or in coastal waters.

Oil-spill response activities, such as vehicular and vessel traffic in shallow areas of seagrass beds and live-bottom communities, can adversely affect sea turtle habitat and cause displacement from these preferred areas. Effects on seagrass and reef habitats have been noted (reviewed by Coston-Clements and Hoss, 1983). Impacting factors might include artificial lighting from night operations, booms, machine and human activity, equipment on beaches and in intertidal areas, sand removal and cleaning, and changed beach landscape and composition. Some of the resulting impacts from cleanup could include interrupted or deterred nesting behavior, crushed nests, entanglement in booms, and increased mortality of hatchlings due to predation during the increased time required to reach the water (Newell, 1995; Lutcavage et al., 1997). The strategy for cleanup operations should vary, depending on the season, recognizing that disturbance to the nest may be more detrimental than the oil (Fritts and McGehee, 1982). As mandated by the Oil Pollution Act of 1990 (Section IV.C.4.), these areas are expected to receive individual consideration during oil-spill cleanup. Required oil-spill contingency plans include special notices to minimize adverse effects from vehicular traffic during cleanup activities and to maximize protection efforts to prevent contact of these areas with spilled oil (Section IV.C.4.). Studies are completely lacking regarding the effects of dispersants and coagulants on sea turtles (Tucker & Associates, Inc., 1990).

Oil spills can adversely affect sea turtles by toxic ingestion or blockage of the digestive tract, inflammatory dermatitis, ventilatory disturbance, disruption or failure of salt gland function, , red blood cell disturbances, immune responses, and displacement from preferred habitats (Witham, 1978; Vargo et al., 1986; Lutz and Lutcavage, 1989; Lutcavage et al., 1995). Sea turtles may become entrapped by tar and oil slicks and rendered immobile (Witham, 1978; Plotkin and Amos, 1988). In the past, tanker washings have been the main source of this oil (Van Vleet and Pauly, 1987). Although disturbances may be temporary, long-term effects remain unknown, and chronically ingested oil may accumulate in organs. Exposure to oil

may be fatal, particularly to juvenile and hatchling sea turtles. Hatchling and small juvenile turtles are particularly vulnerable to contacting or ingesting oil because the currents that concentrate oil spills also form the debris mats in which these turtles are sometimes found (Carr, 1980; Collard and Ogren, 1990; Witherington, 1994). Fritts and McGehee (1982) noted that sea turtle eggs were damaged by contact with weathered oil released from the *Ixtoc* spill. Skin damage in turtles is in marked contrast to that observed in dolphins, where all structural and biochemical changes in the epidermis were minor and reversible. Changes in the skin are consistent with an acute, primary contact or irritant dermatitis. A break in the skin barrier could act as a portal of entry for pathogenic organisms, leading to infection, neoplastic conditions, and debilitation (Vargo et al., 1986).

Some captive turtles exposed to oil either reduced the amount of time spent at the surface, possibly avoiding oil, or became more agitated, and had short submergence levels (Lutcavage et al., 1995). Sea turtles pursue and swallow tar balls, and there is no concrete evidence that free-ranging turtles can detect and avoid oil (Odell and MacMurray, 1986; Vargo et al., 1986). A loggerhead turtle sighted during an aerial survey in the Gulf of Mexico surfaced repeatedly within a surface oil slick for over an hour (Lohefener et al., 1989). Oil might have a more indirect effect on the behavior of sea turtles. Assuming olfaction is critical to the process, oil-fouling of a nesting area might disturb imprinting of hatchling turtles or confuse the turtles on their return migration after a 6-8 year absence (Geraci and St. Aubin, 1985). The effect on reproductive success could therefore be significant. There is also evidence that sea turtles feed selectively in surface convergence lines, which could also result in prolonged contact with viscous weathered oil (Witham, 1978; Hall et al., 1983).

When an oil spill occurs, the severity of effects and the extent of damage to sea turtles are affected by geographic location, oil type, oil dosage, impact area, oceanographic conditions, and meteorological conditions (NRC, 1985; USDOI, MMS, 1987b). Eggs, hatchlings, and small juveniles are particularly vulnerable to contact (Fritts and McGehee, 1982; Lutz and Lutcavage, 1989). Potential toxic impacts to embryos will depend on the type of oil and degree of weathering, type of beach substrate, and especially upon the developmental stage of the embryo. Although many observed physiological insults are resolved in a 21-day recovery period, the impact of tissue oil intake on the long-term health and survival of sea turtles remains unknown (Lutcavage et al., 1995).

It is assumed that about 1,270-1,950 (offshore) and 950-1,050 (inland) spills less than 1,000 bbl could occur each year in the Gulf area. Another 4-5 offshore and 10-15 coastal oil spills $\geq$ 1,000 bbl could occur annually. Since sea turtle habitat in the Gulf includes both inshore and offshore areas, sea turtles are likely to encounter a few OCS or import tanker spills. In the event that oiling of turtles should occur, the effects would probably be sublethal; few immediate deaths are expected; long-term impacts might be lethal. It is important to note that during nesting season, Kemp's ridley would be particularly vulnerable to a spill occurring in the immediate vicinity of its primary nesting beach in Rancho Nuevo, Mexico (Lutz and Lutcavage, 1989).

Sea turtles are vulnerable to harm from human activities throughout their migratory ranges, particularly because of their wide-ranging movements in coastal waters. Major activities that affect sea turtles occurring in the Gulf include commercial fishing, hopper dredging, pollutant discharge, ingestion of or entanglement in debris, nearshore boat traffic, human consumption, and contact with foreign, inshore, or processed oil (reviewed in NRC, 1990 and Lutcavage et al., 1997). Demographic analyses suggest that a reduction of human-induced mortality in juvenile, subadult, or adult life stages will have a significantly greater effect on population growth than reduction of human-induced mortality of eggs and hatchlings (NRC, 1990).

The habitat of Kemp's ridleys (mostly less than 18 m water depths) overlaps with that of the shrimp fishery (Renaud, 1995). A major source of mortality for loggerhead and Kemp's ridleys is incidental capture and drowning in shrimp trawls (Murphy and Hopkins-Murphy, 1989); 70-80 percent of turtle strandings are related to interactions with this fishery (Crowder et al., 1995). Recent analysis of loggerhead strandings in South Carolina shows significant effects of the shrimp fishery in increased strandings, and that the effect of TED's (turtle excluder devices) in reducing strandings was also significant (a 44% reduction) (Crowder et al., 1995). On the other hand, Caillouet et al. (1996) found a significant positive correlation between turtle stranding rates and shrimp fishing intensity in the northwestern Gulf of Mexico. Caillouet et al. (1996) provided five hypotheses as to why TED regulations did not appear to lead to a reduction or elimination in

stranding rates: (a) equipment malfunction or failure; (b) turtles might have succumbed to stresses of repeated passage through trawls with properly working TED's; (c) turtles may have been caught in try nets that had no TED's; (d) violations of TED regulations resulted in incidental catches of turtles; and (e) nonshrimping causes of sea turtle mortality were in synchrony with the shrimping effort. The Kemp's ridley population, due to its distribution and small numbers, is at the greatest risk. In response to high numbers of dead sea turtles that stranded along the coasts of Texas, Louisiana, Georgia, and northeast Florida in 1994-1995, coinciding with nearshore shrimp trawling activity, NMFS increased enforcement efforts (relative to TED's), which decreased the number of strandings. The NMFS is currently proposing a rule that requires the use of hard TED's (banning all soft TED use), as well as prohibiting the use of bottom-opening hard TED's; and establishing Shrimp Fishery Sea Turtle Conservation Areas where shrimping effort and sea turtle abundance are high (*Federal Register*, 1996). However, deaths are believed to occur in association with some inshore shrimping operations that do not presently require TED use (Crouse, 1992). Other fisheries and fishery-related activities are also important sources of mortality, but collectively only one-tenth as important as shrimp trawling (NRC, 1990). Turtles are caught and killed in finfish trawls, seines, gill nets, weirs, traps, longlines, and driftnets, but these deaths are neither fully documented nor regulated (Hillestad et al., 1982; NRC, 1990; Witzell, 1992; Brady and Boreman, 1994). Cannon et al. (1994) reported a number of Kemp's ridleys being caught by hook and line (Cannon et al., 1994). It is possible that some live Kemp's ridleys released after capture by hook and line may suffer from ill effects of hooks lodged in the esophagus or stomach. Collisions with boats may also disable or kill sea turtles. In most cases, it is not possible to determine whether the injuries resulted in death or were post-mortem. An animal with an open wound has an increased probability of predation. Of the turtles stranded in the Gulf, approximately 9 percent had boat-related injuries (Teas and Martinez, 1992). Regions of great concern are those with high concentrations of recreational-boat traffic, such as the many shallow coastal bays in the Gulf.

Dredge-and-fill activities occur in many of the nearshore seasonal habitats of sea turtles in the southeastern U.S. and in other areas. Operations range in scope from propeller dredging by recreational boats to large-scale navigation dredging and fill for land reclamation. Dredging operations affect turtles through incidental take and by degrading the habitat. Hopper dredging has caused turtle deaths in coastal areas, including Cape Canaveral Ship Channel in Florida and the King's Bay Submarine Channel in Georgia (Slay and Richardson, 1988); deaths in the Gulf of Mexico have not been estimated. Nearly all sea turtles entrained by hopper dredges are dead or dying when found, but an occasional small green turtle has been known to survive (NRC, 1990). In addition to direct take, channelization of the inshore and nearshore areas can degrade foraging and migratory habitat through spoil dumping, degraded water quality/clarity, and altered current flow.

Sea turtles frequent coastal areas such as algae and seagrass beds to seek food and shelter (Carr and Caldwell, 1956; Hendrickson, 1980), and these nearshore areas are used by juvenile Kemp's ridleys in Louisiana (Ogren, 1989) and Texas (Manzella and Williams, 1992). Juvenile hawksbill, loggerhead, and green turtles are typically found in nearshore Texas waters (Shaver, 1991). Submerged vegetated areas may be lost or damaged by activities that alter salinity, increase turbidity, or disturb natural tidal and sediment exchange. Natural catastrophes, including storms, floods, droughts, and hurricanes, can also substantially damage sea turtle habitats and nesting beaches (Agardy, 1990). Abnormally high tides and waves associated with storms may exact heavy mortality on sea turtles by washing them from the beach, inundating them with sea water, or altering the depth of sand covering them. Furthermore, excessive rainfall often associated with tropical storms, may reduce the viability of eggs. Turtles could be harmed by rough seas and floating debris (Milton et al., 1994). In addition, the hurricane season for the Caribbean and Western Atlantic (June 1-November 1) overlaps closely with the sea turtle nesting season (March through November) (NRC, 1990). Nests are vulnerable to hurricanes over the long incubation time and also during the time when hatchlings emerge from the nest. Hurricanes cause mortality of turtles nests in two ways: immediate drowning from ocean surges, and after hatching as a result of radically altered beach topography. The greatest surge effect from Hurricane Andrew was felt on beaches closest to the "eye" of the hurricane; egg mortality was 100 percent (Milton et al., 1994). In areas farther from the "eye," the surge was lower and mortality was correspondingly decreased. Sixty-nine percent of the eggs on Fisher Island in Miami, Florida, did not hatch after Hurricane Andrew and appeared to have drowned during the storm (Milton et al., 1994). Further

mortality occurred when surviving turtles suffocated in nests situated in the beach zone where sand had accreted. This later mortality may be substantially reduced if beach topography is returned to normal and beach debris removed after a hurricane (Milton et al., 1994). Species that have limited nesting ranges, such as the Kemp's ridley would be highly impacted if a hurricane hit its nesting beach (Milton et al., 1994). Hurricane Erin had a substantial impact on loggerhead reproductive success (40.2% loss in hatchling production) on the southern half of Hutchinson Island in 1995 (Martin, 1996). A beach can be completely closed to nesting after a hurricane. For example, at Buck Island Reef National Monument on St. Croix, after Hurricane Hugo, 90 percent of the shoreline trees on the North Shore were blown down parallel to the water, blocking access to nesting areas (Hillis, 1990). False crawl ratios for hawksbill turtles doubled after the hurricane, mostly due to fallen trees and eroded root tangles blocking nesting attempts (Hillis, 1990). Other direct impacts of Hurricane Hugo on sea turtle habitats include destruction of coral reef habitats important to hawksbill and, secondarily, to green turtles. Nooks and crannies in the reef used by these turtles for resting have been destroyed in some areas (Agardy, 1990). Also, seagrass beds, which are important foraging areas for green turtles, were widely decimated in Puerto Rico (Agardy, 1990). Indirect and long-term effects on the marine and coastal habitats of sea turtles include pollution of nearshore waters from storm-associated runoff.

Construction, vehicle traffic, beachfront erosion, and artificial lighting are activities that disturb sea turtles or their nesting beaches (Raymond, 1984; Garber, 1985). Traffic may cause compression damage to nests, and beach cleaning may destroy nests or cause compaction, lowering hatching success (Coston-Clements and Hoss, 1983). Physical obstacles, such as tire tracks and sand piles may slow the rate of sea-approach for hatchling turtles and increase their susceptibility to stress and predation (Witham, 1995). Obstructions to the high water mark prevent nesting, and breakwalls are the most common and drastic type of obstruction. Erosion of nesting beaches results in the loss of nesting habitat. Human interference has hastened erosion in many places. Artificial lighting from buildings, street lights, and beachfront properties has a disorienting effect on hatchlings, as well as adults (Witherington and Martin, 1996). Females tend to avoid areas where beachfront lighting is most intense; turtles also abort nesting attempts more often in lighted areas. Hatchlings are attracted to lights, and any delay for them to make it to the water increases vulnerability to terrestrial predators. Condominiums block sun on turtle nesting beaches, which could presumably affect sex ratios of hatchlings (the sex of a turtle is dependent on egg temperature) by increasing the number of males produced (discussed by Mrosovsky et al. 1995). Increased human activities, including organized turtle watches, on nesting beaches may affect nesting activity (Fangman and Rittmaster, 1994; Johnson et al., 1996), specifically, not spending as much time camouflaging nest sites (Johnson et al., 1996).

Sea turtles can become entrained in intake pipes for cooling water at coastal power plants (NRC, 1990). An offshore intake structure may look like a reef to some turtles, suitable for resting, and these turtles are subsequently drawn into the cooling system (Witham, 1995). Feeding leatherbacks probably follow large numbers of jellyfish into the intake (Witham, 1995). Deaths result from injuries sustained in transit through the intake pipe, from drowning in the capture nets, and perhaps from causes before entrainment. Morality from entrainment in power plants is believed to be generally low, with a high number of turtle fatalities at the St. Lucie plant in southeastern Florida (NRC, 1990). Thermal effluents from power plants may cause hatchlings to become disoriented and reduce their swimming speed (O'Hara, 1980). These effluents may also degrade seagrass and reef habitats (reviewed by Coston-Clements and Hoss, 1983).

Sand mining, beach renourishment, and oil-spill cleanup operations may remove sand from the littoral zone and temporarily disturb onshore sand transport, potentially disturbing sea turtle nesting activities. The main causes of permanent nesting beach loss within the Gulf of Mexico are the reduction in sediment transport, rapid rate of relative sea-level rise, coastal construction and development, and recreational use of accessible beaches near large population centers. Crain et al. (1995) reviewed the literature on sea turtles and beach nourishment and found certain problems repeatedly identified. For nesting females, characteristics induced by nourishment can cause (a) beach compaction, which can decrease nesting success, alter nest-chamber geometry, and alter nest concealment, and (b) escarpments, which can block turtles from reaching nesting areas. For eggs and hatchlings, nourishment can decrease survivorship and affect development by altering beach characteristics such as sand compaction, gaseous environment, hydric environment,

contaminant levels, nutrient availability, and thermal environment. Also, nests can be covered with excess sand if nourishment is implemented in areas with incubating eggs.

Human consumption of turtle eggs, meat, or byproducts occurs worldwide and depletes turtle stocks (Cato et al., 1978; Mack and Duplaix, 1979). Commercial sea turtle harvests no longer exist within continental U.S. waters and were recently banned in Mexico (Aridjis, 1990). Since sea turtles are highly migratory species, taking of turtles in artisanal and commercial sea turtle fisheries is still a concern.

Chronic pollution, including industrial and agricultural wastes and urban runoff, threatens sea turtles worldwide (Frazier, 1980; Hutchinson and Simmonds, 1991). Some turtle species have lifespans greater than 50 years (Congdon, 1989; Frazer et al., 1989) and have a high trophic level in the marine ecosystem, creating the potential for bioaccumulation of heavy metals (Hillestad et al., 1974; Stoneburner et al., 1980; Davenport et al., 1990), pesticides (Thompson et al., 1974; Clark and Krynitsky, 1980; Davenport et al., 1990), and other toxins (Lutz and Lutcavage, 1989). Organochlorine pollutants have been documented in eggs, postyearlings, and adult turtles (Rybitski et al., 1995). Not all species accumulate residues at the same rate; loggerheads consistently have higher levels of both PCB's and DDE than green turtles, and it has been hypothesized that the variation is due to dietary differences (George, 1997). Contaminants could stress the immune system of turtles or act as cocarcinogens indirectly by disrupting neuroendocrine functions (Colborn et al., 1993). In some marine mammals, chronic pollution has been linked with immune suppression, raising a concern for sea turtles.

The diseases of sea turtles can be found in a synopses by Herbst and Jacobson (1995) and George (1997). Green turtle fibropapillomatosis (GTFP) (debilitating tumors occurring primarily in green turtles) is a growing threat to the survival of green turtle populations worldwide (Herbst, 1994). The disease was documented in the 1930's (Smith and Coates, 1938), and its incidence has increased in the last century, especially from 1985 to 1990, in turtles found in Florida, Hawaii, and Puerto Rico (Teas, 1991).

This disease may cause an increased susceptibility to marine parasites and anemia, as well as obstructed feeding and swimming, greater vulnerability to fishing net entanglement, disorientation, and impaired vision or blindness (Norton et al., 1990; Barrett, 1996). Similar lesions have been reported in loggerhead turtles (Herbst, 1994). Previous studies suggest that turtles in nearshore habitats with nearby human disturbance have a higher incidence of GTFP (Herbst and Klein, 1995). Turtles with GTFP are chronically stressed and immunosuppressed (Aguirre et al., 1995). Spirorchidiasis has been reported in loggerheads (Wolke et al., 1982). Severe infestations of spirorchid (blood flukes) result in emaciation, anemia, and enteritis, or conversely, emaciation and anemia could make a turtle more susceptible to spirorchid infestation. This infestation can result in death or make turtles more susceptible to succumb to other stresses (Wolke et al., 1982).

Summary and Conclusion

Activities considered under the cumulative scenario have a potential to harm sea turtles. Those activities include structure installation, dredging, water quality and habitat degradation, OCS-related trash and debris, vessel traffic, explosive platform removals, oil-spill response activities, oil spills, natural catastrophes, pollution, dredge operation, vessel traffic, commercial and recreational fishing, human consumption, beach lighting, and power plant entrainment. Small numbers of turtles could be killed or injured by chance collision with service vessels and by eating indigestible trash, particularly plastic items, accidentally lost from drill rigs and service vessels. Deaths due to structure removals are not expected due to mitigation measures (NMFS observer program). The presence of, and noise produced by, service vessels and by the construction, operation, and removal of drill rigs could cause physiological stress and make animals more susceptible to disease, as well as disrupt normal behavior patterns. Contaminants in waste discharges and drilling muds might indirectly affect marine mammals 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 by the Oil Pollution Act of 1990 habitat protection requirements. Contact with oil, and consumption of oil and oil-contaminated prey, may seriously impact turtles. There is direct evidence that turtles have been seriously harmed by oil spills. The majority of OCS activities are estimated to be sublethal (behavioral

effects and nonfatal exposure to or intake of OCS-related contaminants or debris). 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.

(7) Impacts on Coastal and Marine Birds

This cumulative analysis considers the effects of impact-producing factors related to the proposed action plus those related to prior and future OCS sales; State oil and gas activity; crude oil imports by tanker; and other commercial, military, recreational offshore, and coastal activities that may occur and adversely affect populations of nonendangered/nonthreatened and endangered/threatened birds. Air emissions; oil spills and spill-response activities; degradation of water quality; aircraft and vessel traffic and noise, including OCS helicopter and service-vessels; habitat loss and modification resulting from coastal construction and development; OCS pipeline landfalls and coastal facility construction; and accidentally discarded and beached trash and debris are sources of potential adverse impacts. This analysis incorporates the discussion of the effects from these impact-producing factors on coastal and marine birds in Section IV.D.1.a.(7) with additional information as cited.

Sections IV.A.3.f. and IV.D.1.d.(4) consider air emissions including the amount of sulphur dioxide expected to be released due to the proposed action plus that related to prior and future OCS sales; State oil and gas activity; crude oil imports by tanker; and other commercial, military, recreational offshore, and coastal activities that may occur and adversely affect coastal and marine birds.

Pollutant emission into the atmosphere from the activities under the cumulative analysis are projected to have minimum effects on offshore air quality because of the prevailing atmospheric conditions, emission heights, and pollutant concentrations. Onshore impact on air quality from emissions under the OCS cumulative analysis is estimated to be within both Class I and Class II PSD allowable increments as applied to the respective subareas. Emissions of pollutants into the atmosphere under the cumulative analysis are projected to have little effect on onshore air quality because of the atmospheric regime, the emission rates, and the distance of these emissions from the coastline. These judgments are based on average steady state conditions and OCS modeling; however, there will be days of low mixing heights and 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 onshore winds decreases (34%) and the removal of pollutants by rain increases. The summer is more conducive to air quality effects as onshore winds occur more frequently, approximately 85 percent of the time. Increases in onshore annual average concentrations of NO_x, SO_x, and TSP under the cumulative analysis are estimated to be less than Class I and Class II PSD allowable increments for the respective subareas per both the steady state and OCD modeling analyses, and are below concentrations that could harm coastal and marine birds. Indirect impacts on coastal and marine birds due to direct impacts on air quality under the cumulative analysis will have a negligible effect on coastal and marine birds.

It is assumed that about 950-1,050 coastal spills of less than 1,000 bbl could occur in Gulf coastal waters annually. Seventy-eight percent of these spills would be less than one bbl and would affect a very small area, dissipate rapidly, and have a negligible effect on marine and coastal birds. Effects from spills greater than 1 bbl and less than 1,000 bbl that reach wetland areas could result in some degradation of habitat, physical oiling of birds, acute and chronic physiological stress, and mortalities of individuals or localized groups associated with direct and secondary intake of oil. Raptors, such as the bald eagle and peregrine falcon, feed upon weakened or dead birds (and fish, in the case of the eagle) and may, as a result, become physically oiled or affected by the ingestion of the oiled prey. Pelicans are active swimmers and plunge dive for prey. They are, therefore, very susceptible to physical oiling and secondary effects through the ingestion of oiled prey, i.e., fish. Plovers congregate and feed along exposed banks and shorelines. They can be physically oiled while foraging along oiled shores, or secondarily affected through the ingestion of oiled intertidal sediments and prey. The least tern captures fish via shallow splash diving and surface dipping techniques. Some physical oiling could occur during dives, as well as secondary toxic effects through the uptake of prey. It is possible that some deaths of endangered species could occur, especially if inshore spills occur during winter months when raptors and plovers are most common along the coastal Gulf or if spills occur within

preferred or critical habitat for all representatives. Brown pelicans and piping plovers are most susceptible to oiling, as a result of the nature of their preferred habitats and, in the case of the pelican, highly aquatic nature.

About 4-5 offshore and 10-15 coastal oil spills greater than or equal to 1,000 bbl could occur in a typical year in the next 20 years in the Gulf area. These areas are noted for supporting high densities of migratory and resident birds within a broad array of habitats. These spills could contact and affect thel coastline and inshore habitats with resultant deleterious effects, including deaths of coastal and marine birds. These areas are inhabited by endangered bird species, providing nesting habitat for large congregations of brown pelicans, least terns, and piping plovers.

Degradation of coastal and inshore water quality resulting from factors related to the proposed action plus those related to prior and future OCS sales; State oil and gas activity; crude oil imports by tanker; and other commercial, military, recreational offshore, and coastal activities is expected to impact coastal and marine birds.

The effects of the cumulative scenario on coastal water quality is analyzed in detail in Section IV.D.1.d.(3)(a). To summarize cumulative effects on coastal and estuarine water quality, there exists a wide variety of contaminant inputs into coastal waters bordering the Gulf of Mexico; however, the dominant pollution source is the large volume of water from the Mississippi River that enters the Gulf region after draining over two-thirds of the contiguous U.S. Major activities that have added to the contamination of Gulf coastal waters include the petrochemical industry, agriculture, forestry, urban expansion, extensive dredging operations, municipal and camp sewerage treatment processes, marinas and recreational boating, commercial fishing, maritime shipping, and hydromodification activities. Adding to these sources, but not as significant, are large commercial waste disposal operations, livestock farming, manufacturing industry activities, nuclear power plant operations, and pulp and paper mills. Vessel traffic is likely to impact water quality through routine releases of bilge and ballast waters, chronic fuel and tank spills, trash, and domestic and sanitary discharges. Projected oil spills represent an acute significant impact to coastal waters as well as serving as a low-level, chronic source of petroleum contamination to regional coastal water quality.

Coastal and marine birds will likely experience chronic, nonfatal physiological stress (behavioral effects and nonfatal exposure to or intake of contaminants or discarded debris). This will cause temporary disturbances and displacement, some permanent, of localized groups inshore. Chronic sublethal stress, 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. The extensive oil and gas industry operating in the Gulf area has caused low-level, chronic, petroleum contamination of coastal waters. Lethal effects, resulting primarily from uncontained inshore oil spills and associated spill response activities in wetland and other biologically sensitive coastal habitats, are expected to remove a number of coastal and marine bird individuals from any or all groups through primary effects from physical oiling and the ingestion of oil and through secondary effects resulting from the ingestion of oiled prey; recruitment of birds through successful reproduction is expected to take up to many years, depending upon the species and existing conditions. The contribution of discharges from OCS onshore support facilities to water quality problems is considered to be very small and no effect to coastal and marine birds is expected.

Helicopter and service-vessel traffic related to OCS activities could sporadically disturb feeding, resting, or nesting behavior of birds or cause abandonment of preferred habitat. This impact-producing factor could contribute to indirect population loss through reproductive failure resulting from nest abandonment. The FAA (Advisory Circular 91-36C) and corporate helicopter policy states that helicopters must maintain a minimum altitude of 700 ft while in transit offshore, and 500 ft while working between platforms. When flying over land, the specified minimum altitude is 1,000 ft over unpopulated areas or across coastlines and 2,000 ft over populated areas and biologically sensitive areas such as wildlife refuges and national parks. Many undisturbed coastal areas and refuges provide preferred and/or critical habitat for feeding, resting (or staging), and nesting birds. The effects of low-flying aircraft within the vicinity of aggregations of birds on the ground or on the water typically results in mass disturbance and abandonment of the immediate area. Compliance to the specified minimum altitude requirements is expected to significantly reduce effects of aircraft disturbance on coastal and marine birds. It is expected, however, that approximately 10 percent of helicopter trips will 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. Birds in flight over water are expected to avoid helicopters; temporary disruption of feeding or flight paths is expected when encountering low-flying helicopters. It is expected that OCS-support helicopter traffic will periodically disturb coastal and marine birds; general adherence to FAA and corporate helicopter protocol on service altitudes will serve to reduce the level of disturbance. The net effect of OCS-related flights on coastal and marine birds is expected to result in sporadic disturbances, which may result in displacement of localized groups. During nesting periods, this could ultimately result in some reproductive failure from nest abandonment, predation, etc.

Approximately 400,000-500,000 OCS-related service-vessel trips may occur annually in support of OCS operations in the Gulf. Service vessels will use selected nearshore and coastal (inland) navigation waterways, or corridors, and adhere to protocol set forth by the U.S. Coast Guard for reduced vessel speeds within these inland areas. Routine presence and low speeds of service vessels within these waterways diminishes the effects of disturbance from service vessels on nearshore and inland populations of coastal and marine birds. It is expected that service-vessel traffic will seldom disturb populations of coastal and marine birds existing within these areas. Recreational vessel traffic is a much greater source of impact to birds in coastal habitats. These vessels are, in most cases, not required to comply with strict speed/wake restrictions; small recreational fishing boats, ski boats, etc., often flush coastal and marine birds from feeding, resting, and nesting areas. Such disturbances displace local groups from these preferred habitats and could lead to abandonment of the areas in general or reproductive failure. Disturbance may result in increased energy expenditures due to avoidance flights and decreased energy intake due to interference with feeding activity. It is estimated that the effects of non-OCS vessel traffic on birds within coastal areas are substantial.

The greatest impact to coastal and marine birds is the extent of preferred or critical habitat loss resulting from oil spill and spill-response activities, urban and industrial development within coastal areas, erosion of areas bordering navigation channels from vessel usage, and OCS-related activities such as pipeline landfalls and onshore construction. Historic census data show that many of these species are declining in numbers and are being displaced from areas along the coast (and elsewhere) as a result of the encroachment of their preferred habitat(s) by the aforementioned sources. As these birds move to undisturbed areas of similar habitat, their presence augments habitat utilization pressure on these selected areas as a result of intra- and interspecific competition for space and food. The OCS Program contribution to coastal land loss or modification Gulfwide includes construction of approximately 255 pipeline landfalls, 2,770-6,790 km of onshore pipeline, and potentially 1 gas processing plant as well as other facilities identified in Table IV-12. The contribution of development from urban and other industrial growth will be substantial, causing both the permanent loss of lands and increased levels of disturbance associated with and in proximity to new construction and facilities.

Coastal and marine birds are commonly entangled and snared in discarded trash and debris. Many species will readily ingest small plastic debris, either intentionally or incidentally. Interaction with plastic materials is therefore very serious and often leads to permanent injuries and death. Much of the floating material discarded from vessels and structures offshore drifts ashore or remains within coastal waters. These materials include lost or discarded fishing gear such as gill nets and monofilament lines, which cause the greatest damage to birds. It is expected that coastal and marine birds will seldom become entangled in or ingest OCS-related trash and debris as a result of MMS 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. For the purpose of this analysis, OCS-related plastic debris will seldom interact with Gulf coastal and marine birds and, therefore, the effect will be negligible. Despite these regulations, quantities of plastic materials are accidentally discarded and lost into the marine environment, and so remain a threat to individual birds within these areas.

Non-OCS impact-producing factors include habitat degradation; disease; bird watching activities; fisheries interactions; storms and floods; pollution of coastal waters resulting from municipal, industrial, and agricultural runoff and discharge; and collisions of coastal and marine birds with structures such as power line towers, etc. Coastal storms and hurricanes can often cause deaths to coastal birds through high winds;

associated flooding destroys active nests and nesting areas. Elevated levels of municipal, industrial, and agricultural pollutants into coastal wetlands and waters expose resident birds to chronic physiological stress. Collisions with power lines and supporting towers are not atypical during inclement weather and during periods of migration, often causing death or permanent injury to birds (Avery et al., 1980; Avian Power Line Interaction Committee, 1994). Vital habitat needs to be protected so that the life-support system continues for the birds and their prey. Habitat alteration has the potential to disrupt social behavior, food supply, and health of birds that occur in the Gulf of Mexico. Such activities may stress the animals and cause them to avoid traditional feeding and breeding areas or migratory routes. Commercial fisheries may accidentally entangle and drown or injure birds during fishing operations or by lost and discarded fishing gear. Competition for prey species may also occur between birds and fisheries.

All migrating birds found within the Gulf region are subject to impacts from outside the planning areas that are detrimental to existing population levels. Long-term declines in duck populations are thought to be due, in part, to the systematic alteration and destruction of critical summer habitat utilized for breeding grounds (Terborgh, 1989). Other factors impacting waterfowl populations include hunting pressure, degradation of water quality throughout their respective ranges, ingestion of chlorinated hydrocarbons and petroleum, and incidental ingestion of lead shot. Migrating shorebirds are also thought to be affected by the destruction and modification of northern (and southern) hemisphere wetland habitats, which serve as staging areas during their migrational circuit.

Summary and Conclusion

Activities considered under the cumulative scenario will detrimentally affect coastal and marine birds. It is expected that the majority of effects from the major impact-producing factors on coastal and marine birds are sublethal (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris) and will cause temporary disturbances and displacement, some permanent, of localized groups inshore. Chronic sublethal stress, 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. Lethal effects, resulting primarily from uncontained coastal oil spills and associated spill-response activities in wetlands and other biologically sensitive coastal habitats, are expected to remove a number of individuals from any or all groups through primary effects from physical oiling and the ingestion of oil, and secondary effects resulting from the ingestion of oiled prey. Recruitment of birds through successful reproduction is expected to take up to many years, depending upon the species and existing conditions. The net effect of habitat loss from oil spills, new construction, and maintenance and use of pipeline corridors and navigation waterways will alter species composition and reduce the overall carrying capacity of disturbed area(s) in general.

The incremental contribution of the proposed action (Section IV.D.1.a.(7)) to the cumulative impact is negligible because the effects of the most probable impacts, such as sale-related operational discharges and helicopters and service-vessel noise and traffic, are estimated to be sublethal, although some displacement of local individuals or groups may occur. It is expected that there will be little interaction between OCS-related oil spills and coastal and marine birds.

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

(8) Impacts on Commercial Fisheries

This cumulative analysis considers commercial fishing activity, the status of commercial fishery stocks, the effects of impact-producing factors related to the Gulf OCS Program (proposed action and prior and future OCS sales), State oil and gas activity, crude oil imports by tanker, and offshore recreational fishing that may occur and adversely affect the commercial fishing industry in the same general area that may be affected by OCS oil and gas activity located in the WPA. Specific types of impact-producing factors

considered in the analysis include commercial fishing techniques or practices, coastal environmental degradation, emplacement of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, oil spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters.

Sections providing supportive material for the commercial fisheries analysis include Sections III.B.7. (description of fish resources), III.C.2. (commercial fisheries), IV.D.1.d.(1) (impacts on sensitive coastal environments), IV.D.1.d.(2) (impacts on water quality), IV.A.3.b.(2) (space-use conflicts), IV.A.2.a.(4) (structure removals), IV.A.2.a.(1) (seismic surveying operations), IV.A.3.h.(2) (offshore oil spills), IV.B.2.d.(1) (coastal oil spills), IV.A.3.h.(1) (blowouts), IV.A.2.b.(1) (pipelines), and IV.B.2.c. (discharges and wastes).

Competition between large numbers of commercial fishermen, between commercial operations employing different fishing methods, and between commercial and recreational fishermen for a given fishery resource, as well as natural phenomena such as weather, hypoxia, and red tides, may reduce standing populations. Fishing techniques such as trawling, gill netting, or purse seining, when practiced nonselectively, may reduce the standing stocks of the desired target species as well as significantly impact species other than the target. Space-use conflicts can result from different forms of commercial operations and between commercial and recreational fisheries. Finally, hurricanes may impact commercial fisheries by destroying oyster reefs, damaging gear and shore facilities, and changing physical characteristics of inshore and offshore ecosystems. The availability and price of key supplies and services, such as fuel, can also affect commercial fishing operations in the Gulf of Mexico.

Many of the commercially important species harvested from the Gulf of Mexico are believed to be in decline from overfishing (USDOC, NOAA, 1991). Continued fishing at the present levels may result in rapid declines in commercial landings and eventual failure of certain fisheries. Commercial landings of traditional fisheries, such as shrimp and red snapper, have declined over the past decade despite increases in fishing effort. Commercial landings of recent fisheries, such as shark, black drum, and tuna, have increased exponentially over the past five years, and those fisheries are thought to be in danger of collapse (Angelovic, written communication, 1989; USDOC, NMFS, 1991b). It is expected that overfishing of targeted species and trawl fishery bycatch will adversely affect commercial fishery resources. The impact of overfishing on the commercial fisheries resources is expected to cause less than a 10 percent decrease in commercial fishery populations or in commercial fishing. At the estimated level of effect, the resultant influence on Western Gulf fisheries is expected to be substantial and easily distinguished from effects due to natural population variations.

Because approximately 92 percent of commercially important species are estuary dependent, coastal environmental degradation has the potential to affect adversely commercial fisheries. The environmental deterioration and effects on commercial fisheries result from the loss of Gulf wetlands as nursery habitat and from the functional impairment of existing habitat through decreased water quality.

The effect of the OCS Program and non-OCS activities on wetlands and coastal water quality in the WPA is analyzed in detail in Sections IV.D.1.d.(1)(b) and (3)(a), respectively. The indirect effect on commercial fisheries is considered below.

To summarize cumulative effects on wetlands, it is clear that both natural and man-made forces contribute to the ongoing loss of fresh and estuarine marshes in States bordering the Gulf of Mexico. The highest landloss rate occurs in Louisiana. Impacts from residential, commercial, and agricultural and silvicultural developments are expected to continue in all coastal areas, especially in Louisiana and Alabama. Navigation and flood control projects will cause significant saltwater intrusion and movement of seagrass beds and oyster reefs inland in southeastern Louisiana. Construction of new pipeline canals, improper maintenance of existing pipeline canals, and concentrated oil from accidents will cause major long-term decreases in the vegetative productivity of wetlands within and immediately adjacent to the sites and will convert some of the affected area to open water. If spilled oil contacts seagrass beds, oil concentrations will be high enough to cause short-term dieback and general weakening of the associated faunal and floral communities. Both direct and indirect impacts from State onshore oil and gas activities are expected to occur as a result of dredging of new canals, maintenance and use of rig access canals and drill slips, and

preparation of new well sites. The widening of existing pipeline canals and erosion from vessel wakes will continue and will result in the destruction of a significant amount of wetlands.

To summarize cumulative effects on coastal and estuarine water quality, there exists a wide variety of contaminant inputs into coastal waters bordering the Gulf of Mexico; however, the dominant pollution source is the large volume of water from the Mississippi River that enters the Gulf region after draining over two-thirds of the contiguous U.S. Major activities that have added to the contamination of Gulf coastal waters include the petrochemical industry, agriculture, forestry, urban expansion, extensive dredging operations, municipal and camp sewerage treatment processes, marinas and recreational boating, maritime shipping, and hydromodification activities. Adding to these sources, but not as significant, are large commercial waste disposal operations, livestock farming, manufacturing industry activities, nuclear power plant operations, and pulp and paper mills. Vessel traffic is likely to impact water quality through routine releases of bilge and ballast waters, chronic fuel and tank spills, trash, and domestic and sanitary discharges. Potential oil spills represent an acute significant impact to coastal waters as well as serving as a low-level, chronic source of petroleum contamination to regional coastal water quality.

It is expected that coastal environmental degradation from the OCS Program and non-OCS activities will affect commercial fishery resources. The impact of coastal degradation in the WPA is expected to cause less than a 10 percent decrease in commercial fishery populations, in essential habitats, or in commercial fishing. Recovery of commercial fishery resources can occur from more than 90 percent, but not all, of the expected coastal environmental degradation. At the estimated level of effect, the resultant influence on Western Gulf fisheries is expected to be substantial and easily distinguished from effects due to natural population variations.

Those species of commercial importance that are not estuary dependent, such as mackerel, cobia, and crevalle, are considered coastal pelagics. Populations of these species exhibit some degree of coastal movement. These species range throughout the Gulf, move seasonally, and are more abundant in the WPA during the summer (Gulf of Mexico Fishery Management Council, 1985). In general, the coastal movements of these species are restricted to one or two planning areas within the Gulf of Mexico Region and are not truly migratory, as is the case with salmon. The coastal movements of these species are related to reproductive activity, seasonal changes in water temperature, or other oceanographic conditions. Discernible effects to regional populations or subpopulations of these species as a result of the OCS Program are not expected because pelagic species are distributed and spawn over a large geographic area and depth range.

Structure removals result in artificial habitat loss and cause fish kills when explosives are used. It is estimated that 83-123 structure removals by explosives will occur in the WPA as a result of the OCS Program. It is assumed that no more than 17-24 removals will occur in the WPA in any single year during this time. It is estimated that structure removals will have a major effect on Western Gulf fisheries near the removal sites because removals will be routine events. However, only those fish proximate to the removal sites will be killed.

The 270-495 additional platforms resulting from the proposed action, plus prior and future OCS sales in the WPA, are estimated to reduce the trawling area by about 1,620-2,970 ha, which represents an inconsequential amount of the total trawling area in the WPA. The overall annual rate of platform and structure installation is expected to decline over time as fewer reservoirs are located. Annual structure installation will remain in the 50-90 range until 2004, gradually dropping to 20 per year in 2020 and below 10 per year in 2036. It is assumed that the total area lost to commercial fishing due to the presence of OCS production platforms will continue to be less than 1 percent of the total area available to commercial trawling. It is expected that platform emplacement will infrequently affect trawling activity.

Oil spills that contact coastal bays, estuaries, and waters of the OCS when pelagic eggs and larvae are present have the greatest potential to affect commercial fishery resources. In the event that sale-related 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 damage is expected to be limited and lessened due to some 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.

Sections IV.A.3.h.(2), IV.B.2.d., and IV.C.4. contain projected numbers of offshore and coastal oil spills estimated to occur in the Gulf as a result of the OCS Program and non-OCS activities. It is estimated that oil spills $\leq$ 1 bbl in coastal inland waters would occur at a respective frequency of about 740-820 in a typical year. Spills of this volume would affect little area and dissipate rapidly. It is estimated that small oil spills (>1 bbl and <1,000 bbl) could occur in offshore and inland waters at a respective frequency of 250-400 and about 200 in a typical year. Because of the location of origin, contact is assumed to occur along the upper Texas coast. It is expected that small oil spills (>1 bbl and <1,000 bbl) could occasionally affect coastal bays and marshes essential to the well-being of the commercial fishery resources in the WPA.

Under the cumulative scenario, large offshore oil spills ($\geq$1,000 bbl) would come from non-OCS vessel traffic, State oil and gas production, the proposed action, plus prior and future OCS sales in the Gulf of Mexico. Large oil spills are estimated to occur in offshore and inland waters at a respective frequency of 4-5 per year and 10-15 per year. Galveston Bay in Texas is the coastal bay with the highest probability (17-24%) of occurrence and contact within 10 days by a large oil spill occurring from the OCS Program.

Oil spills could regularly contact and affect Western Gulf coastal bays, estuaries, or coastal areas. As a singular example, the highest estimated probability of a large oil spill ($\geq$ 1,000 bbl) occurring and contacting within 10 days Gulf menhaden during their winter spawning in coastal waters is 78-87 percent. The impact of oil spills in the WPA is expected to cause less than a 5 percent decrease in commercial fishery populations or in commercial fishing. At the estimated level of effect, the resultant influence on Western Gulf fisheries is expected to be considerable but not easily distinguished from effects due to natural population variations.

Subsurface blowouts of both oil and natural gas wells and pipeline trenching have the potential to affect adversely commercial fishery resources. Loss of well control and resultant blowouts seldom occur on the Gulf OCS (7 blowouts per 1,000 well starts; 14% will result in some spilled oil). It is assumed that there could be 27-50 blowouts in the WPA resulting from the OCS Program. It is estimated that 48.8 million m^3 of sediment would be resuspended during the installation of approximately 19,530 km of pipelines in water depths less than 60 m. Sandy sediments will be quickly redeposited within 400 m of the trench, and finer sediments will be widely dispersed and redeposited over a period of 30 days or longer within a few thousand meters of the trench. It is expected that the infrequent subsurface blowout that may occur on the Gulf OCS will have a negligible effect on Gulf commercial fisheries. The effect on commercial fisheries from pipeline trenching in the WPA is expected to cause less than a 5 percent decrease in commercial fishery populations or in commercial fishing. At the estimated level of effect, the resultant influence on Western Gulf fisheries is expected to be considerable but not easily distinguished from effects due to natural population variations.

Drilling mud discharges contain chemicals toxic to marine fishes; however, this is only at concentrations four or five orders of magnitude higher than those found more than a few meters from the discharge point. Offshore discharges of drilling muds will dilute to background levels within 1,000 m of the discharge point and have a negligible effect on Western Gulf fisheries.

Produced-water discharges contain components and properties detrimental to commercial fishery resources. Moderate petroleum and metal contamination of sediments and the water column will occur out to several hundred meters downcurrent from the discharge point. Offshore discharges of produced water will disperse and dilute to background levels within 1,000 m of the discharge point and have a negligible effect on Western Gulf fisheries.

Summary and Conclusion

Activities resulting from the OCS Program and non-OCS events have the potential to cause detrimental effects to Western Gulf commercial fisheries. Impact-producing factors of the cumulative scenario that are expected to substantially affect commercial fisheries in the WPA include coastal environmental degradation, overfishing, oil spills, and pipeline trenching. At the estimated level of effect, the resultant influence on Western Gulf fisheries is expected to be substantial and easily distinguished from effects due to natural population variations.

The incremental contribution of the proposed action (as analyzed in Section IV.D.1.a.(8)) to the cumulative impact is inconsequential. The effects of impact-producing factors (coastal environmental

degradation, emplacement of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, oil spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters) related to the proposed action are expected to be negligible. The impact of the cumulative scenario is expected to result in less than a 10 percent decrease in commercial fishery populations, in essential habitat, or in commercial fishing. It will require 3-5 years for fishing activity and 2-3 generations for fishery resources to recover from 99 percent of the impacts.

(9) Impacts on Recreational Resources and Beach Use

This cumulative analysis considers the effects of impact-producing factors related to the proposed action (Section IV.D.1.a.(9)), plus those related to prior and future OCS sales, State offshore oil and gas activity, tankering of crude oil imports, merchant shipping, commercial and recreational fishing, military operations, recreational use of beaches, and other offshore and coastal activities that result in debris, litter, trash, and pollution, which may adversely affect major recreational beaches. Specific OCS-related, impact-producing factors analyzed include oil spills, trash and debris, and platforms and drilling rigs. Other factors such as land development, civil works projects, and natural phenomena have affected, and will continue to affect, beach stabilization (Section IV.D.1.a.(1)(a)). Ultimately, these factors also affect the recreational use of beaches.

In the offshore areas of the Gulf of Mexico, 4-5 large (greater than or equal to 1,000 bbl) oil spills could occur in a typical year, and one of those spills is likely to be associated with OCS Program activities. The probability of one or more OCS-related spills occurring and contacting major recreational beaches within 10 days in Texas is 62-77 percent, and within 3 days the probability is 27-39 percent. The probability of a major OCS Program offshore spill impacting a Louisiana recreational beach is greater. For example, Fourchon Beach has a 61-72 percent probability of being impacted within 10 days and a 36-45 percent probability of impact within 3 days. These probabilitites factor in the level of existing OCS operations, the current rate of OCS leasing in the WPA and CPA, and the projected significant near-term increases in the annual level of Gulf of Mexico oil production. Given this, some Texas and Louisiana beaches are likely to be impacted by oil-spill events over the next 35 years. Large spills from any source are expected to result in short-term disturbances, causing temporary loss or displacement of water-related, nearshore recreational activity on specific beaches directly or indirectly impacted.

Approximately 1,045-1,700 small (less than 1,000 bbl) offshore spills could occur Gulfwide in a typical year from OCS Program activities; a few could contact land but are unlikely to adversely impact beaches. It is important to realize, especially in the cumulative impact context, that of all chronic hydrocarbon pollution existing in the Gulf, only a small percentage is directly related to Gulf of Mexico OCS oil and gas leasing and production (Section IV.C.4.). Chronic natural and human-induced hydrocarbon pollution can manifest on beaches as tarballs, which would adversely impact beach users, recreational developments, and personal property. Current tarball occurrence on WPA and CPA recreational beaches is believed to be derived primarily from sources other than OCS leasing and production in the Gulf of Mexico (Henry et al., 1993). Primary sources are believed to be associated with marine transportation activities (illegal bilge dumping) and natural seeps.

Continued and expanded OCS oil and gas operations in the Gulf of Mexico have contributed to the already serious problem of debris and trash on coastal beaches. Trash and debris detract from the aesthetic quality of beaches, can be hazardous to beach recreational activity, and can increase the cost of beach maintenance programs. Other factors such as merchant shipping, Naval operations, offshore and coastal commercial and recreational fishing, natural phenomena, recreational use of beaches, State oil and gas activity, tankering, pipelines, operational discharges, condominiums, coastal activity in Mexico and Cuba, and other offshore and coastal activities all contribute to flotsam, jetsam, pollution, and litter existing on the major Gulf of Mexico recreational beaches. Trash and debris are a recognized problem affecting enjoyment and maintenance of recreational beaches adjacent to the WPA. It has been estimated that coastal and offshore oil and gas operations are contributing up to 13 percent of the trash and debris affecting Texas and Louisiana recreational beaches (USEPA, 1990; Parker, personal communication, 1990; Miller et al., 1995).

Reports by Lindstedt and Holmes (1988) and the Center for Marine Conservation (1989, 1991, and 1996) indicate Gulf of Mexico beaches from Texas to Mississippi are among the country's most littered shorelines. The reports provide insight into the magnitude and composition of the cumulative trash loads affecting beaches. Items known to be associated with the oil and gas industry have been frequently identified with the beach litter removed from Texas and Louisiana beaches; however, the percentage of the litter attributed to the petroleum industry has noticeably declined in the past few years (Amos, 1991; Miller, 1992b; Miller et al., 1995). Regulatory, administrative, and volunteer programs involving government; industry; environmental, school, and civic groups; and private citizens are monitoring and reducing the gravity of the beach litter problem Gulfwide.

There are approximately 4,500 platforms on the OCS and an additional 270-495 will likely be added in the WPA from previous sales, this proposal, and future sales. All new OCS platforms will be installed more than 10 mi from shore and, therefore, will not be recognizable from Texas recreational beaches. New and existing State leases could lead to drill rigs and platforms within sight of State and local beach parks or even add to existing oil and gas operations within the Padre Island National Seashore. Vessel and helicopter traffic servicing OCS operations will from time to time be seen and heard by beach users. Existing and future oil and gas developments in State waters can exacerbate aesthetic impacts to Texas beach users should they be bothered by the sight and sounds of oil and gas operations.. Aesthetic impacts are unlikely to affect the level of beach recreational use in the Gulf Region, but may affect the sensibilities of some beach users.

Summary and Conclusion

A few large oil spills may preclude short-term recreational use of some Texas or Louisiana beaches at the park or community levels. Additionally, smaller annual offshore spills throughout the planning area are estimated to preclude short-term use of the small segments of recreational beaches adversely impacted, but will have little effect on local recreational use or tourism. OCS-related oil pollution events impacting recreational beaches will generate immediate cleanup response from lease site operators. Pollution and debris associated with the proposed sale will contribute minimally to this impact.

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. The OCS oil and gas industry has improved offshore waste management practices and made a strong commitment to participate in the removal of trash and litter from recreational beaches throughout the WPA coastal areas. Furthermore, 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. The additional contribution of beach trash from the proposed action (as analyzed in Section IV.D.1.a.(9)) to the cumulative impact is expected to be minimal because sale-specific operational activities are unlikely to cause beach park closures or to generate the need for excessive beach maintenance.

Although trash and accidental oil spills from offshore and onshore sources will continue to adversely affect the ambience of recreational beaches between Texas and Alabama, the level of chronic pollution should decline. Beach use at the regional level is unlikely to change; however, closure of specific beaches or parks directly impacted by a few large oil spills is likely during cleanup operations.

(10) Impacts on Archaeological Resources

The following cumulative analysis considers the effects of the impact-producing factors related to the proposed actions, OCS activities in the Western, Central, and Eastern Gulf, prior and future OCS sales, trawling, sport diving, commercial treasure hunting, seismic exploration in State waters, and tropical storms. Specific types of impact-producing factors considered in this analysis include drilling rig and platform

emplacement, pipeline emplacement, anchoring, oil spills, dredging, new onshore facilities, and ferromagnetic debris associated with OCS activities.

(a) Historic

Estimates of future OCS exploration and development activities are presented in Table IV-3. Archaeological surveys are assumed to reduce the potential for an interaction between an impact-producing activity and a historic resource by 95 percent in those areas that have a thin Holocene sediment veneer. Archaeological surveys are estimated to be 90 percent effective in those areas that have a thick blanket of unconsolidated Holocene sediments. Archaeological surveys were first required for Lease Sale 32 held in December 1973; therefore, it is assumed that the major impacts to historic resources resulted from development prior to this time. The potential of an interaction between rig or platform emplacement and a historic shipwreck is greatly diminished by the required archaeological survey, but still exists. Also, while the archaeological survey minimizes the chances of impacting a historic shipwreck, there remains a possibility that a wreck could be impacted by pipeline emplacement. Such interactions would result in the loss of or damage to significant or unique historic information.

The setting of anchors for drilling rigs, platforms, and pipeline lay barges, and anchoring associated with oil and gas service-vessel trips to the OCS has the potential to impact historic wrecks. Archaeological surveys serve to minimize the chance of impacting historic wrecks; however, these surveys are not seen as infallible and the chance of an impact from future activities exists. Impacts from anchoring on a historic shipwreck may have occurred. There is also a potential for future impacts from anchoring on a historic shipwreck. Such an interaction could result in the loss of or damage to significant or unique information.

The combined probabilities for offshore oil spills greater than or equal to 1,000 bbl occurring from the OCS Program and contacting the U.S. shoreline are presented in Appendix C. Oil spills have the potential to impact coastal historic sites directly or indirectly by physical impacts caused by oil-spill cleanup operations. However, the impacts caused by oil spills to coastal historic archaeological resources are generally short term and reversible. Table IV-18 presents the coastal spill scenario from both OCS and non-OCS sources. It is assumed that the majority of the spills will be contained in the water in the general vicinity of the spill. Should such oil spills contact a historic site, the effects would be temporary and reversible.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high probability for historic shipwrecks; the greatest concentrations of historic wrecks are likely associated with these features (Garrison et al., 1989). It is reasonable to assume that significant or unique historic archaeological information has been lost as a result of past channel dredging activity. In many areas, the COE requires remote-sensing surveys prior to dredging activities to minimize such impacts (Espey, Huston & Associates, 1990a).

Past, present, and future OCS oil and gas exploration and development will result in the deposition of several tens of thousands of tons of ferromagnetic debris on the seafloor. A large number of wells and pipelines have been emplaced in the Gulf. Modern marine debris associated with this activity will tend to mask the magnetic signatures of historic shipwrecks, particularly in areas that were developed prior to requiring archaeological surveys. Such masking of the signatures characteristic of historic shipwrecks may have resulted or may yet result in OCS activities impacting a shipwreck containing significant or unique historic information.

Commercial trawling activity would only affect the uppermost portions of the sediment column (Garrison et al., 1989). On many wrecks, this zone would already be disturbed by natural factors and would contain only artifacts of low specific gravity that have lost all original context.

Table IV-12 shows the projected coastal infrastructure related to OCS Program activities. Investigations prior to construction can determine if historic archaeological resources exist at the sites.

Because MMS does not have jurisdiction over pipelines in State waters, the archaeological resource protection requirements of the National Historic Preservation Act (NHPA) are not within MMS's jurisdiction. However, other Federal agencies, such as the COE which lets permits associated with pipelines in State waters, are responsible for the protection of archaeological resources under the NHPA. Therefore, the

impacts that might occur to archaeological resources by OCS-related pipeline construction within State waters should be mitigated under the requirements of the NHPA.

Sport diving and commercial treasure hunting are significant factors in the loss of historic data from wreck sites. Efforts to educate sport divers and foster the protection of historic shipwrecks, such as those of the Texas Historical Commission and the Southwest Underwater Archaeological Society (Arnold, personal communication, 1996), will serve to lessen these potential impacts. While commercial treasure hunters generally impact wrecks with intrinsic monetary value, sport divers may collect souvenirs from all types of wrecks. Since the extent of these activities is unknown, the impact cannot be quantified. Recently, a Spanish war vessel, the *El Cazador*, was discovered in the Central Gulf of Mexico. The vessel contained a large amount of silver coins and has been impacted by salvage operations (The Times Picayune, 1993). It is assumed that some of the data available from this wreck and from other wrecks that have been impacted by treasure hunters and sport divers represent a significant or unique loss.

Prior to 1989, explosives (dynamite) were used on the OCS to generate seismic pulses. Explosives have been replaced by piston-type acoustic sources that generate superior acoustic signals and that do not cause the damaging environmental impacts associated with explosives. Acoustical energy from explosives is characterized by rapid rise time (high velocity), high peak pressure, and rapid energy decrease. Seismic air guns are considered nonexplosive and have long rise times to peak pressure (low velocity). It is assumed that no explosives will be used in future OCS seismic surveys. It does appear that explosives are used in conjunction with seismic surveys within State waters (Arnold, personal communication, 1997). The use of explosives in coastal waters increases the risk of impact to historic shipwrecks in State waters. The coastal waters of the Gulf of Mexico (particularly those within 10 km of the shoreline) are considered to have a very high probability for the occurrence of historic period shipwrecks (cf. Garrison et al., 1989). The recent excavations of the *Belle* in Matagorda Bay highlight the wealth of knowledge that can be garnered from these historic wrecks. Should explosives be used on or near a historic shipwreck, physical destruction of the wreck and associated artifacts could occur. Impacts to historic shipwrecks on the OCS from explosives are not expected. There is, however, a possibility of impact to historic shipwrecks from explosive seismic survey in State waters. Data lost as a result of explosive impact to a historic shipwreck in State waters could be significant or unique.

About one-third of the WPA coast was hit with 16-20 tropical storms between the years 1901 and 1955 (DeWald, 1982). The other two-thirds had slightly lower incidents of cyclones (11-15). Experience with Hurricanes Carla and Beulah has indicated that major hurricanes can have a devastating effect on both the natural and human environment. Overall, a significant loss of data from historic sites has probably occurred, and will continue to occur, in the Gulf from the effects of tropical storms. Some of the data lost have most likely been significant or unique.

Summary and Conclusion

Several impact-producing factors may threaten historic archaeological resources. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a historic shipwreck located on the continental shelf. The archaeological surveys and resulting archaeological analysis and clearance that are required prior to an operator beginning oil and gas activities in a lease are estimated to be 90 percent effective at identifying possible historic shipwrecks in areas with a high probability for the existence of historic period shipwrecks and a thick blanket of unconsolidated sediments. Development prior to requiring archaeological surveys possibly impacted wrecks containing significant or unique historic information.

The loss of several tens of thousands of tons of ferromagnetic debris associated with oil and gas exploration and development could result in the masking of historic shipwrecks. It is expected that dredging, sport diving, commercial treasure hunting, and tropical storms have impacted and will continue to impact historic period shipwrecks. Additionally, it is possible that explosive seismic surveys within State waters could impact historic shipwrecks. Such impact will likely result in the loss of significant or unique archaeological information.

Onshore development as a result of the proposed action could result in the direct physical contact between a historic site and new facility construction and pipeline trenching. It is assumed that archaeological investigations prior to construction will serve to mitigate these potential impacts. The expected effects of oil spills on historic coastal resources are temporary and reversible. Loss of significant or unique historic archaeological information from commercial fisheries (trawling) is not expected.

The effects of the various impact-producing factors discussed in this analysis have likely resulted in the loss of significant or unique historic archaeological information. In the case of factors related to OCS Program activities, it is reasonable to assume that most impacts would have occurred prior to 1973 (the date of initial archaeological survey and clearance requirements). The incremental contribution of the proposed action is expected to be very small due to the efficacy of the required remote-sensing survey and archaeological report. There is an overall trend towards increasing OCS activity. Should this trend continue, there will be an increasing number of offshore bottom-disturbing activities. The archaeological clearance required prior to bottom-disturbing activities in areas with a high probability for historic shipwrecks will serve to protect the resource in the vast majority of cases. However, there is a possibility of an interaction between bottom-disturbing activity (rig emplacement, pipeline trenching, and anchoring) and a historic shipwreck.

(b) Prehistoric

Future OCS exploration and development activities are presented in Table IV-3. Archaeological surveys are assumed to reduce the potential for an interaction between an impact-producing activity and a prehistoric resource by 90 percent. Archaeological surveys were first required for Lease Sale 32 held in December 1973; it is assumed that the major impacts to prehistoric resources resulted from development prior to this time. The potential of an interaction between rig or platform emplacement and a prehistoric site is diminished by the required archaeological survey, but still exists. Also, while the archaeological survey minimizes the chances of impacting a prehistoric site, there remains a possibility that a site could be impacted by pipeline emplacement. Such an interaction would result in the loss of significant or unique archaeological information.

The setting of anchors for drilling rigs, platforms, and pipeline lay barges, and anchoring associated with oil and gas service-vessel trips to the OCS have the potential to impact shallow, emplaced prehistoric sites. Archaeological surveys minimize the chance of impacting these sites; however, these surveys are not seen as infallible and the chance of an impact from future activities exists. Impacts from anchoring on a prehistoric site may have occurred. Such an interaction could result in the loss of significant or unique archaeological information.

The combined probabilities for offshore oil spills greater than or equal to 1,000 bbl occurring from the OCS Program and contacting the U.S. shoreline are presented in Appendix C. Oil spills have the potential to impact coastal prehistoric sites directly or indirectly by physical impacts caused by oil-spill cleanup operations. Coastal oil-spill scenario numbers are presented in Table IV-18 for both OCS and non-OCS sources. It is assumed that the majority of the spills will occur around terminals and be contained in the vicinity of the spill. There is a small possibility of these spills contacting a prehistoric site. The impacts caused by oil spills to coastal prehistoric archaeological resources can severely distort information relating to the age of the site. Contamination of the site organics by modern hydrocarbons can render dating by C-14 methods useless. This loss might be ameliorated by artifact seriation or other relative dating techniques. Coastal prehistoric sites might also suffer direct impact from oil-spill cleanup operations, as well as from looting resulting from interactions between persons involved in cleanup operations and unrecorded prehistoric sites. Interaction between oil-spill cleanup equipment or personnel and a site could destroy fragile artifacts or disturb site context, possibly resulting in the loss of information on the prehistory of North America and the Gulf Coast region. Some coastal sites may contain significant or unique information.

Most channel dredging occurs at the entrances to bays, harbors, and ports. Bay and river margins have a high probability for the occurrence and preservation of prehistoric sites. Prior channel dredging has disturbed buried and/or inundated prehistoric archaeological sites in the coastal plain of the Gulf of Mexico.

It is assumed that some of the sites or site information were unique or significant. In many areas, the COE requires surveys prior to dredging activities to minimize such impacts.

Commercial trawling activity would only affect the uppermost portion of the sediment column (Garrison et al., 1989). This zone would already be disturbed by natural factors, and site context to this depth would presumably be disturbed. Therefore, no effect of trawling on prehistoric sites is assumed. Investigations prior to construction can determine whether prehistoric archaeological resources occur at these sites.

Table IV-12 shows the projected coastal infrastructure related to OCS Program activities. Investigations prior to construction can determine whether prehistoric archaeological resources occur at these sites.

Because MMS does not have jurisdiction over pipelines in State waters, the archaeological resource protection requirements of the NHPA are not within MMS's jurisdiction. However, other Federal agencies, such as the COE which lets permits associated with pipelines in State waters, are responsible for the protection of archaeological resources under the NHPA. Therefore, the impacts that might occur to archaeological resources by OCS-related pipeline construction within State waters should be mitigated under the requirements of the NHPA.

Prior to 1989, explosives (dynamite) were used on the OCS to generate seismic pulses. Explosives have been replaced by piston-type acoustic sources that generate superior acoustic signals and that do not cause the damaging environmental impacts associated with explosives. Acoustical energy from explosives is characterized by rapid rise time (high velocity), high peak pressure, and rapid energy decrease. Seismic air guns are considered nonexplosive and have long rise times to peak pressure (low velocity). It is assumed that no explosives will be used in future OCS seismic surveys. It does appear that explosives are used in conjunction with seismic surveys within State waters (Arnold, personal communication, 1997). The use of explosives in coastal waters increases the risk of impact to submerged prehistoric sites in State waters. Should explosives be used on or near a submerged site, physical destruction of site stratigraphy, site context, and associated artifacts could occur. Impacts to submerged prehistoric sites on the OCS from explosives are not expected. There is, however, a possibility of impact to prehistoric sites from explosive seismic survey in State waters. Data lost as a result of explosive impact to a submerged prehistoric site in State waters could be significant or unique.

About one-third of the WPA coast was hit with 16-20 tropical storms between the years 1901 and 1955 (DeWald, 1982). The other two-thirds had slightly lower incidents of cyclones (11-15). Experience with Hurricanes Carla and Beulah has indicated that major hurricanes can have a devastating effect on both the natural and human environment. Overall, a significant loss of data from prehistoric sites has probably occurred, and will continue to occur, in the Gulf from the effects of tropical storms. Some of the data lost have most likely been significant or unique.

Summary and Conclusion

Several impact-producing factors may threaten prehistoric archaeological resources of the Gulf of Mexico. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric archaeological site located on the continental shelf. The archaeological surveys and resulting archaeological analysis and clearance that are required prior to an operator beginning oil and gas activities in a lease are estimated to be 90 percent effective at identifying possible prehistoric sites. Development prior to requiring archaeological surveys possibly impacted sites containing significant or unique prehistoric information.

Dredging and tropical storms are assumed to have caused the loss of significant archaeological information. It is possible that explosive seismic surveys in State waters could result in impacts to a submerged prehistoric site. The likelihood of an oil spill occurring and contacting the coastline is very high. Such contact, and resulting cleanup activities, could result in the loss of significant or unique information. Onshore development as a result of the proposed action could result in the direct physical contact between a prehistoric site and new facility construction and pipeline trenching. It is assumed that archaeological investigations prior to construction will serve to mitigate these potential impacts. The shallow depth of sediment disturbance caused by commercial fisheries activities (trawling) is not expected to exceed that portion of the sediments that have been disturbed by wave-generated forces.

The effects of the various impact-producing factors discussed in this analysis have likely resulted in the loss of significant or unique prehistoric archaeological information. In the case of factors related to OCS Program activities, it is reasonable to assume that most impacts would have occurred prior to 1973 (the date of initial archaeological survey and clearance requirements). The incremental contribution of the proposed action is expected to be very small due to the efficacy of the required remote-sensing survey and concomitant archaeological report and clearance. There is an overall trend towards increasing OCS activity. Should this trend continue there will be an increasing number of offshore bottom-disturbing activities. The archaeological clearance required prior to bottom-disturbing activities in areas with a high probability for submerged prehistoric sites will serve to protect the resource in the vast majority of cases. However, there is a possibility of an interaction between bottom-disturbing activity (rig emplacement, pipeline trenching, and anchoring) and a prehistoric archaeological site.

(11) Impacts on Socioeconomic Conditions

(a) Employment and Population

The cumulative analysis will focus on the direct, indirect, and induced impacts of the OCS oil and gas industry on the population and employment of the counties in the Western Gulf coastal impact area as a result of prior sales, the proposed sale, and future sales in the Gulf of Mexico. Considered also are employment impacts associated with the cleanup of coastal oil spills and oil spilled during import tankering operations. There would also be other economic impacts, both direct and indirect, associated with the OCS Program resulting from its effect on other industries, such as commercial fishing, tourism, and recreational fishing. The direct benefit or loss in these industries is addressed in the sections of this EIS related specifically to those topics. The OCS Program's indirect and induced effect on these associated industries is much more difficult to quantify. Nevertheless, it will generally constitute a fraction of the magnitude of the direct impact. Also discussed in the cumulative analysis are projected changes in the industrial composition of the regional economy.

Section III.C.1.a. provides a historical perspective of the oil and gas industry, as well as a brief description of recent events that have significantly affected the level of OCS activity in the Gulf of Mexico. A detailed discussion of historical trends in population and employment within the coastal impact area of the Western Gulf can be found in Section III.C.1.b. This section also includes a listing of counties in the Western Gulf coastal impact area, as well as current statistics and future projections of population and employment levels for coastal subareas in the region. These projections will serve as a baseline against which impacts will be measured. The methodology developed to quantify these impacts takes into account changes in OCS-related employment, along with population and labor impacts resulting from these employment changes within each individual coastal subarea. For a detailed description of the methodology used in this analysis, see Section IV.D.1.a.(11)(a).

Baseline employment projections for the coastal impact area of the Western Gulf of Mexico can be found in Figure IV-4. Baseline employment projections, excluding jobs generated in the WPA by the OCS Program, are also displayed on this figure. The difference between these two sets of projections accounts for OCS Program employment impacts to the counties of the Western Gulf resulting from prior sales, proposed sales, and future sales in the Central, Western, and Eastern Gulf of Mexico. Sales in the Central and Eastern Gulf can, and do, result in employment impacts to the Western Gulf. The methodology discussion in Section IV.D.1.a.(11)(a) provides an in-depth treatment of the development of these projections.

Approximately 5.2 to 6.3 million person-years of employment (direct, indirect, and induced) are required in the coastal subareas of the Gulf to support the OCS Program in the Gulf of Mexico. A total of approximately 1.5-1.9 million person-years of employment (direct, indirect, and induced) are required in the Western Gulf coastal subareas in support of the OCS Program in the Gulf of Mexico. Employment peaks at about 50,000 workers involved in primary, secondary, and tertiary industries throughout the years 2003-2016. After this initial peak employment, impacts moderately decline through the year 2036, reflecting

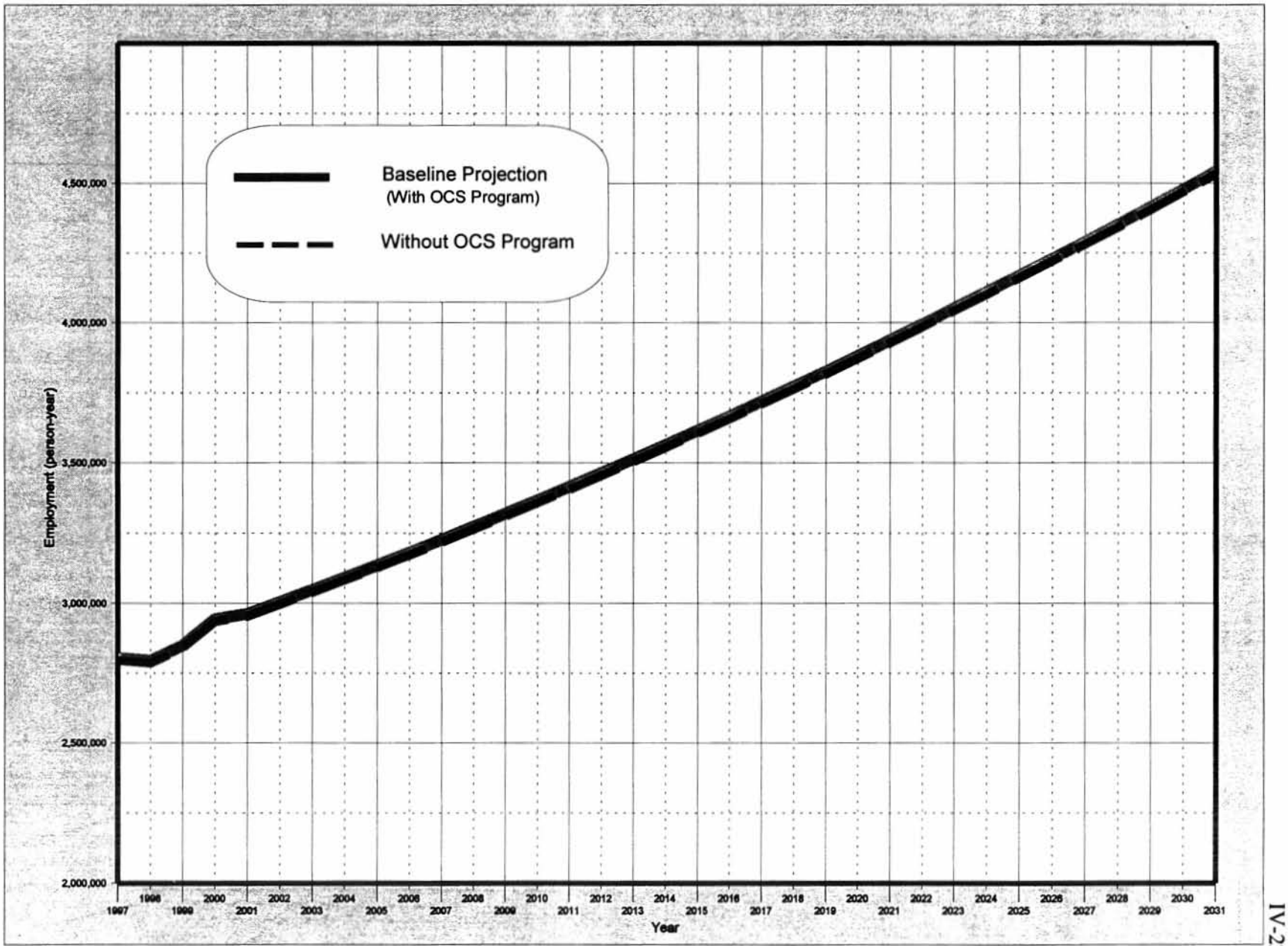


Figure IV-4. Employment Impacts from the OCS Program (Western Planning Area).

employment in the primary oil and gas extraction industry (SIC 13) accounts for about 43 percent of the total employment impacts projected for the Central and Western Gulf coastal subareas over the life of the proposed action. Exploratory activities peak in the years 2004-2009 but only moderately decline through 2036. Employment in oil and gas production activities account for more than half of direct offshore employment due to activities in the Western Gulf. Table IV-33 displays the cumulative model projections of total OCS-related employment impacts (direct, indirect, and induced) for each coastal subarea throughout the life of the proposed action. Table IV-34 provides estimates of annual impacts to the population and employment of each coastal subarea as a percent of levels expected in absence of the OCS Program. These impact estimates represent changes in the new share of the existing population and employment that will be dependent on the OCS oil and gas industry for support as a result of prior sales, the proposed sale, and future sales in the Gulf of Mexico.

Because the coastal communities of Texas are more diversified and less reliant on OCS Program activities than are the coastal communities of Louisiana, the impact to employment on the Texas coastal subareas from the OCS Program is not as great as is the impact on the Louisiana coastal subareas. The greatest impact to employment in Texas is in coastal Subarea TX-2, with peak-year impact estimate for 1998 of almost 1.7 percent. All coastal subareas are expected to experience peak impacts within the first seven years of the life of the proposed action and gradually decline through 2036. The timing of these peak experiences suggests that activities resulting from prior sales are responsible for a significant portion of the employment impact. New OCS development will allow the continuation of some opportunities in the oil and gas industry for currently employed workers or future entrants into the labor force already living in the area. However, as previously mentioned in Section III, some employment is expected to be met through in-migration due to the shadow effect and a labor force lacking the requisite skills for the oil and gas and supporting industries. Particularly with deepwater development, new skill requirements may need to be met outside of the impact area, through in-migration or through obtaining products/services outside of the Gulf of Mexico region. The presence of some in-migrants has been reported for southern Lafourche Parish, including workers from Mexico and India. This temporary importation of labor, particularly in the south Lafourche area of Louisiana, is expected to continue in the near future. This is a unique situation exacerbated by the shadow effect. The unusual work schedules in the oil and gas extraction industry also support employment outside of the impact area since long-distance commuting can be reasonably accomplished on such an infrequent basis. So, while employment opportunities are growing in the oil and gas extraction and supporting industries within the Gulf of Mexico impact area, some of that employment will be met outside of the area. As previously mentioned, the computerized model used in this analysis only reflects (permanent) employment within the coastal impact area. The level of OCS-related employment projected for the Western Gulf will continue to diminish as existing hydrocarbon resources become depleted. However, a resurgence of offshore drilling in the Gulf of Mexico, due primarily to technological advancement and the recent enactment of the OCS Deep Water Royalty Relief Act, suggests that the level of OCS-related employment projected for the coastal communities in the Western Gulf of Mexico will decline at a much slower pace than previously anticipated. Continued leasing in the OCS will, therefore, partially offset the decline in available oil- and gas-related employment in the counties of the WPA.

Employment impacts resulting from oil-spill cleanup activities, because of their highly unpredictable nature, were handled apart from the population and employment model. The level of employment associated with any given cleanup operation is dependent on numerous variables, which, in themselves, are also difficult to predict. Nevertheless, the most labor-intensive cleanup operations are those from spills that contact the coastline, particularly recreational beaches. For the purpose of this analysis, it is assumed that only those spills contacting land will involve significant manpower requirements in their cleanup efforts. Based on employment statistics from recent spill cleanup operations along the coast, the assumption is that, for every kilometer of coastline subjected to heavy oiling, approximately 100 temporary workers will be employed for a maximum of 6 weeks.

Section IV.C.4. presents estimates of the number of offshore spills assumed to occur annually as a result of the cumulative scenario in the Gulf of Mexico. The probability that one or more Size 3 offshore spills will occur as the result of the OCS Program and contact land segments of the Western Gulf within 10 days of the accident is presented in Appendix C.

Table IV-33

OCS-Related Employment Projections (Direct+Indirect+Induced) for the Gulf of Mexico
(person-years)

Year	TX-1	TX-2	LA-1	LA-2	LA-3	MA-1	WGOM	CGOM	Total
1998	2,407 - 2,860	37,102 - 43,581	26,326 - 30,018	39,937 - 46,421	16,627 - 20,089	15,695 - 18,311	39,510 - 46,441	98,585 - 114,838	138,095 - 161,280
1999	2,468 - 2,959	37,556 - 44,263	26,501 - 30,287	40,244 - 46,870	16,807 - 20,301	15,886 - 18,516	40,023 - 47,222	99,438 - 115,974	139,461 - 163,196
2000	2,519 - 3,049	37,898 - 44,872	26,618 - 30,505	40,477 - 47,255	16,948 - 20,487	15,967 - 18,720	40,417 - 47,921	100,010 - 116,967	140,427 - 164,889
2001	2,558 - 3,123	38,119 - 45,351	26,664 - 30,662	40,584 - 47,557	17,021 - 20,632	16,057 - 18,870	40,677 - 48,474	100,326 - 117,721	141,003 - 166,195
2002	2,594 - 3,206	38,282 - 45,958	26,695 - 30,879	40,642 - 48,015	17,060 - 20,838	16,085 - 19,081	40,876 - 49,163	100,483 - 118,814	141,359 - 167,977
2003	2,620 - 3,266	38,369 - 46,239	26,688 - 30,935	40,638 - 48,089	17,059 - 20,871	16,094 - 19,167	40,989 - 49,505	100,480 - 119,062	141,469 - 168,567
2004	2,638 - 3,326	38,407 - 46,514	26,652 - 30,979	40,593 - 48,146	17,041 - 20,900	16,152 - 19,264	41,044 - 49,841	100,438 - 119,289	141,482 - 169,130
2005	2,652 - 3,373	38,352 - 46,664	26,569 - 30,963	40,462 - 48,107	16,971 - 20,874	16,109 - 19,322	41,004 - 50,037	100,111 - 119,265	141,115 - 169,302
2006	2,667 - 3,421	38,252 - 46,795	26,465 - 30,950	40,277 - 48,079	16,872 - 20,847	16,050 - 19,349	40,919 - 50,216	99,663 - 119,225	140,583 - 169,441
2007	2,675 - 3,464	38,126 - 46,911	26,358 - 30,926	40,084 - 48,020	16,765 - 20,809	16,011 - 19,395	40,802 - 50,375	99,219 - 119,149	140,020 - 169,524
2008	2,674 - 3,501	37,945 - 46,978	26,231 - 30,873	39,859 - 47,909	16,634 - 20,740	15,971 - 19,420	40,620 - 50,479	98,696 - 118,942	139,315 - 169,421
2009	2,676 - 3,538	37,767 - 47,067	26,097 - 30,834	39,609 - 47,822	16,491 - 20,681	15,911 - 19,439	40,443 - 50,605	98,109 - 118,776	138,552 - 169,381
2010	2,662 - 3,560	37,490 - 47,036	25,940 - 30,748	39,336 - 47,648	16,333 - 20,578	15,815 - 19,451	40,152 - 50,596	97,424 - 118,426	137,576 - 169,022
2011	2,649 - 3,578	37,242 - 46,969	25,787 - 30,631	39,091 - 47,439	16,191 - 20,455	15,729 - 19,433	39,891 - 50,547	96,799 - 117,958	136,690 - 168,505
2012	2,629 - 3,602	36,934 - 46,924	25,619 - 30,520	38,797 - 47,227	16,025 - 20,333	15,659 - 19,426	39,563 - 50,526	96,099 - 117,506	135,663 - 168,032
2013	2,611 - 3,622	36,665 - 46,841	25,468 - 30,385	38,544 - 46,977	15,876 - 20,188	15,570 - 19,425	39,276 - 50,463	95,458 - 116,975	134,734 - 167,438
2014	2,590 - 3,633	36,387 - 46,658	25,326 - 30,218	38,307 - 46,671	15,733 - 20,014	15,476 - 19,358	38,978 - 50,290	94,843 - 116,262	133,820 - 166,552
2015	2,572 - 3,640	36,138 - 46,446	25,192 - 30,051	38,090 - 46,369	15,603 - 19,839	15,384 - 19,255	38,709 - 50,086	94,268 - 115,514	132,977 - 165,600
2016	2,549 - 3,647	35,868 - 46,223	25,059 - 29,885	37,888 - 46,075	15,482 - 19,670	15,339 - 19,195	38,416 - 49,869	93,768 - 114,825	132,184 - 164,694
2017	2,537 - 3,648	35,640 - 45,963	24,947 - 29,722	37,678 - 45,766	15,360 - 19,494	15,256 - 19,112	38,177 - 49,610	93,241 - 114,095	131,418 - 163,706
2018	2,530 - 3,645	35,481 - 45,698	24,861 - 29,542	37,534 - 45,446	15,275 - 19,311	15,186 - 18,997	38,010 - 49,343	92,856 - 113,296	130,866 - 162,639
2019	2,516 - 3,636	35,289 - 45,378	24,775 - 29,350	37,395 - 45,098	15,188 - 19,112	15,125 - 18,884	37,804 - 49,014	92,483 - 112,444	130,288 - 161,458
2020	2,509 - 3,625	35,163 - 45,073	24,710 - 29,170	37,286 - 44,766	15,122 - 18,920	15,080 - 18,805	37,672 - 48,697	92,198 - 111,661	129,871 - 160,358
2021	2,514 - 3,624	35,090 - 44,884	24,655 - 29,037	37,200 - 44,530	15,073 - 18,784	15,057 - 18,757	37,603 - 48,507	91,984 - 111,108	129,588 - 159,616
2022	2,520 - 3,628	35,049 - 44,664	24,623 - 28,888	37,139 - 44,231	15,040 - 18,612	15,051 - 18,655	37,569 - 48,292	91,852 - 110,386	129,422 - 158,678
2023	2,520 - 3,627	34,993 - 44,431	24,594 - 28,737	37,102 - 43,954	15,013 - 18,452	15,033 - 18,547	37,513 - 48,058	91,742 - 109,690	129,255 - 157,748
2024	2,517 - 3,617	34,931 - 44,175	24,556 - 28,594	37,045 - 43,689	14,979 - 18,293	15,016 - 18,453	37,448 - 47,792	91,596 - 109,029	129,044 - 156,821
2025	2,532 - 3,615	34,982 - 43,943	24,565 - 28,461	37,042 - 43,412	14,979 - 18,134	15,033 - 18,317	37,514 - 47,558	91,619 - 108,324	129,133 - 155,882
2026	2,541 - 3,609	34,988 - 43,703	24,563 - 28,314	37,044 - 43,138	14,974 - 17,980	15,002 - 18,217	37,529 - 47,312	91,583 - 107,649	129,112 - 154,961
2027	2,544 - 3,603	34,931 - 43,490	24,528 - 28,189	36,982 - 42,912	14,940 - 17,852	14,987 - 18,139	37,475 - 47,093	91,438 - 107,092	128,913 - 154,184
2028	2,564 - 3,599	34,991 - 43,328	24,533 - 28,092	36,977 - 42,741	14,941 - 17,756	14,988 - 18,067	37,555 - 46,927	91,439 - 106,656	128,994 - 153,583
2029	2,578 - 3,590	35,017 - 43,141	24,510 - 27,980	36,948 - 42,574	14,931 - 17,663	14,999 - 17,982	37,595 - 46,731	91,388 - 106,198	128,983 - 152,930
2030	2,591 - 3,580	35,039 - 42,946	24,493 - 27,881	36,921 - 42,431	14,913 - 17,578	15,010 - 17,917	37,630 - 46,526	91,337 - 105,807	128,967 - 152,332
2031	2,611 - 3,578	35,071 - 42,800	24,479 - 27,799	36,887 - 42,296	14,900 - 17,499	15,007 - 17,846	37,682 - 46,378	91,273 - 105,440	128,955 - 151,818
2032	2,632 - 3,570	35,101 - 42,678	24,471 - 27,756	36,851 - 42,247	14,880 - 17,467	14,967 - 17,753	37,732 - 46,248	91,168 - 105,222	128,901 - 151,470
2033	2,640 - 3,555	35,071 - 42,519	24,428 - 27,688	36,788 - 42,171	14,845 - 17,421	14,940 - 17,717	37,711 - 46,073	91,002 - 104,997	128,713 - 151,071
2034	2,654 - 3,546	35,085 - 42,381	24,419 - 27,623	36,758 - 42,071	14,829 - 17,359	14,899 - 17,649	37,739 - 45,928	90,905 - 104,701	128,644 - 150,629
2035	2,667 - 3,547	35,096 - 42,336	24,404 - 27,598	36,713 - 42,032	14,805 - 17,339	14,892 - 17,648	37,762 - 45,883	90,814 - 104,617	128,577 - 150,500
2036	2,675 - 3,542	35,085 - 42,222	24,387 - 27,549	36,674 - 41,956	14,784 - 17,291	14,883 - 17,596	37,761 - 45,764	90,729 - 104,392	128,490 - 150,156
Total	987,759 - 1,149,216	613,311 - 751,461	1,494,424 - 1,768,159	601,369 - 729,457	1,414,992 - 1,754,042	1,515,794 - 1,890,391	3,696,863 - 4,398,294	100,803 - 136,349	5,212,658 - 6,288,685

Table IV-34

Employment and Population Percentage Impact Levels for the OCS Program Scenarios for the Gulf of Mexico

Employment Impacts

Year	TX-1	TX-2	LA-1	LA-2	LA-3	MA-1	WGOM	CGM	Total
1998	0.58% - 0.69%	1.43% - 1.68%	11.02% - 12.57%	7.90% - 9.18%	2.87% - 3.47%	3.57% - 4.17%	1.31% - 1.54%	5.60% - 6.52%	2.89% - 3.38%
1999	0.59% - 0.71%	1.42% - 1.67%	10.95% - 12.51%	7.80% - 9.08%	2.86% - 3.46%	3.57% - 4.16%	1.30% - 1.53%	5.56% - 6.49%	2.86% - 3.35%
2000	0.59% - 0.71%	1.40% - 1.66%	10.85% - 12.44%	7.69% - 8.97%	2.85% - 3.44%	3.53% - 4.14%	1.28% - 1.52%	5.51% - 6.45%	2.83% - 3.32%
2001	0.59% - 0.72%	1.39% - 1.65%	10.76% - 12.38%	7.59% - 8.90%	2.83% - 3.43%	3.52% - 4.14%	1.26% - 1.51%	5.45% - 6.39%	2.79% - 3.28%
2002	0.59% - 0.73%	1.38% - 1.65%	10.67% - 12.34%	7.50% - 8.86%	2.81% - 3.43%	3.49% - 4.14%	1.24% - 1.49%	5.38% - 6.36%	2.74% - 3.26%
2003	0.59% - 0.74%	1.36% - 1.64%	10.56% - 12.24%	7.39% - 8.74%	2.78% - 3.41%	3.46% - 4.12%	1.22% - 1.47%	5.30% - 6.28%	2.69% - 3.21%
2004	0.59% - 0.74%	1.34% - 1.63%	10.44% - 12.14%	7.27% - 8.63%	2.75% - 3.38%	3.44% - 4.10%	1.19% - 1.45%	5.22% - 6.20%	2.64% - 3.16%
2005	0.58% - 0.74%	1.32% - 1.61%	10.31% - 12.01%	7.15% - 8.50%	2.72% - 3.34%	3.40% - 4.07%	1.17% - 1.43%	5.12% - 6.10%	2.58% - 3.10%
2006	0.58% - 0.74%	1.30% - 1.60%	10.19% - 11.92%	7.03% - 8.40%	2.68% - 3.31%	3.36% - 4.05%	1.14% - 1.40%	5.03% - 6.01%	2.52% - 3.04%
2007	0.58% - 0.75%	1.29% - 1.58%	10.07% - 11.82%	6.92% - 8.29%	2.64% - 3.28%	3.32% - 4.03%	1.11% - 1.37%	4.93% - 5.92%	2.47% - 2.99%
2008	0.57% - 0.75%	1.27% - 1.57%	9.95% - 11.71%	6.81% - 8.18%	2.60% - 3.25%	3.29% - 4.00%	1.08% - 1.35%	4.84% - 5.83%	2.41% - 2.93%
2009	0.56% - 0.75%	1.25% - 1.55%	9.83% - 11.61%	6.69% - 8.08%	2.56% - 3.21%	3.25% - 3.97%	1.06% - 1.32%	4.74% - 5.74%	2.35% - 2.87%
2010	0.56% - 0.74%	1.25% - 1.54%	9.69% - 11.49%	6.57% - 7.96%	2.52% - 3.17%	3.21% - 3.95%	1.03% - 1.29%	4.64% - 5.64%	2.29% - 2.81%
2011	0.55% - 0.74%	1.21% - 1.52%	9.59% - 11.39%	6.48% - 7.86%	2.48% - 3.14%	3.17% - 3.92%	1.00% - 1.26%	4.54% - 5.54%	2.23% - 2.75%
2012	0.54% - 0.74%	1.19% - 1.51%	9.48% - 11.29%	6.38% - 7.76%	2.45% - 3.10%	3.14% - 3.90%	0.97% - 1.24%	4.45% - 5.44%	2.17% - 2.69%
2013	0.53% - 0.74%	1.17% - 1.50%	9.38% - 11.19%	6.29% - 7.66%	2.41% - 3.07%	3.11% - 3.88%	0.94% - 1.21%	4.36% - 5.34%	2.12% - 2.63%
2014	0.53% - 0.74%	1.15% - 1.48%	9.28% - 11.07%	6.20% - 7.55%	2.38% - 3.03%	3.08% - 3.85%	0.91% - 1.18%	4.27% - 5.23%	2.06% - 2.57%
2015	0.52% - 0.73%	1.14% - 1.46%	9.18% - 10.96%	6.11% - 7.44%	2.35% - 2.98%	3.04% - 3.81%	0.89% - 1.15%	4.18% - 5.12%	2.01% - 2.50%
2016	0.51% - 0.73%	1.12% - 1.45%	9.12% - 10.87%	6.06% - 7.37%	2.32% - 2.95%	3.03% - 3.79%	0.86% - 1.12%	4.10% - 5.02%	1.96% - 2.44%
2017	0.51% - 0.73%	1.11% - 1.43%	9.06% - 10.79%	6.00% - 7.29%	2.30% - 2.92%	3.00% - 3.76%	0.84% - 1.09%	4.02% - 4.92%	1.91% - 2.38%
2018	0.51% - 0.73%	1.10% - 1.42%	9.01% - 10.70%	5.95% - 7.20%	2.28% - 2.89%	2.98% - 3.73%	0.82% - 1.06%	3.95% - 4.82%	1.87% - 2.32%
2019	0.50% - 0.72%	1.09% - 1.40%	8.96% - 10.61%	5.90% - 7.12%	2.27% - 2.85%	2.96% - 3.70%	0.80% - 1.03%	3.88% - 4.72%	1.83% - 2.26%
2020	0.50% - 0.72%	1.08% - 1.39%	8.92% - 10.53%	5.86% - 7.04%	2.25% - 2.82%	2.95% - 3.68%	0.78% - 1.00%	3.82% - 4.62%	1.79% - 2.20%
2021	0.50% - 0.72%	1.08% - 1.38%	8.88% - 10.46%	5.82% - 6.97%	2.24% - 2.79%	2.94% - 3.66%	0.76% - 0.98%	3.75% - 4.53%	1.75% - 2.15%
2022	0.50% - 0.71%	1.07% - 1.37%	8.85% - 10.38%	5.79% - 6.90%	2.23% - 2.76%	2.93% - 3.63%	0.74% - 0.95%	3.70% - 4.44%	1.71% - 2.10%
2023	0.49% - 0.71%	1.07% - 1.35%	8.82% - 10.31%	5.76% - 6.82%	2.22% - 2.73%	2.92% - 3.60%	0.72% - 0.93%	3.64% - 4.35%	1.68% - 2.05%
2024	0.49% - 0.71%	1.06% - 1.34%	8.79% - 10.23%	5.73% - 6.76%	2.21% - 2.70%	2.91% - 3.57%	0.71% - 0.90%	3.58% - 4.27%	1.64% - 2.00%
2025	0.49% - 0.70%	1.06% - 1.33%	8.77% - 10.16%	5.70% - 6.68%	2.21% - 2.67%	2.90% - 3.54%	0.69% - 0.88%	3.54% - 4.18%	1.61% - 1.95%
2026	0.49% - 0.70%	1.05% - 1.31%	8.74% - 10.07%	5.67% - 6.61%	2.20% - 2.64%	2.88% - 3.50%	0.68% - 0.86%	3.48% - 4.10%	1.58% - 1.90%
2027	0.49% - 0.70%	1.04% - 1.30%	8.69% - 9.99%	5.63% - 6.54%	2.18% - 2.61%	2.87% - 3.47%	0.66% - 0.83%	3.43% - 4.02%	1.55% - 1.85%
2028	0.49% - 0.69%	1.04% - 1.29%	8.66% - 9.91%	5.60% - 6.48%	2.18% - 2.59%	2.85% - 3.44%	0.65% - 0.81%	3.38% - 3.94%	1.52% - 1.81%
2029	0.49% - 0.69%	1.04% - 1.28%	8.61% - 9.83%	5.57% - 6.42%	2.16% - 2.56%	2.84% - 3.41%	0.64% - 0.79%	3.33% - 3.87%	1.49% - 1.77%
2030	0.49% - 0.68%	1.03% - 1.26%	8.57% - 9.76%	5.53% - 6.36%	2.15% - 2.54%	2.83% - 3.38%	0.62% - 0.77%	3.28% - 3.80%	1.46% - 1.73%
2031	0.49% - 0.68%	1.03% - 1.25%	8.53% - 9.69%	5.50% - 6.30%	2.14% - 2.52%	2.82% - 3.35%	0.61% - 0.75%	3.23% - 3.73%	1.43% - 1.69%
2032	0.49% - 0.67%	1.02% - 1.24%	8.50% - 9.64%	5.46% - 6.26%	2.13% - 2.50%	2.79% - 3.31%	0.60% - 0.73%	3.18% - 3.67%	1.41% - 1.65%
2033	0.49% - 0.67%	1.01% - 1.23%	8.45% - 9.57%	5.42% - 6.22%	2.12% - 2.48%	2.78% - 3.29%	0.59% - 0.72%	3.13% - 3.61%	1.38% - 1.62%
2034	0.49% - 0.66%	1.01% - 1.22%	8.41% - 9.51%	5.39% - 6.17%	2.11% - 2.47%	2.75% - 3.26%	0.57% - 0.70%	3.08% - 3.55%	1.35% - 1.58%
2035	0.49% - 0.66%	1.00% - 1.21%	8.37% - 9.47%	5.36% - 6.13%	2.09% - 2.45%	2.74% - 3.25%	0.56% - 0.68%	3.04% - 3.50%	1.32% - 1.55%
2036	0.49% - 0.65%	1.00% - 1.20%	8.33% - 9.41%	5.32% - 6.09%	2.08% - 2.44%	2.72% - 3.22%	0.55% - 0.67%	2.99% - 3.44%	1.30% - 1.52%

Population Impacts

Year	TX-1	TX-2	LA-1	LA-2	LA-3	MA-1	WGOM	CGM	Total
1998	0.35% - 0.42%	1.70% - 2.00%	10.95% - 12.48%	9.16% - 10.65%	3.16% - 3.82%	3.79% - 4.42%	1.36% - 1.60%	5.63% - 6.56%	2.96% - 3.46%
1999	0.35% - 0.43%	1.70% - 2.00%	10.95% - 12.52%	9.13% - 10.63%	3.18% - 3.84%	3.81% - 4.45%	1.36% - 1.60%	5.64% - 6.58%	2.96% - 3.47%
2000	0.36% - 0.43%	1.69% - 2.00%	10.93% - 12.53%	9.08% - 10.60%	3.19% - 3.85%	3.81% - 4.47%	1.36% - 1.61%	5.64% - 6.60%	2.96% - 3.47%
2001	0.36% - 0.44%	1.68% - 2.00%	10.89% - 12.52%	9.02% - 10.57%	3.18% - 3.86%	3.81% - 4.48%	1.35% - 1.61%	5.62% - 6.60%	2.94% - 3.47%
2002	0.36% - 0.44%	1.67% - 2.01%	10.84% - 12.54%	8.96% - 10.58%	3.17% - 3.88%	3.80% - 4.50%	1.34% - 1.62%	5.60% - 6.62%	2.92% - 3.47%
2003	0.36% - 0.45%	1.66% - 2.00%	10.78% - 12.49%	8.87% - 10.50%	3.16% - 3.86%	3.78% - 4.50%	1.33% - 1.61%	5.57% - 6.59%	2.90% - 3.46%
2004	0.36% - 0.45%	1.64% - 1.99%	10.70% - 12.44%	8.78% - 10.42%	3.14% - 3.85%	3.77% - 4.50%	1.32% - 1.61%	5.53% - 6.57%	2.88% - 3.44%
2005	0.36% - 0.45%	1.62% - 1.97%	10.61% - 12.36%	8.68% - 10.32%	3.11% - 3.82%	3.74% - 4.49%	1.31% - 1.60%	5.48% - 6.53%	2.84% - 3.41%
2006	0.35% - 0.45%	1.60% - 1.96%	10.51% - 12.29%	8.56% - 10.22%	3.07% - 3.79%	3.71% - 4.47%	1.29% - 1.58%	5.42% - 6.49%	2.81% - 3.38%
2007	0.35% - 0.46%	1.58% - 1.95%	10.40% - 12.21%	8.45% - 10.12%	3.03% - 3.77%	3.68% - 4.45%	1.28% - 1.57%	5.36% - 6.44%	2.77% - 3.36%
2008	0.35% - 0.46%	1.56% - 1.93%	10.29% - 12.11%	8.33% - 10.02%	2.99% - 3.73%	3.64% - 4.43%	1.26% - 1.56%	5.30% - 6.39%	2.74% - 3.33%
2009	0.34% - 0.46%	1.54% - 1.92%	10.18% - 12.03%	8.21% - 9.91%	2.95% - 3.70%	3.61% - 4.41%	1.24% - 1.55%	5.24% - 6.34%	2.70% - 3.30%
2010	0.34% - 0.45%	1.51% - 1.90%	10.06% - 11.93%	8.09% - 9.79%	2.91% - 3.66%	3.57% - 4.39%	1.22% - 1.54%	5.17% - 6.29%	2.66% - 3.27%
2011	0.33% - 0.45%	1.49% - 1.88%	9.94% - 11.81%	7.97% - 9.67%	2.86% - 3.62%	3.52% - 4.35%	1.20% - 1.52%	5.10% - 6.22%	2.62% - 3.23%
2012	0.33% - 0.45%	1.46% - 1.86%	9.82% - 11.69%	7.84% - 9.54%	2.82% - 3.57%	3.49% - 4.32%	1.18% - 1.51%	5.03% - 6.15%	2.58% - 3.20%
2013	0.32% - 0.45%	1.44% - 1.84%	9.70% - 11.57%	7.72% - 9.41%	2.77% - 3.53%	3.44% - 4.30%	1.16% - 1.49%	4.97% - 6.09%	2.54% - 3.16%
2014	0.32% - 0.45%	1.42% - 1.82%	9.58% - 11.43%	7.61% - 9.27%	2.73% - 3.47%	3.40% - 4.25%	1.14% - 1.48%	4.90% - 6.01%	2.50% - 3.12%
2015	0.31% - 0.44%	1.39% - 1.79%	9.47% - 11.30%	7.51% - 9.14%	2.69% - 3.42%	3.36% - 4.20%	1.13% - 1.46%	4.84% - 5.93%	2.47% - 3.07%
2016	0.31% - 0.44%	1.37% - 1.77%	9.36% - 11.17%	7.41% - 9.01%	2.65% - 3.37%	3.32% - 4.16%	1.11% - 1.44%	4.78% - 5.86%	2.43% - 3.03%
2017	0.30% - 0.44%	1.35% - 1.75%	9.26% - 11.04%	7.31% - 8.87%	2.62% - 3.32%	3.28% - 4.11%	1.09% - 1.42%	4.72% - 5.78%	2.40% - 2.99%
2018	0.30% - 0.43%	1.34% - 1.72%	9.17% - 10.90%	7.22% - 8.74%	2.59% - 3.27%	3.25% - 4.06%	1.08% - 1.40%	4.67% - 5.70%	2.37% - 2.95%
2019	0.30% - 0.43%	1.32% - 1.70%	9.08% - 10.76%	7.13% - 8.60%	2.55% - 3.21%	3.21% - 4.01%	1.06% - 1.38%	4.62% - 5.62%	2.35% - 2.91%
2020	0.29% - 0.42%	1.30% - 1.67%	9.00% - 10.63%	7.06% - 8.47%	2.53% - 3.16%	3.18% - 3.97%	1.05% - 1.36%	4.58% - 5.54%	2.32% - 2.87%
2021	0.29% - 0.42%	1.29% - 1.65%	8.93% - 10.51%	6.98% - 8.36%	2.50% - 3.12%	3.15% - 3.93%	1.04% - 1.34%	4.53% - 5.48%	2.30% - 2.83%
2022	0.29% - 0.42%	1.28% - 1.63%	8.86% - 10.39%	6.92% - 8.24%	2.48% - 3.07%	3.13% - 3.88%	1.03% - 1.33%	4.50% - 5.40%	2.28% - 2.79%
2023	0.29% - 0.41%	1.27% - 1.61%	8.79% - 10.27%	6.85% - 8.12%	2.46% - 3.03%	3.11% - 3.83%	1.02% - 1.31%	4.46% - 5.33%	2.26% - 2.76%
2024	0.28% - 0.41%	1.25% - 1.58%	8.72% - 10.16%	6.79% - 8.01%	2.44% - 2.98%	3.08% - 3.79%	1.01% - 1.29%	4.42% - 5.27%	2.24% - 2.72%
2025	0.28% - 0.40%	1.24% - 1.56%	8.67% - 10.05%	6.73% - 7.89%	2.43% - 2.94%	3.06% - 3.73%	1.01% - 1.28%	4.39% - 5.20%	2.22% - 2.68%
2026	0.28% - 0.40%	1.24% - 1.54%	8.63% - 9.95%	6.69% - 7.79%	2.41% - 2.90%	3.04% - 3.69%	1.00% - 1.26%	4.37% - 5.14%	2.21% - 2.65%
2027	0.28% - 0.40%	1.23% - 1.53%	8.57% - 9.85%	6.64% - 7.71%	2.40% - 2.86%	3.02% - 3.65%	0.99% - 1.25%	4.34% - 5.08%	2.19% - 2.62%
2028	0.28% - 0.40%	1.22% - 1.51%	8.53% - 9.77%	6.60% - 7.63%	2.38% - 2.83%	3.00% - 3.62%	0.99% - 1.23%	4.32% - 5.03%	2.18% - 2.59%
2029	0.28% - 0.39%	1.21% - 1.50%	8.48% - 9.69%	6.56% - 7.56%	2.37% - 2.80%	2.99% - 3.58%	0.98% - 1.22%	4.29% - 4.98%	2.17% - 2.57%
2030	0.28% - 0.39%	1.21% - 1.48%	8.44% - 9.60%	6.51% - 7.49%	2.36% - 2.78%	2.97% - 3.55%	0.98% - 1.21%	4.26% - 4.94%	2.15% - 2.54%
2031	0.28% - 0.39%	1.20% - 1.46%	8.39% - 9.53%	6.47% - 7.42%	2.34% - 2.75%	2.95% - 3.51%	0.97% - 1.20%	4.24% - 4.90%	2.14% - 2.52%
2032	0.28% - 0.38%	1.19% - 1.45%	8.35% - 9.47%	6.42% - 7.36%	2.33% - 2.73%	2.93% - 3.47%	0.97% - 1.19%	4.21% - 4.86%	2.13% - 2.50%
2033	0.28% - 0.38%	1.19% - 1.44%	8.29% - 9.40%	6.37% - 7.31%	2.31% - 2.71%	2.91% - 3.45%	0.96% - 1.17%	4.18% - 4.82%	2.11% - 2.48%
2034	0.28% - 0.37%	1.18% - 1.42%	8.25% - 9.33%	6.33% - 7.25%	2.30% - 2.69%	2.88% - 3.41%	0.96% - 1.16%	4.15% - 4.78%	2.10% - 2.45%
2035	0.28% - 0.37%	1.17% - 1.41%	8.20% - 9.28%	6.29% - 7.20%	2.28% - 2.67%	2.86% - 3.40%	0.95% - 1.15%	4.13% - 4.75%	2.08% - 2.44%
2036	0.28% - 0.37%	1.16% - 1.40%	8.16% - 9.22%	6.24% - 7.14%	2.27% - 2.65%	2.85% - 3.37%	0.94% - 1.14%	4.10% - 4.72%	2.07% - 2.42%

Substantial localized temporary employment associated with oil-spill cleanup activity could occur, but the magnitude of such employment, should spill(s) occur and contact land, is expected to be minor compared with employment projected as a result of OCS drilling activities.

Employment levels in the Texas impact area are expected to increase approximately 35 percent from the year 1998 over the life of the proposed action (Section III.C.1.b.). Projected changes in the industrial composition of the regional economy are considerable (USDOC, Bureau of Economic Analysis, 1995). Mining employment is expected to decrease in Texas, Louisiana, Mississippi, and Alabama. However, the Bureau of Economic Analysis' projections have preceded the recent resurgence in OCS drilling activities. Current literature suggests a strong resurgence in mining employment in the short term for the Gulf of Mexico coastal area.

According to 1995 Bureau of Economic Analysis projections, by the year 2025, all sectors of the Texas economy are expected to experience a significant growth in employment over 1998 levels. However, the services industry is currently and is projected in 2025 to be the major contributor to employment in Texas. The relative mix of industrial composition for Texas will remain virtually unchanged over the next 35-40 years, representing a continuation of a diversified economy.

Population in the impact area of Texas is expected to increase approximately 35 percent from the year 1998 over the life of the proposed action (Section III.C.1.b.). Minimal impact on population from activities associated with the OCS Program is expected in Texas coastal Subareas TX-1 and TX-2.

Summary and Conclusion

From a cumulative standpoint, the OCS Program has had a relatively minor impact on the Western Gulf. The OCS Program has had a significant impact on the Central Gulf. However, the oil and gas industry (including both OCS and state production, and foreign and domestic imports) does play an important role for the communities in the eastern Texas coastal area. The trend toward deepwater development has already had a significant impact on local economies. OCS leasing is proving to be more robust than previously projected. Recent OCS lease sales in the Central and Western Gulf of Mexico have been setting records in terms of the number of leases issued. Should development follow this leasing trend, employment needs in the mining and supporting industries would continue and will grow in some communities (and for some skills). The economies of the coastal Texas communities are considerably diversified and are projected to remain diversified over the next 35-40 years. All sectors are projected to experience growth. Peak annual changes in the population and employment of the coastal subareas in the Western Gulf represent less than 2 percent of the levels expected in absence of the OCS Program and do not exceed peak levels of activity already experienced in the Western Gulf. Peak employment impacts from the OCS Program are expected to occur during the period 1998-2004. Employment needs in support of OCS oil and gas activity are likely to be met with the existing population and available labor force. The robustness of OCS leasing is attributed, at least partially, to technological advances and the enactment of the OCS Deep Water Royalty Relief Act.

On a regional level, the cumulative impact from prior sales, the proposed action, and future sales on the population and employment of the counties of the Western Gulf coastal impact area is minimal (approximately 1.5-1.9 million person-years of employment over the life of the proposed action). The incremental contribution of the proposed action (as analyzed in Section IV.D.1.a.(11)(a)) to the cumulative impact level is minimal because peak annual changes in the population and employment of all coastal subareas in the Central and Western Gulf resulting from the proposed action in the Western Gulf represent less than 1 percent of the levels expected in absence of the proposal.

(b) Public Services, Infrastructure, and Land Use Plans

This cumulative analysis considers the effects of OCS-related, impact-producing factors from the OCS Program in the Western, Central, and Eastern Gulf of Mexico, including the effects of prior, current, and future OCS sales, as well as the effects of non-OCS-related, impact-producing factors. Impact-producing factors considered in the analysis include fluctuations in the workforce, net migration, relative income, oil and gas activity from State waters, wetlands loss, and tropical storms. Unexpected events (such as the 1973 Arab Oil Embargo) may influence oil and gas activity within the Gulf of Mexico region. These events

cannot be predicted and will not be considered in this analysis. The historical aspects of OCS activity in the Gulf are presented in Section III.C.1.a. and are herein incorporated by reference.

Public services and infrastructure, as used in this analysis, include commonly provided public, semipublic, and private services and facilities, such as education, police and fire protection, sewage treatment, solid-waste disposal, water supply, recreation, transportation, health care, other utilities, and housing. Changes in OCS activities, as well as changes caused by non-OCS-related impact-producing factors, could result in changes in demands for and usage of public services and infrastructure. Adverse effects could arise if the amount or rate of increase in the usage significantly exceeded the capability of a local area to provide a satisfactory level of service. Adverse effects may also arise if the level of decrease in usage results in the burden of maintenance of redundant, or unnecessary, infrastructure. In addition, a natural disaster, such as a hurricane, could significantly damage infrastructure and create a greater need for service than would be locally available.

Section III.C.1.a. provides a historical perspective of the oil and gas industry, as well as a brief description of recent events that have significantly affected the level of OCS activity in the Gulf of Mexico. Discussions of employment and population, public services, and social patterns are presented in Sections III.C.1.b.-d.

Approximately 5.2-6.3 million person-years of employment (direct, indirect, and induced) are required in the coastal subareas of the Gulf to support the OCS Program in the Gulf of Mexico. Peak-year impacts occur throughout the years 2003-2007 with about 169,000 workers involved in primary, secondary, and tertiary industries. Impacts moderately decline after the initial peak, reflecting a projected modest decline in the level of OCS-related activities. Examination of Table IV-34 reveals that the greatest impact to employment occurs in Subareas LA-1 and LA-2, with peak-year (1998) impact estimates of 12.6 and 9.2 percent, respectively. It is expected that the level of OCS-related employment projected for the Western and Central Gulf coastal subareas will diminish slightly through time. However, a resurgence of offshore drilling in the Gulf of Mexico, due to a melange of reasons including technological advances and deepwater royalty relief, suggests that the level of OCS-related employment projected for coastal communities in the Western and Central Gulf of Mexico will decline at a much slower pace than previously anticipated. It is assumed that continued leasing in the OCS will partially offset the decline in available OCS-related oil and gas employment.

Needs specific to deepwater projects may result in more focused stresses placed on areas that are capable of supporting these large-scale development projects (e.g., ports that can handle deeper draft service vessels). This focusing of activity could result in stresses to infrastructure servicing these focal points, as well as stresses placed on the infrastructure associated with the focal point. It is reasonable to assume that these focused stresses on infrastructure would parallel the amount of deepwater activity and could be expected to parallel the course of overall deepwater activity. Testimony presented at a public hearing for the Central Gulf Multisale Draft EIS at Houma, Louisiana, on June 23, 1997, highlighted the strain on infrastructure (particularly La. Highway 1) associated with activity at Port Fourchon, Louisiana. The testimony indicated that the major reason for the amount of activity at the port was deepwater exploration and development. Examination of recent rig locator reports indicates that Port Fourchon services approximately one-third of WPA deepwater activities and about two-thirds of deepwater activity in the CPA. OCS Program activities will continue to have a significant impact on infrastructure in south Lafourche Parish due to increases in deepwater activity over the short term. There is also the possibility that other ports or service bases, particularly those servicing deepwater activity, could see stresses placed on port and local infrastructure. At present, a precise definition of these stresses is problematic. Information needs identified in the socioeconomic session of a deepwater workshop sponsored by the MMS in April 1997, included an infrastructure inventory of the Gulf Region and identification of stresses on the infrastructure resulting from deepwater activity; an examination of port facilities across the Gulf (an MMS-funded study is currently underway to examine the impacts of deepwater activity on Port Fourchon, Louisiana); and an examination of employment and commuting patterns. Scoping performed in Texas for the present EIS indicated that there is a use conflict in the Corpus Christi area. The conflict results from the need to block usage of the Gulf Intracoastal Waterway several times during construction of tension-leg platforms (TLP's) at the facilities in Ingleside, Texas. At present, a working agreement exists between the USCG and the operators of the

construction facility to ensure that potential users of the GIWW are notified in advance of blockage of the waterway. However, there have been instances where advance notification was not provided and vessel traffic in the GIWW was blocked. At the Texas scoping meeting, the USCG indicated that continued construction of TLP's in the facility may cause more use conflicts and result in the need for more active management of waterway usage. The present trend towards increased oil and gas activity on the OCS could increase the potential for such use conflict.

Fluctuations in the workforce as a result of changing levels of OCS-related oil and gas activity could impact public services and infrastructure. As mentioned above, following the peak years (2003-2007), total OCS-related employment in the Gulf is expected to modestly decline. Projected changes in the industrial composition of the regional economy over the life of the proposed action reveal a decrease in employment in Texas, Louisiana, Mississippi, and Alabama in the mining industry, construction industry, government sector, and manufacturing and wholesale trade industries (USDOC, Bureau of Economic Analysis, 1995). However, the Bureau of Economic Analysis's projections preceded the recent resurgence of offshore drilling. The Louisiana Economic Outlook (Scott et al., 1996) projects a strong resurgence in mining employment in the short term for Louisiana, and it is reasonable to assume that a similar resurgence in Texas. However, the service industry is the greatest contributor to employment in the area. It is assumed for the purpose of analysis that the jobs created in the service sector will be lower paying jobs than those in OCS-related activities. This development may result in a lower tax base, which could make financing problematic for new infrastructure needed in response to normal growth. Layoffs associated with the projected modest decline in OCS-related employment may place stresses on those private and State agencies responsible for assistance. The need for those portions of existing infrastructure built in response to demographic and economic phenomena related to the OCS Program are expected to diminish as OCS employment declines. The current trend towards increased OCS oil and gas activity will preclude a decline in use of infrastructure for OCS-related activity for the near future. Therefore, based on the expected long-term, overall modest decline in OCS activity, it is reasonable to assume that there will be a short-term increase in employment and usage of infrastructure followed by a modest decline in usage.

Following the peak-year, total OCS-related oil and gas employment is expected to decline. Expected growth in the service industry will most likely provide employment for some of the workforce; however, it is assumed that some out-migration will occur among those persons seeking pay comparable to that of OCS-related employment. With the possible exception of some skilled labor, it is expected that employment needs in support of OCS oil and gas activity are likely to be met with the existing population and available labor force, requiring little to no in-migration. There are reports from recent public testimony of in-migration presently occurring in south Lafourche Parish, particularly in-migration of foreign workers who are placed in company-provided housing. To the extent that in-migration occurs, and the relative size of the communities in which it occurs, public services and infrastructure will undergo increased stress. The amount of in-migration that occurs may be affected by a shadow effect that occurs when persons are reluctant to enter into employment in oil- and gas-related activities based on a perception of these jobs as transient and insecure. It is reasonable to assume that the degree to which the shadow effect impacts employment will directly relate to the length of time of the upsurge in oil and gas activity. The assumption is that the impact of the shadow effect on employment should decrease as the duration of the employment opportunities increases. Out-migration over the long term could result in a loss of population, particularly in OCS-related staging and administrative centers. This could stress public services and make portions of the infrastructure base of these centers redundant because of dramatic changes in need.

The relatively high wages paid to OCS-related oil and gas industry personnel increase the tax base in coastal counties and parishes beyond what would be expected if there were no OCS activities. As OCS-related employment modestly decreases through time, it is assumed that taxes originating from OCS-related wages and expenditures will decrease. Consequently, maintenance of existing infrastructure and creation of new infrastructure may become problematic. In addition, an increase in educational strain may occur in association with the declining tax base.

Oil and gas activity within State waters requires similar public services and infrastructure as OCS-related oil and gas activities. Further, it is assumed that oil and gas employment from activities within State waters will decline at a rate similar to that for Federal OCS employment. Infrastructure needs in support of oil and

gas activities in State waters would diminish as employment associated with State-regulated activities decline. Impacts to public services would include increased numbers of individuals requiring assistance. In addition, maintenance of existing infrastructure and creation of new infrastructure may become difficult to support at different levels of oil and gas employment.

About one-third of the WPA coast was hit with 16-20 tropical cyclones between the years 1901 and 1955 (DeWald, 1982). The other two-thirds had a slightly lower incidence of cyclones (11-15). Experience with Hurricanes Carla and Beulah has indicated that major hurricanes can have a devastating effect on both public services and community infrastructure. Assuming that several major storms will impact the Western Gulf coastal subareas during the life of the proposed action, hundreds of millions of dollars of damage to existing infrastructure is expected.

Section IV.D.1.d.(1)(b) analyzes the cumulative impact to coastal wetlands. Decreases in sediment load and dispersal, subsidence, indirect impacts from navigation canals, and other impact-producing factors are expected to result in the loss of thousands of acres of wetlands per year. It is reasonable to assume that transportation networks (roads, bridges, and railroads) in the low-lying portion of the Western Gulf coastal counties and the Central Gulf coastal parishes that support OCS Program activities will require increasing maintenance and protection from inundation in the future. This is particularly true in the coastal marsh areas.

Section IV.C.4. presents estimates of the annual number of offshore spills assumed under the cumulative scenario. Potential impacts could include temporary stresses on local infrastructure including housing, recreation, transportation, and water supply. The duration of these possible impacts would be limited to the amount of time necessary to clean up the spill (a maximum of 6 weeks based on the estimates above).

Table IV-12 shows the projected onshore infrastructure related to OCS Program activities. Each facility projected to be constructed must receive approval from the pertinent Federal, State, county/parish, and/or community involved. In addition, such facilities must be in concurrence with the State's approved CZM plan. All onshore pipelines must obtain similar permit approval and concurrence. Historical development of onshore infrastructure took place prior to the development and implementation of land use plans in the region. It is assumed that projected construction will be approved only if it is consistent with the existing regulatory mechanisms of the involved parties. Should a conflict exist between those mechanisms and the projected construction, it is assumed that approval will either not be granted or that appropriate mitigating measures will be enforced by the political entities. Projected construction of infrastructure to support the OCS Program is therefore anticipated to be in accordance with appropriate land use plans, zoning regulations, and other State/regional/local regulatory mechanisms.

Non-OCS-related impacts would include all those activities that result in conflict with the policies, objectives, and regulatory requirements and guidelines of State/regional/local land use plans and CZM programs. These activities would include, but are not limited to, residential, commercial, industrial, agricultural, institutional, recreational, and other development. Inasmuch as the different regulatory mechanisms of coastal zone management plans and land use plans are effective, the potential development over the next 35-40 years will be in concurrence with the long-range plans behind the mechanisms. However, given the expected growth in the areas of the WPA and CPA, the non-OCS development may result in some deleterious impacts to those plans.

Summary and Conclusion

Modestly declining levels of OCS and State tideland oil and gas employment are expected to occur over the next 35-40 years. The recent resurgence of offshore leasing and drilling activity may serve to decrease the rate of overall decline. Deepwater activity has resulted in focused stresses (e.g., Port Fourchon) to local infrastructure. OCS Program activities will continue to have a significant impact on infrastructure in south Lafourche Parish due to increases in deepwater activity over the short term. There is also the possibility that other ports or service bases, particularly those servicing deepwater activity, could see stresses placed on port and local infrastructure. Economic growth is expected to occur in offshore drilling for the short term and may result in importation of some skilled labor. Increased stresses on local infrastructure and public services are expected to occur in those communities experiencing in-migration. The amount of stress will relate to the size of the community and the amount of in-migration that occurs. The level of pay for service industry

jobs will not be comparable to those lost from OCS-related employment. It is assumed that some out-migration will coincide with moderately declining levels of OCS-related employment and that it will primarily occur from OCS-staging areas and administrative centers.

The decline in the tax base and the increasing need for public and relocation assistance are expected to result in a deterioration of the existing community infrastructure and level of public service delivery, as well as a potential increase in educational strain.

The incremental contribution of the proposed action will serve to partially offset declines in the tax base caused by diminishing OCS oil and gas activity. The proposed action will also serve to decrease or eliminate any out-migration associated with decline in offshore activity. Declines in available public services or the condition of community infrastructure are not expected to occur as a result of the proposed action. Increases in educational strain are not expected to occur as a result of the typical proposed action.

Projected OCS-related infrastructure construction is anticipated to be in accordance with appropriate land use plans, zoning regulations, and other State/regional/local regulatory mechanisms. Non-OCS-related development may result in some deleterious impacts to comprehensive land use plans.

Tropical storm activity has occurred in the past and will occur in the future. It is assumed that several major storms will strike WPA coastal counties during the life of the proposed action. Experience has indicated that these storms could have a major impact on public services and community infrastructure. Community infrastructure in the coastal counties and parishes is linked to the region's physiography. Continued subsidence and erosion are expected to require expanded maintenance of roads, bridges, and railroads, particularly in WPA and CPA coastal marsh areas.

The cumulative impact of the OCS Program is expected to result in the potential for increased educational strain, deteriorating conditions of existing infrastructure, some deleterious impacts to comprehensive land use plans, and difficulties in delivering satisfactory levels of public services.

(c) Sociocultural Issues and Environmental Justice

The cumulative analysis considers the effects of OCS-related, impact-producing factors on the Western and Central Gulf of Mexico coastal subareas. The effects of prior, current, and future OCS sales on sociocultural issues will be examined. The analysis also considers the effects of certain non-OCS-related, impact-producing factors. For the purpose of this analysis, OCS-related, impact-producing factors to sociocultural issues will include OCS-related employment and workforce fluctuations, population and demographic change, relative income, wetlands loss, oil spills, and work scheduling. Non-OCS-related, impact-producing factors included in this analysis are oil and gas activities in State waters and tropical storms. Adverse effects could arise if disruption of social and cultural patterns occurred and resulted in changes in traditional occupations, disruption in the viability of extant subcultures, social and community dysfunction, and detrimental effects on individual or family life. Unexpected events (such as the 1973 Arab Oil Embargo) may influence oil and gas activity within the Gulf of Mexico region. These events cannot be predicted and will not be considered in this analysis. It should be noted that, should such an event occur, the projections on which the current analysis is based could change markedly.

As stated in Section IV.D.1.d.(11)(a), approximately 1.5-1.9 million person-years of employment (direct, indirect, and induced) are required in the coastal subareas of the Western Gulf to support OCS-related activities in the Gulf during the 35-year life of the proposed action. Peak-year impacts occur during 2005-2015, with about 50,000 workers involved in primary, secondary, and tertiary industries. Impacts moderately decline after the peak years, reflecting a projected modest decline in the level of OCS-related activities. Examination of Table IV-34 reveals that the greatest impact to employment occurs in Subareas LA-1 and LA-2, with peak-year (1998) impact estimates of 12.6 and 9.2 percent, respectively. It is expected that the level of OCS-related employment projected for the Western and Central Gulf coastal subareas will diminish as existing hydrocarbon resources become depleted. It is assumed that continued leasing in the OCS will partially offset the modest decline in available OCS-related oil and gas employment. The OCS-related employment is expected to provide jobs that would not exist without the OCS Program and, therefore, would provide some positive impacts.

Under the cumulative scenario, peak-year employment is projected to occur in 1998 with a steady, modest decline in OCS-related employment over the long term. It is likely that employment in OCS-related activities will not require importation of labor and that jobs will be filled by the available labor, with the possible exception of some skilled labor. The recent resurgence in offshore drilling and leasing may serve to diminish or reverse the projected rate of decrease in mining employment. It is assumed for the purpose of this analysis that jobs created in the service sector will be lower paying than jobs in OCS-related activities. Expected growth in the service industry will most likely provide employment for some of the workforce; however, it is assumed that some out-migration will occur among those persons seeking pay comparable to that of OCS-related employment. The quality of family life, in some individual cases, could be adversely affected by layoffs in the OCS oil and gas industry as a result of stress resulting from decreased family income and loss of security. As the level of employment in OCS-related industry decreases, it is likely that more persons will engage in traditional occupations (such as trapping and shrimping) to supplement their income. This could result in overfishing of the resources, which could pose a threat to the continued existence of specific traditional occupations.

An analysis of historical trends indicates that only population impacts greater than 1 percent typically result in positive net migration into a given area. Employment needs in support of OCS oil and gas activities, with the possible exception of some skilled labor, are likely to be met with the existing population and available labor force, requiring little to no in-migration. There are reports from recent public testimony of in-migration presently occurring in south Lafourche Parish, particularly in-migration of foreign workers who are placed in company-provided housing. To the extent that in-migration occurs, and the relative size of the communities in which it occurs, impacts to community cohesion are expected to occur. The amount of in-migration that occurs may be affected by a shadow effect that occurs when persons are reluctant to enter into employment in oil- and gas-related activities based on a perception of these jobs as transient and insecure. It is reasonable to assume that the degree to which the shadow effect impacts employment will directly relate to the length of time of the upsurge in oil and gas activity. The assumption is that the effects of the shadow on employment should decrease as the duration of the employment opportunities increases. Out-migration resulting from the overall modest decline could result in a loss of population, particularly in OCS-related staging centers and administrative centers. Expected impacts would include a diminishment in the number of those persons engaged part-time in traditional occupations, deleterious impacts to family life as a result of the departure of extended family members, and potential loss of community cohesion within some of the communities that serve as staging and administrative centers.

Dependence on the relatively high wages paid to persons in the oil and gas industry (both OCS and non-OCS) may have deleterious impact on family life, if layoffs occur, particularly in view of the projected modest decline in OCS-related oil and gas activity over the life of the proposed action. Impacts associated with the higher OCS-related salaries also include possible destabilization of small businesses that cannot compete with the high wages and larger benefit packages offered by OCS-related companies and a possible lack of incentive for increased business efficiency. The exodus of relatively high-paying, OCS-related jobs will allow small businesses to draw from a larger pool of potential employees; however, it is expected that these jobs will generally be lower paying. As OCS-related employment declines, impacts to small business related to the higher wages associated with OCS employment will decline as well. It has been suggested that a positive relationship exists between OCS activity and basic level educational attainment (e.g., high school education) and that a negative relationship exists between enhanced educational attainment (e.g., college degree) and OCS activity (cf. Seydlitz and Laska, 1994). Holding all other factors equal and assuming that a direct relationship exists, it would be reasonable to expect the rate of high school completion to decrease and the percentage of high school graduates who attend college to increase as the rate of OCS activity declines.

In the peak exploration year of 1998, approximately 141,000 person-years of total employment are required to support OCS activities in the Western, Central, and Eastern Gulf. Approximately 50,000 person-years of this total represents direct offshore employment. The number of persons involved in direct offshore employment is projected to decline following the peak year. These persons will likely encounter the extended work schedule typically associated with OCS offshore activities. The extended work schedule will allow for part-time participation in more traditional occupations (fishing, trapping, etc.). The relationship

between OCS oil and gas activities and traditional culture in the coastal subareas of Louisiana has been mostly positive (Laska et al., 1993). The extended work schedule changes the practice of traditional familial roles in an adaptive response to absence. In the majority of cases, it is expected that the familial adaptations to the extended work schedule will be successful (cf. Storey et al., 1989). However, it is expected that, in a small number of cases, successful adaptation of the family to the extended work schedule will not occur. In these cases, some deleterious impacts to family are expected.

Oil and gas activities within State waters are assumed to result in similar impacts as those found from OCS-related oil and gas activity. Further, it is assumed that oil and gas employment from activities within State waters will decline at a rate similar to that for Federal OCS employment. As employment from these activities declines through time, more persons may turn to full-time participation in traditional occupations. This could result in over-utilization of resources and threaten the continuation of traditional occupations. Family life could also be impacted by the suite of impact-producing factors associated with activities in State waters.

Under the cumulative scenario, wetlands may be adversely impacted by OCS-related activities. Subsidence, a natural geologic process in the region, accounts for a large portion of this loss. The projected amount of wetlands loss may result in an impact to the practice of traditional occupations, such as trapping, as coastal marsh is converted to open water.

Section IV.C.4. presents estimates of the annual number of offshore spills assumed to occur as a result of the cumulative scenario. It is expected that social and cultural impacts related to cleanup activities would be temporary; however, impacts such as housing shortages, social dysfunction, heightened sense of threat, and other impacts associated with a large influx of workers into small communities could occur for the period of the cleanup activities. The direct impact of oil on wetlands could result in the relocation of traplines or recreational fishing activity for the period of time necessary for the marsh to regenerate.

About one-third of the WPA coast was hit with 16-20 tropical cyclones between the years 1901 and 1955 (DeWald, 1982). The other two-thirds had a slightly lower incidence of cyclones (11-15). Experience with Hurricanes Carla and Beulah has indicated that major hurricanes can have a devastating effect on both the natural and human environment. Temporary disruption of traditional occupations and severe impairment of community and family life can result from the effects of tropical storms.

Summary and Conclusion

It is expected that the level of OCS-related employment projected for the WPA will modestly diminish as existing hydrocarbon resources become depleted. The resurgence in offshore activity may serve to reduce, or reverse, the rate of decline in employment. It is assumed that continued leasing in the OCS will partially offset the moderate decline in available OCS-related oil and gas employment. While the overall decline in OCS-related employment is expected to impact communities, families, and individuals during the life of the OCS Program, OCS-related employment is expected to provide jobs that would not exist without the OCS Program and, therefore, would provide some positive impacts. It is assumed for the purpose of this analysis that jobs created in the service sector will be lower paying than jobs in OCS-related activities. The quality of family life, in some individual cases, could be adversely affected by layoffs in the OCS oil and gas industry, resulting in stress from decreased family income and loss of security. If, as has been suggested, there is a relationship between OCS activity and educational attainment, there may be a decline in the rate of high school completion and a concomitant increase in the rate of high school graduates attending college. As the level of employment in OCS-related industry decreases, it is likely that more persons will engage in traditional occupations (such as trapping and shrimping) to supplement their income. This could result in overfishing the resources, which could pose a threat to the continued existence of specific traditional occupations. Little to no in-migration is expected to occur in support of the proposed action, with in-migration of some skilled labor possible. To the extent that in-migration occurs, and the relative size of the communities in which it occurs, impacts to community cohesion are expected to occur. The amount of in-migration may be affected by the shadow effect. Out-migration resulting from the overall modest decline could result in a loss of population, particularly in OCS-related staging centers and administrative centers. As OCS-related employment declines, impacts to small business related to the higher wages associated with

OCS employment will decline as well. The projected amount of wetlands loss may result in impact to the practice of traditional occupations, such as trapping, as coastal marsh is converted to open water. It is expected that social and cultural impacts related to oil-spill cleanup activities assumed in this analysis would be temporary; however, impacts such as housing shortages, social dysfunction, heightened sense of threat, and other impacts associated with a large influx of workers into small communities could occur for the period of the cleanup activities. The direct impact of oil on wetlands could result in the relocation of traplines or recreational fishing activity for the period of time necessary for the marsh to regenerate. It is expected that, in a small number of cases, successful adaptation of the family to the extended work schedule will not occur. In these cases, some deleterious impacts to family life are expected. Community and family life, and the practice of traditional occupations could be impacted by the suite of impact-producing factors associated with activities in State waters. Temporary disruption of traditional occupations and severe impairment of community and family life can result from the effects of tropical storms.

The incremental contribution of the proposed action to impacts on sociocultural issues is expected to be minimal with some deleterious impacts to family life in a small number of cases resulting from the external work schedule and minimal impacts to educational attainment.

2. Unavoidable Adverse Impacts of the Proposed Action

Sensitive Coastal Habitats: If an oil spill were to contact a barrier beach, the removal of beach sand during cleanup activities could result in adverse impacts if the sand is not replaced. If an oil spill contacts coastal wetlands, adverse impacts could be high in localized areas. In some areas, wetland vegetation would experience suppressed productivity for several years. Much of the wetland vegetation would recover within 4-10 years, but some wetland areas would be converted to open water. Unavoidable impacts resulting from maintenance dredging, wake erosion, and other secondary impacts channels would occur as a result of the proposed action.

Sensitive Offshore Habitats: The adoption of the proposed Topographic Features and Live Bottom Stipulations and the provisions of NTL 88-11 would prevent severe and permanent damage to the biota of topographic features and chemosynthetic communities from direct mechanical impacts. Few adverse impacts are expected to these communities. If an oil spill occurred and contacted sensitive offshore habitats, there would be an adverse impact on organisms within the area affected by the spill.

Water Quality: Normal offshore operations would have unavoidable effects to varying degrees on the quality of the surrounding water if the proposal is implemented. Drilling, construction, and pipelaying would cause an increase in the turbidity of the affected waters for the duration of the activity periods and would disturb settled pollutants. A turbidity plume would also be created by the discharge of drill cuttings and drilling fluids. This, however, would only affect water in the immediate vicinity of the rigs and platforms. The discharge of treated sewage from the rigs and platforms 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. Chronic spills from platforms and the discharge of produced waters could result in increases of hydrocarbon levels and trace metal concentrations in the water column in the vicinity of the platforms.

Unavoidable impacts to onshore water quality occurs as a result of chronic point and nonpoint-source discharges such as runoff and effluent discharges from existing onshore infrastructure used in support of sale activities. Vessel traffic contributes to the degradation of impacted bodies of water through inputs of chronic oil leakage, treated sanitary and domestic waste, bilge water, and contaminants known to exist in marine paints. Additional impacts could result from increased sewage due to population growth in isolated communities.

Air Quality: Unavoidable adverse impacts to air quality could occur onshore adjacent to crude oil refineries, gas processing plants, and areas of concentrated OCS-related activities. Unavoidable short-term impacts to air quality could occur near catastrophic events (e.g., oil spills and blowouts) due to evaporation and combustion. Mitigation of long-term effects would be accomplished through existing regulations and development of new control emission technology. However, short-term effects from nonroutine catastrophic events (accidents) are uncontrollable.

Endangered and Threatened Species: Unavoidable adverse impacts to endangered and threatened marine mammals, birds, and sea turtles, due to activities associated with the proposed action (e.g., water quality and habitat degradation, helicopter and vessel traffic, oil spills and spill response, and discarded trash and debris) would be primarily sublethal. Lethal impacts to endangered species are expected to be rare.

Nonendangered and Nonthreatened Marine Mammals: Unavoidable adverse impacts to nonendangered and nonthreatened marine mammals due to activities associated with the proposed action (e.g., water quality degradation, helicopter and vessel traffic, oil spills and spill response, and discarded trash and debris) would be primarily sublethal. Lethal impacts to nonendangered and nonthreatened marine mammals are expected to be rare.

Coastal and Marine Birds: Some injury or mortality to coastal birds could result in localized areas from OCS-related oil spills, pipeline landfalls and coastal facility construction, helicopter and OCS service-vessel traffic, and discarded trash and debris. Marine birds could be affected by noise, disturbances, and trash and debris associated with offshore activities. If an oil spill occurs and contacts marine or coastal bird habitats, some birds could experience sublethal impacts. Birds feeding or resting in the water could be coated with oil and die. Oil spills and oil-spill cleanup activities could also affect local bird prey species.

Commercial Fishing Industry: Losses to commercial fishing resources and fishing gear could occur from production platform placement, oil spills, and produced-water discharges. 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. It is unlikely that commercial fishermen would harvest fish in the area of an oil spill, as spilled oil could coat or contaminate commercial fish species rendering them unmarketable. Other unavoidable adverse impacts include loss of fishing space caused by the installation of pipelines, rigs, platforms, or by other OCS-related structures.

Recreational Beach Use: Even though existing regulations and orders prohibit littering of the marine environment with trash, offshore oil and gas operations involving men, machines, equipment, and supplies may result in some littering of the ocean. Accidents associated with offshore operations can contribute some floatable debris to the ocean environment; this debris may eventually come ashore on major recreational beaches. Accidents can lead to oil spills, which are difficult to contain in the ocean; therefore, it may be unavoidable that some recreational beaches become temporarily soiled by weathered crude oil.

Archaeological Resources: As a result of the proposed action, unique or significant archaeological information may be lost. Required archaeological surveys lower the potential for this loss by identifying potential archaeological sites prior to an interaction occurring, thereby making avoidance or mitigation of impacts possible. In some cases (e.g., in areas of high sedimentation rates), survey techniques may not be effective at identifying a potential resource.

3. Irreversible and Irretrievable Commitment of Resources

Wetlands: An irreversible and irretrievable commitment of biological resources could occur where wetlands are impacted by dredging, construction activities, and oil spills. Dredging and construction activities can result in direct and indirect loss of wetlands, and oil spills can damage or destroy wetland vegetation, which leads to increased erosion and land loss. Construction and emplacement of onshore pipelines in coastal wetlands could result in the loss of coastal wetlands due to mechanical destruction and due to land loss facilitated by erosion of the marsh soils.

Sensitive Offshore Resources: Oil spills and chronic low-level pollution can injure and kill organisms at virtually all trophic levels. Mortality of individual organisms can be expected to occur, and possibly a reduction or even elimination of a few small or isolated populations. The proposed biological stipulations, however, are expected to eliminate most of these risks.

Commercial Fishing Industry: Structure removal by explosives causes mortality to commercial fish species. Fish kills, including valuable species such as red snapper, are known to occur when explosives are used to remove structures in the Gulf of Mexico. If structure removal by explosives is continued, it will adversely impact the commercial fishing industry proximate to the removal site. However, in view of the positive impact of offshore platforms to commercial fishing as a result of the platforms serving as artificial

reefs and fish attracting devices, continued structure removal, regardless of the technique used, would reduce the net benefits to commercial fishing due to the presence of these structures.

Archaeological Resources: Although the impact to archaeological resources as a result of the proposed action is expected to be low, any interaction between an impact-producing factor (drilling of wells, emplacement of platforms, subsea completions, and pipeline installation) and a significant historic shipwreck or prehistoric site could destroy information contained in the site components and in their spatial distribution. This would be an irretrievable commitment of potentially unique archaeological data.

Local Employment, Income, and Population: The proposed action would result in the production of OCS-related goods and services. To the extent that resources would be drawn away from other uses, the production of goods and services of other types would be foregone. Steel products, specialized manpower, and capital constitute required resources that may be scarce; use of these resources for OCS needs means that other opportunities for their use might have to be foregone. While these resources may be reclaimed over time, their use as a result of the proposed action would constitute an irreversible and irretrievable commitment of resources at a given point in time.

Oil and Gas Development: Leasing of the proposed blocks and subsequent development and extraction could represent an irreversible and irretrievable commitment of nonrenewable oil and gas resources. The estimated amount of resources to be recovered as a result of a proposed Western Gulf sale is 0.01-0.09 BBO and 0.57-1.93 tcf of natural gas (Table IV-1).

Loss of Human and Animal Life: The OCS oil and gas exploration, development, production, and transportation are carried out under comprehensive procedures designed to ensure public safety and environmental protection. Notwithstanding, some loss of human and animal life is inevitable from unpredictable and unexpected acts of man and nature (unavoidable accidents, human error and noncompliance, and adverse weather conditions). Some normal and required operations, such as structure removal, can result in the destruction of viable marine life. Although the possibility exists that individual marine mammals, sea turtles, birds, and fish can be injured or killed, a lasting effect on baseline populations is unlikely.

4. Relationship Between the Short-term Use of Man's Environment and the Maintenance and Enhancement of Long-term Productivity

Short-term refers to the total duration of oil and gas exploration and production activities, whereas long-term refers to an indefinite period beyond the termination of oil and gas production. The specific impacts of the proposed action vary in kind, intensity, and duration according to the activities occurring at any given time. Initial activities, such as seismic surveying and exploration drilling, result in short-term, localized impacts. Development drilling and well workovers occur sporadically throughout the life of the proposed action, and also result in short-term, localized impacts. Activities during the production life of a platform may result in chronic impacts over a longer period of time (25-35 years), potentially punctuated by more severe impacts as a result of accidental events. Platform removal is a short-term activity with localized impacts; the impacts of site clearance may be longer lasting. The greatest potential impacting factor associated with offshore oil and gas activities is oil spills; oil-spill impacts are generally short-term, localized impacts. Over the long-term, several decades to several hundreds of years, natural environmental balances are expected to be restored.

Many of the effects discussed in Section IV are considered to be short-term (being greatest during the construction, exploration, and early production phases). These impacts could be further reduced by the mitigative measures discussed in Section II.C.1.c.

The principal short-term use of the leased areas in the Gulf under the proposed action would be for the production of up to 0.01-0.09 BBO and 0.57-1.93 tcf of natural gas. The short-term recovery of hydrocarbons may have long-term impacts on biologically sensitive offshore areas (Section IV.D.1.a.(2)), water quality (Section IV.D.1.a.(3)), or archaeological resources (Section IV.D.1.a.(10)).

After the completion of oil and gas production, the marine environment is generally expected to remain at or return to its normal long-term productivity levels. To date, there has been no discernible decrease in long-term marine productivity in OCS areas where oil and gas have been produced for many years. Areas such

as the Atlantic coast, which experienced repeated incidents of oil pollution as a result of tanker groundings during World War II, show no apparent long-term productivity losses, although baseline data do not exist to verify this. In other areas that have experienced apparent increases in oil pollution, such as the North Sea, some long-term effects do appear to have taken place. Populations of pelagic birds have decreased markedly in the North Sea in recent years--prior to the beginning of North Sea oil production. Until more reliable data become available, the long-term effects of the chronic and major spillage of hydrocarbons and other drilling-related discharges cannot be accurately projected. In the absence of such data, it must be concluded that the possibility of decreased long-term productivity exists as a result of the proposed action.

The OCS development off Texas and Louisiana has enhanced recreational and commercial fishing activities, which in turn has stimulated the manufacture and sale of larger private fishing vessels and special fishing and recreational equipment. Commercial enterprises such as charter boats have become heavily dependent on offshore structures for satisfying recreational customers. The proposed sale could increase these incidental benefits of offshore development. The platforms expected to result from the proposed action would replace some of those being removed where production has terminated. Offshore fishing and diving has gradually increased in the past three decades; platforms have been the focus of much of that activity. As mineral resources become depleted, platform removals would occur and may result in a decline in these activities. To maintain the long-term productivity of site-specific, artificial locations attractive to fishermen and divers, some means, such as artificial reef development programs, may need to eventually replace removed platforms.

OCS activities could temporarily interfere with recreation and tourism in the region, in the event of an oil spill contacting popular tourist beaches. Beach closures and disruption of recreational activities are expected to be short term. Oil-spill cleanup activities could have longer lasting impacts than the actual oil spill.

The proposed leasing may also result in onshore development and population increases that could cause adverse impacts to local community infrastructure, particularly in staging areas for OCS activity where infrastructure is insufficient or in poor condition. The duration of these adverse impacts would persist until either (a) the stresses on local infrastructure diminish as the pace of activity slows or reverses; or (b) new infrastructure is constructed or existing infrastructure improved. Either case would result in the establishment of an equilibrium between the need for and use of the infrastructure.

Although short-term environmental and socioeconomic impacts could result from the proposed action, long-term adverse environmental impacts are not expected from normal operations resulting from the proposed action.. However, some risk of long-term adverse environmental impacts remains due to the potential for accidents, especially oil spills, such as the loss of archaeological information or wetlands vegetation. No long-term productivity or environmental gains are expected as a result of the proposed action; the benefits of the proposed action are expected to be principally those associated with a medium-term increase in supplies of domestic oil and gas and those associated with the artificial reef effect of the offshore production structures. While no reliable data exist to indicate long-term productivity losses as a result of OCS development, productivity losses are possible, perhaps as a result of wetlands loss caused by OCS-related activities.

SECTION V

CONSULTATION AND COORDINATION

V

V. CONSULTATION AND COORDINATION

A. DEVELOPMENT OF THE PROPOSED ACTIONS

The proposed annual Western Gulf sales, as scheduled in the *Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002*, are Sale 171 in 1998, Sale 174 in 1999, Sale 177 in 2000, and Sale 180 in 2001. Each proposed sale would offer for lease all unleased blocks in the WPA, with the following exceptions: Blocks A-375 (East Flower Garden Bank) and A-398 (West Flower Garden Bank) in the High Island Area, East Addition, South Extension, designated as a national marine sanctuary; and Blocks 793, 799, and 816 in the Mustang Island Area, identified by the Navy as needed for testing equipment and for training mine warfare personnel. The proposed actions include existing regulations and proposed lease stipulations designed to reduce environmental risks.

On May 1, 1996, the Gulf of Mexico Region published a *Federal Register* notice, placed notices in Gulf Coast newspapers, and mailed out notices to governmental agencies and other interested parties requesting comments concerning the proposed multisale prelease process and EIS. A public meeting was held in New Orleans on May 22, 1996, to present the proposed multisale concept. Representatives from the Louisiana Department of Natural Resources (LDNR), Texaco, and Taylor Energy were in attendance but did not offer comments. The MMS received seven written responses on the proposed multisale concept.

Written Comments Received on Multisale Prelease Process and EIS

State of Alabama	The State of Alabama supports a balanced and reasonable program that leads to exploration, development, and production with stipulations that all OCS activities be carried out in full compliance with relevant Alabama laws, rules, and regulations, and be consistent with the State's CZM Program.
State of Louisiana	The State of Louisiana, Department of Natural Resources, supports the multisale process. They requested that MMS --improve the analysis of the indirect and cumulative costs to Louisiana's coastal communities, economies, infrastructure, and wetlands; --include a critical review of the predictions made in previous lease sale EIS's, comparing the anticipated impacts with actual results; and --examine new alternative actions, with the goal of achieving more equitable balance of the benefits and costs borne by Louisiana for OCS development.
National Ocean Industries Association	The NOIA membership viewed the proposal as a sensible cost-effective regulatory initiative and a proposal that should be implemented.
POGO Producing Co.	Pogo Producing Co. supports the proposal.
Shell Offshore Inc.	Shell Offshore Inc. supports the proposal and suggested that, in the future, MMS could consider preparing one combined EIS for all sales.
Texaco Exploration and Production	Texaco supports the proposal. The streamlined process will allow MMS to reduce process time and concentrate their efforts on emerging issues or new information.
The AM Group	The AM Group requested to be placed on the MMS mailing list for Call/NOI's.

In July 1996, two public hearings were conducted in Houston and New Orleans to receive comments on the Draft EIS for Sales 166 and 168. These hearings also served as a formal scoping opportunity for input on the scope and significant issues related to the OCS Program and to the development of the multisale Draft EIS for proposed Central Gulf of Mexico Sales 169, 172, 175, 178, and 182. In general, comments were favorable.

The MMS also conducted early coordination with appropriate Federal and State agencies and other concerned parties to discuss and coordinate the proposed multisale prelease process and EIS. Key agencies and organizations included the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Fish and Wildlife Service (FWS), Department of Defense (DOD), U.S. Coast Guard (USCG), U.S. Environmental Protection Agency (USEPA), State Governors' offices, and industry groups.

The Environmental Studies Program's (ESP) Strategic Studies Plan (SSP), completed in September 1996, meets the requirements of the Information Base Review for the proposed Western Gulf of Mexico lease sales. The ESP Strategic Plan is an assessment of the quality and adequacy of the information base available for environmental analysis and decisionmaking on OCS leasing and activities. The SSP summarizes current studies and information, and projects future needs. The SSP incorporates both public and internal assessments of the information base. In addition, an MMS interdisciplinary and comprehensive assessment of the status of the information base was conducted. Information gaps and inadequacies were identified, and environmental studies to fill those gaps and inadequacies were developed and proposed for funding.

On January 29, 1997, the Call for Information and Nominations (Call) and the Notice of Intent to Prepare an EIS (NOI) for the proposed 1998-2001 Western Gulf of Mexico lease sales were published in the *Federal Register*. The required 45-day comment period closed on March 16, 1997. Additional public notices were distributed via newspaper notices, mailouts, and the Internet. Five responses were received as a result of the Call/NOI.

In accordance with the Council on Environmental Quality's (CEQ) regulations implementing the National Environmental Policy Act (NEPA), scoping was conducted to solicit comments on the proposed actions and the multisale EIS, and to update the Gulf of Mexico's environmental information base. Scoping provides those with an interest in the OCS Program an early opportunity to participate in the events leading to the publication of the Draft EIS. Publication of the Call/NOI in the *Federal Register* formally initiated the scoping process for these lease sales.

Scoping efforts and other coordination meetings continue throughout the sale process. The Gulf of Mexico Region's annual Information Transfer Meetings (ITM) provided an opportunity for EIS analysts to attend technical presentations related to OCS Program activities and to meet with representatives from Federal, State, and local agencies; industry; MMS contractors; and academia. Specific opportunities are presented during MMS requests for information, comments, input, and review, which include the following:

- the Strategic Studies Plan for the proposed multisale EIS for the proposed Western Gulf of Mexico lease sales;
- scoping for the multisale EIS and for the proposed Western Gulf of Mexico lease sales;
- the Call and NOI for the proposed Western Gulf of Mexico lease sales;
- the EIS review process for Sales 166 and 168;
- public hearing comments on Sales 166 and 168;
- comments on the Draft EIS for Sales 166 and 168;
- public hearing comments on the draft multisale EIS for Central Planning Area Sales 169, 172, 175, 178, and 182; and
- the EIS review process and comments on the Draft Proposed and Proposed Final *Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002*.

No new issues, alternatives, or mitigating measures were identified during scoping for the proposed Western Gulf lease sales. Numerous potential issues, mitigation measures, and alternatives have been identified through scoping efforts for many past lease sale EIS's. Studies were funded to address and provide

information on many of these topics. As a result of these studies, some topics were added to those discussed or analyzed in the EIS. Other topics were dropped from further consideration if they were shown to be unwarranted or have little or no impact from the OCS Program.

Several activities or factors related to OCS activities were identified during the scoping process as warranting fuller discussion in lease sale EIS's. Many of these activities or factors are related to significant changes or new trends in OCS operations. These topics are 3D seismic surveying, increasing deepwater activities, new exploration and production technologies, extended well testing in deepwater areas, socioeconomic impacts of deepwater development, transport of OCS oil or gas containing hydrogen sulfide, and the aging pipeline infrastructure.

B. DEVELOPMENT OF THE DRAFT EIS

In accordance with NEPA requirements and CEQ regulations, the MMS followed scoping procedures for contacting and coordinating with Federal, State, and local governments; academic institutions; public interest groups; and concerned individuals throughout the development of this document. The scoping process for the proposed sales was officially initiated by the Call/NOI in January 1997. Federal, State, and local governments, along with other interested parties, were requested to send written comments to the Region on the scope of the EIS. These comments are summarized below.

Federal regulations allow for several similar proposals to be analyzed in one EIS (40 CFR 1502.4). Since the sale proposal and projected activities are very similar each year, a single EIS is being prepared for the four remaining Western Gulf sales in the 5-Year Program. The multisale approach is intended to focus the NEPA/EIS process on differences between the proposed sales and on new issues and information. The multisale EIS will eliminate the repetitive issuance of complete draft and final EIS's for each sale, thereby avoiding repetitive reviews by Federal, State, and local agencies and the public. The multiyear approach will also allow the prelease process to take place within a one-year period, rather than the usual two-year process.

Although this EIS addresses four proposed sale actions, only one sale decision will be made each year. This EIS will serve as a decision document for Sale 171, which is scheduled for 1998. Formal consultation and a NEPA review will be conducted for each subsequent sale. An Environmental Assessment (EA) will be conducted to determine whether or not the information and analyses in this original multisale EIS are still valid for each subsequent sale under consideration. The EA will result in either a Finding of No New Significant Impact (FONSI) or in the preparation of a Supplemental EIS (SEIS).

C. RESPONSES TO THE CALL FOR INFORMATION AND NOTICE OF INTENT TO PREPARE AN EIS

On January 29, 1997, the Call for Information and Nominations (Call) and the Notice of Intent to Prepare an EIS (NOI) for the proposed 1998-2001 Western Gulf of Mexico lease sales were published in the *Federal Register*. The required 45-day comment period closed on March 16, 1997. Additional public notices were distributed via newspaper notices, mailouts, and the Internet. Five comments were received in response to the Call/NOI.

Written Comments Received in Response to the Call and NOI

Department of Defense	The Department of the Air Force, Headquarters Air Force Development Test Center, Eglin Air Force Base, Florida, noted that the Western Gulf area is not within the Eglin Water Test Areas and will not impact military operations at Eglin AFB.
U.S. Environmental Protection Agency	The U.S. Environmental Protection Agency requested that this multisale EIS address the cumulative impacts of offshore and onshore sources on the air quality of the Breton Island National Wildlife Refuge Class I area. Specific recommendations were made regarding air quality modeling and the impacts of producing hydrocarbons.
The State of Alabama	No comment regarding the proposed Western Gulf of Mexico oil and gas sales.
The State of Louisiana	The Louisiana Department of Natural Resources (LDNR) supports nomination sales in order to optimize the royalties generated by leases while moderating the rate of development of the OCS in the Gulf of Mexico. The LDNR suggests that new alternative actions that both increase the benefits to Louisiana and avoid, reduce, and/or compensate for the impacts resulting from OCS activities be analyzed in the proposed EIS. The LDNR also recommends that the MMS consider means to compensate/mitigate Louisiana for wetland loss and other adverse impacts from OCS activities in the coastal zone. An analysis of new development patterns associated with deepwater and subsalt exploration and development on the socioeconomic environment of Louisiana is also requested by the LDNR.
The State of Texas	The Texas General Land Office, Coastal Division, expressed no concern regarding the proposed Western Gulf of Mexico oil and gas sales.

D. DISTRIBUTION OF THE DRAFT EIS FOR REVIEW AND COMMENT

The following public and private agencies and groups were provided copies of the Draft EIS for review and comment. The comment period on the Draft EIS closed on December 2, 1997.

Federal Agencies

Congress
- Congressional Budget Office
- House Resources Subcommittee on Energy and Mineral Resources
- Senate Committee on Energy and Natural Resources

Department of Commerce
- National Marine Fisheries Service
- National Oceanic and Atmospheric Administration

Department of Defense
- Department of the Air Force
- Department of the Army
  - Corps of Engineers
- Department of the Navy

Department of Energy
- Strategic Petroleum Reserve PMD

Department of the Interior
- Fish and Wildlife Service
- Geological Survey
- Minerals Management Service
- National Park Service
- Office of Environmental Policy and Compliance
- Office of the Solicitor

Department of State
- Office of Environmental Protection

Department of Transportation
- Coast Guard
- Office of Pipeline Safety

Environmental Protection Agency
- Region 4
- Region 6

Marine Mammal Commission

State and Local Agencies

Texas
- Governor's Office
- Attorney General of Texas
- Department of Water Resources
- General Land Office
- Southeast Texas Regional Planning Commission
- State Legislature Natural Resources Committee
- State Senate Natural Resources Committee
- Texas Historical Commission
- Texas Legislation Council
- Texas Parks and Wildlife Department
- Texas Water Conservation Association
- Texas Water Development Board

Louisiana
- Governor's Office
- Calcasieu Regulatory Planning Commission
- Department of Culture, Recreation, and Tourism
- Department of Environmental Quality
- Department of Natural Resources
- Department of Transportation and Development
- Department of Wildlife and Fisheries
- Louisiana Geological Survey
- State Legislature Natural Resources Committee
- State House of Representatives Natural Resources Committee

Libraries

Texas
- Abilene Christian University, Abilene
- Alma M. Carpenter Public Library, Sourlake
- Aransas Pass Public Library, Aransas Pass
- Austin Public Library, Austin
- Baylor University, Waco
- Bay City Public Library, Bay City
- Brazoria County Library, Freeport
- Calhoun County Library, Port Lavaca
- Chambers County Library System, Anahuac
- Comfort Public Library, Comfort
- Corpus Christi Central Library, Corpus Christi
- Dallas Public Library, Dallas
- East Texas State University Library, Commerce
- Houston Public Library, Houston
- Jackson County Library, Edna
- Lamar University, Mary and John Gray Library, Lamar Station
- La Ratama Library, Corpus Christi
- Liberty Municipal Library, Liberty
- Orange Public Library, Orange
- Port Arthur Public Library, Port Arthur
- Port Isabel Public Library, Port Isabel
- R. J. Kleberg Public Library, Kingsville
- Reber Memorial Library, Raymondville
- Refugio County Public Library, Refugio
- Rice University, Fondren Library, Houston
- Rockwall County Library, Rockwall
- Rosenberg Library, Galveston
- Sam Houston Regional Library & Research Center, Liberty
- Stephen F. Austin State University, Steen Library, Nacogdoches
- Texas A&M University Library, Corpus Christi
- Texas A&M University, Evans Library, College Station
- Texas Southmost College Library, Brownsville
- Texas State Library, Austin
- Texas Tech University Library, Lubbock
- University of Houston Library, Houston
- University of Texas Library, Arlington
- University of Texas Library, Austin
- University of Texas Library, Brownsville
- University of Texas Library, El Paso
- University of Texas Library, San Antonio
- University of Texas at Dallas, McDermott Library, Richardson
- University of Texas, LBJ School of Public Affairs Library, Austin
- University of Texas, Tarlton Law Library, Austin
- Victoria Public Library, Victoria

Louisiana
- Calcasieu Parish Library, Lake Charles
- Cameron Parish Library, Cameron
- Grand Isle Branch Library, Grand Isle
- Iberville Parish Library, Plaquemines
- Jefferson Parish Lobby Branch Library, Metairie
- Jefferson Parish West Bank Outreach Branch Library, Harvey
- Lafayette Public Library, Lafayette
- Lafitte Branch Library, Lafitte
- Lafourche Parish Library, Thibodaux

Louisiana State University Library, Baton Rouge
Louisiana Tech University Library, Ruston
Loyola University, Government Documents Library, New Orleans
LUMCON Library, Chauvin
McNeese State University Library, Lake Charles
New Orleans Public Library, New Orleans
Nicholls State University Library, Thibodaux
Plaquemines Parish Library, Buras
St. Bernard Parish Library, Chalmette
St. Charles Parish Library, Luling
St. John the Baptist Parish Library, Laplace
St. Mary Parish Library, Franklin
St. Tammany Parish Library, Covington
St. Tammany Parish Library, Slidell
Terrebonne Parish Library, Houma
Tulane University, Howard Tilton Memorial Library, New Orleans
University of New Orleans Library, New Orleans
University of Southwestern Louisiana Library, Lafayette
Vermilion Parish Library, Abbeville
West Bank Regional Library, Harvey

Oklahoma
University of Tulsa, McFarlin Library, Tulsa

Industry/Companies

Amoco Production Company
Cartwright & Co., Inc.
John E. Chance and Associates, Inc.
Kerr-McGee Corp.
Louisiana Land and Exploration Company
Louisiana Offshore Oil Port, Inc.

Groups

American Littoral Society, Project Reefkeeper
Audubon Society, Austin, Texas
Clean Gulf Associates
Coastal Conservation Association
Gulf of Mexico Fishery Management Council
Gulf States Marine Fisheries Council
Louisiana Gulf Coast Conservation Association
Louisiana Wildlife Biologists Association
Louisiana Wildlife Federation, Inc.
Natural Resources Defense Council, Inc.
New England Aquarium
Petroleum Information Corporation
Save Our Coast
Sierra Club, Lone Star Chapter
Sierra Club, New Orleans Chapter
Sierra Club, Southern Plains Representatives
Texas Conservation Foundation
Texas Nature Conservancy
Texas Shrimp Association

E. PUBLIC HEARINGS

In accordance with 30 CFR 256.26, MMS held public hearings soliciting comments on the Draft EIS for proposed Western Gulf of Mexico Lease Sales 171, 174, 177, and 180. The hearings also provide the Secretary of the Interior with information from interested parties to help in the evaluation of potential effects of the proposed lease sales.

The hearings were held on the following dates and at the times and locations indicated below:

October 28, 1997	October 29, 1997	October 29, 1997	October 30, 1997
DoubleTree Guest Suites 303 West 15th Street Austin, Texas 1:00 p.m. to 3:00 p.m.	Minerals Management Service 1201 Elmwood Park Blvd. New Orleans, Louisiana 1:00 p.m. to 3:00 p.m.	Texas A&M University 6300 Ocean Drive Natural Resources Center Corpus Christi, Texas 7:00 p.m. to 9:00 p.m.	Adams Mark Hotel 2900 Briarpark Drive Houston, Texas 1:00 p.m. to 3:00 p.m.

No one presented testimony regarding the lease sales or the Draft EIS at any of the public hearings held in Texas. Only one person attended each hearing in Austin and Corpus Christi, and two people attended the hearing in Houston. The hearing held in New Orleans had one person in attendence, presenting four sets of testimony in support of the lease sale and Alternative A.

F. MAJOR DIFFERENCES BETWEEN THE DRAFT AND FINAL EIS'S

Federal and State agencies and the oil and gas industry presented their comments on the Draft EIS by letter and during public hearings held in Louisiana and Texas. As a result of those comments, changes were made between the Draft and Final EIS's. Corrections to the text ranged from minor editorial changes to insertion of new or updated information. In addition, the Minerals Management Service updated acreage and block estimates for planning areas available for lease under the various alternatives presented and updated acreage and block estimates for areas available for lease that contain biologically sensitive features.

G. DRAFT EIS LETTERS OF COMMENTS AND RESPONSES

The Draft EIS for proposed Gulf of Mexico Lease Sales 171, 174, 177, and 180 was filed with the USEPA on October 3, 1997. The comment period on the document ended December 2, 1997. Letters of comment on the Draft EIS were received from the following:

Federal Agencies

Marine Mammal Commission
U.S. Environmental Protection Agency, Region 6
U.S. Department of Commerce
- National Oceanic and Atmospheric Administration
- National Geodetic Survey
- National Marine Fisheries Service

State Agencies

Louisiana
- Louisiana Department of Natural Resources

Alabama
- Governor's Office

Industry

- National Ocean Industries Association

The remainder of Section V includes copies of all of the comment letters received on the Draft EIS and provides responses to these comments, including explanations of how the document was modified in response to the comments, if appropriate.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

ORD
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December 2, 1997

Chris C. Oynes
Regional Director
Mineral Management Service
Gulf of Mexico OCS Region
(MS 5410)
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

Dear Mr. Oynes:

In accordance with our responsibilities under Section 309 of the Clean Air Act, the National Environmental Policy Act (NEPA), and the Council on Environmental Quality Regulations for Implementing NEPA, the U.S. Environmental Protection Agency (EPA) Region 6 office in Dallas, Texas, has completed its review of the U.S. Department of Interior's Minerals Management Service (MMS) Draft Environmental Impact Statement (DEIS) for Gulf of Mexico Outer Continental Shelf (OCS) Oil and Gas Lease Sales 171,174, 177 and 180, Western Planning Area.

This DEIS addresses four proposed Federal actions that offer for lease areas on the Gulf of Mexico OCS that may contain economically recoverable oil and gas resources. All unleased blocks in the Western Planning Area, except two blocks in the Flower Garden Banks National Marine Sanctuary and three blocks for Naval operations, will be available for lease.

US EPA-1

While three mitigative stipulations, topographic features, military areas, and naval mine warfare areas, have been analyzed as part of the proposed action and the alternatives, the EIS is not clear that a commitment will be made by the Secretary of Interior to implement these measures for the protection and mitigation for direct and indirect impacts to important resources within the project area through the use of these stipulations. EPA encourages MMS to continue the practice of applying those stipulations provided to previous lease sales for the OCS to the proposed sales of 1997 to 2002.

Gulf of Mexico OCS Region
MMS
DEC 08 1997
Office of the Regional Director

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EPA classifies your DEIS as "LO," i.e., EPA has "Lack of Objections". Our classification will be published in the Federal Register according to our responsibility under Section 309 of the Clean Air Act, to inform the public of our views on proposed Federal actions.

We appreciate the opportunity to review the DEIS. We request that you send our office one copy of the Final EIS at the same time that it is sent to the Office of Federal Activities, (2251A), EPA, 1200 Pennsylvania Avenue, N.W., Washington, D.C. 20044.

Sincerely yours,

Michael P. Jansky, P.E.
Regional Environmental Review
Coordinator

V-11

UNITED STATES DEPARTMENT OF COMMERCE
Office of the Under Secretary for
Oceans and Atmosphere
Washington, D.C. 20230

November 12, 1997

Regional Director
Minerals Management Service (MMS)
Gulf of Mexico Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123

Dear Sir:

Enclosed are comments from the National Oceanic and Atmospheric Administration (NOAA) on the Draft Environmental Impact Statement (DEIS) for the Proposed Annual (1998 to 2001) Outer Continental Shelf Oil and Gas Lease Sales 171, 174, 177, and 180 in the Western Gulf of Mexico. We hope our comments will assist you. Thank you for giving us an opportunity to review the document.

Sincerely,

Susan B. Fruchter

Susan B. Fruchter
Acting NEPA Coordinator

Enclosure

cc: Director, Minerals Management Service
Department of the Interior
Room 4230
1849 C Street, NW
Washington, DC 20240

Gulf of Mexico OCS Region
MMS
NOV 17 1997
Office of the Regional Director

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Comments of the National Marine Fisheries Service (NMFS), Southeast Region on the Draft Environmental Impact Statement (DEIS) for Proposed 1998 OCS Oil and Gas Lease Sales 171, 174, 177, and 180 in the Western Planning Area of the Gulf of Mexico

General Comments

NMFS-1

Provided the proposed stipulations are implemented, the DEIS generally addresses anticipated environmental impacts and provides an adequate discussion and analysis of living marine resources issues and needed environmental safeguards. The Minerals Management Service (MMS) continues to advise that stipulations designed to prevent severe impacts to deep-water benthic communities and topographic features communities are discretionary to the Secretary, but are almost always made mandatory after a permit is approved. The NMFS continues to request that these stipulations be made mandatory for each specific lease where these communities exist or are found to exist before that lease is bid upon. This would avoid the uncertainty of a Secretarial approval without a mandatory stipulation being made a part of a specified lease. The NMFS has met with MMS personnel on this issue and has been unsuccessful in making the Secretary's approval of these stipulations mandatory.

NMFS-2

The DEIS is totally absent of any discussion concerning damage assessment and habitat restoration mitigation for onshore and offshore environmental impacts from OCS oil and gas operations. These issues have been raised to the MMS for the last several lease sales with no acceptable response. The NMFS again requests that the MMS address damage assessment and habitat mitigation from environmental impacts caused by oil and gas operations. The MMS continues to discuss environmental impacts in great detail, but offers no program to require lessees to replace impacted marine habitat with man-made habitat in a closely associated area or in a "like-kind" area in another location. Most of the MMS mitigating measures are very effective at notifying lessees of what not to do, but are notably absent of any recommendations or requirements for assessing habitat destruction and requiring habitat restoration.

Specific Comments

IV. ENVIRONMENTAL CONSEQUENCES

D. Environmental Impacts of the Proposed Actions and Alternatives

1. Proposed Western Gulf Sales 171, 174, 177, and 180

a. Alternative A - The Proposed Action

(2) Impacts on Sensitive Offshore Resources

(b) Deepwater Benthic Communities

In the discussion of deepwater benthic communities beginning on page IV-94, the MMS states, "The greatest potential for adverse impacts to deepwater chemosynthetic communities would come from those OCS-related, bottom-disturbing activities associated with pipelaying, anchoring, and structure emplacement, as well as from a seafloor blowout." The MMS has implemented the Notice to

NMFS-3

Lessees (NTL) 88-11 which formalizes the MMS review process and makes mandatory the search for and avoidance of dense chemosynthetic communities or areas that have a high potential for supporting these community types, as interpreted from geophysical records. The NMFS agrees that the NTL 88-11 process is effective in identifying and avoiding chemosynthetic community areas, but requests that the MMS prescribe that a 1,000-meter No Activity Zone for all identified chemosynthetic communities be made a part of the NTL 88-11.

(D) Topographic Features

NMFS-4

The NMFS was unable to find any discussion in the DEIS concerning the MMS practice of exempting exploratory drilling from the Topographic Features Stipulation (discharges of drilling effluents within 10 meters of the sea floor by use of a downpipe) inside the 3-Mile Activity Zone (4,828 meters). The NMFS requests that exploratory drilling in the 3-Mile Activity Zone not be exempted from the Topographic Features Stipulation unless the MMS can present supporting research and discussion in the Final Environmental Impact Statement.

UNITED STATES DEPARTMENT OF COMMERCE
Office of the Under Secretary for
Oceans and Atmosphere
Washington, D.C. 20230

December 17, 1997

Regional Director
Minerals Management Service (MMS)
Gulf of Mexico Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123

Dear Sir:

Enclosed are additional comments from the National Oceanic and Atmospheric Administration (NOAA) on the Draft Environmental Impact Statement (DEIS) for the Proposed Annual (1998 to 2001) Outer Continental Shelf Oil and Gas Lease Sales 171, 174, 177, and 180 in the Western Gulf of Mexico. We hope our comments will assist you. Thank you for giving us an opportunity to review the document.

Sincerely,

Susan B. Fruchter
Acting NEPA Coordinator

Enclosure

cc: Director, Minerals Management Service
Department of the Interior
Room 4230
1849 C Street, NW
Washington, DC 20240

Gulf of Mexico OCS Region
MMS
DEC 24 1997
Office of the Regional Director

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
National Geodetic Survey
Silver Spring, Maryland 20910-3282

NOV 1 1 1997

MEMORANDUM FOR: Susan B. Fruchter
Acting Director, Ecology and Conservation Office

FROM: Charles W. Challstrom
Acting Director, National Geodetic Survey

SUBJECT: DEIS for the Proposed Annual (1998 to 2001) Outer Continental Shelf (OCS) Oil and Gas Lease Sales 171, 174, 177, and 180 in the Western Gulf of Mexico

The subject statement has been reviewed within the areas of the National Geodetic Survey's (NGS) responsibility and expertise and in terms of the impact of the proposed actions on NGS activities and projects.

All available geodetic control information about horizontal and vertical geodetic control monuments in the subject area is contained on the NGS home page at the following Internet World Wide Web address: http://www.ngs.noaa.gov. After entering the NGS home page, please access the topic "Products and Services" and then access the menu item "Data Sheet." This menu item will allow you to directly access geodetic control monument information from the NGS data base for the subject area project. This information should be reviewed for identifying the location and designation of any geodetic control monuments that may be affected by the proposed project.

If there are any planned activities which will disturb or destroy these monuments, NGS requires not less than 90 days' notification in advance of such activities in order to plan for their relocation. NGS recommends that funding for this project includes the cost of any relocation(s) required.

For further information about these monuments, please contact Rick Yorczyk; SSMC3, NOAA, N/NGS; 1315 East West Highway; Silver Spring, Maryland 20910; telephone: 301-713-3230 x142; fax: 301-713-4175.

This sale of Oil and Lease blocks in the Western Gulf of Mexico will have no direct bearing on navigational safety. The presence of temporary drilling structures, and permanent oil platforms will be indicated by items published in Local Notices to Mariners. The lease block areas themselves are charted on special chart 1113A. No revision to the charted limited of these areas is anticipated. There are no related references to these areas in United States Coast Pilot 5.

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MARINE MAMMAL COMMISSION
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8 December 1997

Mr. Chris C. Oynes
Regional Director
Minerals Management Service
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

Gulf of Mexico OCS Region
MMS
DEC 09 1997
Office of the Regional Director

Dear Mr. Oynes:

The Marine Mammal Commission, in consultation with its Committee of Scientific Advisors on Marine Mammals, has reviewed the Draft Environmental Impact Statement (DEIS) for Gulf of Mexico Oil and Gas Lease Sales 171, 174, 177, and 180. We offer the following comments, suggestions, and recommendations concerning the DEIS's assessment of matters bearing upon the conservation and protection of marine mammals in the northern Gulf of Mexico.

General Comments

The DEIS provides an assessment of the possible environmental and related socio-economic impacts of oil and gas lease sales proposed to be held in the Western Gulf of Mexico Planning Area in the next five years (1997-2002: Sale 171 in 1998, Sale 174 in 1999, Sale 177 in 2000, and Sale 180 in 2001). In the Marine Mammal Commission's view, the decision to prepare a single Environmental Impact Statement (EIS) to assess the possible impacts of lease sales proposed to be held in the Western Planning Area in the next five years was a sound one.

When finalized, the Environmental Impact Statement will serve as the decision document for proposed sale 171. The planning area includes about 28.4 million acres located from 14 to 357 kilometers offshore Texas in water depths ranging from 8 to more than 3,000 meters. It is estimated that each of the proposed sales could result in the production of 0.01-0.09 billion barrels of oil and 0.57-1.93 trillion cubic feet of gas.

The DEIS provides a thorough and very well-documented summary of published information concerning the marine mammal species that occur in the northern Gulf of Mexico. It also provides a well-documented assessment of the ways that marine mammals, in general, could be affected by seismic surveys, drilling, waste discharges, oil spills, etc. that would or could result if the proposed lease sales are held. The individual(s) who compiled the information and prepared the summaries should be commended for a job well done.

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Although the summaries provide a thorough and objective overview of virtually all relevant published information, they provide little information on the distribution patterns or abundance of the individual species and populations of marine mammals that inhabit the northern Gulf, seasonally or throughout the year. In this regard, it is our understanding that the GulfCet Program, funded cooperatively by the Minerals Management Service and the National Marine Fisheries Service, has provided much new information concerning the distribution, abundance, habitat-use patterns, possible essential habitats, and the characteristics of the possible essential habitats of the marine mammal species found most commonly in the northern Gulf, including the Western Planning Area. If our understanding is correct, the Final Environmental Impact Statement (FEIS) for these sales should be expanded to indicate where, specifically, seismic surveys, drilling, helicopter and vessel support activities, etc. associated with the proposed action would or could occur in or near areas, or transect areas, (a) where concentrations of various marine mammal species have been found, and (b) that could be important, and possibly essential, feeding, breeding, calving, or nursing areas, or migratory routes for those species. Likewise, the FEIS should be expanded to indicate how the individual species and populations of marine mammals and habitats possibly essential to their survival could be affected by the proposed action.

MMC-1

If the available data are insufficient to determine how individual species and populations could be affected directly or indirectly by the proposed action, by itself or in combination with past and possible future exploration and development activities in the northern Gulf, the FEIS should describe (i) the uncertainties and the research being done or planned to resolve them, and/or (ii) the long-term monitoring program(s) being conducted or planned to ensure that oil and gas exploration and development in the northern Gulf do not have significant adverse effects on any marine mammal species or population. This is particularly important since the EIS is intended to provide an assessment of the possible environmental impacts of a series of lease sales over the next five years.

Specific Comments

Page ix, par. 1: The second sentence in this paragraph states that "[t]he proposed action is unlikely to have significant long-term adverse effects on the size and productivity of any marine mammal...species or population stock in the northern Gulf of Mexico." As noted earlier, the DEIS provides almost no information on the distribution, abundance or size of the particular marine mammal species and population stocks that occur in the northern Gulf. Likewise, except for manatees, it does not provide assessments of the possible effects

MMC-2

of the proposed action on the size or productivity of the individual species or stocks. Consequently, this conclusion appears not to be justified by the information and analyses provided in the DEIS.

Page ix, par. 1: The third sentence in this paragraph states that "[l]ethal effects are most likely to be from chance collisions with OCS service vessels and ingestion by eating indigestible trash, particularly plastic items, accidentally lost from drill rigs and service vessels of plastic materials, though few lethal impacts are expected [emphasis added]." The sentence implies that workers on drill rigs, supply boats, etc. never intentionally discard trash at sea. This seems unlikely. Further, if substantial amounts of trash are in fact being lost accidentally from drill rigs and service vessels, it should be possible to identify the cause(s) of, and take steps to prevent, such accidental loss. The Commission therefore suggests that, here and elsewhere in the DEIS where similar statements are made, the word "accidentally" be deleted, or that the source or sources of this "accidental" loss be identified. Further, the Commission recommends that, if the Service has not already done so, it identify and take such steps as necessary to prevent the intentional and accidental discharge of trash from drill rigs and service vessels.

MMC-3

Page I-5 (The Outer Continental Shelf Lands Act): Either here or elsewhere, the FEIS should describe the Service's responsibility under the OCS Lands Act to design and conduct post-sale monitoring programs "for the purpose of identifying any significant changes in the quality and productivity of such [human, marine, and coastal] environments, for establishing trends in the areas studied and monitored, and for designing experiments to identify the causes of such changes" (43 U.S.C. §1346(b)).

MMC-4

In this regard, it appears, as pointed out below, that available information is insufficient to reliably predict how or to what extent OCS activities have affected or may affect the distribution, abundance, and productivity of marine mammal species and populations in the northern Gulf. However, it also appears that data being obtained by the GulfCet Program are providing baselines that can be used to detect and determine the biological significance of possible future changes. Further, it appears that these data are suggesting testable hypotheses concerning the cause-effect relationships between marine mammal distribution, abundance, and habitat-use patterns, and natural variables such as water temperature and depth, and anthropogenic variables such as noise from seismic profiling and drilling operations. Consequently, it appears both possible and, in accordance with the referenced section of the OCS Lands Act, necessary to design and conduct post-sale monitoring programs to confirm the validity of the pre-sale determinations that

MMC-5

exploration and development activities will not have significant adverse effects on the distribution, abundance, or productivity of any marine mammal species or population in the northern Gulf.

As noted earlier, this is particularly important since the EIS is intended to provide an assessment of the possible environmental impacts of a series of lease sales and subsequent activities.

Page I-6 (The Marine Mammal Protection Act): This section provides a very good summary of the intent and relevant provisions of the Marine Mammal Protection Act.

Pages I-11 through I-15 (Post Lease Activities): As noted earlier, the OCS Lands Act, among other things, requires that the Service design and conduct post-sale monitoring programs "for the purpose of identifying any significant changes in the quality and productivity of such [human, marine, and coastal] environments, for establishing trends in the areas studied and monitored, and for designing experiments to identify the causes of such changes." This section of the FEIS should describe what is being done or planned to meet this responsibility.

MMC-6

Page II-14, par. 2: The first two sentences in this paragraph state that --

> The proposed action, by itself, is unlikely to have significant long-term adverse effects on the size and productivity of any marine mammal species or population stock in the northern Gulf of Mexico. Small numbers of marine mammals could be killed or injured by chance collision with service vessels and by eating indigestible trash, particularly plastic items, accidentally lost from drill rigs and service vessels.

As noted earlier, information and analyses provided in the DEIS do not support the conclusion that the proposed action is unlikely to have a significant long-term adverse effect on the size or productivity of any marine mammals species or stock in the northern Gulf. Also, as noted earlier, there appears to be little justification for the implication that trash is lost only accidentally from drill rigs and service vessels and that nothing can be done to prevent this loss. These statements would be more accurate if they were revised to read something like --

MMC-7

> The proposed action, by itself, is unlikely to have significant long-term adverse effects on the size or productivity of any marine mammal species or population stock in the northern Gulf of Mexico provided (a) previous and on-going exploration and development activities have not increased the sensitivity of any marine mammal species to disturbance from seismic

> surveys, rig construction, drilling operations, or ship and helicopter support activities; (b) responses to disturbance do not increase as the level of disturbance increases or do not occur until a sensitivity threshold is reached; and (c) if oil spills occur, they occur at times and in places where significant numbers of marine mammals are not present, and individually and collectively do not adversely affect habitats or habitat components (e.g., important prey species) that are essential to the well-being of any marine mammal species or population stock in the northern Gulf. Small numbers of marine mammals could be killed or injured by chance collision with Service vessels and by eating indigestible trash, particularly plastic items, lost or thrown from drill rigs or service vessels.

On a related matter, the eighth sentence in this paragraph states that "[t]here is little conclusive evidence for long-term displacements and population trends for marine mammals relative to noise." The statement is true. However, it also is true that there is no conclusive evidence that anthropogenic noise has not caused long-term displacements of, or reductions in, marine mammal populations. In this regard, it is important to keep in mind that (a) the distributions, habitat-use patterns, sizes, and productivity of marine mammal populations in the northern Gulf prior to the beginning of offshore oil and gas exploration and development are unknown; (b) significant changes in the distribution, habitat-use patterns, size, and productivity of marine mammal populations in the northern Gulf may already have occurred as a result of offshore oil and gas exploration and development, but have not been detected; and (c) on-going research and monitoring programs probably are not capable of detecting anything but very large changes in the distribution, abundance, or productivity of marine mammal populations in the northern Gulf. The Commission therefore suggests that the referenced sentence be deleted or that it be revised to read something like "[t]here is no conclusive evidence that anthropogenic noise has or has not caused long-term displacements of, or reductions in, marine mammal populations."

MMC-8

On a related point it is not clear what is meant by "long-term". The FEIS should indicate what the Service considers to be "long-term."

MMC-9

Page III-35, first complete paragraph: The seventh sentence in this paragraph states that "[d]uring 1992-1993 GulfCet surveys, an estimated 451 (co-efficient of variance (CV) = 36.5%) bottlenose dolphins occurred over the continental shelf in the northwestern Gulf, and 520 (CV = 56.3%) over the continental slope...." It is not clear whether the estimates are of the total number of bottlenose dolphins occurring over the continental shelf and over the continental slope, or whether they

MMC-10

are estimates of the number of animals sighted during the surveys judged to be over the continental shelf or over the continental slope. This should be clarified in the FEIS.

Page III-35, par. 3: The third sentence in this paragraph states that "[a]ll other delphinids appeared to prefer deeper slope waters (Risso's dolphins and short-finned pilot whales occur at depths less than 860 m; pantropical spotted and Clymene dolphins in waters deeper than 1,200 m; spinner and rough-tooth dolphins at depths from 950-1,100 m) and feed on fish and/or squid...." As drafted, the sentence can be interpreted to indicate that Risso's dolphins and short-finned pilot whales can dive to depths of up to 860 m and that spinner and rough-tooth dolphins occur only at depths of 950-1,100 m below the surface. The sentence presumably would be more accurate if the part in parentheses was revised to read something like -- "(Risso's dolphins and short-finned pilot whales inhabit areas with water depths less than 860 m...; spinner and rough-tooth dolphins in waters from 950-1,100 m in depth)."

MMC-11

The sixth sentence in this paragraph states that "(d)istribution of the striped, spinner, and Clymene dolphins was shown to have a relationship with the 15°C isotherm, demonstrating a preference for waters where this isotherm shoals...(emphasis added)." A relationship does not necessarily demonstrate cause-effect. Thus, the sentence might be more accurate if the word "demonstrating" was changed to "suggesting."

MMC-12

Page III-36, first complete paragraph: As noted earlier, the DEIS provides little information on the distributions, seasonal activity patterns, habitat-use patterns, and abundance of the particular marine mammal species that occur in the northern Gulf. Likewise, it does not indicate whether concentrations of any species, and therefore possibly important habitats, occur in or near areas where seismic surveys, drilling, etc. are likely to occur if leasing occurs as proposed. This paragraph suggests that there are seasonal distribution and abundance data for the marine mammal species that occur most commonly in the western Gulf and that a more thorough assessment of the possible impacts of the proposed action on at least some marine mammal species should be possible.

The last three sentences in this paragraph indicate that --

> The GulfCet II Program is continuing work on patterns of distribution and abundance of Gulf cetaceans, and to identify possible associations between cetacean high-use habitats and the ocean environment. It is hypothesized that certain distribution is [certain distributions are] positively correlated with spatial and temporal variations in regional food stocks of zooplankton and micronekton. These food stocks are

> concentrated in nutrient-rich areas offshore the Mississippi River, within cold-core eddies, or along the edge of warm-core eddies.

It appears from these statements that the GulfCet Program either has provided, or is likely to provide, the baseline data needed to be able to detect changes in the seasonal distribution patterns, abundance, etc. of marine mammals in the northern Gulf possibly caused by offshore oil and gas exploration and development. It also appears that hypotheses have been formulated, which could serve as the basis for designing long-term studies to elucidate cause-effect relationships. Here or elsewhere the EIS should be expanded to describe the scope and objectives of the GulfCet Program in more detail, and to indicate the follow-up monitoring that may be required to verify that the proposed action, by itself and in combination with past and future offshore exploration and development, does not have long-term adverse effects on any marine mammal population as the DEIS concludes.

MMC-13

Page III-16, par. 1: The third sentence in this paragraph indicates that "[t]he northern right whale is one of the world's most endangered whales." Although some small cetaceans are more endangered than the northern right whale, we know of no whale species more endangered than the northern right whale. Therefore, we suggest that the words "one of" be deleted from this sentence.

MMC-14

Page III-37, last complete par.: The seventh sentence in this paragraph indicates that "[s]perm whales in the Gulf were found to occur at mean depths of 950-1,100 m...." Read literally the sentence indicates that sperm whales live at mean depths of 950-1,100 m. The sentence presumably would be more accurate if it were revised to read something like "[s]perm whales in the Gulf were observed to occur most frequently in areas with mean water depths of 950-1,100 m."

MMC-15

The ninth sentence in this paragraph indicates that "Baumgartner (1995) noted that sperm whales avoided warm water features characterized by a depressed 15°C isotherm and warm water at 100 m...." Although it may well be true that sperm whales avoid warm water features as indicated, the fact that fewer sperm whales were observed in warm waters does not necessarily mean that they consciously avoided such areas as implied. It is possible, for example, that key prey species do not occur in such areas and this is why sperm whales seldom or never were observed there. The sentence presumably would be more accurate if it were revised to read "Baumgartner (1995) noted that sperm whales [seldom were observed] [never were observed] in warm waters characterized by...."

MMC-16

Pages IV-13 and IV-14 (Seismic surveying operations):

Information described and referenced in the DEIS indicates that bowhead whales, gray whales, and sperm whales all have been observed to alter their behavior when exposed to impulse sounds from seismic surveys. The distances at which the sounds may be detected and responses occur depend upon variables such as the energy output of the sound source; the depth, temperature, and salinity of the water where the surveys are being conducted; the bottom type (e.g., mud vs. rock) in shallow water areas; ambient, background noise levels; and the depths that the animals occur (dive) in the water column. Responses can include changes in swimming speed and direction, and depths, duration and frequency of dives; interruption of feeding, breeding, nursing, or other vital functions; avoidance of areas where seismic surveys are being, or have been, conducted, either because the sound is aversive or annoying, or because it causes preferred prey species to leave the area or to change their behavior so that they are less vulnerable to capture; attraction to the sound source, either because animals are curious about the sound, or the sound stuns or otherwise affects preferred prey species so that they are easier to capture; and reduced ability to detect and avoid predators and to interact with conspecifics because the sounds from the seismic sources mask or otherwise impair detection of sounds produced by predators (e.g., killer whales) and conspecifics. The responses depend upon variables such as the frequency, intensity, and duration of the sound; the species, ages, sex, and activities of the animals within detection range (for example, as the DEIS points out, animals engaged in focused activities, such as feeding, may be less likely than animals engaged in less focused activities, such as slow swimming or resting, to respond to unfamiliar sounds); and the length of time and number of times that the animals are exposed to the sound (for example, some species and individuals may become accustomed and stop responding to certain sounds if they are exposed to them frequently or for long periods of time, whereas other species and individuals may become more responsive (sensitive) to sounds if they are exposed to them frequently or over long periods of time). Also, repeated exposure or long duration exposure may cause physiological and/or psychological stress which, in turn, can affect the immune system making animals more vulnerable to parasites and disease.

This section of the DEIS indicates that seismic surveys are done before leasing to identify possible oil-bearing structures, and after leasing to determine where best to locate exploration and development wells and to minimize the number of wells required to develop the field. It also notes that prior to 1989, explosives (dynamite) were used to generate seismic pulses and that piston-type acoustic sources are now used to generate the pulses. It is noted, at the top of page IV-14, that --

> The number of prelease geophysical permits in the Gulf has been consistently high over the past five years,

> and the MMS anticipates an increase in the number of permit applications. With the implementation of deep water royalty relief and the record-breaking number of bids at the 1996 Gulf of Mexico lease sales, geophysical surveying companies have committed to large speculative 2D and 3D geophysical surveys in deep water areas.

MMC-17

There is no indication of the length of time required to carry out the various types of surveys, or the number of surveys that might reasonably be expected to be done as a result of the proposed action. Further, there is no indication of the number of seismic surveys likely to be conducted in the future as a result of previous lease sales in the Western Planning Area. Likewise, there is no indication of when seismic profiling began in the western Gulf, or where and how frequently seismic profiling has been conducted since then. Consequently, it is not possible to make reasoned judgements as to when, where, how frequently and for what lengths of time marine mammals may have been exposed previously to seismic profiling in the northern Gulf, or how much additional exposure is likely to result from the proposed action. It also is not possible to make reasoned judgments as to whether additional or different species of marine mammals are likely to be exposed and possibly affected as development occurs in deeper waters.

MMC-18

The next section of the DEIS indicates that 35-115 exploration and delineation wells are projected to be drilled as a result of the proposed action; at present, 250-350 exploration or delineation wells are drilled annually in the Gulf; 50-190 development wells are projected to be drilled as a result of the proposed action; and at present, 300-575 development wells are drilled annually in the Gulf. If only a single seismic survey is done for each exploration, delineation, and development well, an average of two seismic surveys are presently being done each day in the Gulf. We presume that multiple-surveys often are required and that many, if not most, surveys require more than a single day to complete. Therefore, it seems likely that marine mammals in parts of the Gulf have been, and will continue to be, exposed almost on a daily basis to seismic profiling and that marine mammals throughout the Gulf have been, and will continue to be, exposed to seismic profiling on a regular basis.

MMC-19

The Marine Mammal Commission recommends that the section of the FEIS describing seismic operations be expanded to provide more details concerning the nature and extent of both past and anticipated future seismic activities in the Western Planning Area. Minimally, the Commission believes that this section should indicate (1) when seismic profiling began in the northern Gulf; (2) the time it normally takes to complete various types of surveys; (3) the number of surveys estimated to have been

conducted in the northern Gulf since seismic profiling began; and (4) the number of additional surveys expected to be done in the future in the northern Gulf as a result of previous lease sales and likely to occur in the Western Planning Area as a result of the proposed lease sales

Page IV-24 (Service Vessels and Helicopters): This section indicates that an average of 65,000-77,000 service-vessel trips are projected to occur annually in the Western Planning Area, that an average of 400,000-500,000 service-vessel trips are projected to occur annually Gulf-wide, and that almost 1.7 million helicopter trips occur annually in support of Gulf-wide OCS operations. This suggests that more than 1,000 service-vessel trips and more than 2,000 helicopter trips occur daily in the northern Gulf. The DEIS does not identify the types and levels of noise produced by the different types of service vessels and helicopters, the distances at which those sounds may be detected by various species of marine mammals, or how the various species might respond to the sounds. Also, it does not identify specific areas where various species of marine mammals have often been observed, or provide assessments of the frequency that service vessels may transit, and helicopters may overfly, these areas. MMC-20

As noted earlier, it seems likely that the marine mammal distribution, abundance, and behavior data obtained through the GulfCet Program would provide the basis for such an assessment. The Marine Mammal Commission recommends that the FEIS provide a more detailed assessment of where and how individual species of marine mammals may have been affected, and possibly could be affected, by service vessel traffic and helicopter overflights in the Western Planning Area. MMC-21

Likewise, the section concerning drilling and production operations (pps. IV-14-18) does not, but should, provide an assessment of the distances at which sounds associated with rig construction and drilling operations may be detected by, and affect, various marine mammal species. In this regard, it seems possible, if not likely, that marine mammals throughout the northern Gulf have been exposed almost constantly to drilling and related sounds and that the current distribution of marine mammals in the northern Gulf may be due, in part, to that exposure. It also is possible that many or most of the marine mammal species in the northern Gulf have become accustomed to, and are not affected by, routine drilling operations. The Commission recommends that the FEIS provide more detailed assessments of the types and levels of sound produced during drilling operations; the distances at which those sounds may be detected by the marine mammal species known to occur commonly in the northern Gulf; and how the observed distributions of the various species compare to the distribution of exploration and development wells. MMC-22 MMC-23

With regard to the last point, the Commission recommends that, if it has not already done so, the Regional Office develop and use a geographic information system (GIS) to help identify possible relationships between marine mammal distribution patterns, and locations of exploratory, development and production wells, seismic profiling, and service vessel and helicopter transit routes. MMC-24

Page IV-19 (Trash and Debris): The second and third sentences in this section state that --

> Generally, galley, operational, and household waste are collected and stored on the lower deck near the loading dock [of drill rigs] in large receptacles resembling dumpsters. These large containers are generally covered with netting to avoid loss and are returned to shore by Service vessels for disposal in approved landfills [emphasis added]. MMC-25

It is not evident why such wastes are not always kept in covered receptacles and returned to shore for disposal. On a related matter, the last paragraph in this section indicates that --

> Over the last several years, companies have employed waste reduction and improved waste handling practices to reduce the amount of trash offshore that could potentially be lost into the marine environment...These practices have resulted in a marked decline in accidental loss of trash and debris [emphasis added]. MMC-26

It is true that the referenced practices have resulted in a marked decline in the loss and discard of trash and debris from offshore drill rigs. As noted earlier, however, it seems unlikely that all or even most of the loss is accidental as indicated. Also, it seems unlikely that the referenced practices have resulted in a marked decline in accidental loss. If we are correct, the last sentence in this paragraph would be more accurate if it were revised to read something like "[t]hese practices have resulted in a marked decline in the loss and discard of trash and debris."

Pages IV-47 through IV-49 (Probabilities of Contact for the Proposed Action Analyses): This section does not include an assessment of the likelihood of a hypothetical large offshore oil spill contacting feeding areas, breeding areas, or other areas of similar importance to marine mammals. As noted earlier, the GulfCet Program presumably has identified a number of areas where marine mammals occur frequently in the northern Gulf and that could be important feeding areas, etc. Therefore, such an assessment should be possible and, if so, should be included in the FEIS. MMC-27

MMC-28

Pages IV-94 through IV-101 (Impacts on Sensitive Offshore Resources): Among other things, this section provides an assessment of the possible impacts of the proposed action on deep water benthic communities. It does not provide an assessment of the possible impacts on pelagic communities. The DEIS indicates that most marine mammal species in the northern Gulf feed primarily on small fishes and squid. Neither are distributed randomly or uniformly throughout the northern Gulf. That is, squid and small fishes often occur in large aggregations, presumably in areas where water temperatures, nutrients, currents, etc. cause their prey species to be concentrated. Fishery and other data no doubt provide indications of where small fishes and squid are concentrated seasonally in the northern Gulf. If so, this section in the FEIS should provide an assessment of the possible impacts of the proposed action on pelagic squid and fish communities, as well as on deep water benthic communities.

MMC-29

Pages IV-117 through IV-125 (Impacts on Marine Mammals): This section provides very little information concerning the numbers of the various species of marine mammals that occur in and near the Western Planning Area and that possibly could be affected by the proposed action. Much information concerning the distribution and abundance of various marine mammal species in the Western Planning Area presumably has been obtained through the GulfCet Program. If so, it should be possible to provide assessments of the particular species and number of animals that could be affected by the proposed action.

MMC-30

Also, this section concludes that most of the possible effects on marine mammals are likely to be "sublethal", implying that the proposed action is unlikely to have any effect on the size or productivity of marine mammal populations. However, it also points out that oil spills and repeated disturbance by vessel traffic, seismic surveys, drilling sounds, etc. can cause stress, make animals more vulnerable to disease, and affect the long-term survival and productivity of individual animals. Thus, some non-lethal effects may lead to declines in population size and productivity. As pointed out below, it would appear more reasonable, in some cases (with regard to small oil spills, for example), to conclude that relatively few animals are likely to be affected and/or that the effects are likely to be biologically insignificant -- i.e., have virtually no effect on the range, size, or productivity of any marine mammal population -- rather than concluding that the effects are likely to be sub-lethal.

Pages IV-118 and IV-119: The paragraph beginning in the middle of page IV-118 and continuing at the top of page IV-119 provides an assessment of how service vessel traffic and helicopter overflights might affect cetaceans and manatees. It points out that there is no indication that long-term displacement of whales would occur and concludes that short-term

MMC-31

displacement would be sub-lethal. Although short-term displacements are not likely to cause mortality, they may disrupt feeding, breeding, nursing, and other biologically important functions, which if it occurs frequently enough could affect long-term survival and productivity. Thus, it would seem that the sentence which reads -- "[t]here is the likelihood of short-term displacement of movement patterns or disruption of behavior, which would be considered a sub-lethal effect" -- would be more accurate if it were revised to read something like "[t]here is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or productivity, unless they occur frequently." Also, the possibility should be noted that the present distribution patterns of both large and small cetaceans may reflect displacements that have occurred as oil and gas exploration and development activities in the northern Gulf expanded.

MMC-32

Page IV-119, first complete paragraph: The third from the last sentence in this paragraph states that "[t]here are few published data on underwater noise levels near production platforms and on the marine mammals near those facilities...." The sentence implies that there may be unpublished data on underwater noise levels near production platforms and their effect on marine mammals. If so, the FEIS should be expanded, as noted earlier, to indicate the frequencies and intensities of noises generated by platforms and related drilling activities, and the distances at which such noises may be detected by, and affect, the marine mammal species that occur most commonly in the Western Planning Area. If there are simply few data, sound measurements should be made to determine the characteristics and levels of noise produced by platforms and related drilling operations and the distances that those sounds may be heard by different species of marine mammals, taking into account variables, such as water temperature and depth, that affect sound transmissions.

MMC-33

Page IV-120 and IV-121: The next to the last complete sentence on page IV-120 states that "[c]etaceans for the most part did not avoid the ship or array during recent Exxon seismic survey work off California, the one instance of Dall's porpoise moving away was ambiguous, and it was unclear whether the animals were reacting to the firing or to the cable (Pierson, personal communication, 1997)." The listing for "Pierson, personal communication, 1997" in the bibliography (page VI-20) provides no indication of who Pierson is, the particular information provided by the personal communication, or the nature of the Exxon seismic survey and when and where it was done. Without such information, it is not possible to judge whether the survey was done at a time and place where one or more species of marine mammals were likely to be present, or whether it was done at a time and place where marine mammals were not likely to be present and only one Dall's porpoise was present. Here and elsewhere that personal

communications are cited as information sources, the nature of the information obtained and the relevant qualifications of the person providing it should be described, either in the text or as part of the listing in the bibliography.

MMC-34

The last complete sentence on page IV-120 states that "[s]eismic activities would be considered primarily sub-lethal and probably elicit a short-term behavior response." It is not clear what is meant by "would be considered primarily sub-lethal." Also, as noted earlier, it appears that many, if not most, marine mammals in the northern Gulf are exposed frequently to the sounds used for seismic profiling. Repeated disturbance of vital functions, such as feeding, breeding, and nursing, particularly if it occurs frequently, could affect survival and productivity. Likewise, exposure to these and other development-related sounds many be annoying and cause stress, which also can affect survival and productivity, particularly if it occurs frequently. Conversely, some or all species may become accustomed to such sounds if they are exposed to it frequently. The Marine Mammal Commission recommends, as indicated earlier, that the FEIS provide more detailed information concerning (a) where and how frequently seismic profiling has been, and is likely to be, done in or near the Western Planning Area; (b) the distances at which the marine mammal species that occur most commonly in the Western Planning Area may detect and be affected by sounds associated with seismic profiling; (c) the areas in which the various species of marine mammals have been observed commonly during the GulfCet surveys and that are within or near areas where seismic surveys have been, and are likely to be, conducted; and (d) how different species and age/sex classes of marine mammals might be affected by repeated exposure to seismic profiling.

MMC-35

MMC-36

On a related point, it is not clear what is considered to be a short-term behavioral response. For example, if animals move away from an area where seismic profiling is being done, but return to that area after the profiling is completed, would the movement be considered a short-term response if the surveys take several days or weeks to complete? Here and elsewhere, the FEIS should provide a clearer indication of what the Service considers to be a short-term response.

MMC-37

The sentence beginning at the bottom of page IV-120 and continuing at the top of page IV-121 indicates that "[f]or baleen whales in particular, it is not known (a) whether the same individuals return to areas of previous seismic exposure, (b) whether seismic work has caused local changes in distribution or migration routes, or (c) whether whales that tolerate strong seismic pulses are stressed...." These uncertainties are significant and point out the need for both "effects" studies and long-term monitoring to detect possible activity-related changes in distribution, migration routes, and activity patterns.

MMC-38

Page IV-121, par. 4: The third sentance in this paragraph states that "[i]n addition, the Marine Mammal Protection Act requires helicopter pilots to maintain an altitude of 1,000 feet within 100 yd (91 m) of marine mammals." The Act itself has no such requirement. Guidelines and regulations promulgated by the National Marine Fisheries Service under the authority of the Act do include provisions specifying minimum altitudes and other means for avoiding disturbance (harassment) of marine mammals in certain areas. It is not clear whether any of those guidelines or regulations are applicable in the Gulf of Mexico. The Service should consult with the National Marine Fisheries Service to determine the applicable guidelines and regulations, and revise this sentence accordingly. If there are no applicable guidelines or regulations, the MMS and NMFS should consult to determine whether guidelines or regulations are needed to minimize the possible impacts of helicopter and supply vessel traffic on marine mammals.

MMC-39

The next sentance in this paragraph states that "[i]t is estimated that cetaceans will not be affected by routine OCS helicopter traffic operating at these altitudes." This statement probably is true, provided pilots do not alter their flight patterns to attempt to observe or photograph marine mammals that they sight. Therefore, this sentence would be more accurate if it were revised to read something like "[i]t is unlikely that cetaceans will be affected by routine OCS helicopter operations at these altitudes, provided pilots do not alter their flight patterns to more closely observe or photograph marine mammals that they see."

Pages IV-123, par. 5: The first three sentences in this paragraph state that --

> About 550-1,000 OCS-related oil and gas service-vessel trips would occur annually. Noise from service-vessel traffic may elicit a startle and/or avoidance reaction from cetaceans or mask their sound reception. The effect would probably be sub-lethal and constitutes [sic] a temporary impact.

MMC-40

It is not clear whether the number of service vessel trips referenced in the first sentance is the number expected to occur as a result of the proposed action or the total number expected to occur annually to support on-going as well as future exploration, development, and production activities. This should be clarified. Also, it is not clear what is meant by the statement that "[t]hs effects would probably be sub-lethal and constitutes [sic] a temporary impact." That is, it is not clear what is considered to be a sub-lethal effect or temporary impact. Again, clarification is necessary. In this context, it is reasonable, as noted earlier, to presume that a single disturbance is unlikely to have biologically significant effects.

MMC-41

However, if disturbance occurs repeatedly and disrupts vital functions, such as feeding and breeding, the effects may not be biologically insignificant. Thus, the apparent conclusion that disturbance from service-vessel trips likely would have only temporary, biologically insignificant effects may not be valid.

MMC-42

Page IV-124, par. 2: The third sentence in this paragraph states that "[i]t is expected that effects of noise on cetaceans from seismic surveys will be sub-lethal, constituting a short-term startle response and avoidance behavior, with a possible cessation of vocalizations." It is not clear what is meant by "sub-lethal" and "short-term avoidance behavior." Also, while it is reasonable to presume, based upon available information, that any single seismic survey is unlikely to have significant adverse long-term effects, it is not reasonable to presume, based upon the available information, that repeated exposure to seismic surveys, particularly if it occurs frequently, is unlikely to have significant, adverse long-term effects. That is, the apparent conclusion that seismic surveys likely to be done as a result of the proposed action will not have significant long-term adverse effects seems not to be justified. The conclusion either should be revised or better supporting data should be provided.

MMC-43

On a related point, it should be noted here, or elsewhere, in the FEIS that avoidance behavior would be indicative of either Level A or Level B harassment under the Marine Mammal Protection Act and that activities evoking such behaviors would constitute a violation of the Act's moratorium on taking, unless the taking is authorized by a "small-take" exemption or waiver of the Act's moratorium on taking.

MMC-44

Page IV-124, par. 3: Among other things, this paragraph indicates that "[w]hile no conclusive evidence of an impact on cetaceans by the *Exxon Valdez* spill was uncovered..., investigations on the effects on sea otters and harbor seals revealed pathological effects on the liver, kidneys, brain (also evidenced by abnormal behavior) and lungs, as well as gastric erosions...." Although it is true that there was no conclusive evidence that cetaceans were impacted by the *Exxon Valdez* oil spill, it seems likely that cetaceans could be affected in the same ways that sea otters and harbor seals were affected if they breathe fumes from spilled oil for significant periods of time. The only reasonable way to verify this possibility would be to carefully necropsy cetaceans found dead during or following an oil spill. If the Service has not already done so, it should develop a contingency plan to be prepared to locate, recover, and necropsy any cetaceans that may die in association with future oil spills. Here or elsewhere, the FEIS should indicate what would be done to resolve such uncertainties when and if an oil spill occurs in areas where cetaceans are likely to be present.

MMC-45

Page IV-125, par. 1: The first sentence in this paragraph states that "[t]he proposed action, by itself, is unlikely to have significant long-term adverse effects on the size and productivity of any marine mammal species or population stock in the northern Gulf of Mexico." This conclusion is not well-supported by the information and analyses provided in the DEIS. Better supporting evidence should be provided in the FEIS or the conclusion should be revised to reflect the uncertainties. For example, from the information and analyses provided in the DEIS, the referenced conclusion would be better justified if it were revised to read something like "[a]lthough the proposed action by itself seems unlikely to have significant long-term adverse effects on the size and productivity or any marine mammal species or population stock in the northern Gulf of Mexico, the available information is insufficient to be confident that there will be no long-term adverse effects."

As recommended earlier, the FEIS should describe the monitoring programs being conducted or planned to confirm that there are no significant long-term adverse effects on the size or productivity of marine mammal species and populations in the northern Gulf.

MMC-46

Page IV-199, (Impacts on Marine Mammals): The first sentence in this section indicates that "[t]his cumulative analysis considers how the combination of potential impacts resulting from the proposed action in addition to past, present, and future OCS activities, incidental take in fisheries, live captures and removals, anomalous mortality events, habitat alteration, and pollution may affect all marine mammals (endangered, threatened, and or protected) in the region." The analysis does not, but should, consider the possibility that one or more marine mammal populations in the northern Gulf may have been significantly impacted, in unknown ways, by past oil and gas exploration and development, incidental take in fisheries, etc. That is, the FEIS should note that the current distribution of one or more of the marine mammal populations in the northern Gulf may have been determined, in part, by past exploration and development activities.

MMC-47

Page IV-200, par. 1: For the reasons noted earlier, the second, third, and fourth sentences in this paragraph would be more accurate if they were revised to read something like -

> It is unlikely that cetaceans will be affected adversely by routine OCS helicopter traffic at these altitudes, provided pilots do not alter their flight patterns to more closely observe or photograph marine mammals that they see. Routine overflights may elicit a startle response from, and interrupt feeding, breeding, or other behavior of, cetaceans nearby (depending upon the activity of the animals).

Occasional overflights probably have no long-term consequences on cetaceans. However, frequent overflights could have long-term consequences.

Page IV-200, par. 2: The first sentence in this paragraph indicates that about 65,000-77,000 OCS-related service-vessel trips are expected to occur annually as a result of the proposed action, and prior and future OCS sales in the Western Planning Area. The second sentance indicates that noise from service-vessel traffic may elicit startle and/or avoidance reactions from cetaceans and mask their sound reception. The third sentance indicates that the expected extent of service-vessel traffic could affect cetaceans either through active avoidance behavior or displacement of individuals or groups. The fourth sentence states that [t]his effect is thought to be sublethal and would constitute a short-term, temporary impact." Although the meaning is not entirely clear, the latter statement does not follow from the data and analyses provided in the DEIS. The sentence either should be deleted, or clarified.

MMC-48

The last sentence in this paragraph states that "[s]urvey data show that most cetacean species of the Gulf are distributed within deeper waters, on or beyond the continental shelf break." The relevance of the statement is not evident.

MMC-49

Page IV-200, par. 3: The fifth and seventh sentences in this paragraph state that -

> Long-term displacement of animals from an area is also a consideration... Increased ship traffic could increase the probability of collisions between ships and marine mammals, resulting in injury or death to some animals.

The sentences would be more accurate if the word "consideration" at the end of sentence five was changed to "possibility" and the word "could" in the seventh sentance was changed to "will."

MMC-50

Page IV-200, par. 4: The first sentance in this paragraph indicates that "[i]t is projected that about 250-350 exploration and delineation wells and 300-575 development wells will be built annually as a result of the proposed action, plus prior and future OCS sales Gulf-wide and will produce sounds at intensities and frequencies that could be heard by cetaceans." The second sentence states that "[i]t is estimated that noise from drilling activities will be relatively constant and last no longer than two months at each location." The latter sentence appears to imply or to presume that sounds from drilling activities will not be detectable by cetaceans much beyond the immediate vicinity of the activities so that it is unlikely that cetaceans in those areas have been exposed previously to drilling-related sounds

from other sites and that they could not be exposed simultaneously to drilling-related sounds from multiple sites. The rationale for this implication or presumption is not evident and should be provided.

MMC-51

Page IV-201, par. 1: The second sentance in this paragraph states that "[i]t is expected that effects of noise on cetaceans from seismic surveys will be sublethal, constituting a short-term startle response and avoidance behavior." As noted earlier, this conclusion is not supported by data and analyses provided in the DEIS. Either better supporting documentation should be provided in the FEIS or the conclusion should be revised to better reflect available knowledge -- e.g., be revised to read something like "[a]lthough any one seismic survey is unlikely to have long-term adverse effects on any cetacean species or population, available information is insufficient to be confident that seismic activities, collectively, will not have significant adverse long-term effects on the size or productivity of any marine mammal species or population." Also, the FEIS should indicate what is being done or planned to resolve this uncertainty.

MMC-52

Page IV-201, par. 2: The last sentance in this paragraph states that "[t]he effects of offshore oil spills > 1 bbl and < 1000 bbl are expected to be sublethal due to the small area affected and their rapid dispersion." Even small spills could kill small numbers of marine mammals. Thus, this sentence would be more accurate if it were revised to read something like "[o]ffshore oil spills greater than 1 bbl and less than 1,000 bbl are likely to affect only small numbers of animals so that the effects likely would be biologically insignificant." Likewise, the last sentence in the next paragraph would be more accurate if it were revised to read something like "[a]lthough an interaction with small spills may occur, few animals likely would be affected due to possible avoidance by the animals and natural dispersion/weathering of spills in the offshore environment. The effects likely would be biologically insignificant."

MMC-53

Page IV-202, par. 2: The retrospective analyses of tissues from bottlenose dolphins that died during the unusual mortality event along the mid-Atlantic coast in 1987-1988 suggests that the animals died from morbillivirus infections. Thus, the word "also" in the seventh line of this paragraph should be deleted.

MMC-54

Page IV-202, par.1: This paragraph describes the die-off of manatees that occurred along the west coast of Florida in spring 1996. The third sentance indicates that "[b]revatoxin (red tide) was involved, but is not thought to be the sole cause of this die-off; efforts are still underway to elucidate the cause of these deaths (Wright, personal communication, 1996)." The investigation of the die-off has been completed and indicates that red-tide was, in fact, the cause of the die-off. The

MMC-55

description of the event in the FEIS should be updated accordingly.

Page IV-204: The first two complete sentences at the top of this page state that -

> Tucker & Associates, Inc. (1990) recommended that in representative marine mammals in the Gulf of Mexico, levels of environmental contaminants and natural biotoxins should be determined and monitored. Collectively, the National Marine Mammal Tissue Bank, the quality assurance and contaminant monitoring programs, and the regional marine mammal stranding networks constitute NMFS's marine mammal health and stranding response program (MMC 1995).

MMC-56

The first of these two sentences would be more informative if it were revised to read something like "[p]articipants in a workshop convened by the MMS in August 1989 recommended that levels of environmental contaminants and natural biotoxins should be determined and monitored in representative marine mammals that occur in the northern Gulf of Mexico (Tucker & Associates, Inc. 1990)."

MMC-57

The second sentence implies that the National Marine Fisheries Service is conducting the recommended assessment and monitoring programs. To our knowledge, this is not true. Thus, the FEIS should either provide more definitive information indicating that the NMFS is, in fact, conducting the recommended assessment and monitoring programs, or indicate what the MMS has done in response to the recommendation.

MMC-58

Page IV-205, par. 2: Among other things, this paragraph briefly summarizes the results of studies done by Thomas, et al. (1990) to determine how captive beluga whales were affected by playbacks of drilling platform noise. The enclosed paper by Jones, et al. (1994) indicates that playbacks of sounds, including drilling sounds, in San Ignacio Lagoon caused gray whales to leave or avoid the lagoon. The information in this paper may help to provide a better assessment of the possible direct and cumulative effects of drilling noises on cetaceans.

Page IV-205, pars. 3 and 4: The first sentence in paragraph 3 states that "[w]ith regard to the incremental contribution of the proposed action, impacts are expected to be primarily sublethal...; however, combined effects may be deleterious to cetaceans occurring in the Gulf of Mexico." The third sentence in the fourth paragraph states that "[t]he 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." The two sentences appear to reflect somewhat differing conclusions: the first that the proposed action, combined with past and possible future OCS exploration and development, could have deleterious effects on cetaceans in the northern Gulf of Mexico; the second that the cumulative effects on cetaceans are expected to be sublethal, implying that deleterious effects are unlikely. Neither conclusion is well-supported by data and analyses in the DEIS. Further, there is no indication as to how specific marine mammal species and populations may have been affected by past exploration and development activities, or how they may be affected by the proposed and future activities.

MMC-59

As noted earlier, data that have been obtained through the GulfCet Program should allow an assessment of the species and number of marine mammals that are present seasonally in the northern Gulf and that may have been affected by past activities and that could be affected by the proposed and subsequent activities. The Commission believes that the FEIS should provide a more in-depth assessment of the species and numbers of marine mammals that possibly have been and could be affected. The Commission also believes that the FEIS should describe actions that are being taken or planned to resolve the uncertainties.

MMC-60

* * * * *

I hope that these comments, suggestions, and recommendations are helpful. Also, would you please advise us of the studies or monitoring programs that are ongoing or planned to resolve the uncertainties and confirm the validity of the determinations concerning the likely effects of past, ongoing, and expected future exploration and development activities on the distributions, sizes, and productivity of the marine mammal species and populations that occur most commonly in the northern Gulf.

MMC-61

Sincerely,

Robert J. Hofman, Ph.D.
Scientific Program Director

Enclosure

cc with enclosure: Ms. Hilda Diaz-Soltero
Ms. Cynthia Quarterman

ORD
LE

FOB JAMES, JR.
GOVERNOR

STATE OF ALABAMA
GOVERNOR'S OFFICE
MONTGOMERY 36130

November 5, 1997

Mr. Chris Oynes, Regional Director
U.S. Minerals Management Service
GOM OCS Region
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

Dear Mr. Oynes:

With respect to your letter of October 1, 1997, regarding the draft Environmental Impact Statement (EIS) for OCS Lease Sales 171, 174, 177, and 180, in the Western Gulf of Mexico scheduled to be held August in the years 1998-2001, we have no comments.

We look forward to working cooperatively with the Mineral Management Service in the successful and safe utilization of the hydrocarbon resources located offshore Alabama and in sharing in the benefits of OCS leasing and production activities.

Sincerely,

Fob James, Jr.
Governor

FJ:DO:oa

Gulf of Mexico OCS Region
MMS
NOV 10 1997
Office of the Regional Director

cc: Dr. Donald F. Oltz, State Geologist
Geological Survey of Alabama
P.O. Box O
Tuscaloosa, AL 35486-9780

Mr. James D. Martin, Commissioner
Alabama Department of Conservation & Natural Resources
P.O. Box 301456
Montgomery, AL 36130-1456

M.J. "MIKE" FOSTER, JR.
GOVERNOR

State of Louisiana

JACK C. CALDWELL
SECRETARY

DEPARTMENT OF NATURAL RESOURCES
December 5, 1997

Mr. Chris C. Oynes
Regional Director,
Minerals Management Service, Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

Gulf of Mexico OCS Region
MMS
DEC 12 1997
Office of the Regional Director

RE: **C978563, Solicitation of Views**
Minerals Management Service
Direct Federal Action
Draft Environmental Impact Statement (DEIS) for Gulf of Mexico OCS Lease Sales 171, 174, 177 and 180, **Western Gulf of Mexico Planning Area**

Dear Mr. Oynes:

The above referenced DEIS for four OCS Lease Sales in the Western Gulf of Mexico Planning Area has been received and reviewed by this office. We offer the following comments of concern to Louisiana for your consideration in preparing the final EIS document.

LADNR-1

The Draft EIS considers four alternatives inclusive of the no action alternative, but does not address in detail any alternatives to areawide leasing. It is the long held contention of Louisiana that a more restrictive leasing scheme would increase bidding competition and average sale prices for nominated blocks, thereby optimizing the royalties generated by leases and serving as a policy instrument to help moderate the rate of OCS development and extend the life and benefits of petroleum resources in the Gulf of Mexico. This DEIS does not consider any realistic systematic alternative to areawide leasing, despite MMS's statement at the February 14, 1997, meeting between staff level personnel of our respective offices that it would include such an alternative. The DEIS instead notes that a competitive bidding alternative was presented in the 5 year planning decision document; however, the single alternative analyzed therein was to offer one half as many lease sales. This alternative estimated a 40% decline in OCS production that would drastically impact Louisiana's rural coastal economies. It can certainly be argued that this is not a realistic competitive alternative to areawide leasing, nor is it representative of the several leasing strategies MMS might employ to better maximize revenue and to help insulate coastal states from the socioeconomic and environmental impacts of OCS activities.

Section 18 of the Outer Continental Shelf Lands Act requires that lease sales be prepared in a manner consistent with the attainment of "a proper balance among potential for environmental damage, discovery of oil and gas, and adverse impacts on the coastal zone", as well as "consideration of laws, goals and policies of affected states, relative environmental

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sensitivity and marine productivity, and relevant environmental and predictive information" (emphasis added). Greater weight must be placed on the consideration of environmental damage and adverse impacts to the coastal zone. Further, in his letter to Coastal Management Division of July 12, 1996, Mr. Jerry Brashier, MMS's Regional Supervisor for Leasing and Environment, noted that the public comment period for OCS Lease Sales is an appropriate time to consider alternatives to areawide leasing (attached). It is the opinion of this office that MMS should address nominated block and similar alternatives in detail in the Final Environmental Impact Statement for this OCS lease sale, and make such comparisons as may be necessary to determine the best alternative for reducing environmental and socioeconomic impacts resulting from the proposed lease sale. The Western Gulf of Mexico Planning Area is located south of the western and central portion of Louisiana, such that Louisiana bears much of the brunt of impacts from oil and gas activity from this Planning Area. The OCS related impacts generated from these four Western Gulf of Mexico Planning Area lease sales include wetland loss resulting from OCS related traffic along navigation channels; oil spills; water pollution degradation in marshes, canals and valuable estuarine water bodies; overuse and unsustainable overdevelopment of onshore infrastructure at the expense of coastal wetlands; and environmental contamination associated with hazardous wastes produced in these OCS Areas and stored in or disposed of in the Louisiana Coastal Zone.

LDNR-2

The DEIS for the upcoming four lease sales estimates that development of oil and gas activity generated by the typical lease sale will result in the loss of 39 to 221 acres of coastal wetlands, and suppress productivity of 7 to 52 acres of wetlands for up to 10 years. The recent enactment by Congress of the Outer Continental Shelf Deep Water Royalty Relief Act has resulted in increased OCS oil and gas exploration and development, with increased impacts certain to occur in the Louisiana Coastal Zone. For this reason, we believe the high case development scenario and projected wetland acres impacted are more reflective of the potential impacts associated with these Lease Sales than the low case development scenario.

LDNR-3

Many of these impacts will be indirect or cumulative, and cannot be attributed to a specific operator or incident. The DEIS states that the projected marsh loss is not sufficient to affect traditional occupations that exploit marsh resources. This is not true for the cumulative case. The five year plan states that such cumulative impacts are considerable. Yet, the proposed mitigation analyzed in the DEIS are reduction measures, rather than compensatory mitigation. Avoidance and reduction are important methods for dealing with impacts, however, in order to be consistent with the Louisiana Coastal Resources Program, MMS must also provide for compensatory mitigation for unavoidable wetland impacts. The five year plan states that revenue sharing is not analyzed as a mitigation measure because MMS does not have the statutory authority to share revenue. The FEIS should acknowledge that MMS will work with the impacted states to obtain such authority, or find funds for mitigation from other sources.

LDNR-4

LDNR-5

Executive Order 1190 establishes that each Federal agency shall provide leadership and take action to minimize the destruction, loss or degradation of wetland, and to preserve and enhance the natural and beneficial values of wetlands. It is also noteworthy that Louisiana has a policy of no net loss of wetlands in the Coastal Zone, and requires compensatory mitigation for unavoidable losses of wetland, and the Coastal Zone Management Act of 1972 requires Federal

agencies to conduct their operations in a manner consistent with the State's coastal program. To this end, it is requested that MMS propose in the Final EIS suitable mitigation measures in the projection of wetland impacts for proposed Lease Sale alternatives.

LDNR-6

The DEIS repeats the conclusion of numerous past OCS Lease Sale EIS's, continuing to project no significant socioeconomic impacts. Yet, in a public hearing held in Houma, Louisiana (June 23, 1997) on the five OCS lease sales under consideration here, Mr. Ted Falgout, Executive Director of Port Fourchon, criticized the DEIS for not adequately projecting socioeconomic and infrastructure impacts for OCS development "Hot Spots", such as Port Fourchon and the surrounding area, which are experiencing dynamic employment changes and infrastructure needs. Similarly, the ports of New Iberia, Lake Charles and West Cameron are planning or conducting expansions to handle increased petroleum industry activity. Further, the Louisiana Department of Labor reported the Lafayette area's oil and gas employment sector added 900 new jobs over the past year, a gain of 8 percent, while Houma added about 1100 new oil and gas industry jobs over the past year, a growth rate of 18 percent. These items demonstrate a number of significant impacts to the Louisiana Coastal Zone which were identified simply by reading the newspaper or through brief conversations with port representatives, yet were totally overlooked by the DEIS. There undoubtedly are many other impacts to coastal economies, infrastructure, and environments which should have been analyzed in this document. Such gaps in research call into question the credibility of all the conclusions presented in this DEIS.

LDNR-7

This document further states that changes in population, labor and employment are expected to be less than 1%. This low number is presumably obtained through regional modeling techniques such as input-output analysis, where accurate predictions of economic impacts are problematic for smaller spacial aggregation, such as individual coastal parishes. If this was indeed the modeling technique used, it might explain the inaccurate assessment of the socioeconomic impacts to rural coastal Louisiana presented in the DEIS. These low population, labor and employment impacts appear to have been obtained by aggregating distant and much larger metropolitan centers, with their much larger populations and where offshore oil and gas activity is a much smaller percentage of total economic activity, with the rural parishes with their sparser populations and greater economic dependence on oil and gas. Statewide, the petroleum industry has experienced a yearly employment growth rate of 5.3 percent. These actual employment numbers are certainly not consistent with predictions and forecasts made in the current and past EISs. It is our understanding that the DEIS impact analysis of environmental and socioeconomic resources is based on a range of oil and gas resource estimates which are derived from geologic and economic assumptions at a given point of time. These geologic and economic assumptions are 1.5-3.0 years out of date by the time the EIS appears, and further, are utilized to predict the level of petroleum development several years after the lease sale, since it takes several years for operators to explore and develop the petroleum resources from the leases obtained in any given lease sale. Thus, the geologic and economic assumptions concerning recoverable petroleum may be as much as a decade or more out of date before the actual production occurs, and so are the impact projections on environmental and socioeconomic impacts. With the rapid technological changes that the petroleum industry is undergoing, we believe a more up to date and realistic methodology must be developed to predict impacts with greater accuracy. If current

LDNR-8

regional economic modeling methodologies are incapable of accurately modeling offshore oil and gas impacts at the rural parish level where they are currently occurring, this should be clearly stated in the DEIS, and other appropriate methods utilized to estimate the larger population, labor and employment impacts which are to be expected at the coastal parish level.

Impacts to community infrastructure from OCS activity are to be expected, including impacts to local provision of education, police, fire, sewage, solid waste disposal, water, recreation facilities, transportation systems, health care, utility service and housing. CMD is encouraged by action on the part of MMS to study deepwater activity impacts to the infrastructure of Port Fourchon and Lafourche Parish and hope to see similar studies coastwide. The DEIS states that the greatest socio-cultural impacts will be in Louisiana, yet also states that social and cultural problems typically associated with in and out migration are not expected. This is certainly not true in the case of Lafourche Parish, as attested to by Mr. Ted Falgout at the public hearing cited above. His statements at the hearing made reference to the estimated 50 % out of state license plates in the Port's parking lots, the hundreds of garbage trucks filled with OCS- related garbage utilizing dangerous, overstressed highways and trying to dispose of their loads in overflowing landfills, and the inadequate water pressure for local residents due to water demands of the OCS oil and gas industry. Given the many uncertainties facing any prediction about OCS activity levels and impacts, and the fact that Louisiana has experienced economic, social and cultural problems from OCS oil and gas fluctuations in the past, it is unreasonable to assert that negative social and cultural impacts are not to be expected.

LADNR-9

Although MMS has been preparing EIS's on Gulf of Mexico lease sales for many years, there apparently has never been any followup monitoring of lease sale results and impacts to see if the predicted development and impacts are at all similar to the actual impacts of each lease sale. Thus, we have no assurance of the accuracy of MMS impact projections in this or any other EIS. Consequently, MMS should immediately begin to monitor impacts of this and past lease sales to determine the predictive accuracy of these EIS's. Short of a serious monitoring effort on the part of MMS, very little credence can be placed in these EIS documents, as they appear to grossly underestimate environmental, infrastructure and socioeconomic impacts resulting from the degree of OCS development presently going on in coastal Louisiana as noted in the preceding paragraphs.

LADNR-10

Only large or more productive petroleum reservoirs can be economically produced in the deep water areas of the Gulf, which will likely require pipeline landfalls and coastal zone crossings for most deep water development platforms. Such pipeline crossings of the coastal zone impact Louisiana to a high degree. For example, Mississippi Canyon Block 807, Shell's Mars Project, recently required an oil pipeline landfall and routing to northern Lafourche Parish, with a resulting loss of 37 acres of wetland that will need to be restored to preproject conditions at a cost of several million dollars. More such wetland resource intensive projects are expected to result in the near future from yet to be constructed deep water Gulf projects.

A rapid increase in deepwater development could also result in unplanned and unsustainable onshore infrastructure development with exploitive use of social, economic and environmental resources of the region during boom periods, and attendant unemployment, bankruptcies, and disruptive social patterns during bust periods. In consideration of the above

mentioned Lease Sale induced impacts on our vulnerable coastal wetlands and coastal waters, Louisiana Department of Natural Resources requests that MMS aggressively pursue Federal impact assistance to States, such as Louisiana, that bear the brunt of OCS activity.

LADNR-11

In addition to the 8-g decision, there are two funds that share OCS revenue with states: the Historic Preservation Fund and the Land and Water Conservation Fund. Louisiana has received less than $25 million from these funds. New York and California, states without Louisiana's massive OCS investments, have received over $175 million. Florida, Illinois, Michigan, Massachusetts, New Jersey, Ohio, Pennsylvania, and Texas, of which only Texas has any OCS activity at all, have also received between $75 and $125 million from these funds. MMS should help the concerned states to effect legislation changes so that the more heavily impacted states receive a more appropriate proportion of these funds. MMS should also initiate studies and provide assistance to impacted communities to help them plan and implement procedures to diversify their local economies and to develop efficient growth measures that minimize disruption from the fiscal, social and environmental impacts of OCS activity.

LADNR-12

Finally, it must be noted that Louisiana has enjoyed many benefits from OCS exploration and development. The Louisiana Department of Natural Resources appreciates the opportunity to comment on these Lease Sales. We are grateful for the opportunity to voice our concerns regarding the preservation of the resources of the Coastal Zone. It is hoped that our concerns are addressed in the Final Environmental Impact Statement.

Sincerely,

Terry W. Howey

Terry W. Howey
Administrator, CMD

Attachment
cc: Terry Ryder, Governor's Office
Jack Caldwell, Dept. of Natural Resources
Katherine Vaughan, Office of Coastal Restoration & Management
Lan Bahr, Governor's Office
Gus Rodemacher, Office of Mineral Resources
Cynthia Quarterman, MMS Director
Bonnie Johnson, MMS New Orleans
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Cullen Curole, Lafourche Parish
Harvey Stern, Orleans Parish
Mike Hunnicut, St. Bernard Parish
Jody Chenier, St. James Parish

Brian Fortson, St. Tammany Parish
Brad Gain, Alabama Dept. of Environmental Management
Jasmine Raffington, Florida Coastal Management Program
Carliane Johnson, Florida Governor's Office
Janet Fatheree, Texas Coastal Management Program
Mike Walder, Mississippi Dept. of Marine Resources
David Kaiser, NOAA
Anthony McDonald, Coastal States Organization

NOIA

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ROBERT B. STEWART
PRESIDENT

October 15, 1997

Chris Oynes
Regional Director (MS 5410)
Gulf of Mexico OCS Region
Minerals Management Service
1201 Elmwood Park Boulevard
New Orleans, Louisiana 70123-2394

RE: Statement of the National Ocean Industries Association on the Draft Multisale EIS for Proposed Western Gulf of Mexico OCS Lease Sales 171, 174, 177 and 180.

Dear Chris:

The National Ocean Industries Association (NOIA) appreciates this opportunity to provide a statement on the proposed draft multisale Environmental Impact Statement (EIS) for the Western Gulf of Mexico lease sales to be held annually from 1998 through 2001.

NOIA represents more than 280 companies engaged in all aspects of the exploration and production of Outer Continental Shelf (OCS) oil and natural gas resources. The association's member companies hold over 90% of all offshore leases and are responsible for purchasing and manufacturing an estimated 95% of the services used on the OCS. Our membership has a strong interest in the draft EIS and the continued predictability and stability of the federal offshore oil and gas leasing program.

NOIA supports Alternative A of the proposed draft multisale EIS. This option proposes the annual offering for lease of all unleased blocks in the Western Gulf of Mexico Planning Area. This option is responsive to the nation's current and projected energy supply situation as MMS's own projections suggest that each annual sale could contribute significantly to domestic oil and gas production.

Option A's incorporation of existing regulations and the proposed lease stipulations will allow for continued offshore exploration and development activity while ensuring that OCS operations are carried out in an environmentally sound manner.

NOIA supports Option A and commends MMS for its innovation in preparing a multisale EIS.

Sincerely,

Robert B. Stewart

20 1997

Responses to Comments from the U.S. Department of Commerce, National Oceanic and Atmospheric Administration

NGS-1 No response is necessary.

NMFS-1 A decision on the adoption of lease stipulations designed to mitigate potential adverse impacts on the pinnacle trend, deepwater benthic, and topographic feature communities is made at the time of the decision on the Final Notice of Sale, after completion of a lengthy consultative and analytical prelease decision process, including compliance with NEPA. Lease stipulations are one of several methods of mitigation, including regulations and Notices to Lessees and Operators (NTL's), available to MMS. Unlike regulations and NTL's, which are developed and approved according to specific processes outside of the lease sale decision process, lease stipulations are a part of the lease sale decision process. By definition, they are applied to leases by a decision on a Final Notice of Sale.

If lease stipulations address important environmental issues, it is appropriate to analyze their possible use in the NEPA document prepared for a decision on the sale. The MMS has found that these lease stipulations have been an effective tool in mitigating adverse impacts to sensitive resources and, therefore, includes these stipulations in the proposed actions in Central and Western Gulf lease sale EIS's. Rather than making a decision on the use of these environmentally important measures before completion of the NEPA consultations and analysis for a sale, MMS analyzes them in the EIS; and the public and State and Federal agencies are given the opportunity to comment as to their effectiveness, whether they should be revised, and whether they should be adopted. We believe this review process for the lease stipulations reduces the uncertainty in decisionmaking and the level of risk to sensitive marine habitats. It ensures that a decision on the use of lease stipulations is based on a well-founded proposal developed through a public scoping process, on a thorough analysis of the potential environmental effects of the action and of the measures designed to mitigate adverse effects, and on a recognition of the views of others outside the agency regarding the use of these mitigating measures.

NMFS-2 A meeting was held on September 5, 1996, between MMS personnel and a representative from both the Baton Rouge, Louisiana, and Galveston, Texas, offices of NMFS to discuss many of NOAA's concerns about environmental impacts from OCS oil and gas operations. As discussed in the meeting, MMS protects pinnacle features via the Live Bottom (Pinnacle Trend) Stipulation by requiring operators to avoid impacts to these features by modifying their anchor patterns, drill sites, pipeline rights-of-way, etc. The potential for impacts to a live-bottom area are thereby dramatically reduced and would only occur in the event of operator error or an accident. The MMS is developing plans for compliance monitoring to minimize the risk of occurrence of such incidents in areas of sensitive biological communities and to verify that rigs are actually located at the approved location prior to commencement of drilling activities. Toward this end, the Environmental Operations Section of MMS has completed four monitoring trips to areas of the Pinnacle Trends. This compliance monitoring was undertaken to observe industry projects that had been issued avoidance criteria under NTL 88-11 with their permits. Three of the four projects had complied with avoidance criteria as set by MMS, the fourth had not. The compliance monitoring was completed in June 1997, and MMS may seek remedies and penalties from any operators that fail to comply with approvals, including mitigation, under 30 CFR Subpart N, *Remedies and Penalties*. This provision provides a mechanism for the Regional Director to require remedies or penalties for violations that "may constitute or may have constituted a threat of serious, irreparable, or immediate damage or harm to life (including

fish and other aquatic life), property, any mineral deposit, or the marine, coastal, or human environment . . ."

NMFS-3 NTL 88-11 is a proactive, conservative protective measure applied by MMS to identify and avoid areas with the potential to support chemosynthetic communities. The MMS believes that the 43 known chemosynthetic communities are adequately protected by NTL 88-11 and that it is not necessary to designate a 1,000-m No Activity Zone surrounding these communities. A considerable amount of operational experience has contributed to our confidence that these protective measures are effective in identifying and avoiding impacts to dense chemosynthetic communities. Since the discovery of chemosynthetic communities in the mid-1980's, MMS has reviewed data for several hundred different Gulf of Mexico leases in water depths greater than 400 m as a part of our review of postlease plans. The MMS has several meetings per year with oil and gas lease operators to resolve potential conflicts with the protective requirements of NTL 88-11 or to confirm that MMS concurs that their plan will avoid impacts to potential chemosynthetic communities. Plan reviews sometimes result in special requirements as a condition of plan approval. As discussed at the meeting held on September 5, 1996, between MMS personnel and a representative from both the Baton Rouge, Louisiana, and Galveston, Texas, offices of NMFS, if NMFS submits a letter to MMS requesting review of plans in those 43 blocks known to contain chemosynthetic communities, they will have the opportunity to provide comments through the review process.

NMFS-4 Development activities typically involve the drilling of multiple wells (e.g., 5-40), whereas exploratory activities typically involve the drilling of only one to a few wells. Based on studies regarding the areal extent of potential impacts of drilling cuttings and drilling fluids on biota associated with topographic features, MMS believes that the "1-Mile Zone" shunting requirement for exploratory activities provides adequate protection to topographic features. Shunting for exploratory activities in the "3-Mile Zone" is not required because of the fewer number of wells, the shorter duration of drilling activities, and the lower volume of discharges. Furthermore, studies indicate that the shunting requirement even for development activities in the "3-Mile Zone" is probably not necessary to protect the banks. In consultation with the U.S. Fish and Wildlife Service some years ago, MMS opted to adopt a conservative approach on this issue and does require shunting for developmental activities in the "3-Mile Zone."

Responses to Comments from the U.S. Environmental Protection Agency

USEPA-1 See the response to NMFS-1.

Responses to Comments from the Marine Mammal Commission

MMC-1 The MMC has noted in the letter to MMS that "the distributions, habitat-use patterns, sizes, and productivity of marine mammal populations in the northern Gulf prior to the beginning of offshore oil and gas exploration and development are unknown." Also noted is that "significant changes in the distribution, habitat-use patterns, size and productivity of marine mammal populations in the northern Gulf may already have occurred as a result of offshore oil and gas exploration and development, but may not have been detected." The MMS is aware of these information gaps and, in response, has funded cetacean distribution and abundance studies in the Gulf since 1989. The recently completed GulfCet I study provided an important first step in collection of data on the distribution and abundance of cetaceans in the northern Gulf. A summary of what is known about any demography or habitats of Gulf of Mexico cetaceans is currently provided in Section III (description of the resource)

and is based on the marine mammal stock assessment reports from NMFS (which are largely based on the MMS-funded GulfCet studies). The GulfCet II study is continuing such work, as well as working to identify possible associations between cetacean high-use habitats and the ocean environment; data from this study are currently being analyzed.

Abundance estimates are listed for a few Gulf marine mammal species. Abundance estimates for Gulf marine mammal stocks may be found in Waring et al. (1997) and Jefferson (1995 and 1996). The NMFS Stock Assessment Report provides abundance estimates for the entire northern Gulf stock, and this information is not presented in such a manner to apply to MMS planning areas. A similar situation exists for the work by Jefferson, which is entirely based on GulfCet I surveys.

The MMS concurs with the MMC regarding the need for postsale monitoring. Postsale monitoring for many impacts, particularly indirect effects of discharges, will be difficult and costly to assess since marine mammals are protected species and, with the exception of the manatee, top-level predators in the ecosystem. Efforts are currently underway to assess the effects of impacts on lower trophic levels. This should provide useful information as to how cetaceans are indirectly affected by OCS activities. It should also be noted, as mentioned by the MMC in its letter to the MMS, ". . . monitoring programs probably are not capable of detecting anything but very large changes in the distribution, abundance, or productivity of marine mammal populations in the northern Gulf." The MMS has proposed a workshop to be held sometime within the next two years as an update to the workshop that MMS held in 1989 (Tucker & Associates, Inc., 1990). The workshop will look at what items have been studied on the list of needs for marine mammals in the Gulf. The workshop will also develop a new list of study priorities, as well as providing information on the methods of study. This list will aid MMS in developing new requests for research proposals to study various issues.

MMC-2 Refer to the response to MMC-1.

MMC-3 The text has been revised as suggested.

MMC-4 See the response to MMC-1, paragraph 3.

MMC-5 See the response to MMC-1.

MMC-6 See the response to MMC-1, paragraph 3.

MMC-7 The text has been revised as suggested.

MMC-8 The text has been revised as suggested.

MMC-9 According to Richardson et al. (1995), short-term behavioral reactions to noise are on a scale of minutes or hours. Longer-term is past that scale.

MMC-10 The estimates refer to the GulfCet study area. The study area was defined as the region bounded by the 100- and 2,000-m isobaths, and the Florida/Alabama and Texas/Mexico borders.

MMC-11 The text has been revised as suggested.

MMC-12 The text has been revised as suggested.

MMC-13 Refer to the response to MMC-1.

MMC-14 The text has been revised as suggested.

MMC-15 The text has been revised.

MMC-16 The text has been revised as suggested. It should be noted that the reference referred to specifically uses the word "avoids."

MMC-17 The text of the EIS has been revised to include much of the requested information. The length of time required to carry out a seismic survey depends on many factors including the type of survey, the equipment and technology being used, the density of the survey grid, the total area to be surveyed, the weather and sea state, and unforeseen technical problems. A postlease high-resolution survey over one lease block takes about a week to complete; a speculative 2D or 3D survey may cover a large area and may be performed over the course of several months. G&G permits are issued for up to a one-year period.

Most large area CDP surveys are speculative prelease surveys done under G&G permits. Such surveys are not done strictly in support of or as a result of any one proposed action. Postlease CDP surveys are increasing in number as the technology allows more detailed interpretation. These surveys are costly and are usually done over a single lease or over an exploration or development unit, which may include leases from multiple sales. Postlease, high-resolution surveys are done prior to drilling or placement of bottom-founded structure. The use of high-resolution surveys as a result of the proposed action would be related to the number of leases drilled and the number of pipelines installed. The text has been revised to include a range of high-resolution surveys resulting from the proposed action.

Seismic surveying began in the northern Gulf of Mexico in 1960. A total of 1,600,000 line-miles of 2D data and 7,500 blocks of 3D data have been collected over the Gulf OCS. Over the last five years, the number of prelease G&G permits Gulfwide has averaged about 130 permits annually, with 50-70 3D seismic surveys permits annually.

MMC-18 The text of the EIS has been revised to include additional information. Postlease, high-resolution seismic surveying is assumed to be done once for each lease that is drilled, and a single, high-resolution survey over a lease will usually suffice for all of the exploratory, delineation, and development wells drilled on the lease and will support any potential facilities siting. A single, high-resolution survey may be planned to cover multiple adjacent leases, especially all those belonging to a designated exploration or production unit. As indicated in the response to MMC-17 above, most prelease CDP surveys done under G&G permits support several proposed lease sales. Postlease CDP surveys are costly and are usually done over single leases or over units, which may include leases from multiple sales as well as unleased blocks.

In general, there are five CDP survey vessels working on the Gulf of Mexico OCS at any one time.

MMC-19 The text of the EIS has been revised to include much of the requested information.

MMC-20 A general discussion of noise output can be found in Section IV.B., page IV-40. Refer to the response to MMC-1, paragraph 1, for information on cetacean distribution.

MMC-21 The analysis contains information about possible responses to service vessel and helicopter overflights. See also the response to MMC-46.

MMC-22 Noises from various drilling platforms were summarized by Gales (1982) and presented also in Richardson et al. (1995). The data were collected in California and may not be applicable to Gulf platforms for a variety of reasons, including different bottom topographies and oceanographic conditions.

MMC-23 See the response to MMC-22, as well as the response to MMC-1, paragraph 1.

MMC-24 Discussions have been underway to set up such an information base as suggested by the MMC in this round of comments.

MMC-25 The comment prepared by the Marine Mammal Commission is a valid concern, one which the MMS has addressed over the years regarding the efforts to reduce or eliminate trash and debris in the Gulf of Mexico.

In 1986, the Gulf of Mexico OCS Region issued NTL 86-11, which advised that "Special caution should be exercised in handling and disposing of small items and packaging materials, particularly those made of nonbiodegradable, environmentally persistent materials such as plastic or glass, which may be lost in the marine environment and washed ashore. Increasing the individual worker's awareness of the problem and his responsibility to help curtail it will do much to reduce the litter problem." The MMS recommended that operators develop training aids and conduct periodic training and awareness sessions targeted at all offshore workers, which emphasize the proper control and disposal of offshore refuse. The MMS also recommended that (1) all OCS users adopt trash reduction methods, including compaction, and packaging for all materials sent to onshore disposal sites and (2) industry implement a control system to account for the proper disposal of trash, particularly drums and hazardous items.

In 1990, the Region issued a Letter to Lessees (LTL) requesting that industry look at any and all ways possible that might help eliminate debris going into the water. The MMS recommended that industry work toward banning small containers in favor of bulk storage and/or containment systems .

As stated in the EIS, over the last several years, companies have employed waste reduction and improved waste handling practices that have resulted in a marked decline in the loss of trash and debris. With regard to the statement in the EIS that "these large containers are generally covered with netting to avoid loss and are returned to shore by service vessels for disposal in approved landfill," there are no regulations specifically requiring that all containers must be covered. It should be pointed out that not all open containers have a risk of trash or debris blowing out. Some containers may have only large bags or heavy objects, which would not require a cover. However, a number of companies do cover open containers on their facilities as a matter of routine. Also, MMS inspectors do observe containers on their inspection trips and notify operators in the event conditions appear to warrant some corrective action. The MMS will look more closely at this concern to see if there are problems resulting from the open containers. If so, MMS will continue, as in the past, to develop guidelines and or regulations to address the issue.

MMC-26 The text has been revised.

MMC-27 See the response to MMC-1.

MMC-28 Within the format of the EIS, the section titled "Impacts on Sensitive Offshore Resources" comes as a natural progression, from coastal areas to the deepsea, of analyses of benthic features and communities. In no way is it meant to imply that pelagic communities are not sensitive or important elements of the Gulf ecology. The impacts to pelagic fishery resources are analyzed as separate issues in Sections IV.D.1.a.(8) and IV.D.1.d.(8), titled "Impacts to Commercial Fisheries" and "Cumulative Impacts to Commercial Fisheries," respectively. Impacts to fishery resources as well as commercial fishing are analyzed in these sections. In particular, impacts to pelagic and migrating fishery species are analyzed on pages IV-140 and IV-217.

MMC-29 See the response to MMC-1, paragraph 2.

MMC-30 See the response to MMC-53, which is similar in nature.

MMC-31 The text has been revised.

MMC-32 See the response to MMC-23.

MMC-33 The marine mammal monitoring (both acoustic and visual) was carried out during the Exxon 3D seismic survey. In brief, monitoring was conducted as part of the mitigation required by NMFS as conditions for the Incidental Harassment Authorization. The visual monitoring was carried out by Impact Sciences, Inc., of San Diego and included four aerial surveys (using Exxon contract helicopters) and observations were made from aboard the seismic boat by two observers. The MMS also had observers aboard the seismic vessel throughout the survey. Dr. Mark Pierson was present during part of those surveys and provided the original personal communication. So that others may evaluate the findings, we now cite a preliminary report prepared by the contractor to Exxon and have modified information in the EIS to reflect the report. Also added is recently presented information by Texas A&M for sperm whale reactions to seismic pulses, collected during the GulfCet study.

MMC-34 See the response to MMC-30.

MMC-35 See the responses to MMC-17 and MMC-19.

MMC-36 See the response to MMC-9.

MMC-37 See the response to MMC-1, paragraph 3.

MMC-38 The text has been revised as suggested.

MMC-39 The text was revised.

MMC-40 The discussion is for the proposed action. However, additional text was added for clarification.

MMC-41 See the response to MMC-30.

MMC-42 The text has been revised; see also the response to MMC-30.

MMC-43 A discussion of Level A and Level B harassment has been added to the discussion of the Marine Mammal Protection Act in Section I. With regard to effects of OCS activities, MMS requested formal section 7 consultation with NMFS for this multi-year EIS. The

NMFS concluded that the proposed multi-year lease sales and associated activities including oil and gas exploration, development, production and non-explosive abandonment may adversely affect but are not likely to jeopardize the continued existence of listed species, including sperm whales, sea turtles and Gulf sturgeon. It was recognized that a low-level of incidental take may occur annually. The incidental take level and associated requirements identified to monitor and minimize effects associated with oil and gas exploration, development, and production were discussed with MMS staff and were included in the Conservation Recommendations and Incidental Take Statement. The NMFS identified the requirement that surveys be continued to monitor the effects of OCS activities on protected species through continuation of GulfCet surveys or through participation with NMFS in ongoing spring and fall plankton surveys. MMS and NMFS have engaged in cooperative research since 1989 and MMS continues to fund a series of studies on the distribution and abundance of marine mammals along the continental slope of the north-central and western Gulf of Mexico.

MMC-44 Comment noted. The MMS does not have regulatory authority as related to contingency planning for location, recovery, and necropsy of cetaceans. This may more appropriately be considered under the provisions of the Marine Mammal Protection Act (Subchapter V - Marine Mammal Health and Stranding Response, Section 1421c, Unusual mortality event response).

MMC-45 The text was revised.

MMC-46 This information has been added to the conclusion and summary sections of both the proposed action and cumulative analysis.

MMC-47 The text has been revised as suggested.

MMC-48 The sentence in question was deleted.

MMC-49 The text in question was removed.

MMC-50 The text was revised as suggested.

MMC-51 The text was modified to address the concern.

MMC-52 The text has been revised as suggested. Also, refer to the response to MMC-1.

MMC-53 The text has been revised as suggested.

MMC-54 The text has been revised.

MMC-55 Information was updated as suggested. Information on the 1997 red tide impact on manatees was also added.

MMC-56 The first sentence was removed and replaced with the suggested text.

MMC-57 The second sentence that is being referred to was taken directly from the MMC report to Congress (1995). In 1992, the Marine Mammal Health and Stranding Response Act was enacted into law and became Title IV of the MMPA. To implement the Act, the NMFS instituted the Marine Mammal Health and Stranding Response Program which conducts all the activities listed in the section of the EIS that this comments refers to. Additionally,

personal communication with Dr. Cindy Driscoll (Veterinary Officer, NMFS) verifies that such activity is occurring, as does the NMFS Annual Report regarding the administration of the MMPA from 1 Jan 1996 through 31 Dec 1996.

MMC-58 The paper by Jones et al. (1994), not reproduced here, talks about responses of gray whales in the Mexican calving lagoons to playbacks of various sounds. Gray whales were found to move away from the sound projector when drilling sounds were played, as well as to reduce calling rates. These results were in contrast to reactions to outboard engine noise - a common sound in the Mexican lagoons. Whales calls in both noise situations were interpreted as adaptations to reduce masking. Jones et al. concluded that playbacks were the most likely cause of the whales' early departure. Whale numbers were found to return to normal the following winter.

For a number of reasons, parallels may possibly not be made for Gulf cetaceans exposed to drilling noises. (1) The most common cetaceans in the Gulf are odontocetes, which are not always as "behaviorally sensitive" as mysticetes; (2): the study site was a shallow, enclosed lagoon and sound properties may not be comparable to those in the Gulf (based on differences in bottom topography, etc.); and (3) drilling sounds are not a typical sound to be expected in the lagoons in Mexico, whereas industrial noise is quite pervasive in the Gulf. Cetacean presence in areas of great industrial activity might be partial habituation to continuous noise.

MMC-59 The text was revised as suggested. See also the response to MMC-46.

MMC-60 See the response to MMC-1.

MMC-61 The MMS has made sure that the MMC is on the appropriate mailing lists for information relating to MMS.

Responses to Comments from the State of Alabama, Governor's Office

AL-1 No response necessary.

Responses to Comments from the State of Louisiana, Department of Natural Resources

LADNR-1 On February 14, 1997, John Greene and Harry Luton of the Minerals Management Service met with Brian Marks and John Truxillo of the Louisiana Department of Natural Resources (LADNR) to discuss socioeconomic issues and concerns expressed by the State of Louisiana in various comment letters received by the Agency. One of the issues discussed was that the State would like to see an analysis of the socioeconomic impacts and the implications to depletion of natural resources from areawide leasing versus another form of leasing (e.g., nominated tract).

As discussed in previous comments, the issue of alternatives to areawide leasing has been a subject of analysis by MMS during the development of two 5-Year OCS Leasing Programs. In a 1993 *Federal Register* notice, MMS requested comments on alternative leasing policies and subsequently analyzed numerous policy options before deciding, in 1995, to continue with areawide leasing. In the 1996 decision on the 5-Year Program for 1997-2002, the Department adopted the policy of proposing annual areawide lease sales in the Central and Western Gulf. The proposals in the EIS are areawide leasing proposals, but the EIS does analyze deferral alternatives that may mitigate specific environmental effects or use conflicts; and it does analyze the effects of a range of possible exploration and

development levels. LADNR's suggestion is too broad and general to provide the basis of an environmental analysis for an alternative in the Western Gulf multisale Final EIS. However, MMS will continue discussions and information exchange with LADNR staff regarding their concerns about areawide leasing. If they are able to define more specifically how alternative, more restrictive leasing policies may moderate the rate of development in a manner significantly different than that assumed in the range of development analyzed in the EIS, MMS will consider analyzing such alternatives in future EIS's.

LADNR-2 See the response to LADNR-1.

LADNR-3 The projections used to develop the proposed action and OCS Program scenarios are based on resource and reserves estimates as presented in the *Summary of the 1995 Assessment of Conventionally Recoverable Hydrocarbon Resources of the Gulf of Mexico and Atlantic Outer Continental Shelf* (Lore et al., 1996), current industry information, and historical trends. The statistics used for the historic trends exhibit a lag time of about two years; therefore, the models using the trends also reflect two-year-old statistics. In addition, the overall trends average out the "boom and bust" nature of Gulf of Mexico OCS operations. The models cannot fully adjust for short-term changes in the rates of activities. In fact, these short-term changes should not be projected into the long term. An example of a short-term change is the current resurgence of OCS activities in the Gulf as a result of technological advancements in seismic surveying and the enactment of deepwater royalty relief. The short-term effects are "boom"-level activities, which are greater than the activity levels predicted by the resources and socioeconomic models. The acceleration of leasing and exploration cannot be expected to continue indefinitely. The MMS believes that the models, with continuing adjustments and refinements, adequately project Gulf OCS activities in the long term for the EIS analyses.

LADNR-4 The mitigation measures developed in the EIS for attachment to the leases as stipulations can only be applied to activities taking place on the leases themselves. Any mitigating measures developed by MMS, LADNR, and the Corps of Engineers for wetlands impacts would require implementation and enforcement by LADNR and the Corps. Any onshore activities that take place in the wetlands and that are a result of an OCS lease sale will have to comply with the enforceable requirements set forth in the Louisiana Coastal Resources Program. In this manner, Louisiana has control over the application of appropriate mitigation of wetlands impacts.

LADNR-5 The MMS is working with Louisiana and other affected States to address the issue of compensatory mitigation through the OCS Policy Committee of the Minerals Management Advisory Board. In October 1997, the Policy Committee passed a resolution to the Secretary of the Interior recommending a program of coastal impact assistance that was formulated by a working group whose membership included Secretary Jack Caldwell of the Louisiana Department of Natural Resources. The recommended program calls for establishing a fund made up of 27 percent of new OCS revenues that would be available to State and local governments for uses related to mitigating the impacts of OCS activities and projects relating to onshore infrastructure and public services. The OCS Policy Committee's resolution is currently under the Secretary's consideration.

LADNR-6 See the response to LADNR-4.

LADNR-7 Public hearings on the Draft EIS for the WPA proposed lease sales were held in Austin, Corpus Christi, and Houston, Texas, and in New Orleans, Louisiana. The public hearing in Houma, Louisiana (June 23, 1997), was for the Draft EIS for the CPA. As a result of

comments received on the EIS for the CPA, MMS improved the analysis in this EIS as well. However, the main body of analysis in the EIS provides the decision maker with information on the impacts that could be expected from a single lease sale, similar to those that have taken place annually in the Gulf of Mexico for nearly 30 years. The EIS describes the activities and impacts assumed to occur from a "typical proposed lease sale." As stated throughout the document, a single future lease sale is expected to have only minimal incremental impacts to areas affected by Gulfwide OCS Program activities. The analysis presented in the cumulative impact section of the EIS recognizes that the OCS Program and growing development in deep water have had substantial effects on the environments of coastal Louisiana, especially to Port Fourchon and LA Highway 1.

LADNR-8 The EIS does state that the changes in population, labor, and employment are expected to be less than 1 percent for a typical individual Western Gulf of Mexico sale scheduled between 1998 and 2002. The EIS also recognizes the significant economic impact that the OCS Program from a cumulative standpoint has had and continues to have on coastal Louisiana (Section IV.D.1.d.(11)(a)).

The model utilized for this EIS analysis has been developed in-house by MMS and has been used in some form for over 10 years. It has been refined over the years and the input data is updated annually.

For the purposes of analysis (economic and environmental), counties/parishes have been grouped together into coastal subareas where economic characteristics are similar. For instance, where one county/parish is in a Metropolitan Statistical Area (MSA), all counties/parishes in that MSA are included in the subarea. In many cases, source data are not available for counties/parishes within an MSA but are available in aggregate form. In addition, projections are often available for economic "regions" rather than individual counties/parishes. The coastal subarea groupings were formed because of the problematic nature of projecting economic impacts to individual counties/parishes. Projections for the EIS analysis are done for the life of a proposed action, which is over 30 years in the future. The use of larger spatial areas for economic analysis over long periods of time has been deemed to be more scientifically acceptable. Indeed, comparable Bureau of Economic Analysis projections are based on groupings of counties/parishes. This EIS is being modified to point out on a parish/county/community level where in-migration has been occurring and where stresses on infrastructure and other socioeconomic conditions are known in response to such concerns.

Sophisticated economic models cannot reliably predict sudden, exogenous changes such as the steep rise in oil prices in 1973, the price collapse of 1986, or the dramatic technological advances of the mid-1990's. Such fundamental changes must be anticipated by the modeler and reflected in the model inputs. Because it is so difficult to predict the changes–not to mention their extent and timing–likely to occur over several decades, MMS includes ranges of estimates in the EIS to allow the decisionmaker and affected parties to get an idea of possible impacts of alternate scenarios resulting from major changes in the conditions expected to prevail at the time the analysis is completed. Furthermore, the MMS analysis does not try to predict short-term variations. The fact that current conditions are better reflected by the high end of the range developed two years ago does not mean that impacts 10-15 years from now will not be closer to those in the lower end. The perils of basing long-term forecasts too heavily on short-term phenomena can be seen in the billions of dollars lost by oil companies that expected the price increases of the early 1980's to continue indefinitely.

The great increase in petroleum industry employment has implications for potential impacts of the proposed sales but is caused by changes in existing activity levels from the OCS Program, not by the proposed sales analyzed in the EIS. The effects of the proposed sales on employment levels (presumably, always positive) would not necessarily be similar to overall changes in industry employment rates. The proposed sales are expected to affect employment many years in the future, at which time the effect could be either to give jobs to additional workers (if industry employment rates are increasing) or to allow continued employment for workers being hired during the current boom period (if employment rates are decreasing). The use of a range was designed to minimize the effect of changing geologic and economic conditions. Rigorous analysis (including the examination of results of recent sales) are done prior to the development of the resource estimate scenario used as a basis for the EIS analysis.

LADNR-9 In response to comments received on the CPA Draft EIS, both the Final EIS for the CPA and this Draft EIS were revised to more accurately reflect focal point areas of intense OCS-generated activity, such as Port Fourchon.

LADNR-10 As stated earlier in the response to LADNR-7, the EIS describes the activities and impacts assumed to occur from a "typical proposed lease sale." As stated throughout the document, a single future lease sale is expected to have only minimal incremental impacts to areas affected by Gulfwide OCS Program activities. The analysis presented in the cumulative impact section of the EIS recognizes that the OCS Program and growing development in deep water have had substantial effects on the environments of coastal Louisiana.

While no hindcast, per se, has been performed to test the accuracy of MMS development scenarios, the scenarios are based primarily upon historical data. The MMS is constantly acquiring geologic and economic information on which to base the estimates of economically recoverable resources and the infrastructure required to develop them. In addition, recent lease sale results are factored into the analysis used to develop the scenarios used for EIS environmental and socioeconomic analyses. A resource assessment of the Gulf of Mexico is also periodically undertaken. Economic and demographic information/literature are collected and analyzed annually (at a minimum) to update the assumptions used in MMS-developed models. Additionally, MMS is undertaking several socioeconomic studies to broaden its knowledge base and to revise the model used to determine economic and social impacts. These efforts, along with other recently completed studies, will give MMS a baseline of social and economic data and a mechanism to update the data as technology advances.

In terms of monitoring activities, MMS has in place various monitoring activities, such as those concerned with archaeological and biological resources. Additionally, MMS is continuing to fund a wide variety of efforts to assess the effects of OCS activities. The MMS has funded a study to examine stresses placed on local infrastructure as a result of increased usage of Port Fourchon as an OCS staging area ("A Socioeconomic Analysis of Port Expansion at Port Fourchon"). This study, conducted by Louisiana State University, will document the growth of onshore support activities and develop models to project future economic and traffic effects from OCS activities. Preliminary information from this study was incorporated into the analysis in the Final EIS for the CPA. We are also looking at conducting further port studies using the Coastal Marine Institute or other sources. The MMS is developing plans for compliance monitoring to minimize the risk of incident occurrences in areas of sensitive biological communities and to verify that rigs are actually located at the approved location prior to commencement of drilling activities. Toward this end, the Environmental Operations Section of MMS has completed four monitoring trips to areas of the Pinnacle Trends. This compliance monitoring was undertaken to observe

industry projects that had been issued avoidance criteria under NTL 88-11 with their permits (See the responses to NMFS-2 and LADNR-3.)

LADNR-11 See the response to LADNR-5.

LADNR-12 See the responses to LA-4 and LADNR-5.

Response to Comments from National Ocean Industries Association

NOIA-1 Thank you for your comment. The decision of whether to adopt various alternatives or stipulations will be made by the Secretary of the Interior, in accordance with Departmental policy, at the time of the issuance of the Final Notice of Sale.

SECTION VI

BIBLIOGRAPHY AND SPECIAL REFERENCES

VI

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SECTION VIII
GLOSSARY

VIII

VIII. GLOSSARY

Acute -- Sudden, short term, severe, critical, crucial, intense, but usually of short duration.

Anaerobic -- Capable of growing in the absence of molecular oxygen.

Anthropogenic -- Coming from human sources, relating to the effect of humankind on nature.

Aphotic zone -- Zone where the levels of light entering through the surface are not sufficient for photosynthesis or for animal response.

API gravity -- A standard adopted by the American Petroleum Institute for expressing the specific weight of oil. The API gravity equals [(141.5/specific gravity at 60°F) - 131.5].

Aromatic -- Applied to a class of organic compounds containing benzene rings or benzenoid structures.

Attainment area -- An area that is shown by monitored data or by air-quality modeling calculations to be in compliance with primary and secondary ambient air quality standards established by the USEPA.

Barrel (bbl) -- A volumetric unit used in the petroleum industry; equivalent to 42 U.S. gallons or 158.99 liters.

Benthic -- Organisms living on or in the bottom of the sea; associated with live bottoms, hard-bottom banks, patch reefs, and reef complexes.

Biological Opinion -- FWS or NMFS evaluation of the impact of a proposed action on endangered and threatened species.

Block -- A geographical area, as portrayed on an official MMS protraction diagram or leasing map, that contains approximately 2,331 ha (9 mi^2).

Blowout -- An uncontrollable flow of fluids from a wellhead or wellbore. Unless otherwise specified, a flow of fluids from a flowline is not considered a blowout as long as the wellhead control valves can be automatically or manually activated. If the wellhead control valves become inoperative, the flow is classified as a blowout.

Central Planning Area (CPA) -- The sale area south from the territorial sea at approximately 87°45'W. longitude to approximately 29°N. latitude, thence west to approximately 87°55'W. longitude, thence south to approximately 26°N. latitude, thence west to approximately 91°55'W. longitude, except that between approximately 88°23'W. longitude and 91°0'W. longitude the boundary is the U.S.-Mexico provisional maritime boundary; thence north to approximately 27°55'N. latitude, thence generally west to approximately 93°25'W. longitude, thence northwest to the juncture of the territorial sea at approximately 93°50'W. longitude, thence east along the territorial sea to the point of origin.

Cetacean -- An aquatic mammal of the order Cetacea, such as whales, dolphins, and porpoises.

Chemosynthetic -- Organisms that obtain their energy from the oxidation of various inorganic compounds rather than from light (photosynthetic).

Coastal waters -- Inshore waters within the geographical areas defined by each State's Coastal Zone Management Program.

Coastal wetlands -- Forested and nonforested habitats, mangroves, and all marsh islands that are exposed to tidal activity. Included in forested wetlands are hardwood hammocks, mangrove swamps, spoil banks, cypress-tupelo gum swamps, and bottomland hardwoods. Nonforested wetlands include fresh, brackish, and salt marshes. These areas directly contribute to the high biological productivity of coastal waters by input of detritus and nutrients, by providing nursery and feeding areas for shellfish and finfish, and by serving as habitat for many birds and other animals.

Coastal zone -- The coastal waters (including the lands therein and thereunder) and the adjacent shorelands (including the waters therein and thereunder) strongly influenced by each other and in proximity to the shorelines of the several coastal states; the zone includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches and extends seaward to the outer limit of the United States territorial sea. The zone extends inland from the shorelines only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters. Excluded from the coastal zone are lands the use of which is by law subject to the discretion of or which is held in trust by the Federal Government, its officers, or agents.

Completion -- Conversion of a development well or an exploratory well into a production well of oil or gas or both.

Condensate -- Liquid hydrocarbons produced with natural gas; they are separated from the gas by cooling and various other means. Condensate

generally has an API gravity of 50°-120° and is water-white, straw, or bluish in color.

Continental margin -- The ocean floor that lies between the shoreline and the abyssal ocean floor, includes the continental shelf, continental slope, and continental rise.

Continental shelf -- The continental margin province that lies between the shoreline and the abrupt change in slope called the shelf edge, which generally occurs around a water depth of 200 m. The shelf is characterized by a gentle slope (ca. 0.1°).

Continental slope -- The continental margin province that lies between the continental shelf and continental rise, characterized by a steep slope (ca. 3°-6°) and located around depths of 3,000-4,000 m.

Critical habitat -- Specific areas essential to the conservation of a protected species and that may require special management considerations or protection.

Crude oil -- Petroleum in its natural state as it emerges from a well, or after it passes through a gas-oil separator but before refining or distillation. An oily, flammable bituminous liquid that occurs in many places in the upper strata of the earth, either in seepages or in reservoirs; essentially a complex mixture of hydrocarbons of different types with small amounts of other substances; as distinguished from refined oil manufactured from it.

Deferral -- Action taken by the Secretary of the Interior at the time of the Area Identification to remove certain areas/blocks from the proposed sale.

Delineation well -- A well that is drilled for the purpose of delineating an oil or gas reservoir, thereby enabling the lessee to determine whether to proceed with development and production.

Demersal -- Living at or near the bottom of the sea.

Designated environmental preservation areas -- Gulf of Mexico shorefront areas recognized for the quality and significance of their natural environments. They have been legislatively, administratively, or privately protected from the development and are managed solely for the preservation, understanding, and appreciation of their natural attributes. Included are National Parks and Preserves, National and State Wilderness Areas, National Marine and Estuarine Sanctuaries, National Landmarks, Wildlife Sanctuaries, Florida Aquatic Preserves, and Environmentally Endangered Lands.

Detritus -- Particulate organic matter originating primarily from the physical breakdown of dead animal and plant tissue; loose rock and mineral material produced by mechanical erosion.

Development -- Activities that take place following discovery of economically recoverable mineral resources, including geophysical surveying, drilling, platform construction, operation of onshore support facilities, and other activities that are for the purpose of ultimately producing the resources.

Development Operations Coordination Document (DOCD) -- A document that must be prepared by the operator and submitted to MMS for approval before any development or production activities are conducted on a lease in the Western Gulf. The DOCD meets the requirements of 30 CFR 250.34. Environmental information, archaeological report, biological report (monitoring and/or live-bottom surveying), or other information, as determined, may be required in support of the DOCD.

Development well -- A well drilled to a known producing formation to extract oil or gas; a production well; distinguished from a wildcat or exploratory well and from an offset well.

Direct employment -- Consists of those workers involved the primary industries of oil and gas exploration, development, and production operations, including geophysical and seismic surveying, exploratory drilling, well operation, maintenance, and other contract support services (Standard Industrial Classification Code 13--Oil and Gas Extraction).

Discharge -- Something that is emitted; flow rate of a fluid at a given instant expressed as volume per unit of time.

Dispersion -- A suspension of finely divided particles in a medium.

Drilling mud -- A special mixture of clay, water or refined oil, and chemical additives pumped continuously downhole through the drill pipe and drill bit, and back up in the annulus between the pipe and the walls of the hole to a surface pit. The mud lubricates and cools the rapidly rotating bit, lubricates the drill pipe as it turns in the well bore, carries rock cuttings to the surface, serves to keep the hole from crumbling or collapsing, and provides the weight or hydrostatic head to prevent extraneous fluids from entering the well bore and to control downhole pressures that may be encountered; drilling fluid.

Eastern Planning Area (EPA) -- The sale area south from the territorial sea at approximately 87°45'W. longitude to approximately 29°N. latitude, thence west to approximately 87°55'W. longitude, thence south to approximately 26°N. latitude, thence east to approximately 85°55'W. longitude, thence south to the limit of U.S. jurisdiction, thence southeast to approximately 83°55'W. longitude at 24°N. latitude, thence east to 83°W. longitude, thence north to the limits of the territorial sea, thence east to approximately 82°25'W. longitude, thence north and east along the territorial sea abutting the Florida Keys, thence north and east to approximately 81°55'W. longitude, thence north to the limits of the territorial sea, thence north and west along the territorial sea to the point of origin.

Economically recoverable resources -- An assessment of hydrocarbon potential that takes into account the physical and technological constraints on production and the influence of costs of exploration and development and market price on industry investment in OCS exploration and production.

Effluent -- The liquid waste of sewage and industrial processing.

Effluent limitations -- Any restriction established by a State or the USEPA on quantities, rates, and concentrations of chemical, physical, biological, and other constituents discharged from point sources into U.S. waters, including schedules of compliance.

Epifaunal -- Animals living on the surface of hard substrate.

Essential habitat -- Specific areas crucial to the conservation of a species and that may necessitate special considerations.

Estuary -- Coastal semienclosed body of water that has a free connection with the open sea and where freshwater meets and mixes with seawater.

Eutrophication -- Enrichment of nutrients in the water column by natural or artificial methods accompanied by an increase of respiration, which may create an oxygen deficiency.

Exclusive Economic Zone (EEZ) -- The maritime region adjacent to the territorial sea, extending 200 nautical miles from the baseline of the territorial sea, in which the United States has exclusive rights and jurisdiction over living and nonliving natural resources.

Exploration Plan (EP) -- A plan based on available relevant information about a leased area that identifies, to the maximum extent possible, the geology of the potential hydrocarbon accumulations and the type and sequence of exploration activities (including drilling exploratory wells) that are proposed to evaluate the accumulations within the entire area of the lease(s) covered by the plan. Under 30 CFR 250.33, lease operators are required to formulate and obtain approval of such plans by the Director of Minerals Management Service before the proposed the proposed exploration activities may commence.

Exploration well -- A well drilled in unproven or semi-proven territory for the purpose of ascertaining the presence of a commercial petroleum or natural gas deposit; exploratory well.

Floating production, storage, and offloading system (FPSO) -- A converted tanker used for a production and storage base, usually at a deepwater (>400 m) production site.

Gathering lines -- A pipeline system used to bring oil or gas production from a number of separate wells or production facilities to a central trunk pipeline, storage facility, or processing terminal.

Geochemical -- Of or relating to the science dealing with the chemical composition of and the actual or possible chemical changes in the crust of the earth.

Geophysical survey -- A method of exploration in which geophysical properties and relationships are measured by one or more geophysical methods.

Habitat -- A specific type of environment that is occupied by an organism, a population, or a community.

Hermatypic coral -- Reef-building corals that produce hard, calcium carbonate skeletons and that possess symbiotic, unicellular algae within their tissues.

Harassment -- an intentional or negligent act or omission that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns that include, but are not limited to, feeding or sheltering.

Hydrocarbons -- Any of a large class of organic compounds containing primarily carbon and hydrogen. Hydrocarbon compounds are divided into two broad classes: aromatic and aliphatics. They occur primarily in petroleum, natural gas, coal, and bitumens.

Hydrology -- As used in relation to river development and flood control projects, means alteration of the physical configuration of the drainage basin and channels, including dredging of channels to deepen

or widen them; construction of dams, levees, or canals; and addition of irrigation or municipal waters to the natural runoff.

Hypoxia -- Depressed levels of dissolved oxygen in water, usually resulting in decreased metabolism.

Incidental take -- Takings that result from, but are not the purpose of, carrying out an otherwise lawful activity (e.g., fishing) conducted by a Federal agency or applicant (see Taking).

Indirect employment -- Secondary or supporting oil- and gas-related industries, such as the processing of crude oil and gas in refineries, natural gas plants, and petrochemical plants.

Induced employment -- Tertiary industries that are created or supported by the expenditures of employees in the primary or secondary industries (direct and indirect employment), including consumer goods and services such as food, clothing, housing, and entertainment.

Infrastructure -- The facilities associated with oil and gas development, e.g., refineries, gas processing plants, etc.

Jack-up rig -- A barge-like, floating platform with legs at each corner that can be lowered to the sea bottom to raise the platform above the water.

Landfall -- The site where a marine pipeline comes to shore.

Landfill -- Location where disposal of solid waste occurs by burying in layers of earth in low ground.

Lay barge -- A shallow-draft, barge-like vessel used in the construction and laying of underwater pipelines.

LC_{50} -- The concentration at which 50 percent of the test organisms have succumbed after a prescribed period of exposure.

Lease -- Any form of authorization that is issued under Section 8 or maintained under Section 6 of the Outer Continental Shelf Lands Act and that authorizes exploration for, and development and production of, minerals.

Lease sale -- The competitive auction of leases granting companies or individuals the right to explore for and develop certain minerals under specified conditions and periods of time.

Lease term -- The initial period for oil and gas leases, usually a period of 5, 8, or 10 years (a longer period is necessary to encourage exploration and development in areas because of unusually deep water or other adverse conditions).

Lessee -- A party authorized by a lease, or an approved assignment thereof, to explore for and develop and produce the leased deposits in accordance with regulations at 30 CFR 250.

Lightering -- Offloading oil from a large tanker onto smaller vessels or barges for transport to coastal facilities.

Marshes -- Persistent, emergent, nonforested wetlands characterized by vegetation consisting predominantly of cordgrasses, rushes, and cattails.

Military warning area -- An established area within which military activities take place.

Minerals -- As used in this document, minerals include oil, gas, sulphur, and associated resources, and all other minerals authorized by an Act of Congress to be produced from public lands as defined in Section 103 of the Federal Land Policy and Management Act of 1976.

Nepheloid -- A layer of water near the bottom that contains significant amounts of suspended sediment.

Nonattainment area -- An area that is shown by monitored data or by air-quality modeling calculations to exceed primary or secondary ambient air quality standards established by the USEPA.

Nonhazardous oil-field wastes (NOW) -- Wastes that are generated by exploration, development, or production of crude oil or natural gas that are exempt from hazardous waste regulation under the Resource Conservation and Recovery Act (RCRA), as per *Regulatory Determination for Oil and Gas and Geothermal Exploration, Development and Production Wastes,* dated June 29, 1988 (53 FR 25446; July 6, 1988). These wastes may contain hazardous substances.

NORM -- Naturally occurring radioactive materials; any naturally occurring material that emits low levels of radioactivity, originating from processes not associated with the recovery of radioactive material. The radionuclides of concern in NORM are Radium-226, Radium-228, and other isotopes in the radioactive decay chains of uranium and thorium.

OCS Program activities -- All oil and gas activities occurring Gulfwide during the life of the proposal as a result of past, proposed, and future sales in the OCS.

Offloading -- Another name for unloading; offloading refers more specifically to liquid cargo, crude oil, and refined products.

Operational discharge -- Any incidental pumping, pouring, emitting, emptying, or dumping of wastes generated during routine offshore drilling and production activities.

Operator -- An individual, partnership, firm, or corporation having control or management of operations on a leased area or portion thereof. The operator may be a lessee, designated agent of the lessee, or holder of operating rights under an approved operating agreement.

Organic matter -- Material derived from living plants or animals.

Outer Continental Shelf (OCS) -- All submerged lands that comprise the continental margin adjacent to the United States and seaward of State offshore lands.

Pelagic -- Of or pertaining to the open sea; associated with open water beyond the direct influence of coastal systems.

Penaeids -- Chiefly warm water and tropical prawns belonging to the family Penaeidae.

Plankton -- Passively floating or weakly motile aquatic plants (phytoplankton) and animals (zooplankton).

Platform -- A steel or concrete structure from which offshore development wells are drilled.

Primary production -- Organic material produced by photosynthetic or chemosynthetic organisms.

Produced water -- Total water discharged from the oil and gas extraction process; production water or production brine.

Production -- Activities that take place after the successful completion of any means for the extraction of resources, including bringing the resource to the surface, transferring the produced resource to shore, monitoring operations, and drilling additional wells or workovers.

Recoverable reserves -- The portion of the identified hydrocarbon or mineral resource that can be economically extracted under current technological constraints.

Recoverable resource estimate -- An assessment of hydrocarbon or mineral resources that takes into account the fact that physical and technological constraints dictate that only a portion of resources can be brought to the surface.

Recreational beaches -- Those frequently visited sandy areas along the shorefront exposed to the Gulf of Mexico that support multiple recreational activities, most of which are focused at the land-water interface. Included are National Seashores and other selected areas in the National Parks System, State Park and Recreational Areas, county and local parks, urban beachfronts, and private resort areas.

Recreational fishing (marine) -- Hook-and-line sport fishing for fun, food, and occasional incidental profit, inclusive of spearfishing, from a boat seaward of the beach.

Refining -- Fractional distillation, usually followed by other processing (for example, cracking).

Relief -- The difference in elevation between the high and low points of a surface.

Reserves -- Proved oil or gas resources.

Rig -- A structure used for drilling an oil or gas well.

Royalty -- A share of the minerals produced from a lease paid in either money or in kind to the land owner by the lessee.

Saltwater intrusion -- Phenomenon occurring when a body of saltwater, because of its greater density, invades a body of freshwater; occurs in either surface or groundwater sources.

Sciaenids -- Fishes belonging to the croaker family (Sciaenidae).

Seagrass beds -- More or less continuous mats of submerged, rooted, marine, flowering vascular plants occurring in shallow tropical and temperate waters. Seagrass beds provide habitat, including breeding and feeding grounds, for adults and/or juveniles of many of the economically important shellfish and finfish. As such, this habitat type is especially sensitive to oil-spill impacts.

Sediment -- Material that has been transported and deposited by water, wind, glacier, precipitation, or gravity; a mass of deposited material.

Seeps (hydrocarbon) -- Gas or oil that reaches the surface along bedding planes, fractures, unconformities, or fault planes.

Sensitive area -- An area containing species, populations, communities, or assemblages of living resources, that is susceptible to damage from normal

OCS-related activities. Damage includes interference with established ecological relationships.

Shunting -- A method used in offshore oil and gas drilling and production activities where expended cuttings and fluids are discharged through a downpipe, which terminates no more than 10 m from the ocean floor, rather than discharged at the ocean surface.

Structure -- Any OCS facility that extends from the seafloor to above the waterline; in petroleum geology, any arrangement of rocks that may hold an accumulation of oil or gas.

Subarea -- A discrete analysis area.

Supply vessel -- A boat that ferries food, water, fuel, and drilling supplies and equipment to an offshore rig or platform and returns to land with refuse that cannot be disposed of at sea.

Symbiont -- Either of two organisms of different species living together in intimate association with each other.

Taking -- To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any endangered or threatened species, or to attempt to engage in any such conduct (including actions that induce stress, adversely impact critical habitat, or result in adverse secondary or cumulative impacts). Harrassment is the most common form of taking associated with OCS Program activities.

Tension leg platform (TLP) -- A production structure that consists of a buoyant platform tethered to concrete pilings on the seafloor with flexible cable. Assumed to be on the OCS and at water depths greater than 450 m.

Total dissolved solids -- The total amount of solids that are dissolved in water.

Total suspended particulate matter -- The total amount of suspended solids in water.

Total suspended solids -- The total amount of suspended solids in water.

Trunk line -- A large-diameter pipeline receiving oil or gas from many smaller tributary gathering lines that serve a large area; common-carrier line; main line.

Turbidity -- Reduced water clarity due to the presence of suspended matter.

Volatile organic compound (VOC) -- Any organic compound that is emitted to the atmosphere as a vapor.

Water test areas -- Areas established within the Eastern Gulf where research, development, and testing of military planes, ships, and weaponry take place.

Weathering (of oil) -- The aging of oil due to its exposure to the atmosphere, causing marked alterations in its physical and chemical makeup.

Western Planning Area (WPA) -- The sale area east from the territorial sea along the U.S.-Mexico provisional maritime boundary to approximately 25°45'N. latitude, thence along approximately 26°N. latitude to approximately 91°55'W. longitude, thence north to approximately 27°55'N. latitude, thence generally west to approximately 93°25'W. longitude, thence northwest to the juncture of the territorial sea at approximately 93°50'W. longitude, thence along the territorial sea to the point of origin.

SECTION IX
APPENDICES

Appendix A

Blocks Affected by the Topographic Features Stipulations in the Western Gulf of Mexico

Western Gulf of Mexico

A total of 200 blocks in the Western Gulf would be affected by the topographic features stipulation, 139 of which are currently leased. The blocks affected, leasing status, and the affected bank follow (as of February 1998).

Block	OCS-G No. (if leased)	Bank
North Padre Island, East Addition		
A-30	18865	Dream
A-31		Dream
A-40		Dream
A-41	18866	Dream
A-72		Blackfish Ridge
A-83		Mysterious
A-84		Mysterious
Mustang Island		
A-3		North Hospital
A-4		North Hospital and Hospital
A-9		Southern
A-16	3011	Southern
Mustang Island, East Addition		
A-54	15712	Small and Big Dunn Bars
A-61		Baker
A-62		Baker
A-86	12427	Baker and South Baker
A-87		Baker and South Baker
A-95		South Baker
A-117	18883	Aransas and North Hospital
A-118	17086	Aransas
A-136		Aransas, Hospital, and North Hospital
A-137	17088	Hospital
High Island, South Addition		
A-446	2359	Claypile
A-447	2360	Claypile
A-448	2361	Claypile
A-463	17180	Claypile
A-464		Claypile
A-465	14188	Claypile
A-486	6227	Stetson
A-487	18955	Stetson

Block	OCS-G No. (if leased)	Bank
High Island, South Addition		
A-488		Stetson
A-501		Stetson
A-502	17185	Stetson
A-503		Stetson
A-512		Stetson
A-513		Stetson
A-514		Stetson
A-527	17195	Stetson
A-528	13803	Stetson
A-529		Stetson
A-534	15802	32 Fathom
A-535		32 Fathom
A-573	2393	West Flower Garden
A-578	17203	Appelbaum
A-579		Appelbaum
A-580		Appelbaum
A-589	17204	Appelbaum
A-590	14902	Appelbaum
A-591	14903	Appelbaum
A-596	2722	West Flower Garden
High Island, East Addition, South Extension		
A-311		29 Fathom
A-312	14913	29 Fathom
A-327	2418	29 Fathom
A-328		29 Fathom
A-329	15815	29 Fathom
A-330	2421	29 Fathom
A-331		29 Fathom
A-332	2422	29 Fathom
A-340	2426	Coffee Lump
A-346	14917	MacNeil
A-347	14918	MacNeil
A-348	14919	MacNeil
A-349	2743	MacNeil
A-350	2428	MacNeil
A-351	2429	MacNeil and East Flower Garden
A-352	14197	East Flower Garden and MacNeil
A-353	17211	East Flower Garden

Block	OCS-G No. (if leased)	Bank
High Island, East Addition, South Extension (continued)		
A-354	17212	East Flower Garden
A-355	17213	East Flower Garden
A-358	17215	Coffee Lump
A-359	14198	Coffee Lump
A-360	14921	Coffee Lump
A-361	17216	Coffee Lump and West Flower Garden
A-362	14199	West Flower Garden
A-363	17217	West Flower Garden
A-364	17218	East and West Flower Garden
A-365	2750	East Flower Garden
A-366	17219	East Flower Garden
A-367	15820	East Flower Garden
A-368	2433	East Flower Garden, Rankin, and MacNeil
A-369	2751	MacNeil and Rankin
A-370	2434	MacNeil and Rankin
A-371	14200	Rankin
A-372	14201	Rankin and MacNeil
A-373	18970	East Flower Garden, Rankin, and MacNeil
A-374	18971	East Flower Garden
A-375		East Flower Garden
A-376	2754	East Flower Garden
A-377	15821	East and West Flower Garden
A-378	13807	West Flower Garden
A-379	13808	West Flower Garden
A-380	14924	West Flower Garden
A-381		West Flower Garden
A-382	2757	West Flower Garden
A-383	17220	West Flower Garden
A-384	3316	West Flower Garden
A-385	10311	West Flower Garden
A-386	14925	East and West Flower Garden
A-387	17221	East Flower Garden
A-388	18972	East Flower Garden
A-389	2759	East Flower Garden
A-390	18973	East Flower Garden and Rankin
A-391	14202	Rankin
A-392	18974	Rankin
A-393	17223	Rankin
A-394	17224	East Flower Garden
A-395	18975	East Flower Garden
A-396	17225	East and West Flower Garden
A-397	13809	West Flower Garden
A-398		West Flower Garden
A-399	17226	West Flower Garden
A-400		West Flower Garden
A-401		West Flower Garden
A-402	14203	West Flower Garden
A-403	18976	East Flower Garden
East Breaks		
121		Appelbaum
122	17229	Appelbaum
123		Appelbaum
124		Appelbaum
165	6280	Appelbaum
166		Appelbaum
167		Appelbaum
168	17233	Appelbaum
173		West Flower Garden
217	17239	West Flower Garden
Garden Banks		
26		McGrail
27		McGrail
28	14212	McGrail
29	14213	McGrail
30		Rezak and Sidner
31		Rezak and Sidner
33		Rezak and Sidner
61	17280	Geyer
62	17281	Geyer
63	17282	Geyer
70	9200	McGrail
71	9201	McGrail
72	13363	McGrail
73		McGrail
74	17284	Sidner
75	13810	Sidner
76	14216	Sidner
77		Sidner
81		Parker
82	15836	Parker
83	11450	Parker
84	11451	Parker

Block	OCS-G No. (if leased)	Bank
Garden Banks (continued)		
85	14937	Parker
95	19076	East Flower Garden
96		East Flower Garden
97		East Flower Garden and Rankin
98		Rankin
102	14938	Bright
103	19077	Bright
104	15837	Geyer
105	17287	Geyer
106	19078	Geyer
107	17288	Geyer
108	15838	Geyer and Elvers
109		Elvers
110		Elvers
119		Sidner
120		Sidner
121	17290	Sidner
126	15840	Parker
127	11454	Parker
128	11455	Parker
133		West Flower Garden
134	13366	West Flower Garden
135	14217	West Flower Garden
136	14218	West Flower Garden
138		East Flower Garden
139	17295	East Flower Garden
140	14940	East Flower Garden
141	14219	Rankin
142	14220	Rankin
144	17296	Bright
145	17297	Bright
146		Bright
148	19080	Geyer
149	19081	Geyer
150	17298	Geyer
151		Geyer
152	15841	Geyer and Elvers
153		Elvers
154		Elvers
155		Elvers
177	15849	West Flower Garden
178	15850	West Flower Garden
179	17301	West Flower Garden
180	14222	West Flower Garden
192	3301	Geyer
193	17303	Geyer
194	17304	Geyer
195	17305	Geyer
196	17306	Geyer and Elvers
197	19084	Elvers
198		Elvers
237	2812	Geyer
238	17314	Geyer
239	17315	Geyer

Appendix B

Biological Opinions

U.S. Fish and Wildlife Service

Biological Opinion

Gulf of Mexico

Sales 171, 174, 177, and 180

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Division of Ecological Services
17629 El Camino Real, Suite 211
Houston, Texas 77058

March 9, 1998

Memorandum

To: Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, Louisiana, ATTN: Dr. Ann Bull (MS 5412), Leasing and Environment

From: Project Leader, Clear Lake ES Field Office, Houston, Texas

Subject: Endangered Species Act: Biological Opinion for OCS Oil and Gas Lease Sales 171, 174, 177, and 180, Gulf of Mexico Western Planning Area

By memorandum dated September 9, 1997, the Associate Director for Offshore Minerals Management requested formal consultation with the U.S. Fish and Wildlife Service under Section 7 of the Endangered Species Act for a 5-year leasing program (1997-2002) in the Western Planning Area of the Gulf of Mexico. The Western Planning Area includes about 28.4 million acres on the outer continental shelf and slope seaward of the territorial waters of Texas (the three league line) out 220 miles in water depths ranging from 26 feet to more than 9,000 feet.

This program will involve four lease sales (Sale 171 in 1998, Sale 174 in 1999, Sale 177 in 2000, and Sale 180 in 2001) which will offer all unleased blocks in the Western Planning Area, with the exclusion of the East and West Flower Garden Banks (Blocks A-375 and A-398 in the High Island Area, East Addition, South Extension) and three blocks used for Naval mine warfare testing and training (Blocks 793, 799, and 816 in the Mustang Island Area).

This biological opinion is based on information provided in the Draft Environmental Impact Statement dated October 1997 for Gulf of Mexico OCS Oil and Gas Lease Sales 171, 174, 177, and 180 and the Oil-Spill Risk Analysis (OSRA) for the 5-year leasing program. This opinion is also based on pertinent literature, discussions with experts on threatened and endangered species in the probable impact area, and field observations of species reaction to oil spills and other onshore impacts resulting from oil and gas activities.

CONSULTATION HISTORY

Formal consultation reports were provided to MMS for individual lease sales occurring every 1 or 2 years. Complete reports were provided on June 19, 1987 and again on June 16, 1994. For intervening lease sales, the Service only provided verification that the full reports were still valid for a particular lease sale. These reports dealt only with impacts to threatened or endangered species under the responsibility of the Service. Impacts to species under the responsibility of the National Marine Fisheries Service (sea turtles while in the

water and marine mammals, including several species of whales) were dealt within a biological opinion from that agency.

Service reports determined that work under previous lease sales was not likely to jeopardize the continued existence of listed species or adversely modify critical habitat. The Service did not anticipate any incidental take of species but did include several conservation recommendations to facilitate recovery of species.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

A detailed discussion of oil and gas activities in the Western Planning Area is provided in the Environmental Impact Statement dated October 1997, on the 5-year lease sale. This is the first time that MMS has asked for consultation on a multi year lease sale involving four leases over a 5-year period. Actually, only a small percentage of blocks are expected to be leased during any one sale and, of these, only a portion would be drilled and result in subsequent production. Each lease sale, and all activities associated with it, will be considered a proposed action for analysis of impacts on listed species. The average life of a lease is about 35 years which includes an initial period to begin activities (the initial lease period) and the time required for exploration, development, production life, and abandonment. During this time, all impacts would occur from operations in a leased block. Other activities, such as state coastal oil production, import of oil in tankers, and commercial shrimping are not under the purvue of MMS and are included as activities in this biological opinion only with respect to cumulative impacts on listed species.

Each lease sale is presumed to be typical, and impacts from each sale are predicted based upon historical trends. It is estimated that each proposed lease sale could result in exploration, development, and production of 0.01 (at a 95% probability) to 0.09 (at a 0.05% probability) billion barrels of oil (Bbl.) and 0.57 to 1.93 trillion cubic feet (tcf) of gas. These are the low and high estimates of recoverable reserves anticipated for each sale thus requiring that most effects on listed species be presented as lower and upper ranges. Getting this oil to shore would require the installation of 17 to 35 new pipeline landfalls onshore (barging only accounts for about 8 percent of oil transport onshore with no anticipation of any increase in the future). No other infrastructure is projected to be built on barrier beaches and dunes. There is expected to be a start in shuttle tankering to get oil onshore from deep water production platforms.

The principal impact from a lease sale would occur when an oil spill from an offshore production platform, pipeline or barge, or a spill from an onshore pipeline, barge, or support facility contaminates feeding, roosting, or nesting/rookery habitat of listed species along the Texas coast. Second significant impact related to OCS leasing is the loss of habitat which would occur when coastal infrastructure is built or expanded to support offshore operations. OCS-related infrastructure onshore includes service bases, helicopter hubs, construction facilities, oil refineries and gas processing plants, pipeline routes making the landfall at the coast or routes distributing products onshore, pipeline shore facilities, barge terminals, tanker port areas, disposal facilities, and navigation channels. Effects of OCS activities on listed species will focus primarily on these two factors.

Impact probabilities increase significantly when the analysis is broadened to consider the long-term OCS Program throughout the Gulf of Mexico, also presented in the EIS as low and high estimates of reserves (10.72 to 15.19 Bbl of oil and 122.23 to 170.41 tcf of gas). Long term impacts would occur during the 5-year leasing period and subsequent 35-year development period during which estimates of oil and gas in the Gulf of Mexico are recovered (i.e., a 39-year analysis period from 1998 to 2036 during which past, proposed, and future lease sales lead to recovery of resource estimates). An additional 128 to 261 new pipeline landfalls would be needed to bring Gulfwide OCS production onshore.

The impact of oil spills and infrastructure growth can be low for a single lease sale but very significant for the entire Gulf OCS Program. There will be many opportunities to evaluate OCS-wide program impacts on listed species during future consultations when better information is available on the location of resource estimates and any actual impacts on a listed species can be taken into account.

Operational discharges such as produced water and drilling muds and cuttings are regulated by the U. S. Environmental Protection Agency through the NPDES program. All owners and operators of oil handling, storage, or transportation facilities located seaward of the coastline must submit an Oil Spill Response Plan (OSRP) to MMS for approval. Owners or operators of offshore pipelines, which carry by far the largest volume of oil, condensate, and other wet product, are required to operate pipelines in compliance with the approved plan. All OSRP's are reviewed and updated every 2 years or otherwise revised when circumstances (bad spills, change of owners, etc.) warrant. New pipeline rights-of-way that go ashore require an environmental impact analysis before approval. In the absence of swift and effective action by the responsible party for a spill, the U. S. Coast Guard will initiate action pursuant to the Oil Pollution Act (OPA) to control and clean up a spill offshore under regional area contingency plans which have been developed for this scenario.

For onshore operations supporting the OCS program, oil spill response planning is regulated by the Texas General Land Office through the approval of facility, vessel, and pipeline response plans. This state agency, as well as the U. S. Coast Guard, is empowered by state and federal OPA's to act to reduce impacts when necessary and appropriate.

STATUS OF LISTED SPECIES

The red wolf *Canis rufus*, although originally listed as endangered in Texas, no longer occurs there in the wild. The Arctic peregrine falcon *Falco peregrinus tundrius* has recovered sufficiently to be delisted for purposes of section 7. The nine species below occur in Texas coastal counties and are all endangered, but are not likely to be affected by the proposed action.

Aplomado falcon *Falco femoralis*
American peregrine falcon *Falco peregrinus anatum*
Attwater's greater prairie-chicken *Tympanuchus cupido attwateri*
red-cockaded woodpecker *Picoides borealis*
black lace cactus *Echinocereus reichenbachii var. alberti*
Slender-rush pea *Hoffmannseggia tenella*
Texas prairie dawn *Hymenoxys texana*
South Texas ambrosia *Ambrosia Cheiranthifolia*
Bald Eagle *Haliaeetus leucocephalus*

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The following species are found along the shores of beaches and bays of the Texas Gulf coast and may be affected by the proposed oil and gas lease sale.

LISTED BIRDS

Piping Plover ***Charadrius melodus***

The piping plover is listed as endangered in the Great Lakes watershed and as threatened in the remainder of its range, including Texas. This species has three primary breeding areas: the mid-continent prairies, the beaches of Lake Superior and Lake Michigan, and the Atlantic coast from South Carolina to Florida. The first two breeding populations use the Gulf coast as an extended wintering area which includes virtually every month of the year with greatest occurrence between August and May. Preliminary information indicates that Texas is the most important wintering area. The estimated world population is 4,000 birds with at least 400 wintering in Texas (Haig and Oring 1985). More recent work (Eubanks 1994) demonstrates that an even larger population uses the Texas beaches and bay shores to winter.

On the mid and upper coasts of Texas, the sand flats found along inland bay passes provide the principal habitat for plovers. On the lower coast, the passes are much less important and the plover use the extensive sand flats of the Laguna Madre (notably the algal flats of the lower Laguna Madre) where it feeds on surface and infaunal invertebrates. While passes through barrier islands tend to concentrate the birds which use them, the extensive flats on the lower coast are used by loosely knotted flocks with little territoriality, suggesting that food and/or space is not a problem affecting behavioral biology there. At other beaches and bay shores of Texas barrier islands individual plovers can be found with some regularity.

Brown Pelican ***Pelecanus occidentalis***

Historic threats (pesticides and illegal killing) to the brown pelican, which resulted in it being listed as endangered in 1970, have essentially been eliminated. Numbers of birds have increased and the population is now relatively stable along the coast of Texas; however, this pelican is extremely susceptible to disturbance from island intruders or low-flying aircraft and will abandon nests when disturbances are frequent.

Nesting habitat of these colonial birds is found on small coastal islands in salt and brackish waters. Nests are constructed from available vegetation. The major food of the brown pelican is fish, including menhaden, mullet, sardines, and pinfish. The brown pelican catches fish by plunge-diving in coastal waters. Nesting islands are often chosen near channels where shipping and shrimping operations make fish easily available to nesting pairs. These pelicans are rarely found away from saltwater and typically do not venture more than 20 miles out to sea. The timing of pelican breeding activity can vary from year to year, beginning as early as February 15 and ending as late as September 1.

In 1993, more than 500 pairs of brown pelicans nested at only three sites in Texas--Pelican Island in Nueces County, Sundown Island in Matagorda County, and Little Pelican Island in Galveston County. At times during the past 6 years, brown pelicans have also nested at Dressing Point Island and Dog Reef Island in Matagorda County, Cedar Lakes Island in Brazoria County and Second Chain of Islands in Aransas County. The number of nest sites is expected to increase in the future as the brown pelican population expands.

Whooping Crane *Grus americana* B-9

The wintering range of the entire reproducing wild population of the whooping crane is found along the Texas coast, including critical habitat in Aransas, Calhoun, and Matagorda counties within the Aransas National Wildlife Refuge and adjacent lands and waters. In recent years, as the population of whoopers has increased, there has been a tendency for some to defend smaller winter territories than in the past, which results in more whoopers per unit of area in the traditional use areas. Others, though, are wintering away from these areas. These birds wade-fish for crabs and clams in tidal flats, shallow bays and channels in and around the refuge.

Eskimo Curlew *Numenius borealis*

The Eskimo curlew was listed as an endangered species on March 11, 1967. This formerly abundant shorebird previously nested in the Arctic tundra and wintered in southern South America. The population decreased drastically in the 1880's, apparently from spring market hunting (Gallup et al. 1986). Since 1945, there have been eleven sighting of one or more Eskimo curlews on the Texas coast. The more recent sighting on May 7, 1981, was of 23 birds on Atkinson Island in Galveston Bay. Habitats include sand flats, grassy marshes, and grazed pasture. The most recent sighting anywhere was of six birds on Kendall Island, Northwest Territories, Canada on July 10, 1985.

LISTED SEA TURTLES

The Service has responsibility for sea turtles when they come ashore to nest. The National Marine Fisheries Service has jurisdiction for sea turtles in the marine environment. Even though sea turtles are wide ranging and have distributions outside the United States, the Service believes that U. S. populations qualify for separate consideration under section 7.

For at least two decades, several factors have contributed to the decline of sea turtle populations along the Atlantic and Gulf coasts. Turtles have been victims of commercial over-utilization of eggs and turtle parts, incidental catches during commercial fishing operations, disturbance of nesting beaches by coastal housing, and the consequences of marine pollution and debris. The reproductive strategy of sea turtles involves producing large numbers of offspring to compensate for high natural mortality through the first several years of life; however, excessive exploitation of turtles has increased mortality beyond what can be compensated for through high natality. Therefore, activities that continue to affect the survivability of turtles on their remaining nesting beaches, particularly the high-density nesting beaches, will seriously reduce the ability of the Service to conserve sea turtles.

The leatherback sea turtle *Dermochelys coriacea*, the green sea turtle *Chelonia mydas,* and the hawksbill sea turtle *Eretmochelys imbricata*, are all found in Texas coastal waters but do not come ashore to nest. The endangered leatherback is the most pelagic and is normally found in the deeper waters of the Gulf where it may undertake extensive migrations. The endangered hawksbill nests on scattered islands and beaches between 25 degrees North and South latitude including beaches in southeastern Florida and the states of Campeche and Yucatan in Mexico. Young hawksbills are seen with some regularity in Texas waters since northern currents carry them from natile beaches in Mexico. They are normally found as adults in the U.S. only among the coral reefs of southern Florida and the Florida Keys. The green sea turtle is listed as threatened in all of its range except the waters of Florida and the Pacific coast of Mexico, where it is

endangered. Known nesting sites include southern Florida beaches and scattered locations on the Yucatan Peninsula in Mexico. Juvenile green sea turtles can occasionally be found in south Texas bays and lagoons where they feed on seagrasses and algae, often staying in one place for several months.

Kemp's Ridley Sea Turtle ***Lepidochelys kempii***

The Kemp's Ridley sea turtle is the smallest and most endangered of the sea turtles. Adults reach maturity in about 15 years although it appears that the time to maturation may be considerably longer than once believed. Kemp's Ridley's are found almost completely in the Gulf of Mexico where they feed on pelagic foodstuffs, especially crabs. Except for sporadic nests on Padre Island National Seashore in Texas and at scattered locations on the Mexican Gulf coast, the entire population of this species nests on approximately 17 miles of beach at the Playa del Rancho Nuevo in the state of Tamaulipas, Mexico (Hopkins and Richardson 1984). Nests are selected on well-developed dunes in remote areas adjacent to large marsh complexes or shallow embayments. They nest during the daytime, often in groups called "arribadas". Turtles nest annually from April to June and an individual may nest as many as three times a season. Clutch size averages around 100 eggs.

Since 1978, the Service has been involved in an international cooperative project designed to establish nesting sites for the Kemp's Ridley in the United States. Eggs are collected in Mexico, transported to Padre Island National Seashore, and placed in artificial nests. Up until 1993 hatchlings were released from these nests into the water, and then immediately recaptured and raised in "head start" facilities until they were mature enough to be released into the Gulf. It is hoped that turtles imprinted for Padre Island nesting sites will return there when sexually mature. Over the last 2 years several nests have been found on Padre Island indicating that adults from this program have matured and are returning to the experimental beaches to nest.

Loggerhead Sea Turtle ***Caretta caretta***

The loggerhead sea turtle is threatened throughout its range along the southern Atlantic and Gulf coasts. Loggerheads are widely distributed and can be found several hundred miles out to sea or inshore in bays, channels, and shallow marshes. Adults reach maturity in 25 to 30 years when their diet shifts somewhat from pelagic crabs, jellyfish and such to nearshore benthic invertebrates. There are distinct nesting populations on the coasts of the Florida panhandle and the Yucatan Peninsula. Nests can also be found occasionally along other areas of the Gulf coast including the Chandeleur Islands in Louisiana and North and South Padre Island (or at scattered sites elsewhere) in Texas. The loggerhead nests every 2 to 3 years from May to August, usually at nighttime. Sites selected for nesting are high energy, low profile beaches only a few feet above the water. Several clutches may be laid in a given season; clutch size is about 125 eggs.

LISTED MAMMALS

The jaguarundi *Felis yagouaroundi cacomitli* was listed as an endangered species on June 14, 1976. This small nocturnal cat is very elusive and difficult to study. About twice the size of a domestic cat, it has two color phases, one grayish, the other reddish. Males are about 3.5 feet long, of which the tail is more than half (Davis 1974). It is thought to occur in the lower Rio Grande valley with sporadic unconfirmed sightings as far north as Brazoria County. Loss of its prime habitat--large tracts of native brushlands--to extensive agricultural land conversion in the valley has reduced the population of this cat to extremely low numbers. Less than 5 percent of usable habitat still remains within the range of the jaguarundi.

The ocelot *Felis pardalis* was listed as an endangered species on July 21, 1982. This spotted cat is also relatively unstudied. Adult males may be as much as 3 feet-10 inches long, females up to 3 feet, and weigh 20-35 pounds (David 1974). In the United States, the ocelot is confined to native brushlands in the lower Rio Grande valley, and a small area of southeast Arizona. Predator control activities and brush clearing for crop production on the rich soils of the valley have reduced the population to perhaps less than a 100 individuals.

ENVIRONMENTAL BASELINE

The environmental baseline for listed species includes a consideration of collective effects of past and ongoing human and natural factors leading to the current status of the species. The effects of this proposed action, including both direct and indirect effects as well as other interrelated or interdependent actions are then added to the baseline to determine possible jeopardy or take.

Historical spill records provide the database used to predict the number and severity of oil contamination in the Gulf of Mexico. Possible sources of OCS-related oil contamination include blowouts, crude oil and diesel spills from platforms, barge and shuttle tanker spills, and crude oil spills from pipelines. There have been a number of blowouts from offshore oil and gas operations but most have resulted in spills small enough not to pose a threat to shore. The large spills of crude oil and diesel oil (1,000 bbl or larger) from platforms and pipelines pose the worst threat to the coastline because they persist on the water for a long enough time to make landfall. Smaller spills are weathered, treated with dispersants, or otherwise dissipate naturally in the environment and do not pose a significant threat because they have little likelihood of reaching land. There have been no large spills from OCS platforms since 1980. There are no shuttle tanker operations presently in place. There have, unfortunately, been six large crude oil spills from offshore pipelines since 1981 posing the most serious threat to shore environments from offshore activities.

There have been no documented occurrences of oiling of any listed species other than sea turtles while using the beaches of the Texas coast and we can conclude that spills related to the OCS leasing program in the Gulf have not contributed in any identifiable way to the present status of the species considered in this opinion.

EFFECTS OF OIL CONTAMINATION

Oil and gas production resulting from a lease sale (the proposed action) will inevitably lead to oil spills offshore which could reach coastal habitat used by listed species. The impact may be small when considering an individual lease sale but could be significant when considering recovery of all anticipated resource estimates in the Gulf of Mexico. MMS used an Oil Spill Risk Analysis (OSRA) to evaluate spill risk for low and high production rates from a typical OCS lease sale and from the overall OCS Program in the Gulf. Only large spills greater than 1,000 bbl were considered since smaller spills between 50 and 1,000 bbl had little likelihood of making landfall unless they occurred from pipeline breaks near shore (it was assumed that there would be 2 to 3 smaller oil spills actually reaching land during the production life of the OCS Program).

The OSRA first addressed the probability that a large spill would occur based on past experience from platforms and pipelines and from import tanker experience. Spill rates were developed using the relationship

between historical spills and amount of oil produced or handled. An oil spill trajectory analysis was then conducted to predict the probability that a spill, once it has occurred, would reach a certain environmental coastal resource and contaminate habitat of listed species. Finally, spill and landfall probabilities were combined in a broad analysis of the overall threat to habitat from the Gulfwide OCS Program.

The OSRA showed that there is a 2 to 15 percent chance that one or more large spills would occur as a result of an individual lease sale (ranging from no spills under low production to 1 spill under high production). For production of all reserves in the Gulf there would be virtually a 100 percent chance that one or more large spills would occur (spills would average from 19 to 26 large spills at a rate of 1 large spill every 6-8 years from a platform and 1 large spill every 2-3 years from a pipeline).

Once a large spill is released, its path was modeled to determine the probability that a spill from a discreet origin, such as a platform location or a pipeline, would reach certain environmental resources during 3, 10, and 30-day post spill periods. The highest probability for contact occurred when a large spill originating from a near shore pipeline reaches the nearest resource; for example, there is a 31 percent probability that a large oil spill from a pipeline offshore of Bolivar Roads or San Luis Pass would pass into Galveston Bay or West Bay within 3 days and contaminate resources there. This probability rises to 59 percent at Bolivar Roads and 44 percent at San Luis Pass for the 30-day analysis.

Evaluation of combined probabilities for all activities involved in the Gulf OCS Program shows a small chance of a landfall on the Texas coast from a large spill during the first 3 days but a high chance for landfall if the spill persists for a 30-day period. The analysis predicted a 5 to 8 percent chance of a spill entering Galveston and West Bays within 3 days, but a 60 to 73 percent chance of such a spill entering these bays within 30 days. As this analysis shows, high spill probabilities from Gulfwide OCS activities represent a significant threat to environmental resources which might support listed species.

The severity of impact from oil approaching the Texas coast can not be considered by the model because it does not account directly for loss of volume from volatilization or sinking, other types of weathering, or spill response actions such as burning, use of dispersants, installation of barriers, and cleanup. The quickness and efficiency of a response to a spill often determine how bad the impact will be. Each oil company has an oil spill response plan approved by MMS. Most oil companies work cooperatively in this effort through Clean Gulf Associates (CGA). CGA stores pollution control equipment at two locations in Texas (Ingleside and Galveston), each equipped with fast response skimmers. In good weather conditions, fast response with oil booms, skimmers, etc. would require about 17 to 19 hours. The company involved would activate an Emergency Response Team to monitor the path of the spill and determining an appropriate response mode for any biologically sensitive areas under threat.

OCS-related oil spills can also occur in inland waters along the Texas coast as a result of crude oil transport in pipelines and barges, fuel and crude oil transfer operations, and leakage from storage and refining facilities. Non-OCS activities, such as oil production in state waters and the importation and coastwise transport of crude oil and petroleum products in tankers and barges, are discussed later under cumulative impacts. Records are not accurate enough to separate OCS-related spills from spills caused by other activities. Spills related to OCS operations were therefore estimated to be about 6 percent of all inland spills based on volume of OCS oil handled inshore compared to oil handled from other sources. This translates into 75 to 100 small spills and 1 large spill each year from the array of OCS activities, and 1 large spill every 4 years from an onshore pipeline break. Response time for inland spills can be very quick since transportation of equipment to a site is much easier logistically than mobilizing for an offshore spill;

nevertheless, the time to impact from an inland spill can likewise be very quick so efficient response plans and knowledgeable crews are necessary to prevent significant impacts.

Below is a description of the nature of the impact from oil contamination on listed birds and turtles. Impacts to the jaguaroundi and ocelot are discussed in the section which follows dealing with the growth of OCS-related infrastructure.

IMPACTS TO BIRDS

Brown Pelican ***Pelecanus occidentalis***

Pelicans are susceptible to spilled oil in several ways. As they dive for fish, their body can be coated with oil. This may contribute to direct mortality (King et al. 1979) or could result in reduced hatchability when oil is transferred from the feet and feathers of parents to the eggs. Even though island nesting sites in Texas are partially protected from the direct impact of an oil spill by barrier islands, the wide-ranging nature of the bird when foraging would amplify the possibility of nest contamination. Even very small amounts of certain crude and refined oils applied to the surface of eggs cause high embryonic mortality or morphological abnormalities in a variety of avian species (Albers 1982, King and Lefever 1979, Lewis and Malecki 1984, White et al. 1979). If a serious oil spill should occur near a nesting island during the peak of the reproductive season, it is possible that the entire population of the young of the year could be lost along with a large number of adults.

There is a reasonable probability that an oil spill from the proposed lease sale could enter the passes into Galveston Bay or Corpus Christi Bay and landfall on the nesting islands for the brown pelican. There is, of course, no way to predict whether it would coincide with nesting or if it could be contained sufficiently to prevent any damage. Pelicans are sensitive to disturbance so preventive measures, such as dispersal noises or the use of booms and skimmer equipment, might have as much damage as the oil itself by disrupting the nesting process.

Piping Plover ***Charadrius melodus***

The important habitats used by the piping plover are subject to heavy disturbance from recreational use, and are also susceptible to damage from oil spills. Although shorebirds have a tendency to avoid oiled beaches, this does not totally eliminate direct oiling of birds. In addition, an oil spill forces birds to use fewer desirable feeding areas until the cleanup is completed. There is also some evidence of long-term reduction of infaunal populations following an oil spill. This could lower the habitat quality of prime wintering sites for an undetermined period. Because the plover has such restricted requirements for wintering habitat, it is one of the species that could be most severely damaged by an oil spill, especially if long stretches of beach are oiled or a prime wintering area at one of the tidal passes is hit.

Whooping Crane ***Grus americana***

Oiled waters in whooping crane habitats could pose a considerable threat if a spill occurred between November and late April, when the whoopers are on their wintering grounds. As with brown pelican nesting sites, this wintering habitat is protected to some extent from oil spills in the open Gulf by barrier islands, but

the loss of even a relatively small portion of a population, estimated to consist of approximately 110 individuals, could cause serious delays in the recovery of the species.

Eskimo Curlew *Numenius borealis*

This species is nearly extinct, so the loss of even one individual would be very serious. The Texas coast was, and possibly is, a regular stopping point on its spring migration (fall migration was primarily over the Atlantic Ocean off the eastern U.S.). Eskimo curlews could be killed or injured if an oil spill striking the bay shores of Texas estuaries during the period of migration.

IMPACTS TO SEA TURTLES

Oil spills hitting the nesting beaches of Kemp's Ridleys or loggerheads could have significant impacts depending upon the amount of weathering the oil has undergone, the height of deposition on the beach, and the stage of nesting (Fritts and McGehee 1982). Impacts will be different depending upon whether the oil hits the beach before nesting, during nest preparation, or later during incubation and migration of hatchlings to the sea. Studies of the effects of residual petroleum on the development and survival of marine turtle embryos are inconclusive. These studies indicate that oil remaining on the beach approximately 1 year after a spill did not cause significant mortality to sea turtle embryos, most likely because oil-coated sand is displaced when nests are excavated for egg-laying. On the other hand, the impacts of a fresh oil spill on nesting beaches would be significant if oil coated the beaches during the nesting season. Fresh crude oil deposited on sand above a nest can cause extensive mortality to incubating sea turtle eggs. Fritz and McGehee (1982) noted that sea turtle eggs were damaged by contact with weathered oil released from the *Ixtoc* spill in 1979 which oiled the Rancho Nuevo beaches.

Oil collecting at beaches through which nesting adults or retreating hatchlings must pass can also affect the survivability of turtles in several ways. Damage can occur by toxic ingestion with blockage of the digestive tract or internal and external inflammatory responses including infection or poisoning. Most impacts are believed to be sublethal but little are known about the impacts of chronically ingested oil accumulating in organs. There is little doubt that long-term chronic impacts will affect the survivability of turtles, both young and old. More definitive information is needed to assess the impacts of oiling on sea turtle nesting beaches; unfortunately, this must wait until an oiling incident again occurs.

It has been suggested that the release of some chemical substance guides the turtle on its return from the sea to the natal beach for nesting (Lutz et al. 1986). Oil on a potential nesting beach could interfere with these chemical guides and confuse potential nesters or cause them to move to less desirable sites or not nest at all.

There is extremely little chance that a spill from a pipeline or well site would hit a nesting beach on Padre Island or the state of Tamaulipas. Combined probabilities give the same result. There is little reason to believe that spills from activities associated with the proposed lease sale would have a measurable impact on nesting sea turtles or incubating young.

EFFECTS OF COASTAL INFRASTRUCTURE

There are 16 refineries and 26 gas processing plants now on the Texas coast. No new refineries will be built, but several new gas processing plants can be expected to handle deepwater production. Other types of service and support facilities should be adequate to handle future production with little additional need for habitat displacement. No new coastal infrastructure is projected to be built on barrier beaches and dunes. The one notable exception is the significant increase of pipeline landfalls and miles of onshore pipelines, along with an increase in pipeline shore facilities. This infrastructure is expected to double during the life of the OCS Program. Pipeline landfalls are usually built using non-intrusive methods which would not significantly impact barrier beaches. On the other hand, pipeline shore facilities and onshore pipelines could have an impact on coastal habitat including the brushland habitat of the jaguarundi and ocelot unless sites and routes are planned to prevent such impacts.

Although many onshore pipelines and pipeline shore facilities do not require Federal approval, the Service has the opportunity to identify impacts to listed species through the Section 10 take permit program which requires the development of a habitat conservation plan to reduce losses. This would be an especially important mechanism where MMS has no regulatory authority and no wetland habitat is involved which would be reviewed under the Department of the Army permit program.

CUMULATIVE EFFECTS

The vast majority of non-OCS related oil spills offshore would come from import tankers and from barges carrying state-produced crude. The worst of these spills would come from import tankers which could be expected in any year to dump an average of 26,000 bbls of oil into the Gulf. Barge spills would occur at a rate of 5,500 bbls spilled every 2 to 3 per year. These spills approach the total volume of oil spilled from OCS platforms and pipelines. Large tanker spills have the greatest chance of reaching nesting beaches and islands along the Texas coast with devastating results. They are also responsible for much of the oiling of maritime sea turtles which affects successful nesting by killing or disabling mature adults. This is important because turtles take so long to reach maturity and the death of a mature turtle is much more serious than the death of hatchlings and 2-3 year olds.

Spills inshore would be more likely to affect bayshore habitats used by plovers or the nesting islands of the brown pelican. Large inshore spills would occur primarily from tankers and barges while at dock or during coastwise transport of crude oil and petroleum products in barges and pipelines. Tanker spills would occur at the rate of 1 per year; barge spills at 7 to 8 per year; and pipeline spills at 2 to 3 per year. These non-OCS related spills account for 94 percent of all inshore spills, so the impacts would be much more serious than those from the proposed action.

The impact of commercial shrimping in taking maritime turtles is well known. This poses the greatest threat to recovery of turtles and should be the major focus of impact-reducing efforts. Turtles must survive in the open sea for long periods of time before they mature and return to natal beaches. Oiling of mature adults when they come ashore to nest is far less consequential than drowning of adults in trawls.

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CONCLUSION

The occurrence of spills is fundamentally a matter of probability and no one can certify the amount of oil that will be produced, or the size or likelihood of a spill that would occur, during the production life of either an individual lease sale or the entire OCS Program in the Gulf. Statistics on producing acreage and amount of oil produced over the last 20 years indicate that oil production on the OCS has been steady (about 6 million acres leased producing about 300 million barrels of crude each year). This trend is expected to continue at a rate similar to or slightly higher than past production.

Listed birds and turtles use the shores and islands of the Texas coast at certain times of the year so the severity of an oil spill would depend upon coincidence between the contact of a spill with habitat and its use at that time. It is possible that even one spill could be devastating if the probability is high enough and if the spill happens at a time and location so as to harm a number of individuals. The speed and effectiveness with which these spills are contained and cleaned up will determine the extent of the impact. There have been few instances when a spill is so imminent, the weather too inclement, or the volume of spilled oil too large to implement meaningful spill control measures presently in place. We have no reason to predict a devastating spill based upon the information which we now have.

After reviewing the environmental baseline leading to the current status of listed species along the Texas coast and the effects of the proposed lease sale including interdependent and interrelated activities, it is the Service's biological opinion that oil and gas activities associated with this lease sale are not likely to jeopardize the continued existence of the brown pelican, whooping crane, eskimo curlew, piping plover, sea turtles which nest on Texas shores, or the jaguarundi and ocelot in native Texas brushlands. Critical habitat for the whooping crane has been designated in and around the Aransas National Wildlife Refuge, however, no destruction or adverse modification of critical habitat there is anticipated.

INCIDENTAL TAKE STATEMENT

Sections 4(d) and 9 of the Act, as amended, prohibit taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct) of listed species of fish or wildlife without a special exemption. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is any take of listed animal species that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The Service does not anticipate that activities associated with the proposed lease sale will incidentally take any of the listed species considered in this consultation. This conclusion is based on existing spill response requirements that shore or island habitat of listed species is properly identified in spill response plans and quick, effective action is taken to protect these areas and the species using them from a spill.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. The conservation recommendations are discretionary agency activities that could minimize or avoid adverse effects of a proposed action on listed species or critical habitat, help implement recovery plans, or develop information.

The Service is providing the following recommendations to promote the conservation and recovery of the species that are the subject of this consultation:

1. MMS should ensure that all oil spill area contingency plans identify important habitats used by listed species and require the early and effective use of chemical dispersants to avoid contact with trajectory beaches. Plans prepared for nesting beaches of sea turtles should provide for removal of eggs from beaches that are imminently expected to receive spilled oil. The eggs should be incubated and the young turtles released in an uncontaminated area.

2. To avoid disturbance of brown pelican nesting activities, we recommend all aircraft, both helicopter and fixed-wing, be required to avoid flying lower than 1,000 feet above ground level or within a 2,000 foot perimeter around an island containing a nesting colony. Currently, the pelicans are nesting on Pelican Island in Corpus Christi Bay, Sundown Island in Matagorda Bay and Little Pelican Island in Galveston Bay. We also recommend that the MMS contact the Service on a yearly basis for any changes in brown pelican nesting locations.

3. To avoid disturbing wintering whooping cranes, all aircraft should fly above 1,000 feet over Aransas National Wildlife Refuge; whooping crane critical habitat in Aransas, Calhoun and Refugio counties; Blackjack Peninsula; the northern ½ of San Jose Island; and the southern 2/3 of Matagorda Island unless needed to disperse cranes from oiled habitat.

In order for the Service to be kept informed of actions that either minimize or avoid adverse effects or that benefit listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations. Additionally, the applicant should coordinate with the Service on the development and planning stages for the implementation of any of these conservation recommendations.

RE-INITIATION NOTICE

This concludes formal consultation on the proposed lease sale. As required by 50 CFR §402.16, reinitiation of formal consultation is required if:

1. the amount or extent of incidental take is exceeded;

2. new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion;

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3. the agency action is subsequently modified in a manner that caused an adverse effect to the listed species or critical habitat that was not considered in this opinion; or

4. a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending re-initiation.

The Service appreciates the opportunity to provide input to promote conservation of threatened and endangered species. If we may be of further assistance, please contact Fred Werner at 281/286-8282.

Sincerely,

Carlos H. Mendoza
Project Leader

cc:
Deputy Assoc Dir for Resources and Environmental Management, MMS. Washington, DC
Regional Director, ATTN: ARD-Ecological Services, Region 2, Albuquerque, NM
Regional Director, ATTN: ARD-Ecological Services, Region 4, Atlanta, GA
Project Leader, Panama City Field Office, Panama City, FL

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National Marine Fisheries Service

Biological Opinion

Gulf of Mexico

Sales 171, 174, 177, and 180

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, Maryland 20910

B-23

6 1998

Ms. Carolita U. Kallaur
Associate Director for
Offshore Minerals Management
Minerals Management Service
Washington D.C. 20240

Dear Ms. Kallaur:

The biological opinion on the Gulf of Mexico Outer Continental Shelf (OCS) multi-year oil and gas lease sales for the Central and Western Planning Areas is enclosed. Consultation on these sales, requested by letters dated May 6 and September 9, 1997, respectively, was combined as discussed during a meeting between National Marine Fisheries Service Southeast Region and Minerals Management Service (MMS) Gulf of Mexico OCS staff on October 27, 1997. This biological opinion replaces the November 2, 1987 opinion on OCS activities associated with the lease sale program. New information including the 1997 draft environmental impact statements on the multi-year lease sales, observations from aerial and ship board surveys conducted for MMS since 1989, and the ongoing shift in oil and gas development activities into deeper waters, were considered in this consultation.

Based on our review of the best available information, we conclude that the proposed multi-year lease sales and associated activities including oil and gas exploration, development, production and non-explosive abandonment may adversely affect but are not likely to jeopardize the continued existence of listed species, including sperm whales, sea turtles and Gulf sturgeon. (The use of explosives to remove oil and gas structures in the Gulf of Mexico is being considered under a separate and ongoing consultation.) Minerals Management Service (MMS), under the authority and responsibility assigned to them by the Outer Continental Shelf Lands Act and the Oil Pollution Act, has implemented measures that appear to be effectively reducing the likelihood of direct impacts of oil and gas activities on the environment. Despite these precautions, the proposed actions may result in the injury or mortality of loggerhead, Kemp's ridley, green, hawksbill, and leatherback sea turtles and Gulf sturgeon. Therefore, pursuant to Section 7(b)(4) of the ESA, a low-level of incidental take that may occur annually is identified in the incidental take statement attached to the enclosed biological opinion. The incidental take level and associated requirements identified to monitor and minimize effects associated with oil and gas exploration, development, and production were discussed with MMS staff. Because immediate action may be necessary to

fulfill this condition, I would like to bring to your attention the requirement that surveys be continued to monitor the effects of OCS activities on protected species through continuation of GulfCet surveys or through participation with NMFS in ongoing spring and fall plankton surveys. Dr. Terry Henwood, in the NMFS Laboratory in Pascagoula (228 762-4591), can be contacted to discuss placement of listed species observers on the upcoming NMFS surveys.

I would like to commend you on the OCS region's ongoing efforts to assess the effects of oil and gas activities on protected species. The studies done to date have contributed to the continually improving quality and volume of information incorporated into the National Environmental Policy Act documents prepared for the lease sales. I look forward to a continued collaborative relationship with MMS to evaluate, monitor and minimize the impacts of OCS activities on listed species and to ultimately promote the recovery of those species.

Sincerely,

Hilda Diaz-Soltero
Director
Office of Protected Resources

Enclosure

cc: MMS Gulf of Mexico, OCS Region:
Oynes
Bull
Lang
MMS, Herndon - Wilson

Endangered Species Act - Section 7 Consultation

Biological Opinion

Agency: Minerals Management Service

Activity: Gulf of Mexico Outer Continental Shelf Oil and Gas Lease Sales: Central Planning Area Lease Sales 169, 172, 175, 178, and 182 Western Planning Area Lease Sales 171, 174, 177, and 180

Consultation Conducted By: National Marine Fisheries Service, Southeast Region

Date Issued: January 6, 1998

BACKGROUND INFORMATION:

In a letter dated May 6, 1997, Minerals Management Service (MMS) asked National Marine Fisheries Service (NMFS) to conduct a formal consultation, pursuant to Section 7(a)(2), on the Gulf of Mexico Outer Continental Shelf (OCS) Oil and Gas Lease Sales in the Central Planning Area for Lease Sale 169, 172, 175, 178, and 182, which are planned for April 1998, 1999, 2000, 2001 and 2002, respectively. Consultation on the Western Gulf of Mexico multi-year oil and gas lease sales, including sales 171, 174, 177, and 180, which are planned for August 1998, 1999, 2000, and 2001, respectively, was requested in a second letter dated September 9, 1997. Draft Environmental Impact Statements (DEIS) and an associated Oil Spill Risk Analysis were submitted for NMFS' review.

Section 7 consultations between MMS and NMFS regarding the impact of the Gulf of Mexico Outer Continental Shelf (OCS) oil and gas lease sales have been conducted since 1979, when a biological opinion of the effects of lease sales on listed species in the Southeast Region was issued. The opinion and subsequent consultations on annual lease sales considered only the impacts of the lease sales themselves. A consultation was conducted in 1987 to consider the effects of other actions associated with and resulting from lease sales, including exploration, development and non-explosive decommissioning. The consultation concluded with a biological opinion issued on November 2, 1987 that found that OCS oil and gas activities had the potential to adversely affect listed marine species. The scarcity of basic information on listed species in the Gulf of Mexico, however, precluded a

full assessment of the possible impacts, although they were thought to be minimal. No incidental take was authorized.

Since 1987, formal consultations on lease sales have concluded that there was no new information that changed the basis for the conclusions of the 1987 regional biological opinion, although data needs regarding the distribution, abundance, and status of marine mammals and sea turtles in the Gulf of Mexico were identified. MMS and NMFS have engaged in cooperative research since 1989, conducting aerial and vessel surveys to assess the distribution and abundance of cetaceans and sea turtles in the Gulf of Mexico, to address some of these data gaps. Additionally, MMS has indicated that future lease sales are likely to result in increased oil and gas development in waters 1,000 feet and over, known as the deep water area. Because the EIS' supporting these sales are the first documents considering the multi-year program, and due to the new information collected on surveys conducted since 1989, and the shift in oil and gas development into deep water, consultation on OCS activities resulting from lease sales was reinitiated to replace the 1987 opinion.

PROPOSED ACTION:

A complete description of the proposed actions can be found in the DEIS' prepared by MMS and submitted to NMFS on September 9, 1997, for the proposed multi-year lease sales.

Oil and natural gas has been produced in the Central and Western Gulf of Mexico for over 40 years. Over 1,000 oil fields have been identified in the Gulf, including 810 that were being developed or producing by 1993. MMS is the administrative agency that is responsible for the mineral leasing of submerged lands outside of state waters. The agency is also charged with the supervision of offshore operations after leases have been issued. Each year, MMS holds oil and gas lease sales for blocks within the Central and Western Planning Areas of the Gulf of Mexico Outer Continental Shelf. Each sale offers for lease all the unleased blocks within the planning areas. Only a small percentage of the blocks are expected to be leased, and only a portion of those leased are likely to be drilled and to support production.

The Central Gulf Planning Area (CPA) includes almost 48 million acres outside of the state waters of Louisiana, Mississippi, and Alabama. Water depths range from 4 to 3,400 meters (m). During each lease sale, all unleased blocks within the CPA are offered for lease. Regulations and lease stipulations have been implemented to reduce environmental risks. Each annual lease sale in the CPA may result in the production of 0.15 to 0.44

billion barrels of oil, and 1.53 to 4.39 trillion cubic feet of natural gas.

The Western Gulf Planning Area (WPA) consists of over 28 million acres offshore of Texas and Louisiana in water depths of 8 to 3,000 m. All unleased blocks are offered for lease in each sale except for some that occur in East and West Flower Garden Banks, which are within a designated marine sanctuary. Additionally, 3 blocks off of Mustang Island Texas have been removed from lease sales due to their use by the Navy for mine warfare training. Regulations and lease stipulations, including those outlined below, are in place to reduce environmental risks from the lease sales. MMS estimates that each annual lease sale could result in the production of 0.01 to 0.09 billion barrels of oil and 0.57 - 1.93 trillion cubic feet of natural gas.

MMS is responsible for regulating and monitoring all oil and gas operations in the Federal OCS, therefore this consultation considers the impacts of all activities associated with exploration, development, and production of oil and gas in the Central and Western Planning Areas of the Gulf of Mexico. Abandonment and subsequent removal of oil and gas structures in the Gulf is also considered except for the removal of structures using explosives. Explosive rig removals are being considered under a separate and ongoing consultation. The following overview provided by the MMS' OCS Region describes the regulations and programs implemented by MMS to ensure that operations resulting from the proposed lease sales in the Western and Central Gulf Planning Areas are orderly, safe, and pollution-free. Specifically, these programs reduce the risk of oil spill occurrence and provide requirements that will mitigate impacts should an oil spill occur.

Proposed oil and gas operations must meet or exceed the safety standards set by MMS. Regulations for oil, gas, and sulphur lease operations on the OCS are specified in 30 CFR 250. Regulations for geological and geophysical exploration operations on the OCS are specified in 30 CFR 251.

To assure OCS activities are conducted in a safe manner and to promote the prevention of oil spills and air pollution, the MMS requires the use of the Best Available and Safest Technology (BAST),as required by the Outer Continental Shelf Lands Act. This includes requirements for state-of-the-art drilling technology, production safety systems, completion of oil and gas wells, oil-spill contingency plans, pollution-control equipment, and specifications for platform/structure designs.

The MMS does a technical and safety review of all proposed platform designs and installation procedures. The operator must design, fabricate, install, use, inspect, and maintain all

platforms and structures on the OCS to assure their structural integrity for the safe conduct of operations at specific locations. Production safety equipment used on the OCS must be designed, installed, used, maintained, and tested in a manner to assure the safety and protection of the human, marine, and coastal environments. All tubing installations open to hydrocarbon-bearing zones below the surface must be equipped with safety devices that will shut off the flow from the well in the event of an emergency, unless the well is incapable of flowing. All surface production facilities must be designed, installed, and maintained in a manner that provides for efficiency, safety of operations, and protection of the environment.

Notice to Lessees (NTL 96-4N) requires operators to submit, for early technical and safety review by MMS, a Deep water Operations Plan (DWOP) for all operations in deep water and all projects using subsea technology. The DWOP requirement was established to address the different functional requirements of equipment in deep water, particularly the safety system requirements associated with subsea development systems, and the complexities and unique types of fixed and floating production facilities. The DWOP allows the MMS and industry to identify very early in the plan review process any potential issues specific to deep water operations.

Several regulations require a departure or alternative compliance approval to permit development operations to proceed in deep water areas of the Gulf. For the MMS to grant alternative compliance approvals, the operator must demonstrate an equivalent or improved degree of safety. A departure can be granted when necessary if the operator can demonstrate that an acceptable level of safety exists. The MMS safety, technical, and engineering review of departure requests can involve risk assessment and a review of hazards analyses.

The MMS evaluates the design and fabrication of pipelines. Operators are required to periodically inspect pipeline routes by methods prescribed by the MMS for any indication of pipeline leakage. Monthly over-flights are conducted to inspect pipeline routes for leakage.

The Oil Pollution Act (OPA) of 1990 requires removal of spilled oil and establishes a national system for planning for and responding to oil spill incidents. MMS responsibilities include spill prevention, oil-spill contingency plans, oil-spill containment and clean-up equipment, financial responsibility certification, and civil penalties. MMS regulations require that all owners and operators of oil handling, storage, or transportation facilities located seaward of the coastline submit an Oil Spill Response Plan (OSRP's) for approval before an owner/operator can use a facility. Owners or operators of

offshore pipelines are required to submit a plan for any pipeline that carries oil, condensate that has been injected into the pipeline, or gas and naturally occurring condensate; pipelines carrying essentially dry gas do not require a plan. To continue operations, the facility must be operated in compliance with the approved plan. All MMS-approved OSRP's are required to be reviewed and updated every two years.

The Gulf of Mexico has received "Special Area" status under MARPOL, thereby prohibiting the disposal of all solid waste into the marine environment. Fixed and floating platforms, drilling rigs, manned production platforms, and support vessels operating under a Federal oil and gas lease are required to develop Waste Management Plans and to post placards reflecting discharge limitations and restrictions. MMS regulations explicitly prohibit the disposal of equipment, cables, chains, containers, or other materials into offshore waters. Portable equipment, spools or reels, drums, pallets, and other loose items weighing 18 kg or more must be marked in a durable manner with the owner's name prior to use or transport over offshore waters. Smaller objects must be stored in a marked container when not in use.

The MMS established regulations at 30 CFR 250 to comply with the Clean Air Act. Regulated pollutants include carbon monoxide, particulates, sulphur dioxide, nitrogen oxides, hydrogen sulfide, and volatile organic compounds (as a precursor to ozone). These regulations allow the collection of information about potential sources of pollution for the purpose of determining whether the projected emissions of air pollutants from the facility may result in onshore ambient air concentrations above significance levels provided in the regulations and appropriate emissions controls as deemed necessary to prevent accidents and air quality deterioration. The MMS issued an NTL titled "Hydrogen Sulfide (H_2S) Requirements" to provide guidance on sensor location, sensor calibration, respirator breathing time, measures for protection against sulfur dioxide, requirements for classifying an area for the presence of H_2S, requirements for flaring and venting of gas containing H_2S, and other issues pertaining to H_2S-related operations.

Under MMS operating regulations and lease agreements, all lessees must remove objects and obstructions upon termination of a lease. Lessees must ensure all objects related to their activities were removed following termination of their lease.

The MMS conducts onsite inspections to assure compliance with lease terms, NTL's, and approved plans, and to assure that safety and pollution-prevention requirements of regulations are met. These inspections involve items of safety and environmental concern. If an operator is found in violation of a safety or

environmental requirement, a citation is issued requiring that it be fixed within 7 days.

The primary objective of initial inspections is to assure proper installation of mobile units or structures and associated equipment. After operations begin, additional announced and unannounced inspections are conducted. Unannounced inspections are conducted to foster a climate of safe operations, to maintain an MMS presence, and to focus on operators with a poor performance record. They are also conducted after a critical safety feature has previously been found defective. Annual inspections are conducted on all platforms, but more frequent inspections may be conducted on rigs and platforms. On-board inspections involve the inspection of all safety systems of a production platform. The MMS is cooperating with the USEPA in monitoring compliance with more restrictive water pollution controls, and MMS inspectors have assumed new duties in collecting water samples from offshore platforms and performing more visual inspections for discharged effluents.

Proper training of personnel is essential to ensure that offshore oil and gas operations are carried out in a manner that emphasizes operational safety and minimizes the risk of environmental damage. All operators must have trained personnel to operate oil-spill cleanup equipment or must retained a trained contractor(s) to operate the equipment for them. The Drilling Well-Control Training Program was instituted by MMS in 1979. In 1983, the Safety Device Training Program was established to ensure that personnel involved in installing, inspecting, testing, and maintaining safety devices are qualified.

SPECIES ACCOUNT:

Endangered

Sperm whale	*Physeter macrocephalus*
Green turtle*	*Chelonia mydas*
Leatherback turtle	*Dermochelys coriacea*
Hawksbill turtle	*Eretmochelys imbricata*
Kemp's ridley turtle	*Lepidochelys kempii*

Other endangered whales, including North Atlantic right whales (*Eubalaena glacialis)* and humpback whales (*Megaptera novaengliae*), have been observed occasionally in the Gulf of Mexico. The individuals observed have likely been inexperienced juveniles straying from the normal range of these stocks. NMFS does not believe that there are resident stocks of these species in the Gulf of Mexico, and these species are not likely to be adversely affected by projects in the Gulf.

*Green turtles in U.S. waters are listed as threatened except for the Florida breeding population which is listed as endangered. Due to the inability to distinguish between these populations away from the nesting beach, green turtles are considered endangered wherever they occur in U.S. waters.

Threatened

Loggerhead sea turtle	*Caretta caretta*
Gulf sturgeon	*Acipenser oxyrinchus desotoi*

BIOLOGY AND DISTRIBUTION

Sperm Whale (*Physeter macrocephalus*)

There are estimated to be two million sperm whales worldwide. Generally, they are distributed between 60° N latitude and 60° S latitude throughout the world's oceans (Leatherwood and Reeves 1983, Rice 1988, Brownell *et al.* 1989). In the western North Atlantic they range from Greenland to the Gulf of Mexico and the Caribbean. The sperm whales that occur in the eastern US EEZ are believed to represent only a small portion of the total western Atlantic population (Blaylock *et al.* 1995).

Sperm whales are found year-round in the Gulf of Mexico, suggesting that there may be a discrete stock in the Gulf (Schmidly 1981). The Gulf of Mexico cetacean surveys (GulfCet surveys) conducted in recent years were designed to establish the relative abundance and distribution of marine mammals on the continental shelf, and have not encompassed the entire range of this stock. The resultant population estimates calculated from these surveys, therefore, are minimum estimates. The draft 1996 stock assessment identified an estimate of 411 sperm whales for the Northern Gulf of Mexico stock, based on a 1991-1994 average abundance estimate of 530 sperm whales (Waring *et al.* 1997). Abundance estimates from the GulfCet surveys give a range of 295 to 953 sperm whales in the Gulf (Hansen *et al.* 1996).

Sperm whales were hunted in America from the 17th century through the early 1900's. The exact number of takes in the commercial fishery is not known (Townsend 1935). The International Whaling Commission estimates that nearly a quarter-million sperm whales were killed worldwide in whaling activities between 1800 and 1900 (IWC 1969). With the advent of modern whaling the larger rorqual whales were targeted. However as their numbers decreased, greater attention was paid to smaller rorquals and sperm whales. From 1910 to 1982 there were nearly 700,000 sperm whales killed worldwide from whaling activities (IWC Committee for Whaling Statistics 1959-1983).

In most areas sperm whales are found in waters greater than 180 meters in depth. While they may be encountered almost anywhere on the high seas their distribution appears to be associated with continental margins, sea mounts, and areas of upwelling, where food is abundant (Leatherwood and Reeves 1983). They have been sighted throughout the oceanic Gulf of Mexico, but appear to concentrate in continental slope waters, especially in the region of the Mississippi River Delta (Mullin *et al.* 1994, Hansen *et al.* 1996, Davis and Fargion 1996). Sperm whales feed primarily on medium to large-sized mesopelagic squids *Architeuthis* and *Moroteuthis*. Sperm whales, especially mature males in higher latitude waters, also take significant quantities of large demersal and mesopelagic sharks, skates, and bony fishes (Clarke 1962, 1980).

Sperm whale populations are often organized into two types of groupings: breeding schools and bachelor schools. Older males are often solitary (Best 1979). Breeding schools consist of females of all ages, and juvenile males. The mature females ovulate April through August in the Northern Hemisphere. During this season one or more large mature bull temporarily joins each breeding school. A single calf is born at a length of about 4 meters after a 15 month gestation period. A mature female will produce a calf every 3-6 years. Females attain sexual maturity at the mean age of 9 years and a length of about 9 meters. Males have a prolonged puberty and attain sexual maturity at about age 20 and a body length of 12 meters. Bachelor schools consist of maturing males who leave the breeding school and aggregate in loose groups of about 40 animals. As the males grow older they separate from the bachelor schools and remain solitary most of the year (Best 1979).

Nine sperm whale strandings were documented in the northern Gulf between 1987 and 1994. Vessel strikes may have caused the mortality of one of these whales, which had deep prop scars through the dorsal ridge. Cause of death could not be assigned to the other sperm whale carcasses (Waring *et al.* 1997). No sperm whale mortalities associated with oil and gas exploration, development or production activities have been documented.

SEA TURTLES

Five species of sea turtles occur in Gulf of Mexico waters. Kemp's ridley and loggerhead turtles are the most common turtle species found in the Gulf as evidenced by strandings. However leatherbacks are not uncommon and hawksbill and green turtle stranding and incidental captures are documented regularly. Recovery Plans developed for each sea turtles species, and the *1995 Status Reviews for Sea Turtles Listed under the Endangered Species Act of 1973* (NMFS and USFWS 1995) provide extensive

descriptions of the biology, distribution, and population trends for these species.

Historical accounts of the occurrence of sea turtles in Texas, Louisiana, and Florida waters are consistent with current observations, although fluctuations in populations are apparent (Fuller 1978, Cox and Mauermann 1978, and Fuller and Tappan 1986).

Few sea turtle mortalities have occurred in association with Gulf of Mexico oil and gas development and production activities. Sea turtle mortalities occurred in 1993 after a freighter hit two barges transporting fuel from Mississippi and Louisiana to Tampa, Florida. Sea turtle takes have also been attributed to explosive rig removals (Klima *et al.* 1988). No sea turtle takes by injury or mortality due to other oil and gas production activities in the Gulf of Mexico have been documented. Commercial fisheries remain the major known direct cause of sea turtle takes.

Green turtle (*Chelonia mydas*)

Green turtles are distributed circumglobally, mainly in waters between the northern and southern 20°C isotherms (Hirth, 1971). Green turtles were traditionally highly prized for their flesh, fat, eggs, and shell, and fisheries in the United States and throughout the Caribbean are largely to blame for the decline of the species.

In the western Atlantic, several major nesting assemblages have been identified and studied (Peters, 1954; Carr and Ogren, 1960; Parsons, 1962; Pritchard, 1969; Carr *et al.*, 1978). In the continental United States, green turtle nesting occurs on the Atlantic Coast of Florida (Ehrhart, 1979). Occasional nesting has been documented along the Gulf Coast of Florida, at Southwest Florida beaches, as well as the beaches of the Eglin Air Force Base on the Florida Panhandle (Meylan *et al. 1995*). Most documented green turtle nesting activity occurs on Florida index beaches, which were established to standardize data collection methods and effort on key nesting beaches. The pattern of green turtle nesting shows biennial peaks in abundance, with a generally positive trend during the six years of regular monitoring since establishment of the index beaches in 1989, perhaps due to increased protective legislation throughout the Caribbean (Meylan *et al.* 1995).

While nesting activity is obviously important in identifying population trends and distribution, the major portion of a green turtle's life is spent on foraging grounds. For the majority of their life, green turtles are herbivores, and appear to prefer marine grasses and algae in shallow bays, lagoons and reefs (Rebel 1974). Some of the principal feeding pastures in the Gulf

of Mexico include inshore south Texas waters, the upper west coast of Florida and the northwestern coast of the Yucatan Peninsula. Additional important foraging areas in the western Atlantic include the Indian River Lagoon System in Florida, Florida Bay, the Culebra archipelago and other Puerto Rico coastal waters, the south coast of Cuba, the Mosquito Coast of Nicaragua, the Caribbean coast of Panama, and scattered areas along Colombia and Brazil (Hirth, 1971). The preferred food sources in these areas are *Cymodocea, Thalassia, Zostera, Sagittaria, and Vallisneria* (Babcock 1937; Underwood, 1951; Carr, 1952; 1954).

Green turtles were once abundant enough in the shallow bays and lagoons of the Gulf to support a commercial fishery, which landed over one million pounds of green turtle in 1890 (Doughty, 1984). Doughty (1984) reported the decline in the turtle fishery throughout the Gulf of Mexico by 1902. Currently, green turtles are uncommon in offshore waters of the northern Gulf, but abundant in some inshore embayments. Shaver (1994) live-captured a number of green turtles in the channels between the Gulf of Mexico and the Laguna Madre, in South Texas. She noted the abundance of green turtle strandings in Laguna Madre inshore waters and opined that the turtles may establish residency in the inshore foraging habitats as juveniles. However, algae along the jetties at entrances to the inshore waters of South Texas was thought to be important to green turtles associated with a radio-telemetry project (Renaud *et al.* 1995). Transmitter laden turtles remained near jetties for most of the tracking period. This project was restricted to late summer months, and therefore may reflect seasonal influences. Coyne (1994) observed strong site fidelity along with the increased movements of green turtles observed during warm water months.

Hawksbill turtle (*Eretmochelys imbricata*)

The hawksbill turtle is relatively uncommon in the waters of the continental United States, preferring tropical waters with abundant coral reefs such as those found in the Caribbean and Central America. Hawksbills feed primarily on a wide variety of sponges but also consume bryozoans, coelenterates, and mollusks. Nesting areas in the western North Atlantic include Puerto Rico and the Virgin Islands (Meylan 1985, Vicente 1993). There are accounts of hawksbills on the reefs of south Florida, and a surprising number of small hawksbills are encountered in Texas. Most of the Texas records are probably in the 1-2 year class range. Many of the individuals captured or stranded are unhealthy or injured (Hildebrand, 1983). The lack of sponge-covered reefs and the cold winters in the northern Gulf of Mexico probably prevent hawksbills from establishing a strong presence in this area.

Despite the protections of the Endangered Species Act, hawksbill populations depleted for their beautiful shell during the twentieth century remain depleted today. Few systematic surveys of nesting beaches exist to allow evaluation of current trends in the population. Generally, experts believe that hawksbill populations may not be declining, but are showing no signs of recovery (NMFS and USFWS, 1995).

Leatherback turtle (*Dermochelys coriacea*)

The Recovery Plan for Leatherback Turtles (*Dermochelys coriacea*) contains a description of the natural history and taxonomy of this species (NMFS and USFWS 1992). Leatherbacks are widely distributed throughout the oceans of the world, and are found throughout waters of the Atlantic, Pacific, Caribbean, and the Gulf of Mexico (Ernst and Barbour, 1972). Leatherbacks are predominantly distributed pelagically, feeding primarily on jellyfish such as *Stomolophus*, *Chryaora*, and *Aurelia* (Rebel, 1974). They may come into shallow waters if there is an abundance of jellyfish nearshore. Leary (1957) reported a large group of up to 100 leatherbacks just offshore of Port Aransas, Texas associated with a dense aggregation of *Stomolophus*.

Trends in the leatherback population are the most difficult to assess since major nesting beaches occur over broad areas within tropical waters outside the United States. Some nesting occurs on Florida's east coast, although nests are likely under reported because surveys are not conducted during the entire period that leatherbacks may nest. In the eastern Caribbean, nesting occurs primarily in the Dominican Republic, the Virgin Islands, and on islands near Puerto Rico. Sandy Point, on the western edge of St. Croix, Virgin Islands, has been designated by the U.S. Fish and Wildlife Service as critical habitat for nesting leatherback turtles. The primary leatherback nesting beaches in the western Atlantic occur in French Guiana, Surinam and Mexico. Although increased observer effort on some nesting beaches has resulted in increased reports of leatherback nesting, declines in nest abundance have been reported from the beaches of greatest nesting densities. At Mexiquillo, Michoacan, Mexico, between 1986 and 1987, 4,796 nests were laid on 4.5 km of beach. During the 1990-1991 season, only an estimated 1200 nests were reported. Another large western Atlantic nesting beach is located at Yalimapo-Les Hattes, French Guiana, where Fretey and Girondot estimated the total number of adult females at 14,700 to 15,300 in the late 1980s. Beach erosion has pushed nesting into Surinam, confounding efforts to monitor trends from this colony. Anecdotal information suggests nesting has declined at Caribbean beaches over the last several decades (NMFS and USFWS, 1995).

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Kemp's Ridley (*Lepidochelys kempii*)

Of the seven extant species of sea turtles of the world, the Kemp's ridley has declined to the lowest population level. The Recovery Plan for the Kemp's Ridley Sea Turtle (*Lepidochelys kempii*) (USFWS and NMFS, 1992) contains a description of the natural history, taxonomy, and distribution of the Kemp's or Atlantic ridley turtle. Kemp's ridleys nest in daytime aggregations known as arribadas, primarily at Rancho Nuevo, a stretch of beach in Mexico. Most of the population of adult females nest in this single locality (Pritchard, 1969). When nesting aggregations at Rancho Nuevo were discovered in 1947, adult female populations were estimated to be in excess of 40,000 individuals (Hildebrand, 1963). By the early 1970s, the world population estimate of mature female Kemp's ridleys had been reduced to 2,500-5,000 individuals. The population declined further through the mid 1980's. Recent observations of increased nesting, discussed below, suggest that the decline in the ridley population has stopped, and there is cautious optimism that the population is now increasing.

The nearshore waters of the Gulf of Mexico are believed to provide important developmental habitat for juvenile Kemp's ridley and loggerhead sea turtles. Ogren (1988) suggests that the Gulf Coast, from Port Aransas, Texas, through Cedar Key, Florida, represents the primary habitat for subadult ridleys in the northern Gulf of Mexico. Stomach contents of Kemp's ridleys along the lower Texas coast had a predominance of nearshore crabs and mollusks, as well as fish, shrimp and other foods considered to be shrimp fishery discards (Shaver, 1991). Analyses of stomach contents from sea turtles stranded on upper Texas beaches apparently suggest similar nearshore foraging behavior (Plotkin, pers comm).

Research being conducted by Texas A&M University has resulted in the intentional live-captured of 100's of Kemp's ridleys at Sabine Pass and the entrance to Galveston Bay. Between 1989 and 1993, 50 of the Kemp's ridleys captured were tracked by biologists with the NMFS Galveston Laboratory using satellite and radio telemetry. The tracking study was designed to characterize sea turtle habitat and to identify small and large scale migration patterns. Preliminary analysis of the data collected during these studies suggests that subadult Kemp's ridleys stay in shallow, warm, nearshore waters in the northern Gulf of Mexico until cooling waters force them offshore or south along the Florida coast (Renaud, NMFS Galveston Laboratory, pers. comm.).

In recent years, unprecedented numbers of Kemp's ridley carcasses have been reported from Texas and Louisiana beaches during periods of high levels of shrimping effort. NMFS established a team of population biologists, sea turtle scientists and

managers, known as the Expert Working Group(EWG), to conduct a status assessment of sea turtle populations. Analyses conducted by the group have indicated that the Kemp's ridley population is in the early stages of recovery; however, strandings in some years have increased at rates higher than the rate of increase in the Kemp's population (Expert Working Group, June 1996). While many of the stranded turtles observed in recent years in Texas and Louisiana are believed to have been incidentally taken in the shrimp fishery, other sources of mortality exist in these waters. These stranding events illustrate the vulnerability of Kemp's ridley and loggerhead turtles to the impacts of human activities in nearshore Gulf of Mexico waters.

The EWG focused on determining population estimates for Kemp's ridley and loggerhead sea turtles, the species of greatest concern in the Gulf of Mexico due to high historical incidental take levels in the shrimp fishery. Internal reports submitted by the EWG, entitled "Kemp's ridley (*Lepidochelys kempii*) Sea Turtle Status Report", dated June 28, 1996 and the "Status of the Loggerhead Turtle Population (*Caretta caretta*) in the Western North Atlantic" dated July 1, 1996, were submitted in early July of 1996.

The EWG developed a population model to evaluate trends in the Kemp's ridley population through the application of empirical data and life history parameter estimates chosen by the EWG. Model results identified three trends in benthic immature Kemp's ridleys. Benthic immatures are those turtles that are not yet reproductively mature but have recruited to feed in the nearshore benthic environment, where they are available to nearshore mortality sources that often result in strandings. Benthic immature ridleys are estimated to be 2-9 years of age and 20 - 60 cm in length. Increased production of hatchlings from the nesting beach beginning in 1966 resulted in an increase in benthic ridleys that leveled off in the late 1970's. A second period of increase followed by leveling occurred between 1978 and 1989 as hatchling production was further enhanced by the cooperative program between the U.S. Fish and Wildlife Service (USFWS) and Mexico's Instituto Nacional de Pesca (INP) to increase the nest protection and relocation program in 1978. A third period of steady increase, which has not leveled off to date, has occurred since 1990 and appears to be due to the greatly increased hatchling production and an apparent increase in survival rates of immature turtles beginning in 1990 due, in part, to the introduction of TEDs. Adult ridley numbers have now grown from a low of approximately 1,050 adults producing 702 nests in 1985, to greater than 3,000 adults producing 1940 nests in 1995 and about 2,200 nests in 1997.

The EWG was unable to estimate the total population size and current mortality rates for the Kemp's ridley population.

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However, they listed a number of preliminary conclusions. They indicated that the Kemp's ridley population appears to be in the early stage of exponential expansion. Over the period 1987 to 1995, the rate of increase in the annual number of nests accelerated in a trend that would continue with enhanced hatchling production and the use of turtle excluder devices. Nesting data indicated that the number of adults declined from a population that produced 6,000 nests in 1966 to a population that produced 924 nests in 1978 and a low of 702 nests in 1985. This trajectory of adult abundance tracks trends in nest abundance from an estimate of 9,600 in 1966 to 1,050 in 1985. The EWG estimated that in 1995 there were 3,000 adult ridleys. The increased recruitment of new adults is illustrated in the proportion of neophyte, or first time nesters, which has increased from 6% to 28% from 1981 to 1989 and from 23% to 41% from 1990 to 1994. The EWG's population model projected that Kemp's ridleys could reach the intermediate recovery goal identified in the Recovery Plan, of 10,000 nesters by the year 2020 if the assumptions of age at sexual maturity and age specific survivorship rates used in their model are correct. Their data review suggested that adult Kemp's ridley turtles are restricted somewhat to the Gulf of Mexico in shallow nearshore waters, but that benthic immature turtles of 20-60 cm straight line carapace length, are found both in nearshore coastal waters (including estuaries) of the Gulf of Mexico and the Atlantic.

Figure 1 illustrates Kemp's ridley nesting data from Rancho Nuevo and, more recently, adjacent beaches in Mexico, through 1997. The EWG identified an average Kemp's ridley population growth rate of 13% per year between 1991 and 1995. Total nest numbers have continued to increase, however the 1996 and 1997 nest numbers did not reflect growth at the same rate. The population growth rate does not appear as steady as forecasted by the EWG, however annual fluctuations due in part to irregular internesting periods are normal for sea turtle populations.

The area surveyed for ridley nests in Mexico was expanded in 1990 due to destruction of the primary nesting beach by Hurricane Gilbert. The EWG assumed that the increased nesting observed particularly since 1990 was a true increase, rather then the result of expanded beach coverage. Because systematic surveys of the adjacent beaches were not conducted prior to 1990, there is no way to determine what proportion of the nesting increase documented since that time is due to the increased survey effort rather then an expanding ridley nesting range. As noted by the EWG, trends in Kemp's ridley nesting even on the Rancho Nuevo beaches alone suggest that recovery of this population has begun but continued caution is necessary to ensure recovery and to meet the goals identified in the Kemp's ridley Recovery Plan.

Loggerhead Sea Turtles (*Caretta caretta*) **B-39**

The threatened loggerhead is the most abundant species of sea turtle occurring in U.S. waters. The nearshore waters of the Gulf of Mexico are believed to provide important developmental habitat for juvenile loggerheads. Studies conducted on loggerheads stranded on the lower Texas coast (south of Matagorda Island) have indicated that stranded individuals were feeding in nearshore waters shortly before their death (Plotkin *et al.* 1993).

The EWG identified four nesting subpopulations of loggerheads in the western North Atlantic based on mitochondrial DNA evidence. These include: (1) the Northern Subpopulation producing approximately 6,200 nests/year from North Carolina to Northeast Florida; (2) the South Florida Subpopulation occurring from just north of Cape Canaveral on the east coast of Florida and extending up to Naples on the west coast and producing approximately 64,000 nests/year; (3) the Florida Panhandle Subpopulation, occurring at Eglin Air Force Base and the beaches near Panama City and producing approximately 450 nests/year; and (4) the Yucatan Subpopulation occurring on the northern and eastern Yucatan Peninsula in Mexico and producing approximately 1,500 - 2,000 nests/year.

Genetic analyses of benthic immature loggerheads collected from Atlantic foraging grounds identify a mix of the east coast subpopulations that is disproportionate to the number of hatchlings produced in these nesting assemblages. Although the Northern Subpopulation produces only approximately 9% of the loggerhead nests, loggerheads on foraging grounds from the Chesapeake Bay to Georgia are nearly equally divided in origin between the two subpopulations (Sears, 1994; Sears *et al.*, 1995; Norrgard, 1995). Of equal interest, 57% of the immature loggerheads sampled in the Mediterranean were from the South Florida Subpopulation, while only 43% were from the local Mediterranean nesting beaches (Laurent *et al.*, 1993; Bowen, 1995). Genetic work has not yet been done on nesting or foraging loggerheads in the Gulf of Mexico.

The EWG considered nesting data collected from index nesting beaches to index the population size of loggerheads and to consider trends in the size of the population. They constructed total estimates by considering a ratio between nesting data (and associated estimated number of adult females and therefore adults in nearshore waters), proportion of adults represented in the strandings, and in one method, aerial survey estimates. These two methods indicated that for the 1989 - 1995 period, there were averages of 224,321 or 234,355 benthic loggerheads, respectively. The EWG listed the methods and assumptions in their report, and suggested that these numbers are likely underestimates. Aerial

survey results suggest that loggerheads in U.S. waters are distributed in the following proportions: 54% in the Southeast U.S. Atlantic, 29% in the northeast U.S. Atlantic, 12% in the eastern Gulf of Mexico, and 5% in the western Gulf of Mexico.

The EWG considered long-term index nesting beach datasets when available to identify trends in the loggerhead population. Overall, they determined that trends could be identified for two loggerhead subpopulations. The Northern Subpopulation appears to be stabilizing after a period of decline; the South Florida Subpopulation appears to have shown significant increases over the last 25 years suggesting the population is recovering, although the trend could not be detected over the most recent 7 years of nesting. An increase in the numbers of adult loggerheads has been reported in recent years in Florida waters without a concomitant increase in benthic immatures. These data may forecast limited recruitment to South Florida nesting beaches in the future. Since loggerheads take approximately 20-30 years to mature, the effects of decline in immature loggerheads might not be apparent on nesting beaches for decades. Therefore the EWG cautions against considering trends in nesting too optimistically.

Briefly, the EWG made a number of conclusions regarding the loggerhead population. Based on genetic evidence, they concluded that four distinct nesting populations exists although separate management is not possible because of insufficient information on the in-water distribution of each subpopulation. They concluded that the recovery goal of more than 12,800 nests for the Northern Subpopulation was not likely to be met. Currently, nests number about 6,200 and no perceptible increase has been documented. The recovery goal or "measurable increases" for the South Florida Subpopulation (south of Canaveral and including Southwest Florida) appears to have been met, and this population appears to be stable or increasing. However, index nesting surveys have been done for too short a time, therefore it is difficult to evaluate trends throughout the region. Recovery rates for the entire subpopulation cannot be determined with certainty at this time. However, caution is warranted because, although nesting activity has been increasing, catches of benthic immature turtles at the St. Lucie Nuclear Power Plant intake canal, which acts as a passive turtle collector on Florida's east coast, have not been increasing. The EWG recommended establishing index nest surveys areas in the Gulf of Mexico to monitor those populations, which do not currently have recovery goals assigned to them.

Gulf Sturgeon (*Acipenser oxyrinchus desotoi*)

Detailed information regarding the life history, abundance and distribution of Gulf sturgeon can be found in the Gulf Sturgeon

Recovery/Management Plan (FWS and GSMFC 1995). Gulf sturgeon were listed as threatened in 1991, and are under the joint jurisdiction of the Fish and Wildlife Service and NMFS.

The Gulf sturgeon is subspecies of the Atlantic sturgeon, *Acipenser oxyrinchus*. This subspecies is restricted to the waters and drainage of the Gulf of Mexico, and occurs primarily from the Mississippi to the Suwannee Rivers. Historically, Gulf sturgeon occurred in most major rivers between the Mississippi and the Suwannee, as well as in marine waters from the Mississippi to Florida Bay.

Gulf sturgeon are anadromous, migrating between fresh and salt water. The timing, location, and habitat requirements associated with these migrations are not well documented. Most subadult and adult gulf sturgeon spend up to nine months each year in rivers, and three or four months (November through February) in the Gulf of Mexico or estuaries. Sturgeon less than two years old likely remain in riverine habitats and estuaries year round. Adult fish feed on invertebrates during winter months, and do not feed once they return to freshwater. Thermal refuges including deep cool waters near springs are likely sought during summer months in the river. The few larvae samples that have been collected were taken between April 3 and May 11 in Florida, when water temperatures were between 16.1 and 23.9° Celsius (USFWS unpub. data). Spawning habitat likely includes deep pools with rock or gravel substrate.

Gulf sturgeon are believed to have a strong affinity for the rivers in which they are spawned. Preliminary data from an ongoing study analyzing MtDNA suggests that gulf sturgeon from geographically distinct drainage are significantly different.

There is sparse information available regarding the distribution of Gulf sturgeon once they have entered the marine environment. A few takes incidental to commercial and recreational fishing have been documented offshore of Louisiana, in the Mississippi Sound and Biloxi Bay, Pensacola Bay, Apalachicola Bay, Tampa Bay and Charlotte Harbor. Although biotelemetry studies geared toward identifying the movements of sturgeon once they have entered marine waters, little information has been developed yet. Gulf sturgeon likely leave riverine waters to forage on mud and sand bottoms and seagrass communities, where they feed on benthic invertebrates

Directed and incidental take in fisheries and habitat loss have been identified as the major threats to the recovery of Gulf sturgeon. No takes of sturgeon due to activities associated with the oil and gas industry have been documented.

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ASSESSMENT OF IMPACTS:

Despite the many regulations implemented to reduce the likelihood of environmental impacts of OCS Oil and gas development activities, these activities have numerous direct and indirect effects on listed and protected species in the Gulf of Mexico. These effects are described in detail in the environmental impact statements prepared by MMS for their multi-year lease sales and are summarized below.

Wetlands Loss:

MMS has projected the loss of wetlands due to oil development and production activities, including channelization, pipeline construction and maintenance activities, oil spills due to pipeline and tanker accidents, maintenance dredging of navigation channels as well as widening and deepening projects to accommodate larger service vessels for deep water development. In some cases, wetlands will be converted to open water. Additionally, if seagrasses are contacted by oil, temporary effects to the seagrasses are likely and epifauna associated with the grasses may be damaged for one to two years. OCS activities are projected to contribute less than 3% of the total wetland losses believed likely to occur between 1998 and 2036. The loss or reduction in the productivity of wetlands may have indirect effects on loggerhead, Kemp's ridley and green sea turtles by reducing the availability of forage species that rely on these sensitive habitats. Currently, it is unlikely that sea turtle populations are habitat-limited in the northern Gulf, although future impacts should be minimized.

MMS periodically funds studies of mitigation management techniques, particularly associated with canals and inland marshes along the northern Gulf of Mexico. Currently, the effectiveness of existing mitigation techniques and the results of past projects are being assessed. Additionally, MMS is compiling a comprehensive database of existing pipelines including those going onshore. These data will be used to monitor future coastal habitat impacts associated with OCS activities, and to improve mitigation efforts through implementation of the most effective techniques.

Noise:

Oil and gas exploration, development and production activities contribute numerous sources of additional noise into Gulf of Mexico waters.

Seismic surveys in OCS waters involve towed arrays of airguns generating sound pulses to obtain information for site evaluation for drilling rigs, platform design and emplacement, or to assess

potential hydrocarbon reservoirs to optimally locate exploration and development wells. Generally, a sleeve-type air gun array releases compressed air into the water, producing an air-filled cavity that expands violently, contracts, and re-expands, creating an acoustical energy pulse that penetrates the seafloor. The airguns are towed 5-10 meters below the surface of the water and release the compressed air regularly every several seconds followed by 5-15 second silent periods. Twelve to 70 airguns may be towed to study deep waters structures. The peak levels of sound pulses produced by the airgun arrays are well above ambient and vessel sound levels, but short pulses limit the total energy released. The sound from the seismic sources is directed downward, however some horizontal propagation that can be detected many kilometers away will occur (Malme *et al.* 1983 in Richardson *et al.* 1995). Richardson *et al.* (1995) hypothesized that marine mammals would have to be well within 100 m of an airgun array to be susceptible to immediate hearing damage. Generally, they concluded that most seismic operations were unlikely to cause permanent injury to marine mammals because seismic exploration is transitory, marine mammals appear to tolerate strong calls from themselves and their social groups, and some baleen whales have shown avoidance behavior that would remove them from the area of harm. During surveys conducted to find and tag sperm whales in the Gulf of Mexico, sperm whales sighted over a few days in a particular area began to leave the area when seismic activities occurred (Stafford and Mate 1993), suggesting that sperm whales may be harassed by seismic surveys, but would possibly remove themselves from harmful exposure to airgun pulses.

NMFS agrees that the best available information suggests that, while the effects of the noise produced by seismic surveys is believed to be sublethal, sea turtles and marine mammals, including listed sperm whales, may have short-term startle or avoidance responses. Noise generated by service vessels may also elicit startle reactions. Increased sea turtle surfacing behavior and associated risk of vessel collisions may result. Although vessel strikes are commonly documented in association with sea turtle stranding reports from Gulf of Mexico beaches, there is usually no way to determine whether turtles were killed prior to vessel strikes, or what type of vessel was involved. To date, NMFS has not received any reports associating takes of sea turtles by injury or mortality specifically with OCS vessels. Monitoring for such incidents, however, has not been conducted and would be extremely difficult.

Additional sources of sound associated with oil and gas exploration, development and production include; aircraft, support and crew vessels, work barges, dredging, drilling, and noises associated with operations of the rig. Whales and dolphins may dive or turn in response to low overflights.

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Intensive vessel activity may result in avoidance of some areas. Richardson *et al.* (1995) suggested that sounds associated with drilling, dredging and production activities have little effect on the behavior of whales and dolphins. Generally, responses of marine mammals to noise appear to vary with species as well as sources and types of exposure. The same is probably true for sea turtles, which have been the subject of even fewer studies. Reactions, such as avoidance behavior, might result in disruption of normal activities including feeding. Important habitats may be avoided due to noise production in the vicinity. There is no information regarding the possible consequences these disturbances may have on marine mammals and sea turtles over a long period. Effects would likely be more critical for reproductively mature animals during breeding or gestation periods, but in most cases would likely be sublethal.

Oil Spills:

Oil spills associated with OCS activities may result in adverse effects to listed species and the other living marine resources in the Gulf of Mexico. As discussed above, MMS is responsible for implementing programs to minimize this threat. MMS has established requirements that operators use the "Best Available and Safest Technology" (BAST) for drilling and production of wells, as well as in the development of oil spill contingency plans and in the design of pollution-control equipment. Safety devices are required to shut of well flow during emergencies. Regular pipeline inspections are required, as well as monthly over-flights, to inspect for pipeline leakage. Oil Spill Response Plans must be approved by MMS before a facility can be used, and operators must comply with approved plans to continue operating facilities. These Plans are reviewed and updated, incorporating the BAST, every two years. Air quality control regulations have also been implemented to monitor emissions to detect potential sources of pollution to ensure that they do not result in violations of the allowed onshore ambient concentrations. MMS conducts regular onsite visits, including unannounced inspections, of offshore platforms. Operators are required to fix violations within 7 days. Additionally, MMS requires operators to have trained personnel or contractors available to handle oil-spill cleanup equipment. Despite the implementation of programs to minimize the possibility of oil spills, some accidental discharges continue to occur at all stages of exploration, development and production. However, the volume of crude oil spilled from pipelines and platforms in the OCS between 1980 and 1995 (56,000 billion barrels) was significantly lower than that observed between 1964 and 1979 (400,000 billion barrels), suggesting that many of MMS' programs to reduce oil spills have been effective.

The severity of the effects of an oil spill on listed species is obviously related to the location of the spill, the type of oil, the level of contact with the oil that the whales, turtles or fish have, and the life stage of the animal encountering the oil. Direct contact with oil can result in irritation and damage to skin and soft tissues of whales and dolphins, and similar effects to sea turtles and Gulf sturgeon. Dolphins exposed to petroleum products exhibited reduced food intake, modifications in respiration and gas metabolism, and depressed nervous functions (Lukina *et al.* 1996 as cited in MMS 1997). Inhalation of toxic vapors released by fresh crude oil spills and other volatile distillates may irritate respiratory membranes, congest lungs and cause pneumonia. Hydrocarbons absorbed in the blood stream may accumulate in the brain and liver and result in neurological disorders. Trained dolphins could detect, and appeared to avoid, dark oil slicks. However, bottlenose dolphins did not consistently avoid entering slick oil during the Mega Borg oil spill (Smultea and Wursig, 1991, 1995 as cited in MMS 1997).

The DEIS prepared for the Western Gulf of Mexico lease sales (MMS 1997) recounts numerous studies of the effects of oil on sea turtles. Eggs, hatchlings and juvenile turtles are the most vulnerable to mortalities associated with oil spills. Fresh oil was found to be toxic to sea turtle nests, particularly during the last quarter of the incubation period (Fritts and McGehee 1982 in MMS 1997). Based on direct observations, all of the major systems in sea turtles are adversely affected by short exposure to weathered oil (Vargo *et al.*, 1986, Lutz and Lutcavage, 1989). The long-term effects and the effects of chronic exposure are unknown. Oil adheres to the body surface of sea turtles, and has been observed on eyes, nares, mouth and upper esophagus. Feeding along convergence lines could prolong sea turtles' contact with oil (Witherington, 1994). Chronically ingested oil may accumulate in organs. Entrapment in tar and oil slicks may occur. Blood chemistry studies on sea turtles after oiling revealed decreases in hematocrit and hemoglobin concentrations (Lutcavage *et al.* 1995). This reduction in critical components of the oxygen transport system and associated high white blood cell counts suggests that sea turtles are significantly stressed by exposure to oil.

A loggerhead sea turtle was sighted surfacing repeatedly in an oil slick in the Gulf of Mexico for over an hour. In 1993, eggs, hatchlings and juvenile sea turtle mortalities occurred after a freighter hit two barges transporting fuel from Mississippi and Louisiana to Tampa, Florida. Strandings of oiled turtles or turtles associated with tar are reported regularly to the Sea Turtle Stranding and Salvage Network database, particularly from south Florida and along Padre Island, Texas.

The Kemp's ridley nesting beach and important foraging areas off of Mexico and along the US northern Gulf of Mexico occur in areas at high risk of oil spills. A catastrophic spill in these areas could slow the recovery rate of the ridley population, particularly if large numbers of adult turtles are affected. Current procedures to reduce the likelihood of spills and control the size of spills that do occur appear to be effectively preventing large spills associated with OCS activities. Industries conducting production and development activities in Mexican waters should be encouraged to adopt the same prevention, mitigation and response procedures.

Gulf sturgeon may attempt to avoid oil spills. While early life stages are sensitive to the toxic effects of hydrocarbons, it may take several months of exposure to high levels of hydrocarbons for adult fish to exhibit toxicological compounds suggesting biological harm. Generally, only acute exposure would be expected in association with individual spill events.

Chronic exposure of listed and protected whales, marine mammals, sea turtles and Gulf sturgeon to the components of oil spills may result in contamination or reduction of prey. Additionally, physiological stress on these animals might result in reduced fitness and vulnerability to disease and parasites. However, annually, few deaths are likely due to the low likelihood that many listed or protected species may occur in the small areas contacted by oil spills, and dispersion and loss of oil is likely to be rapid if a spill occurs. Coastal oil-spill contingency plans should reduce the impact of spills, although some spill clean-up activities may affect sea turtles. Protection efforts generally attempt to prevent contact of oil on sensitive areas such as nesting beaches where turtles are particularly vulnerable.

Additional contaminants:

Water quality degradation occurs in the nearfield of platforms from operational discharges including drilling fluids and waste discharges. As platforms move into deeper waters, multiple wells will be associated with each structure and the resultant cumulative amount of contaminants allowed in discharges will be larger. Dilution into deeper waters should result in a sufficient reduction in contaminant concentration to avoid immediate adverse effects to water-column organisms. However, the resulting introduction of contaminants into the Gulf of Mexico may affect sea turtles, marine mammals including listed sperm whales, and Gulf sturgeon through biomagnification in the food chain or a reduction in available prey. Chronic sublethal effects could cause declines in the health of listed species, or lowered reproductive fitness. Tissues from dead stranded bottlenose dolphins and sea turtles have contained high levels of

organochlorides and heavy metals. The contribution of OCS related activities to these contaminants relative to other known sources such as the Mississippi River is not known but is thought to be low.

Other potential sources of impacts:

NMFS has received complaints regarding man-made debris associated with oil platforms and platform removals. A survey of marine debris and its likely sources was conducted on Padre Island National Seashore (PINS) between March 1, 1994 and February 28, 1995 (Miller *et al.*, 1995). Sixteen miles of beach along PINS was surveyed. Thirteen percent appeared to be associated with the oil and gas industry, including lumber, plastic straps, and 5 gallon containers. Stomach content analyses conducted on sea turtle carcasses indicate that ingestion of plastic is not uncommon. In Texas, 34 percent of the Kemp's ridleys necropsied had plastic items among the stomach contents found (Shaver, 1991). Although infrequent, the ingested debris does appear to occasionally contribute to the mortality of sea turtles. To implement the prohibitions of MARPOL, MMS requires fixed and floating platforms, drilling rigs, manned production platforms, and support vessels operating under a Federal oil and gas lease to develop Waste Management Plans and to post placards reflecting discharge limitations and restrictions. These programs are apparently not fully successful, although existing debris levels may be greatly reduced from previous or potential levels.

CONCLUSION:

NMFS concludes that the proposed multi-year lease sales and associated activities may adversely affect but are not likely to jeopardize the continued existence of listed species. Sperm whales, sea turtles and Gulf sturgeon may be vulnerable to vessel strikes by vessels supporting OCS activities. Noise associated with exploration, development, and production of oil and gas in the Gulf of Mexico may cause chronic or acute harm to whales, turtles and Gulf sturgeon ranging from injury to harassment away from valuable foraging areas. Oil spills and the discharge of contaminants into the Gulf may result in injuries and mortalities or chronic impacts on the health of marine mammals, sea turtles and Gulf sturgeon. Despite these ongoing impacts of OCS activities, only a few sea turtle takes associated with oil and gas activities in the Gulf of Mexico have been documented, and no sperm whale or Gulf sturgeon takes have been reported. Ongoing oil and gas development and production in the Gulf of Mexico has not prevented the onset of recovery by the Kemp's ridley sea turtle population, which relies on the Gulf of Mexico for important foraging, mating and nesting habitats. MMS has implemented measures that appear to be effectively reducing the likelihood of direct impacts of oil and gas activities on the

environment. Despite these precautions, the proposed actions may result in the injury or mortality of loggerhead, Kemp's ridley, green, hawksbill, and leatherback sea turtles and Gulf sturgeon. Therefore, pursuant to Section 7(b)(4) of the ESA, a low-level of incidental take that may occur is identified in the attached incidental take statement. Terms and conditions necessary to minimize and monitor the impacts of the proposed actions are given.

Currently, no efforts are underway to specifically monitor trends in the health of sea turtles, marine mammals, or Gulf sturgeon in the Gulf of Mexico, nor to monitor trends in the distribution and abundance of listed and protected species in the Gulf. Some level of monitoring of the relative abundance and distribution of protected species is necessary to provide the baseline information that will allow us to detect chronic effects of OCS activities on listed and protected species. These efforts are particularly important for sperm whales, Risso's dolphins (Baumgartner 1997), and other protected species that appear to occur primarily along the narrow continental shelf, where oil and gas exploration, development and production activities are increasing. The narrow band of habitat within the Gulf of Mexico that supports these populations, which is apparently associated with their exclusive diets, makes these species vulnerable to disturbances that could be avoided without harm by species with broader habitat preferences. Conservation recommendations and terms and conditions of the incidental take statement have been identified to better monitor and minimize risks to these more specialized populations.

CUMULATIVE EFFECTS:

"Cumulative effects" are those effects of future state or private activities, not involving Federal actions, that are reasonably certain to occur within the action area of the Federal action subject to consultation.

Throughout the coastal Gulf of Mexico, but particularly in Louisiana, the loss of thousands of acres of wetlands is occurring due to natural subsidence and erosion, as well as reduced sediment input from the Mississippi River. Impacts caused by residential, commercial and agricultural developments appear to be the primary causes of wetland loss in Texas.

Oil spills from tankers transporting foreign oil, as well as the illegal discharge of oil and tar from vessels discharging bilge water will continue to affect water quality in the Gulf of Mexico. Cumulatively, these sources and natural oil seepage contribute most of the oil discharged into the Gulf of Mexico. Floating tar sampled during the 1970's, when bilge discharge was

still legal, concluded that up to 60% of the pelagic tars sampled did not originated from the northern Gulf of Mexico coast.

Coastal runoff and river discharges carry large volumes of petrochemical and other contaminants from agricultural activities, cities and industries into the Gulf of Mexico. The coastal waters of the Gulf of Mexico have more sites with high contaminant concentrations than other areas of the coastal United States, due to the large number of waste discharge point sources.

State regulated commercial and recreational fishing activities in the Gulf of Mexico waters probably take endangered species. These takes are not reported and are unauthorized. It is expected that states will continue to license/permit large vessel and thrill-craft operations which do not fall under the purview of a Federal agency and will issue regulations that will affect fishery activities. NMFS will continue to work with states to develop ESA Section 6 agreements and Section 10 permits to enhance programs to quantify and mitigate these takes. Increased recreational vessel activity in inshore waters of the Gulf of Mexico will likely increase the number of turtles taken by injury or mortality in vessel collisions. Recreational hook-and-line fisheries have been known to lethally take sea turtles, including Kemp's ridleys. In a study conducted by the NMFS Galveston Laboratory between 1993 through 1995, 170 ridleys were reported associated with recreational hook-and-line gear; including 18 dead stranded turtles, 51 rehabilitated turtles, five that died during rehabilitation, and 96 that were released by fishermen (Cannon and Flanagan, 1996). The Sea Turtle Stranding and Salvage Network (STSSN) also receives stranding reports that identify carcass anomalies that may be associated with the recreational fishery (entangled in line or net, fish line protruding, fish hook in mouth or digestive tract, fish line in digestive tract. The reports do not distinguish between commercial or recreational sources of gear, such as hook, net, and line, which may be used in both sectors. Cumulatively, fishery entanglement anomalies are noted in fewer than 4% of the stranded sea turtle carcasses reported between 1990 and 1996, and some carcasses carry more than one anomaly (e.g. fishing line in digestive tract/fishing line protruding from mouth or cloaca), therefore summing these reports may result in some double counting.

REINITIATION OF CONSULTATION:

Reinitiation of formal consultation is required if (1) the amount or extent of taking specified in the incidental take statement (enclosure 1) is exceeded, (2) new information reveals effects of the action that may affect listed species or critical habitat (when designated) in a manner or to an extent not previously

considered, (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the identified action.

Conservation Recommendations

Pursuant to Section 7(a)(1) of the ESA, the following conservation recommendations are made to assist MMS in reducing/eliminating adverse impacts to listed and proposed species and promoting their conservation and recovery.

(1) MMS should work with NMFS to develop methods to monitor the effects of oil and gas activities on the behavior (breeding, feeding), distribution, and relative abundance of the marine mammals that occur in low numbers or limited habitats in **oceanic** Gulf of Mexico waters, and that may be affected by the recent movement of OCS activities into deep water areas. These surveys should be designed to better identify those areas in the Gulf that are preferred by cetaceans, assessing the distribution and relative abundance of marine mammals at the canyons and the Mississippi Delta, for examples. Species of particular concern include sperm whales, Bryde's whales, and Risso's dolphins. The distribution of these species appears to be tied to habitat preferences along a narrow area of the continental slope in the Gulf of Mexico, making them potentially more vulnerable to increased OCS activities in this area. Ongoing Gulf-wide surveys have not provided sufficient resolution to detect changes in the relative abundance and distribution of these species unless those changes are catastrophic.

(2) MMS should continue to analyze tar samples collected from stranded sea turtles and marine mammals, as well as beaches and driftlines, to determine the source of the tar. Additionally, research on neonatal turtle habitat in the Gulf of Mexico, which may include driftlines where tarballs accumulate, should be conducted.

(3) MMS should work with NMFS to identify bottlenose dolphin stock structure in Gulf of Mexico offshore waters to improve their ability to assess the potential effects of OCS activities on bottlenose dolphins.

(4) MMS should work with NMFS to determine whether sperm whale stocks in the Gulf of Mexico represent a distinct stock, as inferred from observation of their smaller average size and their year-round presence in the Gulf of Mexico. Skin samples should be obtained through biopsies or sloughed skin collected during shipboard surveys and from stranded carcasses for genetic analyses and comparison to samples from other areas of the North

Atlantic. The severity of direct and indirect effects of oil and gas exploration, development and production on sperm whales cannot be fully assessed without a determination of stock identity.

(5) The limited data available suggest that seismic surveys may affect sea turtles and sperm whales. An appropriate monitoring program should be designed or further detailed studies of the effects of seismic surveys on listed species should be conducted.

(6) Surveys of the Mexican Gulf of Mexico should be conducted to further efforts to determine the distribution and relative abundance of sea turtles and cetaceans in the Gulf.

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INCIDENTAL TAKE STATEMENT

Section 7(b)(4) of the Endangered Species Act (ESA) requires that when a proposed agency action is found to be consistent with action 7(a)(2) of the ESA and the proposed action may incidentally take individuals of listed species, NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. It also states that reasonable and prudent measures, and terms and conditions to implement the measures, shall be provided that are necessary to monitor and minimize such impacts. Only incidental taking resulting from the agency action as described in the proposed action section of the biological opinion, including incidental takings caused by activities approved by the agency, and that comply with the specified reasonable and prudent measures and terms and conditions, are exempt from the takings prohibition of section 9(a), pursuant to Section 7(o) of the ESA.

Section 7(b)(4)(c) of the ESA specifies that in order to provide an incidental take statement for an endangered or threatened species of marine mammal, the taking must be authorized under section 101(a)(5) of the Marine Mammal Protection Act of 1972 (MMPA). Since no incidental take of endangered marine mammals in the Gulf of Mexico has been authorized under section 101(a)(5) of the MMPA, no statement on incidental take of endangered sperm whales is provided.

The best available information suggests that the level of impacts of oil and gas exploration, production, development and abandonment activities on listed species is related to the location and duration of the activities, time of year, clean-up efforts and many other factors that are difficult to fully anticipate. Given past observations and documented takes associated with the industry, sea turtle takes and a Gulf sturgeon take, by injury or mortality, may occur in some years. In years that spills do occur, and when they occur near nesting beaches, takes may included multiple turtles. Therefore, pursuant to Section 7(b)(4) of the ESA, a documented annual incidental take (by injury or mortality) of twenty five sea turtles, including no more than five Kemp's ridley, green, hawksbill, or leatherback turtles and no more than ten loggerhead turtles, and one Gulf sturgeon is set for OCS oil and gas exploration, development, production, and abandonment activities. If the incidental take meets or exceeds this level, MMS must reinitiate consultation.

Following are the reasonable and prudent measures and terms and conditions that NMFS believes are necessary to monitor and minimize the impact of incidental takings associated with OCS activities.

1. Continued minimal monitoring of the effects of OCS activities on listed species is necessary. Monitoring can be conducted through continued synoptical surveys using dedicated platforms, such as GulfCet or through deployment of protected species observers on ongoing NMFS spring and fall plankton surveys. Conduct of these surveys would provide population estimates comparable to those collected during GulfCet I and II. Large changes in distribution or abundance of the more common species would be revealed through these ongoing surveys.

2. MMS must sponsor a workshop on information needs for cetaceans, sea turtles and Gulf sturgeon in the Gulf of Mexico within the next three years. Results and recommendations from the first MMS sponsored protected species workshop, held in 1990, should be reviewed and future needs should be identified.

3. NMFS, the National Institute of Standards and Technology, the Fish and Wildlife Service, and the Biological Resources Division of Geological Survey are developing an interagency agreement to design and conduct collaborative research and monitoring programs that will address biota health, environmental contaminants and long-term specimen banking. Currently, the group's efforts are focussed on health assessment of marine mammals in Alaska, however their efforts are expanding to include other regions and national concerns, and sea turtle health assessment programs are likely to be considered in the near future. The Gulf of Mexico OCS office of MMS must identify an individual to work with the NMFS Health Assessment Coordinator (Dr. Teri Rowles at 301 713-2322) to evaluate MMS' ability to participate in this agreement. Participation in this national interagency program will provide MMS with an ability to monitor and evaluate the effects of chronic exposure of resident sea turtles, cetaceans, and other biota to petrochemical and other contaminants associated with the oil and gas industry in the Gulf of Mexico.

4. MMS must develop and maintain a database on OCS related materials that are spilled into state waters to improve their efforts to monitor the additive effects of OCS activities on listed species and the marine environment.

5. MMS must facilitate and encourage the use of the Best Available and Safest Technology for prevention, mitigation and clean-up by industries operating in Mexican Gulf of Mexico waters, particularly for exploration, development, production and transport activities in the vicinity of Kemp's ridley nesting beaches.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, Maryland 20910

B-60

JAN 15 1998

Ms. Carolita U. Kallaur
Associate Director for
Offshore Minerals Management
Minerals Management Service
Washington D.C. 20240

Dear Ms. Kallaur:

This letter revises the terms and conditions of the reasonable and prudent measures identified in the incidental take statement accompanying the January 6, 1998, biological opinion on the Gulf of Mexico Outer Continental Shelf (OCS) multi-year oil and gas lease sales for the Central and Western Planning Areas. The amended incidental take statement is enclosed.

At the request of the Minerals Management Service (MMS), the National Marine Fisheries Service (NMFS) is deleting term and condition number 4 -- develop and maintain a database on OCS related materials that are spilled into state waters. The database requirement was formulated during a recent meeting with MMS staff. NMFS does not believe that this requirement is necessary, at this time, to fulfill MMS's responsibility under section 7(b)(4). NMFS also has amended term and condition number 2 to specify MMS' continued responsibility for gathering the best available information on protected species in the Gulf of Mexico (GOM), which could be done through a second GOM protected species workshop. Lastly, NMFS has amended condition number 3 to recognize MMS' preliminary efforts to work with the NMFS Health Assessment Coordinator.

Other than the enclosed amendments, the January 6, 1998, biological opinion is, in total, incorporated by reference.

Sincerely,

for Hilda Diaz-Soltero
Director
Office of Protected Resources

Enclosure

cc: MMS Gulf of Mexico, OCS Region:
Oynes
Bull
Lang
MMS, Herndon - Wilson

Section 7(b)(4) of the Endangered Species Act (ESA) requires that when a proposed agency action is found to be consistent with action 7(a)(2) of the ESA and the proposed action may incidentally take individuals of listed species, NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. It also states that reasonable and prudent measures, and terms and conditions to implement the measures, shall be provided that are necessary to monitor and minimize such impacts. Only incidental taking resulting from the agency action as described in the proposed action section of the biological opinion, including incidental takings caused by activities approved by the agency, and that comply with the specified reasonable and prudent measures and terms and conditions, are exempt from the takings prohibition of section 9(a), pursuant to Section 7(o) of the ESA.

Section 7(b)(4)(c) of the ESA specifies that in order to provide an incidental take statement for an endangered or threatened species of marine mammal, the taking must be authorized under section 101(a)(5) of the Marine Mammal Protection Act of 1972 (MMPA). Since no incidental take of endangered marine mammals in the Gulf of Mexico has been authorized under section 101(a)(5) of the MMPA, no statement on incidental take of endangered sperm whales is provided.

The best available information suggests that the level of impacts of oil and gas exploration, production, development and abandonment activities on listed species is related to the location and duration of the activities, time of year, clean-up efforts and many other factors that are difficult to fully anticipate. Given past observations and documented takes associated with the industry, sea turtle takes and a Gulf sturgeon take, by injury or mortality, may occur in some years. In years that spills do occur, and when they occur near nesting beaches, takes may include multiple turtles. Therefore, pursuant to Section 7(b)(4) of the ESA, a documented annual incidental take (by injury or mortality) of twenty five sea turtles, including no more than five Kemp's ridley, green, hawksbill, or leatherback turtles and no more than ten loggerhead turtles, and one Gulf sturgeon is set for OCS oil and gas exploration, development, production, and abandonment activities. If the incidental take meets or exceeds this level, MMS must reinitiate consultation.

Following are the reasonable and prudent measures and terms and conditions that NMFS believes are necessary to monitor and minimize the impact of incidental takings associated with OCS activities.

1. Continued minimal monitoring of the effects of OCS activities on listed species is necessary. Monitoring can be conducted through continued synoptical surveys using dedicated platforms, such as GulfCet or through deployment of protected species observers on ongoing NMFS spring and fall plankton surveys. Conduct of these surveys would provide population estimates comparable to those collected during GulfCet I and II. Large changes in distribution or abundance of the more common species would be revealed through these ongoing surveys.

2. MMS must continue to collect the best available information on protected resources in the Gulf of Mexico and should identify additional data needs, particularly related to the anticipated increase in deep water development. Results and recommendations from the first MMS sponsored protected species workshop, held in 1989, should be reviewed. MMS should consider holding or sponsoring a second workshop on cetaceans, sea turtles and Gulf sturgeon in the Gulf of Mexico within the next three years to review information collected since 1989 and to identify future information needs.

3. NMFS, the National Institute of Standards and Technology, the Fish and Wildlife Service, and the Biological Resources Division of Geological Survey are developing an interagency agreement to design and conduct collaborative research and monitoring programs that will address biota health, environmental contaminants and long-term specimen banking. Currently, the group's efforts are focussed on health assessment of marine mammals in Alaska, however their efforts are expanding to include other regions and national concerns, and sea turtle health assessment programs are likely to be considered in the near future. MMS must continue to work with the NMFS Health Assessment Coordinator (Dr. Teri Rowles at 301 713-2322) to evaluate MMS' ability to participate in this agreement. Participation in this national interagency program will provide MMS with an ability to monitor and evaluate the effects of chronic exposure of resident sea turtles, cetaceans, and other biota to petrochemical and other contaminants associated with the oil and gas industry in the Gulf of Mexico.

4. MMS must continue to facilitate and encourage the use of the Best Available and Safest Technology for prevention, mitigation and clean-up of oil spills by industries operating in the Gulf of Mexico, particularly for exploration, development, production and transport activities in Mexican waters in the vicinity of Kemp's ridley nesting beaches.

Appendix C

Oil Spill Risk Analysis Model Results for the Proposed Action and OCS Program

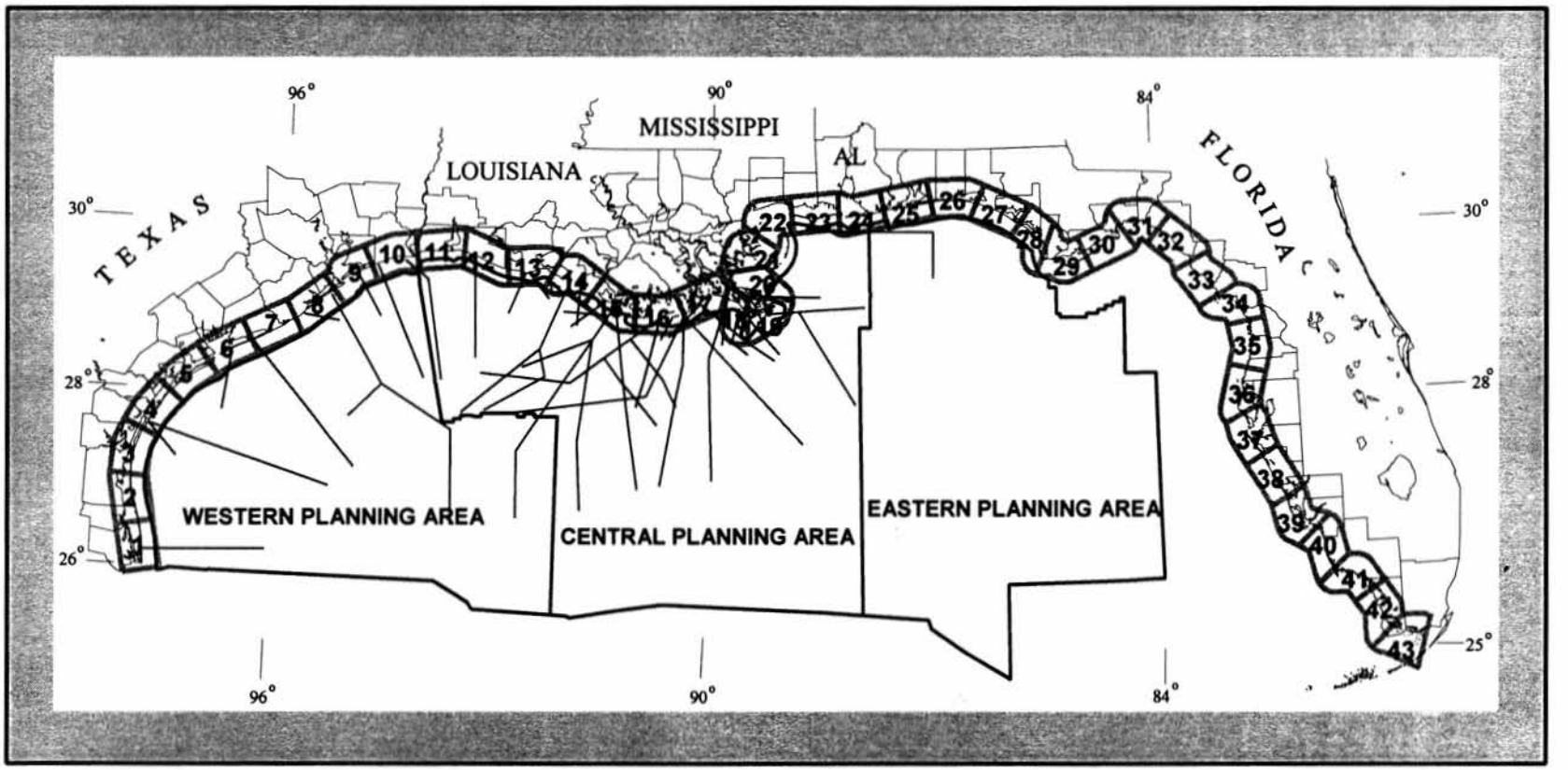

Figure C-1. Land Segments and Hypothetical Pipeline Segments Used in the Minerals Management Service's Oil Spill Risk Analysis Model.

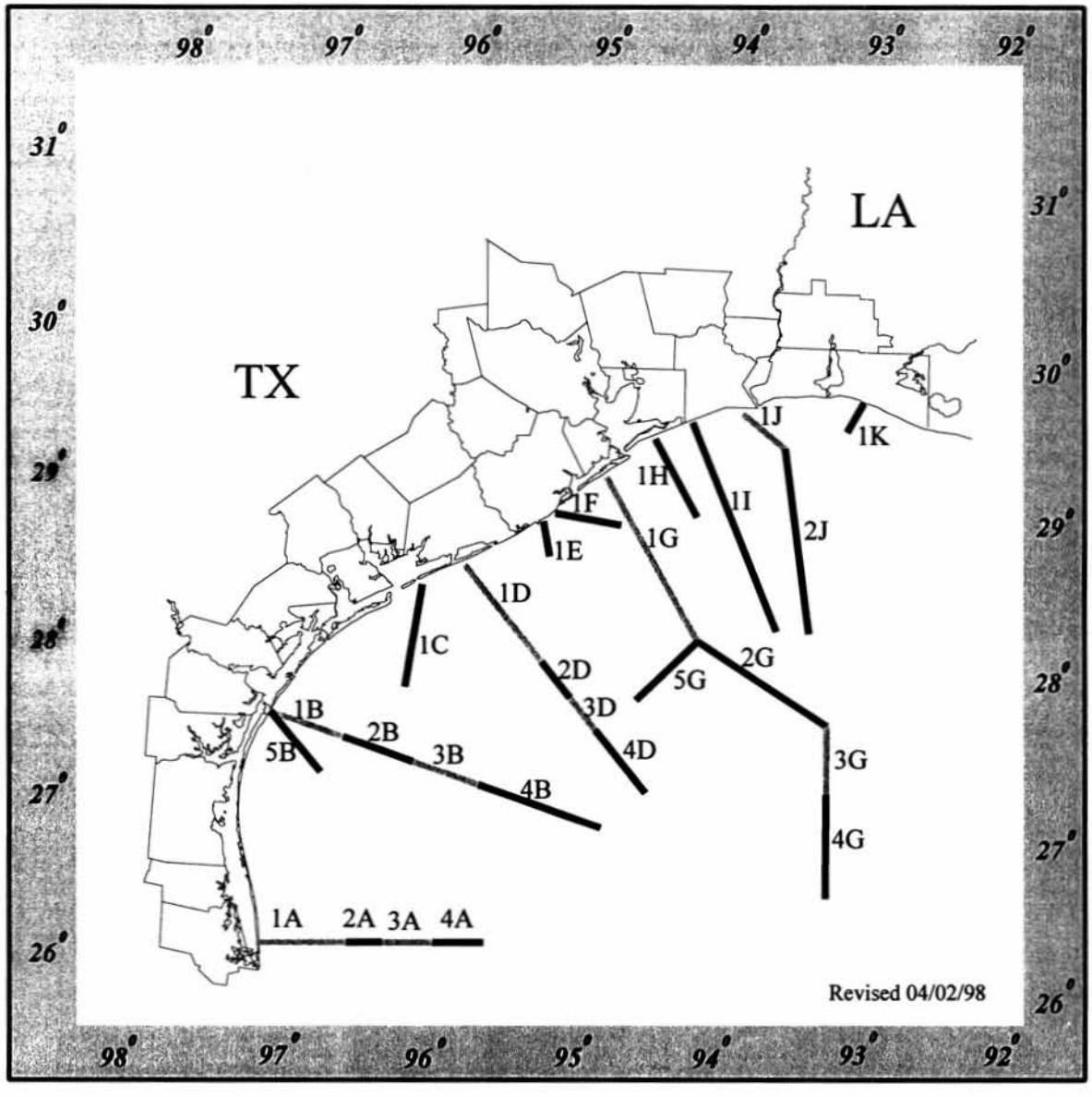

Figure C-2. Pipeline Segments 1-4A, 1-5B, 1C, 1-4D, 1E, 1F, 1-5G, 1H, 1I, 1-2J, and 1K.

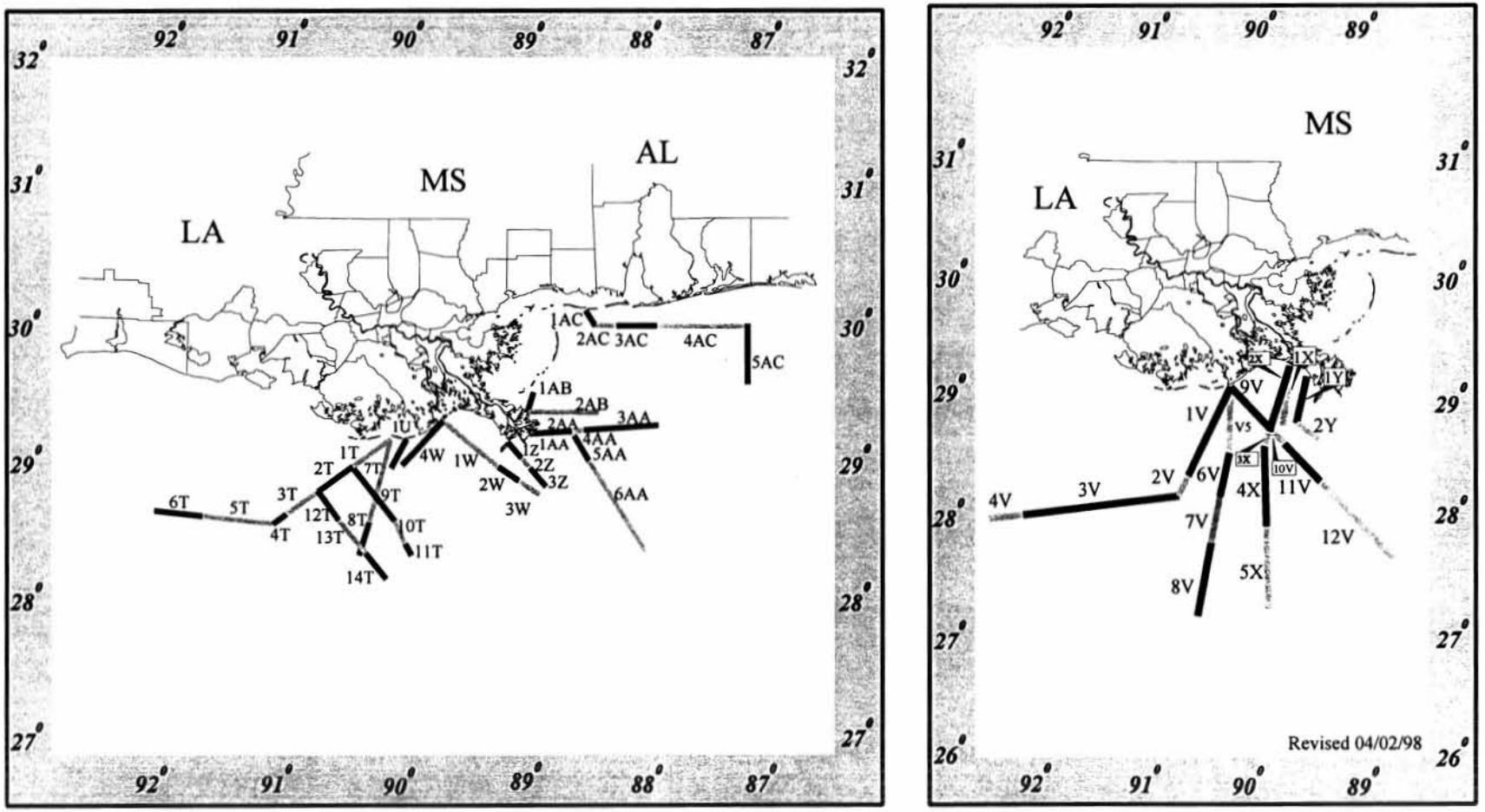

Figure C-3. Pipeline Segments 1-6AA, 1-2AB, 1-5AC, 1-14T, 1U, 1-12V, 1-4W, 1-5X, 1-2Y, and 1-3Z.

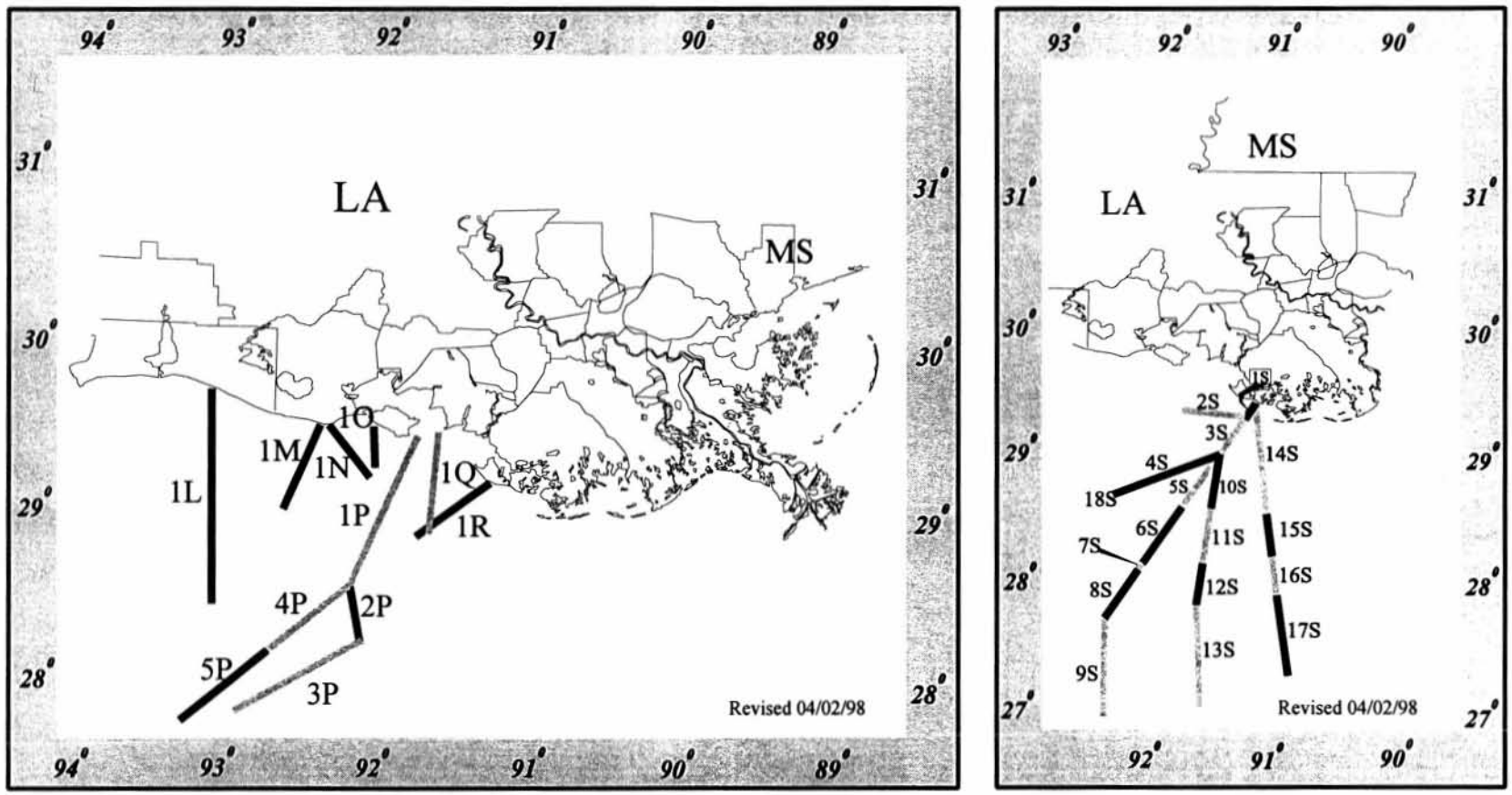

Figure C-4. Pipeline Segments 1L, 1M, 1N, 1O, 1-5P, 1Q, 1R, and 1-17S.

Table C-1

Probabilities and Estimated Number of One or More Spills Greater Than or Equal To 1,000 Barrels Occurring and Contacting Environmental Resources and Land Segments from Gulfwide OCS Program Operations for a Range of Resource Estimates for the Years 1998-2036

	Within 3 Days				Within 10 Days				Within 30 Days			
	Percent Probability		Mean Number		Percent Probability		Mean Number		Percent Probability		Mean Number	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
U.S. Shoreline	91	96	2.4	3.3	**	**	6.2	8.5	**	**	12	17
Tamaulipas, Mexico	n	n	0	0	n	n	0	0	n	n	0	0
Land Segment 58 (Mexico)	n	n	0	0	1	1	0	0	1	2	0	0
OFFSHORE												
C. Winter Menhaden	74	83	1.3	1.8	85	92	1.9	2.5	90	96	2.3	3.2
W. Winter Menhaden	46	56	0.6	0.8	78	87	1.5	2	91	96	2.4	3.3
Florida Middle Ground	n	n	0	0	n	n	0	0	n	n	0	0
Flower Gardens NMS	5	9	0.1	0.1	12	19	0.1	0.2	30	44	0.4	0.6
Stetson Bank NMS	2	3	0	0	4	6	0	0.1	10	15	0.1	0.2
TEXAS												
Coastal Waters	44	59	0.6	0.9	72	86	1.3	2	97	**	3.6	5.3
Major Recreational Beaches	27	39	0.3	0.5	62	77	1	1.5	95	99	3.1	4.5
Cameron	4	7	0	0.1	6	11	0.1	0.1	7	13	0.1	0.1
Kenedy/Kleberg/Nueces/Aransas	8	13	0.1	0.1	19	29	0.2	0.3	29	44	0.3	0.6
Calhoun	2	2	0	0	10	15	0.1	0.2	21	32	0.2	0.4
Matagorda	4	7	0	0.1	11	18	0.1	0.2	31	44	0.4	0.6
Brazoria	4	6	0	0.1	12	18	0.1	0.2	39	52	0.5	0.7
Galveston	6	9	0.1	0.1	21	29	0.2	0.3	68	79	1.1	1.6
Jefferson	3	4	0	0	14	18	0.1	0.2	47	57	0.6	0.8
Padre Island National Seashore	4	6	0	0.1	12	18	0.1	0.2	19	30	0.2	0.4
Corpus Christi/Aransas Bays	3	5	0	0.1	7	11	0.1	0.1	12	19	0.1	0.2
Sabine Lake*	2	3	0	0	10	13	0.1	0.1	35	44	0.4	0.6
Galveston/West Bays	5	8	0.1	0.1	17	24	0.2	0.3	60	73	0.9	1.3
Matagorda Bay	3	5	0	0	10	15	0.1	0.2	24	35	0.3	0.4
Aransas Refuge	1	1	0	0	3	5	0	0	4	6	0	0.1
Espiritu Santos/Matagorda Bays	4	6	0	0.1	12	19	0.1	0.2	31	45	0.4	0.6
Laguna Madre Seagrass	6	10	0.1	0.1	14	22	0.1	0.3	20	33	0.2	0.4
Land Segment 1	4	7	0	0.1	6	11	0.1	0.1	8	13	0.1	0.1
Land Segment 2	1	1	0	0	3	6	0	0.1	5	9	0.1	0.1
Land Segment 3	1	2	0	0	5	8	0	0.1	9	15	0.1	0.2
Land Segment 4	7	11	0.1	0.1	13	20	0.1	0.2	19	30	0.2	0.4
Land Segment 5	2	3	0	0	10	16	0.1	0.2	20	31	0.2	0.4
Land Segment 6	4	6	0	0.1	12	19	0.1	0.2	31	45	0.4	0.6
Land Segment 7	4	7	0	0.1	11	18	0.1	0.2	32	45	0.4	0.6
Land Segment 8	5	7	0.1	0.1	13	19	0.1	0.2	44	57	0.6	0.8
Land Segment 9	3	4	0	0	10	13	0.1	0.1	41	52	0.5	0.7
Land Segment 10*	4	5	0	0.1	17	22	0.2	0.3	56	67	0.8	1.1
LOUISIANA												
Coastal Waters	97	99	3.5	4.6	**	**	6.2	8.3	**	**	9.3	13
Major Recreational Beaches	44	54	0.6	0.8	75	84	1.4	1.8	91	96	2.4	3.2
Cameron	6	9	0.1	0.1	26	33	0.3	0.4	64	75	1	1.4
La Fourche	36	45	0.5	0.6	61	72	0.9	1.3	69	80	1.2	1.6
Jefferson	25	32	0.3	0.4	47	57	0.6	0.8	54	65	0.8	1.1
Vermilion/Atchafalaya Bays	18	23	0.2	0.3	55	65	0.8	1.1	79	88	1.5	2.1
Timbalier Bay	40	49	0.5	0.7	69	80	1.2	1.6	80	89	1.6	2.2
Barataria Bay	33	41	0.4	0.5	59	70	0.9	1.2	67	78	1.1	1.5
Caminada Headland	37	47	0.5	0.6	62	73	1	1.3	71	81	1.2	1.7
Chandeleur/Breton	9	12	0.1	0.1	23	30	0.3	0.4	35	43	0.4	0.6
Chenier Coastal Barrier	27	35	0.3	0.4	76	85	1.4	1.9	99	**	4.3	5.9
Sabine Lake*	2	3	0	0	10	13	0.1	0.1	35	44	0.4	0.6
Land Segment 10*	4	5	0	0.1	17	22	0.2	0.3	56	67	0.8	1.1
Land Segment 11	6	8	0.1	0.1	24	31	0.3	0.4	63	74	1	1.3
Land Segment 12	7	9	0.1	0.1	30	38	0.4	0.5	62	73	1	1.3

* Environmental resource/land segment within two states; spill probabilities and mean number of spills shown are for the entire resource/land segment.

** Greater than 99.5%

n Less than 0.5%

Table C-1. Probabilities and Estimated Number of One or More Spills Greater Than or Equal To 1,000 Barrels Occurring and Contacting Environmental Resources and Land Segments from Gulfwide OCS Program Operations for a Range of Resource Estimates for the Years 1998-2036 (continued)

	Within 3 Days				Within 10 Days				Within 30 Days			
	Percent Probability		Mean Number		Percent Probability		Mean Number		Percent Probability		Mean Number	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
LOUISIANA (continued)												
Land Segment 13	12	15	0.1	0.2	39	48	0.5	0.7	63	74	1	1.3
Land Segment 14	7	10	0.1	0.1	26	33	0.3	0.4	42	52	0.5	0.7
Land Segment 15	17	22	0.2	0.2	40	50	0.5	0.7	53	64	0.8	1
Land Segment 16	28	35	0.3	0.4	53	64	0.8	1	65	76	1.1	1.4
Land Segment 17	38	47	0.5	0.6	65	75	1	1.4	73	83	1.3	1.8
Land Segment 18	19	25	0.2	0.3	33	42	0.4	0.5	41	51	0.5	0.7
Land Segment 19	28	35	0.3	0.4	37	46	0.5	0.6	41	51	0.5	0.7
Land Segment 20	11	14	0.1	0.2	21	27	0.2	0.3	27	35	0.3	0.4
Land Segment 21	n	1	0	0	6	8	0.1	0.1	14	18	0.1	0.2
Land Segment 22*	1	1	0	0	5	7	0.1	0.1	15	19	0.2	0.2
MISSISSIPPI												
Coastal Waters	3	5	0	0	9	12	0.1	0.1	19	25	0.2	0.3
Major Recreational Beaches	3	4	0	0	11	15	0.1	0.2	28	36	0.3	0.4
Hancock	n	n	0	0	3	4	0	0	8	11	0.1	0.1
Harrison	1	1	0	0	4	5	0	0.1	11	15	0.1	0.2
Jackson	2	3	0	0	7	10	0.1	0.1	18	24	0.2	0.3
Mississippi Sound	3	5	0	0	12	17	0.1	0.2	30	39	0.4	0.5
Land Segment 22*	1	1	0	0	5	7	0.1	0.1	15	19	0.2	0.2
Land Segment 23*	2	3	0	0	7	10	0.1	0.1	19	25	0.2	0.3
ALABAMA												
Coastal Waters	4	6	0	0.1	9	13	0.1	0.1	21	28	0.2	0.3
Major Recreational Beaches	2	4	0	0	7	10	0.1	0.1	19	25	0.2	0.3
Mobile	1	2	0	0	4	6	0	0.1	11	15	0.1	0.2
Baldwin	1	2	0	0	4	6	0	0.1	11	15	0.1	0.2
Mobile Bay	1	2	0	0	3	5	0	0	9	12	0.1	0.1
Gulf Shores Coastal Barrier	1	2	0	0	4	5	0	0.1	10	14	0.1	0.2
Endangered Mouse Habitat*	n	1	0	0	2	3	0	0	6	9	0.1	0.1
Gulf Island National Seashore*	3	4	0	0	10	14	0.1	0.2	27	35	0.3	0.4
Land Segment 23*	2	3	0	0	7	10	0.1	0.1	19	25	0.2	0.3
Land Segment 24	1	2	0	0	4	5	0	0.1	10	14	0.1	0.2
FLORIDA												
Coastal Waters	1	2	0	0	3	4	0	0	14	19	0.2	0.2
Panhandle Coastal Waters	1	1	0	0	2	4	0	0	10	14	0.1	0.1
Panhandle Major Recreational Beache	n	1	0	0	1	2	0	0	6	9	0.1	0.1
Emerald	n	1	0	0	1	2	0	0	6	8	0.1	0.1
Bay	n	n	0	0	n	n	0	0	n	n	0	0
Gulf	n	n	0	0	n	n	0	0	n	n	0	0
Franklin	n	n	0	0	n	n	0	0	n	n	0	0
Big Bend Seagrass	n	n	0	0	n	n	0	0	n	n	0	0
Florida Keys NMS	n	n	0	0	n	1	0	0	6	8	0.1	0.1
Everglades Manatees	n	n	0	0	n	n	0	0	2	2	0	0
Manatees	n	n	0	0	n	n	0	0	2	3	0	0
Apalachicola Bay	n	n	0	0	n	n	0	0	n	n	0	0
Saint Andrew's Bay	n	n	0	0	n	n	0	0	n	n	0	0
Saint Joseph's Bay	n	n	0	0	n	n	0	0	n	n	0	0
Esc. Bay/Pens. Bay/Santa Rosa Sound	n	n	0	0	1	1	0	0	4	6	0	0.1
Choctawhatchee Bay	n	n	0	0	n	n	0	0	1	1	0	0
Endangered Mouse Habitat*	n	1	0	0	2	3	0	0	6	9	0.1	0.1
Gulf Island National Seashore*	3	4	0	0	10	14	0.1	0.2	27	35	0.3	0.4
Land Segment 25	n	n	0	0	1	1	0	0	3	5	0	0.1
Land Segment 26	n	n	0	0	n	n	0	0	1	1	0	0
Land Segment 44	n	n	0	0	n	n	0	0	n	1	0	0
Land Segment 45	n	n	0	0	n	n	0	0	1	1	0	0
Land Segment 46	n	n	0	0	n	n	0	0	n	1	0	0

* Environmental resource/land segment within two states; spill probabilities and mean number of spills shown are for the entire resource/land segment.

** Greater than 99.5%

n Less than 0.5%

Table C-2

Pipeline Routes: Probabilities (expressed as a percent chance) that an Oil Spill Starting at a Particular Location will Contact a Certain Land Segment within 3, 10, and 30 Days

3/10/30 Days

	1A	2A	3A	4A	1B	2B	3B	4B	5B	1C	1D	2D	3D	4D	1E	1F	1G	2G	3G
U.S. Shoreline	31/65/93	1/26/81	-/12/67	-/3/47	54/94/99	1/57/93	-/17/70	-/1/37	54/95/**	47/90/99	27/72/93	-/19/69	-/6/53	-/1/34	67/93/99	55/90/99	16/49/87	-/1/47	-/-/29
Tamaulipas, Mexico	-/1/1	-/-/1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 58 (Mexico)	-/-/3	-/-/3	-/-/3	-/-/2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OFFSHORE																			
C. Winter Menhaden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W. Winter Menhaden	-	-	-/-/1	-/-/1	-	-	-/-/2	-/-/5	-	-	-	-/-/2	-/-/6	-/-/7	-	-	-/-/2	-/3/14	-/3/19
Florida Middle Ground	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flower Gardens NMS	-	-/-/1	-/-/4	-/-/7	-	-/-/1	-/-/5	-/3/15	-	-	-/-/1	-/2/6	-/6/14	-/10/20	-	-	-/1/1	34/40/42	2/11/16
Stetson Bank NMS	-	-/-/1	-/-/1	-/-/2	-	-	-/-/2	-/1/3	-	-	-	-/1/3	-/3/5	-/2/5	-	-	4/4/5	2/5/6	-/-/2
TEXAS																			
Coastal Waters	52/74/94	2/32/81	-/16/69	-/5/49	76/96/99	6/67/94	-/23/73	-/2/38	77/97/**	71/95/99	44/80/94	-/26/72	-/10/53	-/2/33	92/98/99	85/96/99	29/59/86	-/3/38	-/-/20
Major Recreational Beaches	28/58/80	1/22/67	-/10/56	-/3/39	49/81/86	1/44/74	-/13/57	-/1/30	51/85/90	21/52/60	23/60/78	-/16/59	-/5/43	-/1/26	66/89/94	55/86/94	16/48/79	-/1/32	-/-/16
Cameron	26/35/36	1/8/11	-/3/5	-/1/3	-	-/-/1	-/-/1	-/-/1	-	-	-	-	-	-	-	-	-	-	-
Kenedy/Kleberg/Nueces/Aransas	2/22/34	-/10/30	-/4/23	-/1/14	47/70/73	-/18/33	-/3/17	-/-/6	51/78/82	-/8/12	-/2/5	-/1/6	-/-/5	-/-/4	-/-/2	-/-/1	-/-/2	-/-/2	-/-/1
Calhoun	-/1/8	-/3/16	-/3/12	-/1/8	2/11/12	-/23/29	-/4/12	-/-/6	-/7/7	18/36/38	1/9/13	-/3/10	-/1/6	-/-/4	-/3/4	-/2/3	-/1/4	-/-/3	-/-/2
Matagorda	-/-/1	-/-/8	-/1/9	-/-/8	-	-/2/7	-/4/15	-/-/7	-	3/9/9	20/36/41	-/5/15	-/1/9	-/-/5	14/24/24	5/14/15	-/6/12	-/-/6	-/-/2
Brazoria	-	-/-/2	-/-/4	-/-/4	-	-/-/3	-/1/7	-/-/6	-	-	2/10/14	-/6/16	-/2/11	-/-/5	51/58/58	37/48/50	6/17/23	-/-/7	-/-/3
Galveston	-	-/-/1	-/-/3	-/-/3	-	-/-/1	-/-/5	-/-/5	-	-	-/2/6	-/2/14	-/-/12	-/-/7	3/8/9	26/39/42	13/30/44	-/1/11	-/-/6
Jefferson	-	-	-	-	-	-	-	-/-/1	-	-	-	-/-/1	-/-/2	-/-/2	-	-/-/1	-/1/4	-/-/6	-/-/2
Padre Island National Seashore	2/20/27	-/8/21	-/4/16	-/1/11	20/32/35	-/10/20	-/2/10	-/-/4	27/44/46	-/3/5	-/1/3	-/-/4	-/-/3	-/-/2	-/-/1	-	-/-/1	-/-/1	-
Corpus Christi/Aransas Bays	-/3/7	-/3/9	-/1/6	-/-/3	22/30/31	-/8/12	-/1/7	-/-/2	17/28/29	-/5/7	-/1/3	-/-/2	-/-/2	-/-/2	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1
Sabine Lake*	-	-	-	-	-	-	-	-/-/1	-	-	-	-/-/1	-/-/1	-/-/1	-	-	-/-/2	-/-/3	-/-/1
Galveston/West Bays	-	-/-/1	-/-/3	-/-/2	-	-/-/1	-/-/5	-/-/5	-	-	-/2/6	-/2/13	-/-/10	-/-/6	5/9/10	31/42/44	11/27/38	-/-/9	-/-/5
Matagorda Bay	-/-/4	-/2/11	-/1/10	-/1/7	-/2/2	-/12/18	-/5/13	-/-/5	-/1/1	39/53/54	5/16/20	-/4/12	-/2/8	-/-/5	1/5/6	-/4/5	-/2/6	-/-/4	-/-/3
Aransas Refuge	-/1/5	-/1/4	-/-/2	-	5/13/13	-/5/5	-	-	2/9/9	-	-	-	-	-	-	-	-	-	-
Espiritu Santos/Matagorda Bays	-/-/4	-/2/13	-/2/13	-/1/9	-/2/2	-/12/19	-/6/18	-/-/7	-/1/1	40/57/58	10/27/32	-/6/16	-/2/11	-/-/7	1/9/10	-/6/8	-/3/9	-/-/6	-/-/4
Laguna Madre Seagrass	31/57/64	1/17/31	-/7/20	-/2/13	4/12/15	-/6/15	-/1/9	-/-/4	8/19/22	-/1/3	-/-/2	-/-/2	-/-/3	-/-/2	-/-/1	-	-/-/1	-	-
Land Segment 1	27/35/37	1/9/12	-/3/6	-/1/4	-	-/-/1	-/-/2	-/-/1	-/-/1	-	-	-	-	-	-	-	-	-	-
Land Segment 2	4/13/15	-/5/9	-/3/7	-/1/5	-/1/2	-/1/4	-/-/2	-/-/1	-/2/2	-/-/1	-	-/-/1	-	-	-	-	-	-	-
Land Segment 3	-/8/12	-/3/10	-/1/7	-/-/5	4/11/13	-/5/10	-/1/5	-/-/2	8/17/19	-/1/2	-/-/1	-/-/2	-/-/2	-/-/1	-	-	-/-/1	-	-
Land Segment 4	-/6/13	-/4/13	-/1/10	-/-/6	43/57/59	-/12/20	-/2/10	-/-/3	42/59/61	-/6/9	-/2/4	-/1/4	-/-/3	-/-/3	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1
Land Segment 5	-/2/11	-/3/17	-/3/12	-/1/8	7/22/23	1/26/32	-/4/12	-/-/6	3/15/16	7/23/25	-/6/9	-/2/8	-/1/5	-/-/4	-/2/3	-/1/3	-/-/3	-/-/3	-/-/2
Land Segment 6	-/-/4	-/2/13	-/2/13	-/1/9	-/2/2	-/12/19	-/6/18	-/-/7	-/1/1	40/57/58	10/27/32	-/6/16	-/2/11	-/-/7	1/9/10	-/6/8	-/3/9	-/-/6	-/-/4
Land Segment 7	-/-/1	-/-/6	-/-/8	-/-/6	-	-/1/5	-/3/13	-/-/7	-	-/3/4	16/32/36	-/7/17	-/2/10	-/-/5	32/41/42	10/20/22	1/8/14	-/-/6	-/-/2
Land Segment 8	-	-/-/1	-/-/3	-/-/3	-	-/-/1	-/-/6	-/-/4	-	-	-/5/8	-/4/14	-/1/11	-/-/5	33/39/40	42/55/56	11/25/32	-/-/8	-/-/4
Land Segment 9	-	-	-/-/1	-/-/1	-	-	-/-/2	-/-/2	-	-	-/-/2	-/-/4	-/-/4	-/-/3	-/1/1	2/6/7	4/11/17	-/-/4	-/-/2
Land Segment 10*	-	-	-	-	-	-	-/-/1	-/-/1	-	-	-/-/1	-/-/2	-/-/3	-/-/3	-	-/1/2	-/2/7	-/-/7	-/-/3
LOUISIANA																			
Coastal Waters	-	-	-	-	-	-	-/-/1	-/-/2	-	-	-	-/-/2	-/-/4	-/-/5	-	-/-/1	-/-/4	-/-/14	-/-/12
Major Recreational Beaches	-	-	-	-	-	-	-	-/-/1	-	-	-	-/-/1	-/-/2	-/-/3	-	-	-/-/2	-/-/6	-/-/5
Cameron	-	-	-	-	-	-	-	-/-/1	-	-	-	-/-/1	-/-/2	-/-/3	-	-	-/-/2	-/-/6	-/-/5
La Fourche	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vermilion/Atchafalaya Bays	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-/-/2	-/-/2
Timbalier Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Barataria Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caminada Headland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chandeleur/Breton	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chenier Coastal Barrier	-	-	-/-/1	-/-/2	-	-	-/-/3	-/-/5	-	-	-/-/3	-/-/8	-/-/10	-/-/10	-/1/2	2/7/9	4/13/27	-/1/23	-/-/16
Sabine Lake*	-	-	-	-	-	-	-	-/-/1	-	-	-	-/-/1	-/-/1	-/-/1	-	-	-/-/2	-/-/3	-/-/1
Land Segment 10*	-	-	-	-	-	-	-/-/1	-/-/1	-	-	-/-/1	-/-/2	-/-/3	-/-/3	-	-/1/2	-/2/7	-/-/7	-/-/3
Land Segment 11	-	-	-	-	-	-	-	-/-/1	-	-	-	-/-/1	-/-/2	-/-/3	-	-	-/-/2	-/-/6	-/-/5
Land Segment 12	-	-	-	-	-	-	-	-/-/1	-	-	-	-	-/-/1	-/-/1	-	-	-/-/1	-/-/4	-/-/4
Land Segment 13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-/-/1	-/-/2
Land Segment 14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* Environmental resource/land segment within two states; spill probabilities shown are for the entire resource/land segment.

** Greater than 99.5%

- less than 0.5%

Table C-2. Pipeline Routes: Probabilities (expressed as a percent chance) that an Oil Spill Starting at a Particular Location will Contact a Certain Land Segment within 3, 10, and 30 Days (continued)

3/10/30 Days

	1A	2A	3A	4A	1B	2B	3B	4B	5B	1C	1D	2D	3D	4D	1E	1F	1G	2G	3G
LOUISIANA (continued)																			
Land Segment 17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 22*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MISSISSIPPI																			
Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Major Recreational Beaches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hancock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harrison	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jackson	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mississippi Sound	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 22*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 23*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ALABAMA																			
Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Major Recreational Beaches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mobile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baldwin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mobile Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Shores Coastal Barrier	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Endangered Mouse Habitat*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Island National Seashore*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 23*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FLORIDA																			
Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panhandle Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panhandle Major Recreational Beaches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emerald	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Franklin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Big Bend Seagrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Keys NMS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Everglades Manatees	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manatees	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Apalachicola Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saint Andrew's Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saint Joseph's Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Esc. Bay/Pens. Bay/Santa Rosa Sound	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Choctawhatchee Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Endangered Mouse Habitat*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Island National Seashore*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* Environmental resoure/land segment within two states; spill probabilities shown are for the entire resource/land segment.

** Greater than 99.5%

- less than 0.5%

Table C-2. Pipeline Routes: Probabilities (expressed as a percent chance) that an Oil Spill Starting at a Particular Location will Contact a Certain Land Segment within 3, 10, and 30 Days (continued)

3/10/30 Days

	4G	5G	1H	1I	1J	2J	1K	1L	1M	1N	1O	1P	2P	3P	4P	5P	1Q	1R	1S
U.S. Shoreline	-/-/15	-/7/58	35/80/98	15/46/85	50/89/99	2/29/79	56/89/99	13/42/84	27/66/93	31/71/95	44/78/96	16/50/87	-/12/65	-/4/50	-/10/63	-/2/49	33/67/93	18/56/90	38/68/91
Tamaulipas, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 58 (Mexico)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OFFSHORE																			
C. Winter Menhaden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
W. Winter Menhaden	-/-/12	-/-/6	-	-/-/3	-	-/1/4	-	-/3/5	5/6/6	1/1/1	-/1/1	25/26/27	37/46/47	8/26/34	28/39/42	2/18/29	7/9/10	15/18/19	2/5/7
Florida Middle Ground	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flower Gardens NMS	-/3/11	2/10/14	-	-/1/2	-	-/2/3	-	-/-/1	-/-/1	-	-	-/-/1	-/1/3	-/3/5	-/2/3	1/4/6	-/-/1	-	-/-/1
Stetson Bank NMS	-/-/1	14/18/19	-	-/1/2	-	-/1/1	-	-/-/1	-	-	-	-	-/-/1	-/-/1	-/-/1	-/1/1	-	-	-
TEXAS																			
Coastal Waters	-/-/10	-/10/57	61/90/97	25/56/82	75/87/90	6/33/69	8/25/29	2/21/48	-/16/32	-/11/24	-/8/19	-/6/28	-/1/32	-/-/27	-/1/35	-/1/30	-/4/18	-/3/21	-/1/13
Major Recreational Beaches	-/-/7	-/6/47	35/78/92	15/44/75	44/76/84	2/25/63	3/21/28	-/14/45	-/11/30	-/7/22	-/5/18	-/4/25	-/1/27	-/-/22	-/1/30	-/-/24	-/2/16	-/2/19	-/-/12
Cameron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kenedy/Kleberg/Nueces/Aransas	-/-/1	-/-/3	-/-/1	-/-/1	-	-/-/1	-	-	-	-	-	-	-	-	-	-/-/1	-	-	-
Calhoun	-/-/1	-/1/5	-/1/2	-/-/2	-/-/1	-/-/2	-/-/1	-/-/1	-/-/1	-/-/1	-	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-	-	-
Matagorda	-/-/1	-/2/9	-/5/8	-/2/7	-/1/3	-/-/6	-/-/2	-/-/5	-/-/2	-/-/2	-/-/1	-/-/3	-/-/2	-/-/2	-/-/3	-/-/3	-/-/2	-/-/2	-/-/1
Brazoria	-/-/1	-/2/12	3/16/18	-/6/14	-/4/6	-/2/11	-/1/3	-/1/7	-/-/5	-/-/4	-/-/3	-/-/4	-/-/5	-/-/4	-/-/5	-/-/6	-/-/2	-/-/3	-/-/3
Galveston	-/-/2	-/2/17	34/61/68	13/31/45	8/25/28	-/13/31	-/9/12	-/6/21	-/4/14	-/3/11	-/2/9	-/1/11	-/-/15	-/-/10	-/-/14	-/-/12	-/1/7	-/-/9	-/-/5
Jefferson	-/-/1	-/-/4	-/3/5	2/8/13	37/48/49	1/11/18	3/12/13	-/8/14	-/7/11	-/4/7	-/3/6	-/3/8	-/-/7	-/-/6	-/-/8	-/-/5	-/2/5	-/1/6	-/-/4
Padre Island National Seashore	-	-/-/2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corpus Christi/Aransas Bays	-	-/-/1	-	-/-/1	-	-/-/1	-	-	-	-	-	-	-	-	-	-	-	-	-
Sabine Lake*	-/-/1	-/-/2	-/1/2	-/3/6	27/34/34	1/6/10	3/9/10	1/6/10	-/5/8	-/4/6	-/3/4	-/2/6	-/-/5	-/-/4	-/-/5	-/-/4	-/1/4	-/2/5	-/-/2
Galveston/West Bays	-/-/2	-/2/14	31/54/59	7/23/36	4/17/19	-/10/25	-/6/9	-/4/17	-/3/11	-/2/9	-/1/7	-/-/9	-/-/11	-/-/8	-/-/12	-/-/10	-/-/5	-/-/7	-/-/4
Matagorda Bay	-/-/1	-/1/7	-/2/3	-/1/4	-/-/1	-/-/3	-/-/1	-/-/2	-/-/1	-/-/1	-/-/1	-/-/1	-/-/2	-/-/2	-/-/3	-/-/2	-/-/1	-/-/1	-/-/1
Aransas Refuge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Espiritu Santos/Matagorda Bays	-/-/1	-/2/10	-/3/5	-/1/6	-/1/2	-/-/5	-/-/1	-/-/3	-/-/2	-/-/1	-/-/1	-/-/2	-/-/2	-/-/3	-/-/3	-/-/3	-/-/1	-/-/1	-/-/1
Laguna Madre Seagrass	-	-/-/1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 3	-	-/-/1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 4	-	-/-/2	-	-/-/1	-	-/-/1	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 5	-/-/1	-/-/4	-/-/1	-/-/2	-/-/1	-/-/1	-	-/-/1	-/-/1	-/-/1	-	-	-/-/1	-/-/1	-/-/1	-/-/1	-	-	-
Land Segment 6	-/-/1	-/2/10	-/3/5	-/1/6	-/1/2	-/-/5	-/-/1	-/-/3	-/-/2	-/-/1	-/-/1	-/-/2	-/-/2	-/-/3	-/-/3	-/-/3	-/-/1	-/-/1	-/-/1
Land Segment 7	-/-/2	-/2/10	-/7/10	-/2/8	-/2/4	-/1/7	-/-/2	-/-/5	-/-/3	-/-/2	-/-/2	-/-/3	-/-/2	-/-/3	-/-/3	-/-/4	-/-/2	-/-/2	-/-/2
Land Segment 8	-/-/1	-/2/13	6/22/25	1/9/17	-/6/8	-/4/14	-/3/5	-/2/9	-/1/6	-/-/5	-/-/4	-/-/5	-/-/7	-/-/5	-/-/7	-/-/6	-/-/3	-/-/4	-/-/2
Land Segment 9	-/-/1	-/-/6	25/38/41	6/16/23	4/12/14	-/7/15	-/5/6	-/3/11	-/2/6	-/1/5	-/1/4	-/-/6	-/-/6	-/-/5	-/-/6	-/-/5	-/-/3	-/-/4	-/-/3
Land Segment 10*	-/-/1	-/-/7	3/9/12	8/16/22	41/56/58	1/14/23	3/14/15	-/10/18	-/8/14	-/5/9	-/4/7	-/3/10	-/-/10	-/-/8	-/1/11	-/-/7	-/2/7	-/2/8	-/-/4
LOUISIANA																			
Coastal Waters	-/-/6	-/-/6	-/1/3	-/1/6	10/15/16	-/5/14	69/78/79	17/33/42	41/63/69	48/75/79	70/86/88	31/55/67	-/14/40	-/5/29	-/11/35	-/3/25	57/77/84	36/66/77	61/81/87
Major Recreational Beaches	-/-/3	-/-/4	-/-/2	-/1/4	3/8/9	-/3/7	37/46/47	6/16/21	3/16/19	-/12/14	-/7/9	-/9/14	-/4/14	-/1/10	-/4/13	-/1/10	-/5/9	-/5/11	-/2/6
Cameron	-/-/3	-/-/4	-/-/2	-/1/4	3/8/9	-/3/7	37/46/47	6/16/21	3/16/19	-/12/14	-/7/9	-/9/14	-/4/14	-/1/10	-/4/13	-/1/10	-/5/9	-/5/11	-/2/6
La Fourche	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vermilion/Atchafalaya Bays	-/-/1	-/-/1	-	-	-	-/-/1	-	-/-/1	14/19/21	26/37/40	42/54/56	16/27/31	-/2/9	-/1/6	-/1/7	-/-/4	32/50/54	8/28/33	1/16/20
Timbalier Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-/-/1	1/3/4
Barataria Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caminada Headland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chandeleur/Breton	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chenier Coastal Barrier	-/-/8	-/1/18	29/48/56	14/33/51	50/80/85	2/25/51	56/86/90	13/40/66	27/65/82	31/69/83	41/71/82	8/38/63	-/11/50	-/4/37	-/9/47	-/2/34	6/31/48	3/31/54	-/13/29
Sabine Lake*	-/-/1	-/-/2	-/1/2	-/3/6	27/34/34	1/6/10	3/9/10	1/6/10	-/5/8	-/4/6	-/3/4	-/2/6	-/-/5	-/-/4	-/-/5	-/-/4	-/1/4	-/2/5	-/-/2
Land Segment 10*	-/-/1	-/-/7	3/9/12	8/16/22	41/56/58	1/14/23	3/14/15	-/10/18	-/8/14	-/5/9	-/4/7	-/3/10	-/-/10	-/-/8	-/1/11	-/-/7	-/2/7	-/2/8	-/-/4
Land Segment 11	-/-/3	-/-/3	-/1/2	-/1/4	6/11/12	-/3/7	29/39/40	6/16/21	2/15/18	-/11/14	-/7/9	-/9/14	-/3/13	-/1/10	-/4/12	-/1/10	-/5/9	-/5/11	-/2/6
Land Segment 12	-/-/2	-/-/2	-	-/-/1	-/1/1	-/1/4	25/28/29	7/11/15	12/20/22	5/15/17	2/12/13	1/11/15	-/5/14	-/2/10	-/4/13	-/1/8	-/8/10	-/9/13	-/4/6
Land Segment 13	-/-/1	-	-	-	-	-/-/1	-	-/-/1	14/19/21	26/36/38	38/47/49	7/15/18	-/2/8	-/-/5	-/1/5	-/-/3	6/16/19	3/15/18	-/8/10
Land Segment 14	-	-	-	-	-	-	-	-	-	-/1/2	4/6/7	8/12/13	-/-/1	-/-/2	-/-/1	-/-/1	26/34/35	5/12/14	1/9/10
Land Segment 15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1/2/3	9/13/13	38/45/46
Land Segment 16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-/1/1

* Environmental resource/land segment within two states; spill probabilities shown are for the entire resource/land segment.

** Greater than 99.5%

- less than 0.5%

Table C-2: Pipeline Routes: Probabilities (expressed as a percent chance) that an Oil Spill Starting at a Particular Location will Contact a Certain Land Segment within 3, 10, and 30 Days (continued)

3/10/30 Days

	4G	5G	1H	1I	1J	2J	1K	1L	1M	1N	1O	1P	2P	3P	4P	5P	1Q	1R	1S
LOUISIANA (continued)																			
Land Segment 17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 22*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MISSISSIPPI																			
Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Major Recreational Beaches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hancock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harrison	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jackson	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mississippi Sound	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 22*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 23*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ALABAMA																			
Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Major Recreational Beaches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mobile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baldwin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mobile Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Shores Coastal Barrier	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Endangered Mouse Habitat*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Island National Seashore*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 23*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FLORIDA																			
Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panhandle Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panhandle Major Recreational Beaches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emerald	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Franklin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Big Bend Seagrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Keys NMS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Everglades Manatees	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manatees	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Apalachicola Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saint Andrew's Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saint Joseph's Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Esc. Bay/Pens. Bay/Santa Rosa Sound	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Choctawhatchee Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Endangered Mouse Habitat*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Island National Seashore*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* Environmental resource/land segment within two states; spill probabilities shown are for the entire resource/land segment.
** Greater than 99.5%
- less than 0.5%

Table C-2. Pipeline Routes: Probabilities (expressed as a percent chance) that an Oil Spill Starting at a Particular Location will Contact a Certain Land Segment within 3, 10, and 30 Days (continued)

3/10/30 Days

	2S	3S	4S	5S	6S	7S	8S	9S	10S	11S	12S	13S	14S	15S	16S	17S	1T	2T	3T
U.S. Shoreline	15/56/90	8/45/85	-/18/70	-/20/70	-/5/49	-/1/38	-/-/31	-/-/19	-/20/70	-/5/47	-/1/31	-/-/19	10/37/76	-/7/48	-/2/35	-/-/22	23/51/83	1/29/75	-/14/64
Tamaulipas, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 58 (Mexico)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OFFSHORE																			
C. Winter Menhaden	-	-	-	-	-	-	-	-	-	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/3	-/-/6	-/2/3	-/-/1	-
W. Winter Menhaden	6/10/12	21/26/27	42/48/49	37/46/48	7/27/37	1/15/29	-/10/26	-/2/20	28/41/45	5/25/36	-/10/26	-/3/20	8/20/25	1/19/32	-/8/25	-/2/20	4/11/13	16/28/32	20/37/42
Florida Middle Ground	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flower Gardens NMS	-	-/-/1	-/1/2	-/-/2	-/1/3	-/1/4	-/1/6	-/1/7	-/-/2	-/-/3	-/-/5	-/-/5	-/-/1	-/-/2	-/-/2	-/-/2	-/-/1	-/-/1	-/-/2
Stetson Bank NMS	-/-/1	-	-/-/1	-	-/-/1	-/-/1	-/-/1	-/-/1	-	-	-/-/1	-/-/1	-	-/-/1	-/-/1	-	-	-	-/-/1
TEXAS																			
Coastal Waters	-/4/22	-/3/23	-/2/32	-/2/27	-/-/22	-/-/17	-/-/14	-/-/9	-/2/26	-/-/16	-/-/10	-/-/6	-/1/19	-/-/13	-/-/7	-/-/4	-/1/16	-/2/24	-/-/24
Major Recreational Beaches	-/2/20	-/1/20	-/1/28	-/1/24	-/-/18	-/-/14	-/-/11	-/-/6	-/1/22	-/-/13	-/-/7	-/-/4	-/-/17	-/-/10	-/-/5	-/-/3	-/-/14	-/-/21	-/-/21
Cameron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kenedy/Kleberg/Nueces/Aransas	-	-	-	-	-	-	-	-/-/1	-	-	-	-	-	-	-	-	-	-	-
Calhoun	-	-	-	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-	-	-	-	-	-	-	-	-	-	-/-/1
Matagorda	-/-/2	-/-/2	-/-/2	-/-/2	-/-/2	-/-/2	-/-/2	-/-/1	-/-/2	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-	-/-/1	-/-/2	-/-/1
Brazoria	-/-/4	-/-/3	-/-/5	-/-/4	-/-/3	-/-/3	-/-/1	-/-/1	-/-/3	-/-/2	-/-/2	-	-/-/3	-/-/1	-/-/1	-	-/-/3	-/-/3	-/-/4
Galveston	-/-/9	-/-/9	-/-/14	-/-/13	-/-/9	-/-/6	-/-/5	-/-/2	-/-/12	-/-/6	-/-/3	-/-/2	-/-/8	-/-/5	-/-/2	-/-/1	-/-/7	-/-/11	-/-/11
Jefferson	-/2/7	-/1/7	-/1/9	-/1/7	-/-/5	-/-/4	-/-/3	-/-/1	-/1/6	-/-/4	-/-/2	-/-/1	-/-/6	-/-/4	-/-/2	-/-/1	-/-/5	-/-/7	-/-/6
Padre Island National Seashore	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corpus Christi/Aransas Bays	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sabine Lake*	-/1/4	-/1/5	-/1/6	-/1/5	-/-/3	-/-/2	-/-/1	-/-/1	-/1/6	-/-/3	-/-/1	-/-/1	-/-/4	-/-/3	-/-/1	-/-/1	-/-/4	-/-/4	-/-/5
Galveston/West Bays	-/-/7	-/-/7	-/-/11	-/-/10	-/-/7	-/-/5	-/-/4	-/-/2	-/-/9	-/-/5	-/-/3	-/-/1	-/-/7	-/-/4	-/-/2	-/-/1	-/-/6	-/-/9	-/-/9
Matagorda Bay	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-	-/-/1	-	-	-	-/-/1	-/-/1	-/-/1
Aransas Refuge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Espiritu Santos/Matagorda Bays	-/-/1	-/-/1	-/-/2	-/-/1	-/-/2	-/-/1	-/-/2	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-	-/-/1	-/-/1	-/-/1
Laguna Madre Seagrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 5	-	-	-	-/-/1	-/-/1	-/-/1	-/-/1	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 6	-/-/1	-/-/1	-/-/2	-/-/1	-/-/2	-/-/1	-/-/2	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-	-/-/1	-/-/1	-/-/1
Land Segment 7	-/-/2	-/-/2	-/-/3	-/-/2	-/-/2	-/-/1	-/-/2	-/-/1	-/-/2	-/-/1	-/-/1	-/-/1	-/-/2	-/-/1	-	-	-/-/2	-/-/2	-/-/2
Land Segment 8	-/-/4	-/-/4	-/-/6	-/-/5	-/-/4	-/-/3	-/-/2	-/-/1	-/-/5	-/-/3	-/-/2	-/-/1	-/-/3	-/-/2	-/-/1	-	-/-/3	-/-/4	-/-/5
Land Segment 9	-/-/4	-/-/5	-/-/7	-/-/6	-/-/4	-/-/3	-/-/3	-/-/1	-/-/6	-/-/3	-/-/1	-/-/1	-/-/5	-/-/2	-/-/1	-/-/1	-/-/3	-/-/6	-/-/5
Land Segment 10*	-/2/9	-/1/9	-/1/11	-/1/9	-/-/6	-/-/5	-/-/3	-/-/2	-/1/9	-/-/5	-/-/3	-/-/2	-/-/7	-/-/4	-/-/2	-/-/1	-/-/6	-/-/8	-/-/8
LOUISIANA																			
Coastal Waters	29/63/75	18/53/69	1/21/46	1/23/50	-/7/33	-/2/26	-/1/21	-/-/13	2/24/51	-/8/37	-/2/26	-/-/17	17/45/64	-/10/41	-/4/32	-/-/21	38/61/75	4/36/58	-/18/48
Major Recreational Beaches	-/7/12	-/6/13	-/4/13	-/3/13	-/1/9	-/-/8	-/-/7	-/-/5	-/3/13	-/1/9	-/-/6	-/-/3	-/3/10	-/-/9	-/-/6	-/-/4	-/2/8	-/3/12	-/2/12
Cameron	-/7/12	-/6/13	-/4/13	-/3/13	-/1/9	-/-/8	-/-/7	-/-/5	-/3/13	-/1/9	-/-/6	-/-/3	-/3/9	-/-/9	-/-/5	-/-/3	-/2/7	-/3/12	-/2/12
La Fourche	-	-	-	-	-	-	-	-	-	-	-	-	-	-/-/1	-/-/1	-/-/1	-/1/1	-	-
Jefferson	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vermilion/Atchafalaya Bays	11/32/37	3/22/28	-/6/12	-/9/16	-/2/10	-/-/7	-/-/6	-/-/3	-/10/18	-/3/13	-/1/8	-/-/5	-/14/21	-/4/15	-/1/10	-/-/6	-/10/16	1/15/21	-/8/17
Timbalier Bay	-/1/1	-/1/2	-	-	-/-/1	-	-	-	-/-/1	-/-/1	-/-/1	-/-/1	1/2/3	-/1/3	-/-/4	-/-/3	19/24/25	-/2/3	-/-/1
Barataria Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-/-/1	-	-	-	-
Caminada Headland	-	-	-	-	-	-	-	-	-	-	-	-	-	-/-/1	-/-/1	-/-/1	-/1/2	-	-
Chandeleur/Breton	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chenier Coastal Barrier	5/35/58	1/27/56	-/16/55	-/17/55	-/5/36	-/1/27	-/-/23	-/-/14	-/17/54	-/4/35	-/1/21	-/-/13	-/16/44	-/3/32	-/1/21	-/-/13	-/11/33	-/19/53	-/12/48
Sabine Lake*	-/1/4	-/1/5	-/1/6	-/1/5	-/-/3	-/-/2	-/-/1	-/-/1	-/1/6	-/-/3	-/-/1	-/-/1	-/-/4	-/-/3	-/-/1	-/-/1	-/-/4	-/-/4	-/-/5
Land Segment 10*	-/2/9	-/1/9	-/1/11	-/1/9	-/-/6	-/-/5	-/-/3	-/-/2	-/1/9	-/-/5	-/-/3	-/-/2	-/-/7	-/-/4	-/-/2	-/-/1	-/-/6	-/-/8	-/-/8
Land Segment 11	-/6/11	-/5/12	-/3/13	-/2/13	-/1/9	-/-/8	-/-/6	-/-/4	-/2/13	-/-/9	-/-/6	-/-/3	-/2/9	-/-/8	-/-/5	-/-/3	-/2/7	-/3/12	-/2/11
Land Segment 12	-/9/13	-/8/14	-/7/15	-/7/14	-/2/9	-/-/7	-/-/6	-/-/4	-/6/13	-/1/9	-/-/6	-/-/4	-/5/11	-/1/8	-/-/6	-/-/3	-/3/7	-/6/13	-/4/12
Land Segment 13	5/18/21	1/13/16	-/5/10	-/7/12	-/2/7	-/-/5	-/-/4	-/-/3	-/7/13	-/2/9	-/-/5	-/-/3	-/9/13	-/2/9	-/-/6	-/-/5	-/6/10	-/10/14	-/6/12
Land Segment 14	6/14/15	2/10/12	-/1/3	-/2/4	-/-/3	-/-/2	-/-/1	-/-/1	-/3/5	-/1/4	-/-/3	-/-/2	-/6/8	-/2/6	-/1/4	-/-/2	-/4/6	-/5/8	-/2/6
Land Segment 15	4/7/8	4/8/9	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-	-/-/2	-/-/2	-/-/2	-/-/1	10/15/16	-/2/4	-/-/4	-/-/3	7/16/17	1/4/4	-/1/1
Land Segment 16	-	-/-/1	-	-	-	-	-	-	-	-/-/1	-/-/1	-	-/-/1	-/-/2	-/-/2	-/-/2	16/19/21	-/1/2	-/-/1

* Environmental resoure/land segment within two states; spill probabilities shown are for the entire resource/land segment.

** Greater than 99.5%

- less than 0.5%

Table C-2. Pipeline Routes: Probabilities (expressed as a percent chance) that an Oil Spill Starting at a Particular Location will Contact a Certain Land Segment within 3, 10, and 30 Days (continued)

3/10/30 Days

	2S	3S	4S	5S	6S	7S	8S	9S	10S	11S	12S	13S	14S	15S	16S	17S	1T	2T	3T
LOUISIANA (continued)																			
Land Segment 17	-	-	-	-	-	-	-	-	-	-	-	-	-	-/-/1	-/-/1	-/-/1	-/-/1	-	-
Land Segment 18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 22*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MISSISSIPPI																			
Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Major Recreational Beaches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hancock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harrison	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jackson	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mississippi Sound	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 22*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 23*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ALABAMA																			
Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Major Recreational Beaches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mobile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baldwin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mobile Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Shores Coastal Barrier	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Endangered Mouse Habitat*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Island National Seashore*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 23*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FLORIDA																			
Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panhandle Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panhandle Major Recreational Beaches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emerald	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Franklin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Big Bend Seagrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Keys NMS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Everglades Manatees	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manatees	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Apalachicola Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saint Andrew's Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saint Joseph's Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Esc. Bay/Pens. Bay/Santa Rosa Sound	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Choctawhatchee Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Endangered Mouse Habitat*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Island National Seashore*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* Environmental resource/land segment within two states; spill probabilities shown are for the entire resource/land segment.

** Greater than 99.5%

- less than 0.5%

Table C-2. Pipeline Routes: Probabilities (expressed as a percent chance) that an Oil Spill Starting at a Particular Location will Contact a Certain Land Segment within 3, 10, and 30 Days (continued)

3/10/30 Days

	4T	5T	6T	7T	8T	9T	10T	11T	12T	13T	14T	1U	1V	2V	3V	4V	5V	6V	7V
U.S. Shoreline	-/9/59	-/7/57	-/6/59	10/32/71	-/7/48	1/21/66	-/7/46	-/5/41	-/15/63	-/8/50	-/3/37	28/53/81	12/33/69	-/8/50	-/4/42	-/1/41	17/40/72	-/10/48	-/3/37
Tamaulipas, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 58 (Mexico)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OFFSHORE																			
C. Winter Menhaden	-	-	-	-/2/3	-/1/3	-/1/3	1/8/12	1/10/17	-/-/1	-/-/2	-/2/7	3/6/6	6/8/9	-/1/4	-/-/1	-	38/40/40	8/16/20	-/9/17
W. Winter Menhaden	15/37/43	15/36/41	9/28/33	2/13/18	-/14/28	4/16/24	-/9/22	-/6/18	11/30/37	1/18/31	-/7/22	1/6/9	-/10/17	-/14/27	1/17/31	1/17/32	-/7/13	-/8/19	-/4/16
Florida Middle Ground	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flower Gardens NMS	-/1/3	-/1/3	-/2/4	-/-/1	-/-/2	-/-/1	-/-/1	-/-/2	-/-/2	-/-/2	-/-/2	-/-/1	-/-/1	-/-/2	-/-/2	-/2/5	-/-/1	-/-/1	-/-/2
Stetson Bank NMS	-/-/1	-/-/1	-/1/1	-	-/-/1	-	-	-	-/-/1	-	-	-	-	-	-/-/1	-/-/1	-	-	-
TEXAS																			
Coastal Waters	-/-/24	-/1/29	-/1/34	-/-/17	-/-/12	-/1/19	-/-/10	-/-/8	-/-/21	-/-/13	-/-/8	-/-/14	-/-/14	-/-/12	-/-/14	-/-/21	-/-/12	-/-/10	-/-/6
Major Recreational Beaches	-/-/20	-/-/24	-/1/29	-/-/14	-/-/9	-/-/16	-/-/8	-/-/6	-/-/18	-/-/10	-/-/6	-/-/12	-/-/12	-/-/10	-/-/11	-/-/18	-/-/10	-/-/8	-/-/5
Cameron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kenedy/Kleberg/Nueces/Aransas	-	-	-/-/1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calhoun	-/-/1	-/-/1	-/-/1	-	-	-	-	-	-/-/1	-	-	-	-	-	-	-/-/1	-	-	-
Matagorda	-/-/2	-/-/3	-/-/3	-/-/1	-/-/1	-/-/1	-	-	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-	-/-/1	-/-/2	-/-/1	-/-/1	-
Brazoria	-/-/4	-/-/3	-/-/6	-/-/2	-/-/1	-/-/3	-/-/1	-/-/1	-/-/3	-/-/2	-/-/1	-/-/2	-/-/2	-/-/2	-/-/2	-/-/3	-/-/2	-/-/1	-/-/1
Galveston	-/-/10	-/-/12	-/-/15	-/-/7	-/-/5	-/-/8	-/-/4	-/-/3	-/-/9	-/-/5	-/-/3	-/-/5	-/-/6	-/-/5	-/-/5	-/-/8	-/-/5	-/-/4	-/-/2
Jefferson	-/-/6	-/-/7	-/-/6	-/-/5	-/-/3	-/-/5	-/-/3	-/-/2	-/-/6	-/-/3	-/-/2	-/-/4	-/-/4	-/-/4	-/-/4	-/-/5	-/-/3	-/-/3	-/-/2
Padre Island National Seashore	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corpus Christi/Aransas Bays	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sabine Lake*	-/-/4	-/-/4	-/-/5	-/-/3	-/-/2	-/-/4	-/-/2	-/-/2	-/-/4	-/-/2	-/-/1	-/-/3	-/-/3	-/-/3	-/-/3	-/-/3	-/-/2	-/-/2	-/-/2
Galveston/West Bays	-/-/7	-/-/9	-/-/12	-/-/6	-/-/4	-/-/6	-/-/3	-/-/2	-/-/7	-/-/4	-/-/2	-/-/5	-/-/5	-/-/4	-/-/4	-/-/7	-/-/4	-/-/3	-/-/2
Matagorda Bay	-/-/1	-/-/2	-/-/2	-	-	-/-/1	-	-	-/-/1	-	-	-	-	-/-/1	-/-/1	-/-/2	-	-	-
Aransas Refuge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Espiritu Santos/Matagorda Bays	-/-/1	-/-/3	-/-/3	-/-/1	-/-/1	-/-/1	-	-	-/-/1	-/-/1	-	-/-/1	-	-/-/1	-/-/1	-/-/2	-	-	-
Laguna Madre Seagrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 5	-	-	-/-/1	-	-	-	-	-	-	-	-	-	-	-	-	-/-/1	-	-	-
Land Segment 6	-/-/1	-/-/3	-/-/3	-/-/1	-/-/1	-/-/1	-	-	-/-/1	-/-/1	-	-/-/1	-	-/-/1	-/-/1	-/-/2	-	-	-
Land Segment 7	-/-/2	-/-/2	-/-/4	-/-/1	-/-/1	-/-/1	-/-/1	-	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/2	-/-/1	-/-/1	-/-/1
Land Segment 8	-/-/4	-/-/5	-/-/7	-/-/3	-/-/2	-/-/4	-/-/2	-/-/1	-/-/4	-/-/2	-/-/1	-/-/2	-/-/3	-/-/2	-/-/2	-/-/4	-/-/2	-/-/2	-/-/1
Land Segment 9	-/-/4	-/-/5	-/-/6	-/-/4	-/-/2	-/-/4	-/-/2	-/-/1	-/-/5	-/-/3	-/-/1	-/-/3	-/-/3	-/-/3	-/-/2	-/-/4	-/-/2	-/-/2	-/-/1
Land Segment 10*	-/-/8	-/-/9	-/-/9	-/-/6	-/-/4	-/-/7	-/-/4	-/-/3	-/-/8	-/-/4	-/-/2	-/-/5	-/-/5	-/-/5	-/-/5	-/-/6	-/-/4	-/-/4	-/-/2
LOUISIANA																			
Coastal Waters	-/12/42	-/9/36	-/6/30	16/41/62	-/10/42	3/28/54	-/10/42	-/7/39	-/20/49	-/10/43	-/5/35	44/65/77	20/42/63	-/11/44	-/6/33	-/2/25	28/49/68	-/14/44	-/5/36
Major Recreational Beaches	-/1/12	-/2/11	-/3/12	-/2/10	-/-/8	-/1/10	-/1/10	-/1/8	-/1/11	-/-/9	-/-/7	4/6/11	4/7/13	-/-/9	-/-/8	-/-/9	8/11/18	-/1/9	-/-/8
Cameron	-/1/11	-/2/11	-/3/12	-/1/9	-/-/7	-/1/10	-/-/7	-/-/4	-/1/11	-/-/9	-/-/6	-/1/5	-/1/7	-/-/8	-/-/7	-/-/9	-/-/6	-/-/6	-/-/4
La Fourche	-	-	-	-/1/2	-/-/1	-/-/1	-/1/3	-/1/4	-	-/-/1	-/-/2	4/5/6	4/6/7	-/-/1	-	-	8/11/12	-/1/3	-/-/4
Jefferson	-	-	-	-	-	-	-/-/1	-/-/2	-	-	-/-/1	-/1/1	-/1/1	-	-	-	-/1/2	-/-/1	-/-/2
Vermilion/Atchafalaya Bays	-/5/13	-/2/9	-/-/5	-/8/15	-/4/14	-/9/17	-/2/10	-/-/8	-/9/18	-/4/15	-/1/10	-/7/11	-/6/13	-/4/13	-/2/10	-/-/6	-/4/11	-/2/10	-/-/8
Timbalier Bay	-/-/1	-	-	9/14/16	-/1/5	-/4/6	-/3/8	-/3/11	-/1/2	-/1/4	-/1/6	27/35/37	11/18/21	-/1/5	-/-/2	-	17/27/30	-/5/11	-/2/9
Barataria Bay	-	-	-	-/-/1	-/-/1	-	-/-/1	-/-/3	-	-	-/-/1	-/1/1	-/1/2	-/-/1	-	-	1/2/3	-/-/2	-/-/3
Caminada Headland	-	-	-	-/2/2	-/-/1	-/-/1	-/1/3	-/1/4	-	-/-/1	-/-/2	6/8/8	5/7/8	-/-/1	-/-/1	-	9/12/13	-/1/3	-/-/4
Chandeleur/Breton	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chenier Coastal Barrier	-/8/45	-/7/44	-/6/42	-/8/35	-/3/30	-/8/40	-/1/25	-/-/18	-/11/46	-/3/32	-/1/20	-/6/25	-/5/28	-/3/30	-/2/30	-/1/30	-/4/24	-/1/23	-/-/17
Sabine Lake*	-/-/4	-/-/4	-/-/5	-/-/3	-/-/2	-/-/4	-/-/2	-/-/2	-/-/4	-/-/2	-/-/1	-/-/3	-/-/3	-/-/3	-/-/3	-/-/3	-/-/2	-/-/2	-/-/2
Land Segment 10*	-/-/8	-/-/9	-/-/9	-/-/6	-/-/4	-/-/7	-/-/4	-/-/3	-/-/8	-/-/4	-/-/2	-/-/5	-/-/5	-/-/5	-/-/5	-/-/6	-/-/4	-/-/4	-/-/2
Land Segment 11	-/1/11	-/2/10	-/2/12	-/1/8	-/-/7	-/1/9	-/-/6	-/-/4	-/1/10	-/-/8	-/-/5	-/1/5	-/-/7	-/-/7	-/-/7	-/-/8	-/-/5	-/-/6	-/-/4
Land Segment 12	-/3/13	-/3/12	-/3/11	-/2/8	-/1/8	-/3/9	-/-/6	-/-/5	-/3/11	-/1/9	-/-/5	-/2/5	-/1/6	-/1/7	-/1/8	-/-/8	-/1/5	-/-/5	-/-/4
Land Segment 13	-/4/9	-/2/7	-/-/4	-/5/9	-/2/9	-/5/10	-/1/7	-/-/5	-/7/13	-/2/9	-/-/6	-/4/7	-/4/8	-/2/9	-/1/7	-/-/4	-/2/7	-/1/6	-/-/5
Land Segment 14	-/1/3	-/-/2	-/-/1	-/4/6	-/2/5	-/4/7	-/1/3	-/-/3	-/3/5	-/2/6	-/-/4	-/3/5	-/3/5	-/1/5	-/1/3	-/-/1	-/2/4	-/1/3	-/-/3
Land Segment 15	-/-/1	-	-	2/9/10	-/2/5	1/6/8	-/3/6	-/1/6	-/2/3	-/2/5	-/1/4	3/11/12	1/8/10	-/3/6	-/-/2	-	1/8/11	-/4/8	-/1/5
Land Segment 16	-	-	-	8/11/13	-/1/4	-/3/4	-/2/6	-/2/7	-/-/1	-/-/2	-/-/4	25/31/32	9/14/16	-/1/4	-/-/1	-	13/20/22	-/4/8	-/1/7

* Environmental resource/land segment within two states; spill probabilities shown are for the entire resource/land segment.

** Greater than 99.5%

- less than 0.5%

Table C-2. Pipeline Routes: Probabilities (expressed as a percent chance) that an Oil Spill Starting at a Particular Location will Contact a Certain Land Segment within 3, 10, and 30 Days (continued)

3/10/30 Days

	4T	5T	6T	7T	8T	9T	10T	11T	12T	13T	14T	1U	1V	2V	3V	4V	5V	6V	7V
LOUISIANA (continued)																			
Land Segment 17	-	-	-	-/1/1	-/-/1	-	-/-/2	-/-/3	-	-	-/-/1	-/2/2	2/3/4	-/-/1	-/-/1	-	4/6/7	-/1/2	-/-/3
Land Segment 18	-	-	-	-	-	-	-	-/-/1	-	-	-	-	-/-/1	-/-/1	-	-	-/-/1	-/-/1	-/-/1
Land Segment 19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 22*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MISSISSIPPI																			
Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Major Recreational Beaches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hancock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harrison	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jackson	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mississippi Sound	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 22*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 23*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ALABAMA																			
Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Major Recreational Beaches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mobile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baldwin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mobile Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Shores Coastal Barrier	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Endangered Mouse Habitat*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Island National Seashore*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 23*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FLORIDA																			
Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panhandle Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panhandle Major Recreational Beaches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emerald	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Franklin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Big Bend Seagrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Keys NMS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Everglades Manatees	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manatees	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Apalachicola Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saint Andrew's Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saint Joseph's Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Esc. Bay/Pens. Bay/Santa Rosa Sound	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Choctawhatchee Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Endangered Mouse Habitat*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Island National Seashore*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* Environmental resource/land segment within two states; spill probabilities shown are for the entire resource/land segment.
** Greater than 99.5%
- less than 0.5%

Table C-2. Pipeline Routes: Probabilities (expressed as a percent chance) that an Oil Spill Starting at a Particular Location will Contact a Certain Land Segment within 3, 10, and 30 Days (continued)

3/10/30 Days

	8V	9V	10V	11V	12V	1W	2W	3W	4W	1X	2X	3X	4X	5X	1Y	2Y	1Z	2Z	3Z
U.S. Shoreline	-/-/25	29/54/80	7/31/66	-/22/55	-/3/27	38/72/88	9/47/74	3/33/62	45/65/86	34/68/86	33/65/85	6/29/64	-/13/47	-/2/27	33/69/86	8/41/72	48/71/85	15/52/76	6/37/65
Tamaulipas, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 58 (Mexico)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OFFSHORE																			
C. Winter Menhaden	-/2/13	37/40/40	31/43/46	10/32/39	-/8/23	36/39/39	31/41/44	11/31/39	10/13/13	41/43/43	42/43/43	34/43/45	8/23/32	-/6/21	48/50/50	30/42/46	8/14/16	20/32/36	12/29/37
W. Winter Menhaden	-/1/15	-/4/8	-/5/11	-/3/9	-/-/5	-/1/3	-/3/5	-/2/5	-/4/5	-/1/3	-/2/4	-/6/13	-/4/12	-/1/11	-/1/2	-/3/6	-/1/2	-/2/4	-/2/5
Florida Middle Ground	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Flower Gardens NMS	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-	-	-	-/-/1	-	-	-/-/1	-/-/1	-/-/1	-	-/-/1	-	-	-
Stetson Bank NMS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TEXAS																			
Coastal Waters	-/-/4	-/-/9	-/-/9	-/-/6	-/-/1	-/-/4	-/-/5	-/-/4	-/-/9	-/-/5	-/-/6	-/-/10	-/-/7	-/-/3	-/-/5	-/-/7	-/-/3	-/-/4	-/-/3
Major Recreational Beaches	-/-/3	-/-/7	-/-/6	-/-/4	-/-/1	-/-/3	-/-/4	-/-/3	-/-/7	-/-/4	-/-/4	-/-/8	-/-/5	-/-/2	-/-/4	-/-/6	-/-/2	-/-/3	-/-/2
Cameron	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kenedy/Kleberg/Nueces/Aransas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calhoun	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Matagorda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brazoria	-	-/-/1	-/-/1	-/-/1	-	-/-/1	-/-/1	-	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-	-/-/1	-/-/1	-	-	-
Galveston	-/-/2	-/-/4	-/-/3	-/-/2	-/-/1	-/-/2	-/-/2	-/-/2	-/-/4	-/-/2	-/-/2	-/-/4	-/-/3	-/-/1	-/-/2	-/-/3	-/-/1	-/-/2	-/-/1
Jefferson	-/-/1	-/-/2	-/-/2	-/-/1	-	-/-/1	-/-/1	-/-/1	-/-/3	-/-/1	-/-/1	-/-/3	-/-/2	-/-/1	-/-/1	-/-/2	-/-/1	-/-/1	-/-/1
Padre Island National Seashore	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Corpus Christi/Aransas Bays	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sabine Lake*	-/-/1	-/-/2	-/-/2	-/-/1	-	-/-/1	-/-/1	-/-/1	-/-/2	-/-/1	-/-/1	-/-/2	-/-/1	-/-/1	-/-/1	-/-/1	-	-/-/1	-/-/1
Galveston/West Bays	-/-/1	-/-/3	-/-/3	-/-/2	-	-/-/1	-/-/2	-/-/1	-/-/3	-/-/2	-/-/2	-/-/3	-/-/2	-/-/1	-/-/2	-/-/2	-/-/1	-/-/1	-/-/1
Matagorda Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aransas Refuge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Espiritu Santos/Matagorda Bays	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Laguna Madre Seagrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 7	-	-/-/1	-	-	-	-	-	-	-/-/1	-	-	-	-	-	-	-	-	-	-
Land Segment 8	-	-/-/2	-/-/1	-/-/1	-	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-	-/-/1	-/-/1	-	-/-/1	-/-/1
Land Segment 9	-/-/1	-/-/2	-/-/2	-/-/1	-	-/-/1	-/-/1	-/-/1	-/-/2	-/-/1	-/-/1	-/-/2	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-
Land Segment 10*	-/-/1	-/-/3	-/-/3	-/-/2	-/-/1	-/-/1	-/-/2	-/-/1	-/-/3	-/-/1	-/-/2	-/-/4	-/-/3	-/-/1	-/-/2	-/-/3	-/-/1	-/-/1	-/-/1
LOUISIANA																			
Coastal Waters	-/1/24	44/65/79	13/40/65	2/28/55	-/5/28	60/83/90	22/58/76	9/42/64	62/76/86	56/79/88	53/75/87	12/36/61	1/17/46	-/3/27	72/86/92	18/52/73	77/88/93	36/66/79	14/48/68
Major Recreational Beaches	-/-/5	22/28/34	5/11/19	-/10/18	-/2/10	29/46/50	5/22/29	-/13/21	33/38/42	18/33/37	18/32/37	4/8/15	-/5/12	-/1/7	9/26/30	7/20/28	1/9/12	1/17/23	-/14/22
Cameron	-/-/3	-/-/4	-/-/5	-/-/3	-/-/1	-/-/2	-/-/3	-/-/2	-/-/3	-/-/2	-/-/3	-/-/5	-/-/3	-/-/1	-/-/2	-/-/4	-/-/1	-/-/2	-/-/2
La Fourche	-/-/2	22/27/28	5/11/14	-/9/14	-/2/8	23/37/39	4/19/22	-/12/17	33/37/38	15/27/29	16/27/29	4/8/10	-/5/9	-/1/5	8/21/23	6/18/22	1/9/10	1/15/18	-/12/17
Jefferson	-/-/1	4/7/8	1/4/5	-/5/8	-/1/5	24/37/38	3/14/16	-/8/12	17/19/20	13/23/24	13/22/23	1/2/3	-/1/3	-/-/3	6/18/19	3/11/14	-/6/7	-/11/13	-/8/12
Vermilion/Atchafalaya Bays	-/-/6	-/3/8	-/2/9	-/-/6	-/-/2	-/1/3	-/1/5	-/-/4	-/4/7	-/1/4	-/1/4	-/2/9	-/1/6	-/-/3	-/1/4	-/1/6	-/-/2	-/-/5	-/-/4
Timbalier Bay	-/-/5	27/38/42	6/21/27	-/11/18	-/1/8	8/19/21	2/19/24	-/11/17	31/39/41	7/18/21	9/20/23	6/20/25	-/10/18	-/2/10	5/17/19	4/21/26	1/9/11	1/14/18	-/11/16
Barataria Bay	-/-/2	6/10/11	2/5/7	-/8/12	-/1/6	29/47/49	4/19/22	-/12/18	19/22/23	23/38/40	22/36/38	1/3/4	-/2/5	-/1/4	10/28/29	4/14/18	-/8/9	1/16/19	-/11/17
Caminada Headland	-/-/3	23/29/31	5/11/14	-/9/14	-/2/8	24/38/39	4/20/23	-/12/17	33/38/39	15/28/29	16/27/29	4/8/10	-/5/9	-/1/5	8/22/24	6/19/23	1/9/10	1/15/19	-/13/17
Chandeleur/Breton	-	-	-	-	-/-/1	-	-	-/-/1	-	-	-	-	-	-	-	-	-/-/1	-/-/1	-/1/2
Chenier Coastal Barrier	-/-/11	-/3/17	-/1/19	-/-/13	-/-/5	-/-/8	-/1/13	-/-/8	-/3/15	-/-/9	-/1/11	-/1/22	-/-/15	-/-/7	-/1/9	-/1/15	-/-/5	-/-/9	-/-/8
Sabine Lake*	-/-/1	-/-/2	-/-/2	-/-/1	-	-/-/1	-/-/1	-/-/1	-/-/2	-/-/1	-/-/1	-/-/2	-/-/1	-/-/1	-/-/1	-/-/1	-	-/-/1	-/-/1
Land Segment 10*	-/-/1	-/-/3	-/-/3	-/-/2	-/-/1	-/-/1	-/-/2	-/-/1	-/-/3	-/-/1	-/-/2	-/-/4	-/-/3	-/-/1	-/-/2	-/-/3	-/-/1	-/-/1	-/-/1
Land Segment 11	-/-/3	-/-/4	-/-/5	-/-/3	-/-/1	-/-/2	-/-/3	-/-/2	-/-/3	-/-/3	-/-/3	-/-/5	-/-/3	-/-/1	-/-/2	-/-/4	-/-/1	-/-/2	-/-/1
Land Segment 12	-/-/2	-/-/4	-/-/5	-/-/4	-/-/1	-/-/2	-/-/3	-/-/2	-/-/2	-/-/2	-/-/3	-/-/5	-/-/4	-/-/2	-/-/2	-/-/3	-/-/1	-/-/2	-/-/2
Land Segment 13	-/-/4	-/2/4	-/1/5	-/-/3	-/-/1	-/-/2	-/-/3	-/-/2	-/2/5	-/-/2	-/1/3	-/1/6	-/-/4	-/-/2	-/-/2	-/-/4	-/-/1	-/-/3	-/-/3
Land Segment 14	-/-/3	-/2/3	-/1/4	-/-/2	-/-/1	-/-/1	-/1/2	-/-/2	-/2/3	-/1/2	-/1/2	-/1/4	-/-/2	-/-/1	-/-/1	-/1/3	-/-/1	-/-/2	-/-/2
Land Segment 15	-/-/3	-/5/7	-/5/8	-/2/5	-/-/3	-/2/3	-/3/5	-/1/4	-/5/6	-/3/4	-/3/4	-/5/9	-/2/6	-/-/3	-/2/3	-/4/6	-/1/2	-/2/3	-/1/3
Land Segment 16	-/-/4	15/24/27	4/15/20	-/7/12	-/1/5	2/8/9	1/11/15	-/7/11	17/23/24	3/10/11	4/11/14	4/15/18	-/7/12	-/1/8	2/9/11	2/13/17	-/6/7	-/8/11	-/6/10

* Environmental resource/land segment within two states; spill probabilities shown are for the entire resource/land segment.

** Greater than 99.5%

- less than 0.5%

Table C-2. Pipeline Routes: Probabilities (expressed as a percent chance) that an Oil Spill Starting at a Particular Location will Contact a Certain Land Segment within 3, 10, and 30 Days (continued)

3/10/30 Days

	8V	9V	10V	11V	12V	1W	2W	3W	4W	1X	2X	3X	4X	5X	1Y	2Y	1Z	2Z	3Z
LOUISIANA (continued)																			
Land Segment 17	-/-/2	14/19/20	3/8/10	-/9/14	-/2/8	31/50/52	5/22/26	-/13/20	27/32/33	22/38/40	23/37/40	2/5/7	-/3/7	-/1/4	11/29/31	5/18/22	1/9/11	1/18/22	-/14/20
Land Segment 18	-/-/1	-/1/2	-/1/2	-/3/5	-/1/3	4/10/12	2/8/10	1/6/8	-/1/2	9/16/17	6/12/13	-/-/1	-/1/2	-/-/2	20/26/27	1/4/7	14/17/18	5/11/13	2/7/10
Land Segment 19	-	-	-	-/1/1	-/-/1	-/1/1	1/2/2	2/5/6	-	-	-	-	-/-/1	-/-/1	-/1/1	-/1/1	33/37/37	9/12/13	4/8/9
Land Segment 20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-/-/1	-/1/1
Land Segment 21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-/-/1
Land Segment 22*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MISSISSIPPI																			
Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-/-/1
Major Recreational Beaches	-	-	-	-	-	-	-	-/-/1	-	-	-	-	-	-	-	-	-/-/1	-/-/1	-/-/1
Hancock	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Harrison	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Jackson	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-/-/1
Mississippi Sound	-	-	-	-	-	-	-	-/-/1	-	-	-	-	-	-	-	-	-/-/1	-/-/1	-/-/1
Land Segment 22*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 23*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-/-/1
ALABAMA																			
Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-/-/1	-/-/1	-/-/1
Major Recreational Beaches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-/-/1	-/-/1	-/-/1
Mobile	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Baldwin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mobile Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Shores Coastal Barrier	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Endangered Mouse Habitat*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Island National Seashore*	-	-	-	-	-	-	-	-/-/1	-	-	-	-	-	-	-	-	-/-/1	-/-/1	-/-/1
Land Segment 23*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-/-/1
Land Segment 24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FLORIDA																			
Coastal Waters	-	-	-	-	-/-/1	-	-	-	-	-	-	-	-	-/-/1	-	-	-/-/1	-	-
Panhandle Coastal Waters	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Panhandle Major Recreational Beaches	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Emerald	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Franklin	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Big Bend Seagrass	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Keys NMS	-	-	-	-	-/-/2	-	-	-	-	-	-	-	-	-/-/1	-	-	-	-	-
Everglades Manatees	-	-	-	-	-/-/1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manatees	-	-	-	-	-/-/1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Apalachicola Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saint Andrew's Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saint Joseph's Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Esc. Bay/Pens. Bay/Santa Rosa Sound	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Choctawhatchee Bay	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Endangered Mouse Habitat*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gulf Island National Seashore*	-	-	-	-	-	-	-	-/-/1	-	-	-	-	-	-	-	-	-/-/1	-/-/1	-/-/1
Land Segment 25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

* Environmental resource/land segment within two states; spill probabilities shown are for the entire resource/land segment.

** Greater than 99.5%

- less than 0.5%

Table C-2. Pipeline Routes: Probabilities (expressed as a percent chance) that an Oil Spill Starting at a Particular Location will Contact a Certain Land Segment within 3, 10, and 30 Days (continued)

3/10/30 Days

	1AA	2AA	3AA	4AA	5AA	6AA	1AB	2AB	1AC	2AC	3AC	4AC	5AC
U.S. Shoreline	28/50/77	4/28/65	-/15/56	6/30/66	3/25/61	-/6/33	52/76/90	21/45/77	47/80/95	29/69/91	29/66/89	18/51/79	2/22/58
Tamaulipas, Mexico	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 58 (Mexico)	-	-	-	-	-	-	-	-	-	-	-	-	-
OFFSHORE													
C. Winter Menhaden	-/3/5	-/4/8	-/2/6	-/5/8	-/10/16	-/6/18	-	-/1/2	-	-	-	-	-
W. Winter Menhaden	-/-/1	-/-/1	-/-/1	-/-/2	-/1/2	-/-/3	-	-	-	-	-	-	-
Florida Middle Ground	-	-	-	-	-	-	-	-	-	-	-	-	-
Flower Gardens NMS	-	-	-	-	-	-	-	-	-	-	-	-	-
Stetson Bank NMS	-	-	-	-	-	-	-	-	-	-	-	-	-
TEXAS													
Coastal Waters	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-	-/-/1	-	-	-	-	-
Major Recreational Beaches	-/-/1	-/-/1	-	-/-/1	-/-/1	-/-/1	-	-	-	-	-	-	-
Cameron	-	-	-	-	-	-	-	-	-	-	-	-	-
Kenedy/Kleberg/Nueces/Aransas	-	-	-	-	-	-	-	-	-	-	-	-	-
Calhoun	-	-	-	-	-	-	-	-	-	-	-	-	-
Matagorda	-	-	-	-	-	-	-	-	-	-	-	-	-
Brazoria	-	-	-	-	-	-	-	-	-	-	-	-	-
Galveston	-	-	-	-	-	-	-	-	-	-	-	-	-
Jefferson	-	-	-	-	-	-	-	-	-	-	-	-	-
Padre Island National Seashore	-	-	-	-	-	-	-	-	-	-	-	-	-
Corpus Christi/Aransas Bays	-	-	-	-	-	-	-	-	-	-	-	-	-
Sabine Lake*	-	-	-	-	-	-	-	-	-	-	-	-	-
Galveston/West Bays	-	-	-	-	-	-	-	-	-	-	-	-	-
Matagorda Bay	-	-	-	-	-	-	-	-	-	-	-	-	-
Aransas Refuge	-	-	-	-	-	-	-	-	-	-	-	-	-
Espiritu Santos/Matagorda Bays	-	-	-	-	-	-	-	-	-	-	-	-	-
Laguna Madre Seagrass	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 1	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 2	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 3	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 4	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 5	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 6	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 7	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 8	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 9	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 10*	-	-	-	-/-/1	-	-	-	-	-	-	-	-	-
LOUISIANA													
Coastal Waters	56/71/79	11/39/57	2/20/44	15/42/59	9/36/59	-/10/34	81/84/85	42/61/71	17/32/35	11/34/38	2/20/27	-/5/13	-/-/9
Major Recreational Beaches	-/2/4	-/2/5	-/1/4	-/2/5	-/4/10	-/2/9	-	-/1/2	-	-	-	-	-
Cameron	-/-/1	-/-/1	-	-/-/1	-/-/1	-/-/1	-	-	-	-	-	-	-
La Fourche	-/2/3	-/2/4	-/1/3	-/2/4	-/4/9	-/2/7	-	-/-/2	-	-	-	-	-
Jefferson	-/1/2	-/1/2	-/-/2	-/1/3	-/2/6	-/1/5	-	-/-/1	-	-	-	-	-
Vermilion/Atchafalaya Bays	-/-/1	-/-/1	-/-/1	-/-/1	-/-/2	-/-/1	-	-	-	-	-	-	-
Timbalier Bay	-/2/3	-/2/4	-/1/3	-/2/5	-/3/8	-/1/6	-	-/1/1	-	-	-	-	-
Barataria Bay	-/1/2	-/1/3	-/-/3	-/2/3	-/3/7	-/1/7	-	-/-/1	-	-	-	-	-
Caminada Headland	-/2/3	-/2/4	-/1/3	-/2/4	-/4/9	-/2/7	-	-/-/2	-	-	-	-	-
Chandeleur/Breton	4/14/20	1/11/19	-/4/13	1/12/20	-/6/13	-/1/4	24/31/33	8/19/27	11/24/26	7/25/29	1/14/18	-/3/7	-/-/4
Chenier Coastal Barrier	-/-/2	-/-/3	-/-/2	-/-/3	-/-/3	-/-/2	-	-/-/1	-	-	-	-	-
Sabine Lake*	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 10*	-	-	-	-/-/1	-	-	-	-	-	-	-	-	-
Land Segment 11	-/-/1	-/-/1	-	-/-/1	-/-/1	-/-/1	-	-	-	-	-	-	-
Land Segment 12	-	-/-/1	-	-/-/1	-/-/1	-	-	-	-	-	-	-	-
Land Segment 13	-	-/-/1	-	-/-/1	-/-/1	-/-/1	-	-	-	-	-	-	-
Land Segment 14	-	-	-	-	-/-/1	-/-/1	-	-	-	-	-	-	-
Land Segment 15	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-/-/1	-	-	-	-	-	-	-
Land Segment 16	-/1/2	-/1/2	-/-/2	-/1/3	-/2/4	-/-/4	-	-/-/1	-	-	-	-	-

* Environmental resoure/land segment within two states; spill probabilities shown are for the entire resource/land segment.

** Greater than 99.5%

- less than 0.5%

Table C-2. Pipeline Routes: Probabilities (expressed as a percent chance) that an Oil Spill Starting at a Particular Location will Contact a Certain Land Segment within 3, 10, and 30 Days (continued)

3/10/30 Days

	1AA	2AA	3AA	4AA	5AA	6AA	1AB	2AB	1AC	2AC	3AC	4AC	5AC
LOUISIANA (continued)													
Land Segment 17	-/2/3	-/2/4	-/1/3	-/2/4	-/4/9	-/2/8	-	-/-/1	-	-	-	-	-
Land Segment 18	1/2/2	-/2/2	-/1/2	-/1/2	-/2/3	-/1/3	-	-/-/1	-	-	-	-	-
Land Segment 19	24/29/30	3/10/12	-/5/9	4/11/13	2/10/13	-/3/5	-	3/7/8	-	-/-/1	-/-/1	-/-/1	-/-/1
Land Segment 20	3/9/11	1/8/12	-/3/9	1/8/13	-/4/7	-/-/2	49/60/61	17/26/31	-/5/7	-/6/10	-/4/9	-/1/5	-/-/3
Land Segment 21	-/3/7	-/2/6	-/1/5	-/2/6	-/1/4	-/-/1	3/12/16	-/5/9	-/6/9	-/5/10	-/2/6	-/-/2	-/-/2
Land Segment 22*	-/2/7	-/2/8	-/-/5	-/2/8	-/1/5	-/-/2	-/3/7	-/3/9	3/15/19	2/13/18	-/7/11	-/1/3	-/-/1
MISSISSIPPI													
Coastal Waters	-/2/8	-/2/10	-/2/9	-/2/10	-/1/7	-/-/2	-/2/6	-/3/10	67/74/76	28/42/45	8/22/25	-/4/7	-/-/3
Major Recreational Beaches	-/3/12	-/3/15	-/2/13	-/3/15	-/1/10	-/-/3	-/4/10	-/5/17	47/68/73	26/51/59	12/32/40	-/5/11	-/-/4
Hancock	-/1/4	-/1/4	-/-/3	-/1/4	-/-/3	-/-/1	-/2/4	-/2/5	1/7/9	1/6/9	-/3/6	-/-/1	-/-/1
Harrison	-/2/5	-/1/6	-/-/3	-/1/6	-/1/4	-/-/1	-/2/5	-/2/6	3/12/14	1/10/14	-/5/9	-/1/2	-/-/1
Jackson	-/1/7	-/2/9	-/2/9	-/2/8	-/1/6	-/-/2	-/1/4	-/2/10	45/56/60	25/41/46	11/27/32	-/5/9	-/-/3
Mississippi Sound	-/3/13	-/4/17	-/3/15	-/3/16	-/2/11	-/-/3	-/4/11	-/5/19	47/68/75	29/55/64	19/42/51	1/8/15	-/-/5
Land Segment 22*	-/2/7	-/2/8	-/-/5	-/2/8	-/1/5	-/-/2	-/3/7	-/3/9	3/15/19	2/13/18	-/7/11	-/1/3	-/-/1
Land Segment 23*	-/1/6	-/2/9	-/2/10	-/1/8	-/1/6	-/-/1	-/1/4	-/3/10	43/53/56	27/42/46	18/36/40	1/7/12	-/-/4
ALABAMA													
Coastal Waters	-/1/7	-/2/9	-/3/12	-/1/9	-/1/6	-/-/1	-/-/4	-/2/10	3/6/9	14/20/24	37/48/52	20/38/44	-/9/19
Major Recreational Beaches	-/-/6	-/1/8	-/2/11	-/1/7	-/-/5	-/-/1	-/-/3	-/1/8	3/5/8	11/16/22	25/39/44	13/35/43	-/8/19
Mobile	-/-/3	-/1/5	-/2/6	-/1/5	-/-/3	-/-/1	-/-/2	-/1/5	3/5/7	11/15/19	21/31/34	2/10/14	-/1/5
Baldwin	-/-/4	-/-/4	-/1/6	-/-/4	-/-/2	-/-/1	-/-/2	-/-/4	-/1/3	1/2/5	11/17/20	13/29/35	-/8/16
Mobile Bay	-/-/2	-/1/4	-/1/4	-/-/3	-/-/3	-	-/-/1	-/1/4	-/1/3	2/5/7	15/21/23	4/12/15	-/1/6
Gulf Shores Coastal Barrier	-/-/3	-/-/4	-/1/6	-/-/4	-/-/2	-	-/-/1	-/-/4	-/1/3	1/2/5	11/16/19	11/26/30	-/6/14
Endangered Mouse Habitat*	-/-/2	-/-/2	-/-/4	-/-/2	-/-/1	-/-/1	-/-/1	-/-/3	-/-/1	-/-/2	-/3/5	12/25/30	1/12/20
Gulf Island National Seashore*	-/2/11	-/3/14	-/2/13	-/2/13	-/1/9	-/-/3	-/2/8	-/4/15	46/62/68	26/47/54	12/31/39	8/22/31	2/15/28
Land Segment 23*	-/1/6	-/2/9	-/2/10	-/1/8	-/1/6	-/-/1	-/1/4	-/3/10	43/53/56	27/42/46	18/36/40	1/7/12	-/-/4
Land Segment 24	-/-/3	-/-/4	-/1/6	-/-/4	-/-/2	-	-/-/1	-/-/4	-/1/3	1/2/5	11/16/19	11/26/30	-/6/14
FLORIDA													
Coastal Waters	-/-/4	-/-/4	-/1/6	-/-/4	-/-/3	-/-/1	-/-/3	-/-/5	-/-/2	-/1/4	-/3/7	33/45/52	10/35/52
Panhandle Coastal Waters	-/-/3	-/-/4	-/-/5	-/-/4	-/-/3	-/-/1	-/-/2	-/-/4	-/-/1	-/-/4	-/2/6	25/37/45	8/31/48
Panhandle Major Recreational Beaches	-/-/2	-/-/2	-/-/3	-/-/2	-/-/1	-	-/-/1	-/-/2	-/-/1	-/-/2	-/1/5	9/22/31	2/18/36
Emerald	-/-/2	-/-/2	-/-/3	-/-/2	-/-/1	-	-/-/1	-/-/2	-/-/1	-/-/2	-/1/4	9/22/30	2/18/34
Bay	-	-	-	-	-	-	-	-	-	-	-	-/-/1	-/-/2
Gulf	-	-	-	-	-	-	-	-	-	-	-	-	-/-/1
Franklin	-	-	-	-	-	-	-	-	-	-	-	-	-
Big Bend Seagrass	-	-	-	-	-	-	-	-	-	-	-	-	-
Florida Keys NMS	-	-	-	-	-	-/-/1	-	-	-	-	-	-	-
Everglades Manatees	-	-	-	-	-	-	-	-	-	-	-	-	-
Manatees	-	-	-	-	-	-	-	-	-	-	-	-	-
Apalachicola Bay	-	-	-	-	-	-	-	-	-	-	-	-	-
Saint Andrew's Bay	-	-	-	-	-	-	-	-	-	-	-	-/-/1	-/-/1
Saint Joseph's Bay	-	-	-	-	-	-	-	-	-	-	-	-	-
Esc. Bay/Pens. Bay/Santa Rosa Sound	-/-/1	-/-/2	-/-/2	-/-/1	-/-/1	-	-/-/1	-/-/2	-/-/1	-/-/1	-/1/3	7/16/23	2/15/29
Choctawhatchee Bay	-	-	-	-	-	-	-	-	-	-	-/-/1	-/1/4	-/3/9
Endangered Mouse Habitat*	-/-/2	-/-/2	-/-/4	-/-/2	-/-/1	-/-/1	-/-/1	-/-/3	-/-/1	-/-/2	-/3/5	12/25/30	1/12/20
Gulf Island National Seashore*	-/2/11	-/3/14	-/2/13	-/2/13	-/1/9	-/-/3	-/2/8	-/4/15	46/62/68	26/47/54	12/31/39	8/22/31	2/15/28
Land Segment 25	-/-/1	-/-/1	-/-/2	-/-/1	-/-/1	-	-/-/1	-/-/1	-	-/-/1	-/1/2	7/15/19	2/12/20
Land Segment 26	-	-	-	-	-	-	-	-	-	-	-/-/1	-/1/4	-/3/9
Land Segment 27	-	-	-	-	-	-	-	-	-	-	-	-/-/1	-/-/2
Land Segment 28	-	-	-	-	-	-	-	-	-	-	-	-/-/1	-/-/1
Land Segment 29	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 43	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 44	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 45	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 46	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 47	-	-	-	-	-	-	-	-	-	-	-	-	-
Land Segment 55	-	-	-	-	-	-	-	-	-	-	-	-	-

* Environmental resoure/land segment within two states; spill probabilities shown are for the entire resource/land segment.

** Greater than 99.5%

- less than 0.5%

SECTION X
KEYWORD INDEX

X. KEYWORD INDEX

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The Department of the Interior Mission

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

The Minerals Management Service Mission

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

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

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

Minerals Management Service
Gulf of Mexico Region

Managing America's offshore energy resources

Protecting America's coastal and marine environments