Commodity is oil and gas

SEA No. N-6570

UNITED STATES DEPARTMENT OF THE INTERIOR
MINERALS MANAGEMENT SERVICE
Gulf of Mexico OCS Region
New Orleans, Louisiana

SITE-SPECIFIC ENVIRONMENTAL ASSESSMENT

INITIAL DEVELOPMENT OPERATIONS COORDINATION DOCUMENT
GREEN CANYON AREA, BLOCKS 158 AND 202

May 9, 2000

SHELL DEEPWATER DEVELOPMENT INC.
INITIAL DEVELOPMENT OPERATIONS COORDINATION DOCUMENT NO. N-6570

Related Environmental Documents:

CER's for N-2689A, S-3356, R-2983, S-4402, S-4980

NOTED - SCHEXNAILDRE

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FINDING OF NO SIGNIFICANT IMPACT

SHELL DEEPWATER DEVELOPMENT INC.
GULF OF MEXICO, OFFSHORE, LOUISIANA
GREEN CANYON AREA, BLOCK 158, OCS-G 7995
GREEN CANYON AREA, BLOCK 202, OCS-G 7998
(Control No. N-6570)

Minerals Management Service
Gulf of Mexico OCS Region
1201 Elmwood Park Boulevard
New Orleans, LA 70123-2394

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

5/9/00
Date

I. FINDING

Shell Deepwater Development Inc. (SDDI) (One Shell Square, P.O. Box 60833, New Orleans LA 70160-0833) submitted to the Gulf of Mexico OCS Region of the Minerals Management Service (MMS) an Initial Development Operations Coordination Document to drill five wells to total depth (TLP-4 through TLP-8), complete and produce eight wells (TLP-1 through TLP-8), and install Platform "A" in Green Canyon Area, Block 158, OCS-G 7995. The platform will be a 12-well slot Tension Leg Platform (TLP). All of the wells have surface locations in Green Canyon Area, Block 158 and three of the eight wells (TLP-1, TLP-4, and TLP-6) have bottom hole locations in Green Canyon Area, Block 202, OCS-G 7998. SDDI's deepwater field in Green Canyon Area, Blocks 158 and 202 is often referred to by its nickname "Brutus." Safety features include well control and blowout prevention equipment as described in 30 CFR 250.406, 250.407, 250.408, 250.409, 250.514, 250.515, and 250.516. The proposed drilling and completion of these wells and platform construction is described and analyzed in the attached Site-Specific Environmental Assessment (SEA) released in April 2000.

Based on the environmental analysis contained in the SEA, the Minerals Management Service has determined that the activities described in the SDDI's Initial Development Operations Coordination Document, with mitigating measures, will not cause significant (40 CFR 1508.27) or undue harm to the quality of the human environment and preparation of an Environmental Impact Statement will not be necessary.

II. MANAGEMENT CONSIDERATIONS

The proposed action was reviewed for potential effects to the quality of the human environment. The attached SEA documents this review, which is summarized in the following paragraph.

Potential impacts to air quality were reviewed. Because the projected NO_x emission amounts in the plan were calculated using historic run times, mitigation to maintain records of the actual run times for the three generators and provide the information to this office upon request are provided in this FONSI. Since the proposed operations would be located in Military Warning Area W-92 and the routes to be taken by boats in support of the proposed activities would traverse Military Warning Area W-59, mitigation reminding and advising lessees or their contractors to coordinate with the appropriate base commanders when operating in these areas are provided in this FONSI. Impacts to benthic communities were analyzed, and it was determined that proposed drilling, completion, and platform installation activities will have no effect on chemosynthetic communities. Potential impacts from an accidental release of oil from a high-volume blowout are of concern; however, the historical database indicates that it is rare for such a pollution event to occur. For the period from 1971 to 1995, based on 24,237 wells drilled, there were 17 well blowouts that resulted in the release of oil (0.07% probability). Mitigating the potential for a blowout and spill are the well control and blowout prevention equipment, procedures, and inspections required in 30 CFR 250.406, 250.407, 250.408, 250.409, 250.514, 250.515, and 250.516. The SDDI's access to skimming equipment and other response equipment maintained by National Response Corporation and Marine Spill Response Corporation is outlined in their Regional Oil Spill Response Plan and could serve to further mitigate potential impacts from an accidental oil spill.

III. MITIGATION

The projected NO_x emissions amounts in your plan were calculated using historic run times. Therefore, please be advised that you will maintain records of the actual run times for the three generators and provide the information to this office upon request. (2.5)

Please be reminded of your lease stipulation, which requires you to enter into an agreement with the Naval Air Station, Air Operations Department, Air Traffic Division/Code 52, New Orleans, Louisiana 70146-5000 (contact ACC A. W. Thrift at (504) 678-3100 or (504) 678-3101) concerning the control of electromagnetic emissions and use of boats and aircraft in Military Warning Area W-92. (10.1)

Our review indicates that the routes to be taken by boats and aircraft in support of your proposed activities are located in or could traverse Military Warning Area W-59. Therefore, please be advised that you will contact the Naval Air Station-JRB, New Orleans, Louisiana 70143-0027 (contact Msgt. Proze at (504) 391-8696 or (504) 391-8697) concerning the control of electromagnetic emissions and use of boats and aircraft in Military Warning Area W-59. (11.10)

SITE-SPECIFIC ENVIRONMENTAL ASSESSMENT PREPARED FOR INITIAL DEVELOPMENT OPERATIONS COORDINATION DOCUMENT (DOCD), N-6570, FOR GREEN CANYON AREA, BLOCKS 158 AND 202, OCS-G 7995 AND OCS-G 7998

I. PURPOSE AND NEED FOR THE ACTION

Introduction

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

The purpose of this Site-Specific Environmental Assessment (SEA) is to assess the specific impacts associated with proposed oil and gas exploration, development, and production activities. The SEA has been prepared because the potential for a high-volume blowout during the proposed activities may have highly controversial environmental effects.

This SEA implements the tiering process outlined in 40 Code of Federal Regulations (CFR) 1502.20, which encourages agencies to tier environmental documents and eliminates repetitive discussions of the same issue. By use of reference to the most recent Final Environmental Impact Statement (EIS) for the Gulf of Mexico Central Planning Area for Lease Sales 169, 172, 175, 178, and 182 and by tiering to related environmental documents, this SEA concentrates on environmental issues specific to the proposed action (USDOI, MMS, 1997).

A. THE PROPOSED ACTION

On August 4, 1999, Shell Deepwater Development Inc. (SDDI) filed an Initial Development Operations Coordination Document to drill five wells to total depth (TLP-4 through TLP-8), complete and produce eight wells (TLP-1 through TLP-8), and install Platform "A" in Green Canyon Area, Block 158, OCS-G 7995 (Shell, 1999). The platform will be a 12-well slot Tension Leg Platform (TLP). All of the wells have surface locations in Green Canyon Area, Block 158 and three of the eight wells (TLP-1, TLP-4, and TLP-6) have bottom hole locations in Green Canyon Area, Block 202, OCS-G 7998. SDDI's deepwater field in Green Canyon Area, Blocks 158 and 202 is often referred to by its nickname "Brutus." The following plan "amendments" were also submitted by SDDI:

- August 26, 1999 - Corrected projected air emissions information and increased the size of both the oil and gas exporting pipelines from 18-inch to 20-inch;
- October 8, 1999 - Spreadsheets for Balder Rig installation and stand-by positions;
- December 29, 1999 - Initial response to the Minerals Management Service's (MMS) additional hydrocarbon-related information request dated November 3, 1999;

- February 16, 2000 - Follow-up response to December 29, 1999, submittal (Most-likely spill scenario response table); and
- February 23, 2000 - Follow-up response to December 29, 1999, submittal (Fluid sample information).

In addition to the above submittals, SDDI representatives also met with MMS on November 2, 1999, and held a teleconference with MMS on February 10, 2000, to discuss the proposed action and related MMS information requests.

The proposed development area would be located approximately 89 miles from the nearest Louisiana shoreline, approximately 127 miles from the onshore support base (for boats) in Morgan City, Louisiana, and approximately 84 miles from the onshore support base (for helicopters) in Fourchon, Louisiana (Figure 1). Water depth at the proposed development site would be 2,895 feet below sea level.

A fact sheet summarizing the Brutus Project, which includes details on exploration and discovery, development, production, and TLP engineering/construction, is included as Figures 2a, 2b, 2c, and 2d.

B. ISSUES

Would there be impacts to air quality from projected NO_x emissions?

Would there be any impacts to Military Warning Areas W-59 or W-92 from boat or air traffic electromagnetic emissions?

Would there be impacts to biological chemosynthetic communities?

Would there be impacts to the environment from an accidental release of oil from a high-volume blowout?

C. THE DECISION TO BE MADE ON THIS ANALYSIS

Should Shell Deepwater Development Inc. be permitted to drill five wells to total depth, complete and produce eight wells, and install Platform "A" in Green Canyon Area, Block 158, OCS-G 7995?

II. THE ALTERNATIVES CONSIDERED

A. NONAPPROVAL OF THE PROPOSAL

The applicant would not be allowed to undertake the proposed activities. This alternative could prevent the development, production, and transportation of much needed hydrocarbon resources; would result in the loss of royalty income for the United States; and would increase the United States' dependence on foreign oil. Considering these aspects and the fact that minimal impacts are anticipated, this alternative was not selected for further analysis.

B. APPROVAL WITH EXISTING MITIGATION

Measures that Shell Deepwater Development Inc. proposes to implement to limit potential environmental effects are discussed in their Initial Development Operations Coordination Document submitted August 4, 1999, as well as in subsequent amendments. The OCS Operating Regulations, Notices to Lessees and Operators, and other regulations and laws were identified throughout this assessment as existing mitigation to minimize potential environmental effects associated with the proposed action. Additional information can be found in the Final EIS for the Central Planning Area for Lease Sales 169, 172, 175, 178, and 182.

The MMS has established operating regulations and procedures to ensure that proposed activities are orderly, safe, and pollution free. The MMS's regulations (30 CFR 250 Subpart D and E) establish performance standards with which the lessee must comply when conducting OCS oil and gas drilling and well-completion operations. These regulations include requirements for specific equipment, redundant safety systems, testing of safety systems, and training, and are described as hydrocarbon spill prevention and operating safeguards in the following Section II.C.

Since additional mitigation were identified to avoid or mitigate potential impacts associated with the proposed action, this alternative was not selected.

C. APPROVAL WITH EXISTING AND ADDITIONAL MITIGATION

Measures that Shell Deepwater Development Inc. proposes to implement to limit potential environmental effects are discussed in their Initial Development Operations Coordination Document submitted August 4, 1999, as well as in subsequent amendments. The OCS Operating Regulations, Notices to Lessees and Operators, and other regulations and laws were identified throughout this assessment as existing mitigation to minimize potential environmental effects associated with the proposed action. Additional information can be found in the Final EIS for the Central Planning Area for Lease Sales 169, 172, 175, 178, and 182. The following mitigation measures will be included in MMS's approval of the proposed action to ensure environmental protection, consistent environmental policy, and safety by the National Environmental Policy Act (NEPA), as amended:

1. The projected NO_x emissions amounts in your plan were calculated using historic run times. Therefore, please be advised that you will maintain records of the actual run times for the three generators and provide the information to this office upon request. (2.5)

2. Please be reminded of your lease stipulation which requires you to enter into an agreement with the Naval Air Station, Air Operations Department, Air Traffic Division/Code 52, New Orleans, Louisiana 70146-5000 (contact ACC A. W. Thrift at (504) 678-3100 or (504) 678-3101) concerning the control of electromagnetic emissions and use of boats and aircraft in Military Warning Area W-92. (10.1)

3. Our review indicates that the routes to be taken by boats and aircraft in support of your proposed activities are located in or could traverse Military Warning Area W-59. Therefore, please be advised that you will contact the Naval Air Station-JRB, New Orleans, Louisiana 70143-0027 (contact Msgt. Proze at

(504) 391-8696 or (504) 391-8697) concerning the control of electromagnetic emissions and use of boats and aircraft in Military Warning Area W-59. (11.10)

The MMS has established operating regulations and procedures to ensure that proposed activities are orderly, safe, and pollution free. The MMS regulations (30 CFR 250 Subpart D and E) establish performance standards with which the lessee must comply when conducting OCS oil and gas drilling and well-completion operations. These regulations include requirements for specific equipment, redundant safety systems, testing of safety systems, and training, and are described as hydrocarbon spill prevention and operating safeguards in the following paragraphs.

During drilling, lessees are required to take necessary precautions to keep their wells under control at all times (30 CFR 250.400). The MMS has well casing and cementing requirements for all wells drilled on the OCS (30 CFR 250.404P). The quantities, characteristics, use, and testing of drilling muds and the related drilling procedures must be designed and implemented to prevent the loss of well control (30 CFR 250.408). Blowout preventer (BOP) systems must be designed, installed, used, maintained, and tested to assure well control (30 CFR 250.406-407). Redundancy within the BOP system is required by MMS to ensure safety and reliability. For example, this redundancy includes multiple pipe rams and a shear ram capable of cutting drill pipe; redundant underwater hydraulic control manifolds; backup hydraulic reserves; multiple remote-control panels; and redundant choke/kill lines.

Lessees must also conduct well control drills (30 CFR 250.408). These drills enhance the preparedness of the rig crews to deal with a well-control emergency and are in addition to the other safety training and drills (e.g., fire and hydrogen sulfide). Both announced and scheduled annual inspections of offshore facilities are conducted by MMS to ensure that environmental protection equipment and safety equipment are installed and operating properly.

Proposed operations must meet or exceed the safety standards set by MMS. The MMS requires the use of the "Best Available and Safest Technology (BAST) for OCS operations. BAST requirements include state-of-the-art drilling technology and pollution control equipment (30 CFR 250.400). In an effort to provide state-of-the-art technology guidance to OCS operators drilling in deepwater environments, the International Association of Drilling Contractors (IADC) and the Offshore Operators Committee (OOC) have published a document entitled "IADC/OOC Deepwater Well Control Guidelines" (IADC/OOC, 1998). This document was designed to aid the oil and gas drilling industry by making them aware of the rapidly evolving technology and techniques dealing with deepwater operations. This document provides guidance for deepwater operators on the following topics: well planning, well control procedures, equipment, emergency response, and training.

During well-completion operations, lessees are required to protect against harm or damage to life (including fish and other aquatic life), property, natural resources of the OCS including any mineral deposits (in areas leased and not leased), the national security or defense, or the marine, coastal, or human environment (30 CFR 250.500). Prior to engaging in well-completion operations, crew members are instructed in the safety requirements of the operations to be performed, possible hazards to be encountered, and general safety considerations to protect personnel, equipment, and the environment (30 CFR 250.506).

Well-control fluids, equipment, and operations shall be designed, used, maintained, and/or tested as necessary to control the well in foreseeable conditions and circumstances (30 CFR 250.514). The BOP system, system components, and related well-control equipment shall be designed, used, maintained, and tested in a manner necessary to assure well control in foreseeable conditions and circumstances (30 CFR 250.515-516). Wellhead, tree, and related equipment shall have a pressure rating greater than the shut-in tubing pressure and shall be designed, installed, used, maintained, and tested so as to achieve and maintain pressure control (30 CFR 250.517). Subsurface safety equipment shall be installed, maintained, and tested in compliance with regulations outlined in Subpart H - Oil and Gas Production Safety Systems.

III. ENVIRONMENTAL EFFECTS

A. INTRODUCTION

In accordance with the NEPA of 1969, as amended (P.L. 91-190, 42 U.S.C. 4321-4347, January 1, 1970, as amended by P.L. 94-52, July 3, 1975; P.L. 94-83, August 9, 1975; and P.L. 97-258, § 4(b), September 13, 1982) and the Council on Environmental Quality implementing regulations, 40 CFR Sec. 1502.15, Affected Environment, the following potential environmental effects were identified from the proposed action. The MMS requires the operator to comply with mitigating measures to prevent or minimize environmental effects potentially caused by the proposed activity as described in 40 CFR 1508.27.

B. AIR QUALITY

These operations will occur west of 87.5 degrees west longitude and hence falls under MMS's jurisdiction for enforcement of the Clean Air Act. The air over the OCS water is not classified, but is presumed to be better than the National Ambient Air Quality Standards for all criteria pollutants. The blocks involved, Green Canyon 158 and 202, are offshore, south of Terrebonne parish, Louisiana. Terrebonne parish is in attainment of the National Ambient Air Quality Standards.

The projected air emissions submitted by Shell Deepwater Development Inc. (SDDI) for this project are below the MMS exemption levels. SDDI has estimated the emissions associated with this project. These emission projections are required to represent the worst case. The following three emission reduction efforts are being included in this project: (1) running only two of three generators at any given time; (2) installation of a vapor recovery unit on the storage tanks; and (3) installation of a water cooled condenser on the glycol still vent. The projected NO_x emissions amounts in SDDI's plan were calculated using historic run times. SDDI is advised that they will maintain records of the actual run times for the three generators and provide the information to this office upon request. (See Appendix B for further discussion of air quality.)

C. BIOLOGICAL RESOURCES

The proposed TLP surface location and proposed anchor patterns for the semisubmersible drilling rig "Ocean Worker" and the Heerema "Balder" TLP installation rig will not cause seafloor disturbances to features or areas that could support high-density chemosynthetic communities. The nearest probable sensitive feature is a probable shallow gas and fluid expulsion zone located approximately 577 feet from proposed TLP installation rig anchor and chain PS-3. (See Appendix C for further discussion of biological resources.)

D. ACCIDENTAL HYDROCARBON SPILL EFFECTS

Shell provided MMS with estimates of the most likely spill volume and duration associated with a blowout from the proposed Brutus wells during the development drilling mode, the workover/completion mode, the production mode, and the wireline mode. The resulting composite was 29,125 bbl/day with an expected duration of 8.1 days. In the unlikely event that a blowout occurs, the total volume that could be lost over 8.1 days is approximately 234,000 bbl, excluding storage tanks volume (3,293 bbl), piping volume on the TLP (100 bbl), and pipeline volume (4,000 bbl) that could be lost from the TLP during the first day of the blowout. This is the scenario analyzed in this EA. On the 15^{th} day (7 days after expected cessation of the blowout), the estimated volume of oil that could be expected to remain on the water surface would total 85,072 bbl out of the originally spilled 234,000 bbl, after taking into account hydrocarbon spill containment/cleanup capabilities and effectiveness for mechanical recovery and dispersant use, as well as weathering. (See Appendix D for further discussion of hydrocarbon spill effects.)

E. MILITARY WARNING AREAS

The proposed activities would be located in Military Warning Area W-92, and the routes to be taken by boats in support of the proposed activities would traverse Military Warning Area W-59. When operating in these areas, oil and gas lessees or their contractors coordinate with the appropriate base commanders. These coordinating efforts reduce impacts and maintain safety, and also control electromagnetic emissions to prevent unacceptable interference to Department of Defense operations.

IV. CONSULTATION AND COORDINATION

The Initial Development Operations Coordination Document (Control No. N-6570) for Green Canyon Area, Blocks 158 and 202, OCS-G 7995 and OCS-G 7998 was reviewed by the State of Louisiana, Coastal Management Division/Department of Natural Resources, and was found to be consistent with the Louisiana Coastal Resources Program.

V. REFERENCES

IADC/OOC. 1998. Deepwater well control guidelines. International Association of Drilling Contractors and Offshore Operators Committee. 382 pp.

Shell Deepwater Development Inc. 1999. Initial Development Operations Coordination Document and Amendments, OCS-G 7995 and OCS-G 7998, Green Canyon Area, Blocks 158 and 202.

U.S. Dept. of the Interior. Minerals Management Service. 1997. Gulf of Mexico OCS Oil and Gas Lease Sales 169, 172, 175, 178 and 182: Central Planning Area, Final Environmental Impact Statement. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS EIS/EA MMS 97-0033.

VI. PREPARERS

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VII. APPENDICES

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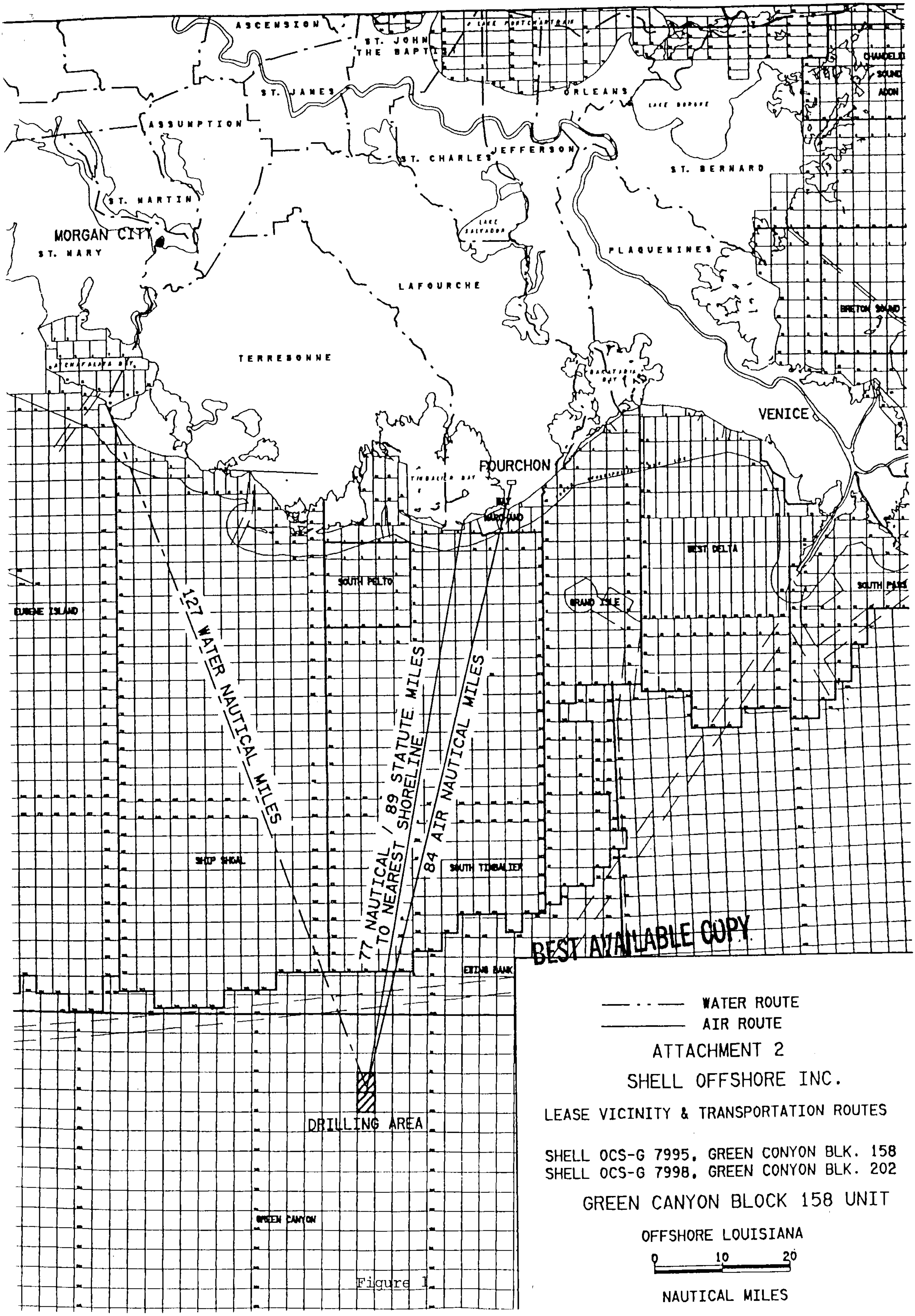
D. Accidental Hydrocarbon Discharge Review

APPENDIX A

Figures


ASCENSION
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LAKE BORGNE
ASSUMPTION
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JEFFERSON
ST. BERNARD
ST. MARTIN
MORGAN CITY
ST. MARY
PLAQUEMINES
LAFOURCHE
TERREBONNE
VENICE
FOURCHON
SOUTH PELTO
EUGENE ISLAND
GRAND ISLE
WEST DELTA
BRETON SOUND
SOUTH PASS
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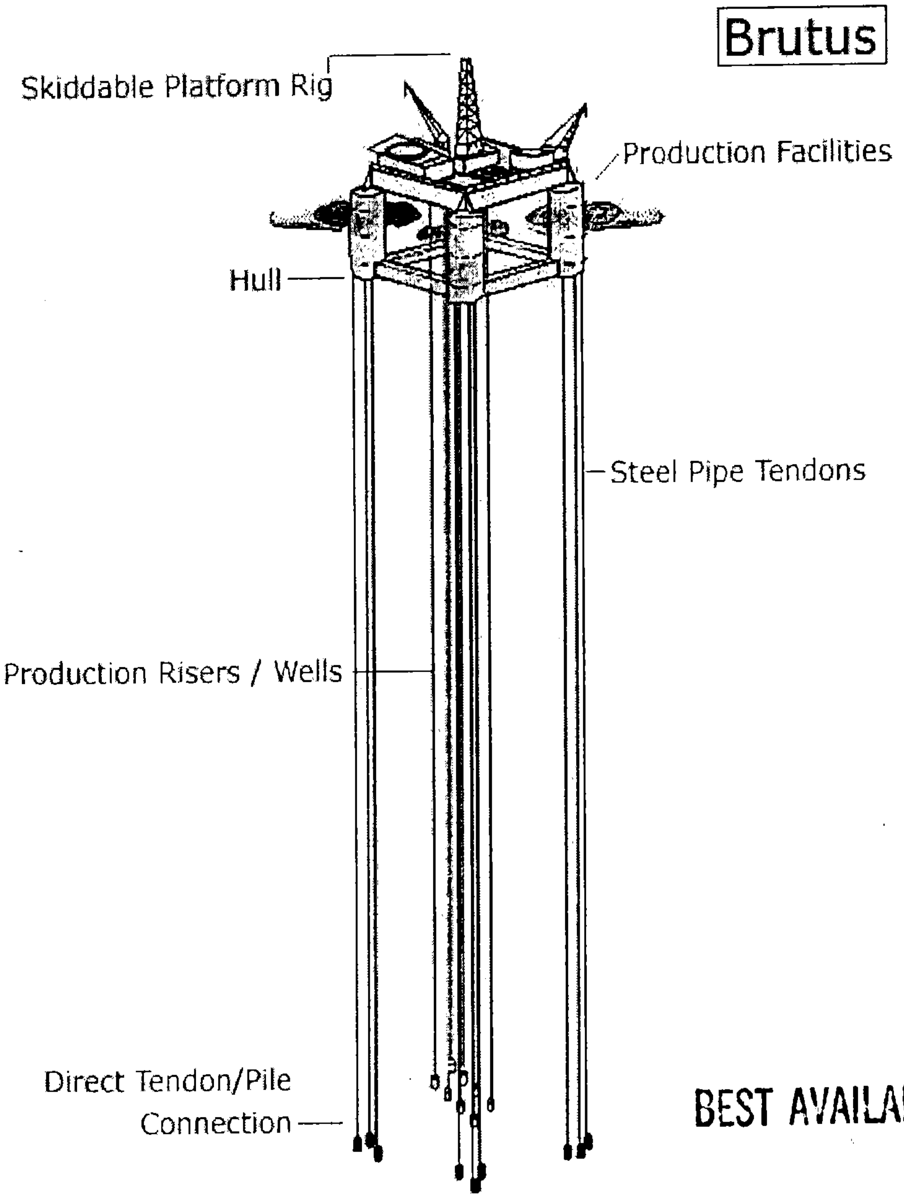
77 NAUTICAL / 89 STATUTE MILES TO NEAREST SHORELINE
84 AIR NAUTICAL MILES
SHIP SHOAL
SOUTH TIMBALIER
EWING BANK
BEST AVAILABLE COPY
DRILLING AREA
GREEN CANYON
WATER ROUTE
AIR ROUTE
ATTACHMENT 2
SHELL OFFSHORE INC.
LEASE VICINITY & TRANSPORTATION ROUTES
SHELL OCS-G 7995, GREEN CONYON BLK. 158
SHELL OCS-G 7998, GREEN CONYON BLK. 202
GREEN CANYON BLOCK 158 UNIT
OFFSHORE LOUISIANA
0 10 20
NAUTICAL MILES

Figure 1

Brutus

Tension Leg Platform

- Home
- Fact Sheet
- Location Map



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Brutus Fact Sheet | Brutus Home | Brutus Location Map

SEPCo Home | Shell Oil | Shell Chemical

Figure 2a

Brutus
Tension Leg Platform

- Fact Sheet
- Home
- Location Map

EXPLORATION AND DISCOVERY

- Brutus encompasses two OCS leases in the Green Canyon area - Blocks 158 and 202. It is located approximately 165 miles southwest of New Orleans in water depths ranging from 2,750 to 3,300 feet.
- The leases were acquired in OCS Lease Sale 98 in March 1985, for a total bonus of $ 15.5 million.
- Shell Deepwater Development Inc. owns 100% of the leases.
- The discovery well was drilled on Green Canyon Block 158 in December 1988. An appraisal well was drilled on Green Canyon Block 158 in 1994. A third well was drilled in 1997 on that same block, with a bottom hole location on Green Canyon Block 202.
- Target reserves are in the Plio-Pleistocene sands at a depth of approximately 12,500 - 17,500 feet, subsea.

DEVELOPMENT

- Shell announced in April 1999 its plans to develop Brutus utilizing a tension leg platform (TLP) to be installed on Green Canyon Block 158 in 2,985 feet of water.
- Estimated ultimate gross recovery from the development is greater than 200 million barrels of oil equivalent, with a 70:30 oil/gas ratio. Average API gravity for the oil is low-mid 30 degrees. Sulfur is 1.5%.
- Total project cost is expected to be less than $ 900 MM including pipelines, excluding lease costs.
- Eight wells will be batch set using a semi-submersible rig beginning in the third quarter of 1999. At least one of the planned development wells for the eight-slot TLP will be predrilled following the batch set operations.
- Further development wells will be drilled with a contract platform rig. The total number of wells necessary to develop this prospect will be determined after production begins.
- Installation of the TLP is anticipated to take place mid-year 2001. Heerema is the contractor for the installation.

- Oil production from the platform is planned to be transported approximately 26 miles via a 20-inch diameter pipeline to South Timbalier 301 "B" platform where it will be connected to the existing Amberjack System. The pipeline will be owned and operated by Equilon Pipeline Company, LLC.
- Gas production from the platform is planned to be transported approximately 24 miles via a 20-inch gas pipeline and will be connected to the existing Manta Ray Offshore Gathering System in Ship Shoal Block 332. The pipeline will be owned by Nemo Gathering LLC, a company owned 66% by Tejas and 34% by Leviathan Gas Pipeline.

PRODUCTION

Figure 2b

- Production is anticipated to begin by late 2001.
- The TLP facilities are designed for a peak gross production of approximately 100,000 barrels of oil per day and 300 million cubic feet of gas per day. The TLP will be utilized as a hub for surrounding developments and thus, is designed to handle an amount of gas greater than that required for the Brutus development only, which is about 150 million cubic feet of gas per day.

TLP ENGINEERING/CONSTRUCTION DETAILS

- The Brutus TLP is being designed and engineered by Shell's Deepwater Services, with support from various design consultants.
- Completely assembled, the TLP will be 3,250 feet high, from seafloor to the crown block of the drilling rig.
- The TLP is designed to simultaneously withstand hurricane-force waves, currents and winds.
- Hull:
  - The hull is comprised of four circular steel columns, 66.5 feet in diameter and 166 feet high. Pontoons connect the columns which will be 35.5 feet wide and 23 feet high with a rectangular cross section.
  - The hull will weigh approximately 13,500 tons, with a total displacement of 54,700 tons.
  - Daewoo Heavy Industries Co. of South Korea will build the hull. Delivery date is anticipated to be early 2001.
- Deck:
  - The installed deck will have dimensions at the outside truss rows of 245 feet square and approximately 40 feet high. The deck will be composed of five modules: process, drilling, power, quarters, and wellbay.
  - The deck modules will be an open truss frame design with a total structural steel weight of approximately 7,650 tons.
  - The total topside weight is approximately 22,000 tons, including all process equipment and the drilling rig.
  - J. Ray McDermott will build the modules at its Amelia, LA. fabrication yard. Delivery date is anticipated to be early 2001.
- Tendons:

  - There will be 12 tendons, 3 per corner, each with a diameter of 32 inches and a wall thickness of 1.25 inches.
  - Each tendon will be approximately 2,900 feet long. The total weight for the 12 tendons is approximately 7,500 tons.
  - The TLP foundation system is comprised of 12 piles, to which the tendons will be attached.
  - The piles will be 82 inches in diameter and 340 feet long, weighing approximately 245 tons each.

Figure 2c

- Drilling and Production Topsides:
  - There will be 8 well slots, with the well layout on the seafloor arranged in a rectangular pattern.
  - The TLP will support a contract-drilling rig, equipped with a surface BOP and high pressure drilling riser.
  - There will be complete separation, dehydration and treatment facilities designed to process 100,000 barrels of oil and condensate per day, plus 300 million cubic feet of gas per day and 30,000 barrels of produced water per day.
  - The quarters module will house up to 94 people, and will contain a control room and an emergency response center.
- Pipelines:
  - A 20-inch diameter oil pipeline and 20-inch diameter natural gas pipeline will transport production.
  - Pipeline construction is scheduled to begin in 2000.
  - Installation of the steel catenary risers will occur immediately after TLP installation.
  - J. Ray McDermott, Inc. will install the oil and gas pipelines beginning in the second quarter 2000 using the dynamically-positioned Derrick Barge 16.

Brutus Fact Sheet | Brutus Home | Brutus Location Map

SEPCo Home | Shell Oil | Shell Chemical

Figure 2d

APPENDIX B

Air Quality Review

GC 158/202
N-6570
OCS-G 7995/7998
"Brutus" TLP & 8 Wells

DESCRIPTION OF THE ENVIRONMENT: AIR QUALITY

These operations will occur west of 87.5 degrees west longitude and hence fall under MMS's jurisdiction for enforcement of the Clean Air Act. The air over the OCS water is not classified, but it is presumed to be better than the National Ambient Air Quality Standards for all criteria pollutants. The blocks involved, Green Canyon 158 and 202, are offshore, south of Terrebonne Parish, Louisiana. Terrebonne Parish is in attainment of the National Ambient Air Quality Standards (EPA, 1998).

The primary meteorological influences upon air quality and the dispersion of emissions are the wind speed and direction, the atmospheric stability, and the mixing height.

The general wind flow for this area is driven by the clockwise circulation around the Bermuda High, resulting in a prevailing southeasterly to southerly flow. Superimposed upon this circulation are smaller scale effects such as the sea breeze effect, tropical cyclones, and mid-latitude frontal systems. Because of the various factors, the winds blow from all directions in the area of concern. (DOI, 1988).

Not all of the Pasquill-Gifford stability classes are routinely found offshore in the Gulf of Mexico. Specifically, the F stability class is rare. This is the extremely stable condition that usually develops at night over land with rapid radiative cooling; this large body of water is simply incapable of loosing enough heat overnight to set up a strong radiative inversion. Likewise, the A stability class is also rare. It is the extremely unstable condition that requires a very rapid warming of the lower layer of the atmosphere, along with cold air aloft. This is normally brought about when cold air is advected in aloft and strong insolation rapidly warms the earth's surface which, in turn, warms the lowest layer of the atmosphere. Once again, the ocean surface is incapable of warming rapidly; therefore, you would not expect to find stability class A over the Gulf of Mexico. For the most part, the stability is slightly unstable to neutral.

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

EFFECTS ON AIR QUALITY

The projected air emissions submitted by Shell Deepwater Development Inc. (SDDI) for this project are below the MMS exemption levels. SDDI has estimated the emissions associated with this project. These emission projections are required to represent the worst case and are summarized below:

EMISSIONS (tons)

	TSP	SO_x	NO_x	VOC	CO
2001	30	178	1,424	212	355
2002	20	102	1,166	624	418
2003	9	34	660	609	307
2004-2012	8	28	586	608	277
MMS exemption level	2,964	2,964	2,964	2,964	6,877

(Source: EPA, 1993)

Three emission reduction efforts are being included in this project. First, the facility has three generators; only two will run at any given time; and the third is a backup. The emission totals shown above include this reduction, and the operator will be required to maintain logs of the usage of these generators to verify that only two are used at any given time. The second measure is the installation of a vapor recovery unit on the storage tanks. This unit is expected to reduce the above-depicted VOC emissions by approximately 574 tons/yr. The final measure is the installation of a water cooled condenser on the glycol still vent. This control device is approximately 99 percent efficient and is down typically less than one week per year. The VOC totals shown above already reflect the reductions from this control device.

UNAVOIDABLE IMPACTS

There will be a limited degree of degradation of air quality in the vicinity of the operations for the 12-year period of proposed production activities.

Air quality would be affected in the event of a blowout or oil spill. The VOC's, which would escape, are precursors to photochemically produced ozone. A spike in VOC's could contribute to a corresponding spike in ozone, especially if the release were to occur on a hot sunny day in a NO_2 rich environment. The corresponding onshore area is in attainment for ozone. (EPA, 1998)

If a fire occurs, particulate and combustible emissions will be released in addition to the VOC's.

MITIGATION

Mitigation 2.5 (Advisory) - Fuel usage or run time documentation

The projected NO_x emissions amounts in your plan were calculated using historic run times. Therefore, please be advised that you will maintain records of the actual run times for the three generators and provide the information to this office upon request.

REFERENCES

U.S. Dept. of the Interior. Minerals Management Service. 1988. Meteorological database and synthesis for the Gulf of Mexico. Prepared by Florida A&M University for the Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 88-0064. 486 pp.

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APPENDIX C

Biological Review

CHEMOSYNTHETIC INVERTEBRATE COMMUNITY REVIEW

November 2, 1999
Shell Deepwater Development
Green Canyon 158 (OCS-G 7995)
Plan No. N-6570
Wells TLP-1 to TLP-8
Ocean Worker Semi-submersible and Heerema *Balder* TLP Installation Rig

Chemosynthetic invertebrate communities are not expected in the area of the proposed action. The anchored semi-submersible drilling rig "Ocean Worker" and an anchored TLP installation rig "Heerema Balder" would be used. Seafloor faults are necessary as conduits for chemogenic hydrocarbons to reach the seafloor and support invertebrate chemosynthetic communities. No faults are anywhere near the proposed anchors/chains for the semisubmersible Ocean Worker. The TLP installation rig Heerema Balder will install the tension leg platform (TLP), which is anchored to the seafloor by vertical tendons. For the TLP installation rig, anchor and chain PS-3 is about 577 ft from a probable shallow gas and fluid expulsion zone. Neither the well site nor any of the other anchor assemblies come that close to such probable sensitive features.

No mitigative measures are required.

Source: Fugro-McClelland Marine Geosciences, Inc. 1998. Shallow hazards report, Blocks 123, 124, 158, and 159, Green Canyon Area, Gulf of Mexico, prepared for Shell Offshore Inc., New Orleans, Louisiana, September 1998.

Instruments used: Deep-tow EDO Western 4075 side scan sonar with subbottom profiler system; EDO Western 4077 narrow beam bathymetry system.

Deepwater Chemosynthetic Communities

The deepwater chemosynthetic communities consist of organisms that are most abundant in water 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. The primary chemosynthetic organisms are bacteria, both free-living as bacterial mats and symbiotic in the tissues of other organisms.

Most of the following is from the U.S. Department of Interior (1997). Chemosynthetic clams, mussels, and tube worms, have been discovered in association with hydrocarbon and H_2S seeps in the northern Gulf of Mexico. Although these communities are widespread across the northern Gulf of Mexico slope and often form dense populations, they are sometimes found in very sparse concentrations of less than one animal per m^2. 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 geographic range of chemosynthetic communities in the Gulf of Mexico, 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.). Recently, in July 1997, populations of an unidentified species of ice worm (family Hessionidae) have been found in abundance associated with gas hydrates and should be added to the list. 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. Heterotrophic species at seep sites are a mixture of species unique to seeps and those that are a normal component from the surrounding environment.

All evidence indicates that hydrocarbon seeps and the associated chemosynthetic communities persist in the same locations for long time periods (Powell, 1993). 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. He found general consistency with few cases in which the community type changed (from mussel to clam communities, for example) or had disappeared completely.

Recovery of impacted communities would be slow. 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.

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.

Potential adverse impacts to deepwater chemosynthetic communities would come from OCS-related, bottom-disturbing activities associated with pipelaying, anchoring, and structure emplacement, as well as from a seafloor blowout. These activities cause localized bottom disturbances and disruption of benthic communities in the immediate area with recovery requiring years. Dense chemosynthetic communities are protected from OCS activities because, although at least 43 community sites have been located across the northern Gulf of Mexico continental slope, they are considered rare, slow to recover, and of great scientific interest and importance. Companies conducting activities at water depths greater than 400 m must analyze for the potential of community presence as part of their multisensory geophysical survey required for the action. As described in the site-specific Chemosynthetic Community Review in this appendix, the proposed developmental action should not disturb chemosynthetic communities and no mitigative measures will be required for the protection of potential communities on this proposed plan.

Literature Cited

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APPENDIX D

Accidental Hydrocarbon Discharge Review

ACCIDENTAL HYDROCARBON DISCHARGE ANALYSIS

Prepared for the Shell Deepwater Development Inc. proposal to install a 12-well slot tension leg platform (TLP), lay one 20-inch oil pipeline, and one 20-inch gas line. The plan also includes the drilling of five wells to total depth (TLP-4 through TLP-8), and completing and producing eight wells (TLP-1 through TLP-8) in Green Canyon Blocks 158 and 202 - N-6570.

I. HYDROCARBON SPILL ACCIDENTS

A. Potential Sources of A Spill As A Result Of the Proposal

This proposal covers the installation of a 12-well slot tension leg platform (TLP) in approximately 3,000 feet of water and the laying of one 20-inch oil export pipeline and one 20-inch gas export line. The plan also includes the drilling of five wells to total depth (TLP-4 through TLP-8), and completing and producing eight wells (TLP-1 through TLP-8) in Green Canyon Blocks 158 and 202. The TLP will be set with the "Heerema Balder." The eight wells will be batch set through any shallow zones and 1-3 of these wells will be pre-drilled to a total depth and cased with the semi-submersible drilling rig the "Ocean Worker." The remaining wells will be deepened to total depth with the TLP platform rig.

Potential sources of hydrocarbon spills from the proposed development activity would include

- the loss of hydrocarbons during the proposed operations;
  - resulting from a storage tank(s) accident on the drilling rig or the TLP,
  - during a transfer operation mishap(s) between the supply vessel and the rig and/or TLP,
  - resulting from a leak from the departing pipeline riser or pipeline; and/or
- the loss of hydrocarbons as a result of a blowout.

Facility Storage and Transfer Operations (Diesel)

The "Ocean Worker" will have a storage capacity totaling 12,096 bbl for liquid oils. The carrying capacity for the "Heerema Balder" that will be used to install the TLP is not known. The operator also states that there will be no liquid crude oil stored above 50,000 bbl. Approximately seven trips per month will be made to the drillsite by supply vessels during which the transfer of hydrocarbon products could occur. The carrying capacity of the fuel supply vessels is 4,500 to 7,500 bbl. The following table lists the storage capacity for the tanks on the TLP that are capable of holding liquid oils by oil type and volume:

Storage of Liquid Oils on the Brutus TLP

Liquid Hydrocarbons	No. of Storage Container(s)	Volume of tanks (bbl)	Total Capacity (bbl)
Aviation Fuel	1 tank and 3 extra transport tanks	60 bbl 3 transport containers at 12 bbl each	96 bbl
Diesel	1 tank	1,550 bbl	1,550 bbl
Lubricating Oil – Shell Rotella T-15-40	2-3 tanks	12 bbl each	36 bbl
Lubricating Oil – Shell Turbo 32	2-3 tanks	12 bbl each	36 bbl
Produced Crude Oil	2 tanks	1 dry oil tank at 1,100 bbl 1 wet oil tank at 475 bbl	1,575 bbl
Total	13 tanks	N/A	3,293 bbl

Blowouts

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

Although not a new potential source of spills, the likelihood of spills from loss of control (blowouts) in deep water may be different from the risk of spills in shallow water. Further investigation is required before the consequences of blowouts in deep water can be fully evaluated. Of particular concern is the ability to stop well control loss once it begins, thus limiting the size of a spill. Regaining well control in deep water may be a problem since it could require the operator to cap and control well flow at the seabed in great water depths (in this instance, over 2,958 feet) and could require simultaneous fire-fighting efforts at the surface. In addition, the availability of rig, riser, and associated deepwater drilling equipment is somewhat limited.

In the event that a subsea blowout occurs, the intervention that would most likely be employed to regain control of the well would be the drilling of a relief well. Drilling an intervention well could take anywhere from 30 to 90 days (Regg, 1998; Stauffer, 1998; McCarrel, 1998). The actual amount of time required to drill the relief well will depend upon the complexity of the intervention, the location of a suitable rig, the type of operation that must be terminated in order to release the rig (e.g., may need to run casing before releasing the rig), and any problems mobilizing personnel and equipment to the location (Regg, 1998; Stauffer, 1998; McCarrel, 1998).

Keeping in mind that it is rare for a well blowout to result in a release of oil, MMS feels that if a blowout were to occur, it is more likely for a blowout in deep water to occur at the seafloor because there is less containment capability subsea. However, it is possible that a surface blowout could occur. Whether a surface or subsurface blowout in deep water occurs, MMS will most likely require that the operator begin preparations to drill a relief well (McCarrel, 1998). Because some deepwater sediments are unconsolidated, industry has proposed the theory that a deepwater blowout will bridge over before it can be controlled through the drilling of a relief well (in less than 30 days) (McCarrel, 1998).

Along this line, Shell has submitted information that indicates that the potential for the well to bridge over is greatly influenced by the timing of the blowout. In the drilling mode, with no sand control in place, the well is expected to bridge over quite quickly and, in fact, the well flow is less restricted, i.e., the higher the rate, the quicker the well is expected to bridge. In the workover/completion mode, the timing is again critical. If the blowout occurs after sand control is in place, the less likely the well is to bridge over, especially if the flowrate is restricted. It may take some time for the flowpath to erode to the point that the rate is high enough to fail the gravel pack. In the production and wireline modes, it is assumed that the sand control is in place, and while the rates would be lower due to tubing and other possible restrictions, the event would most probably last longer (Shell, 1999).

Per Shell, the potential for surface intervention would depend greatly on the nature of the breach, the flow volume, and to a lessor degree, whether the well flowed predominantly oil or gas. Brutus will be predominantly oil and somewhat less dangerous to deal with from the standpoint of uncontrolled flow. A relatively small leak could probably be managed in several different ways. Larger flows, although more challenging, could be handled by diverting the flow away from the work area. If the outer casing strings are breached, the likelihood of a successful surface intervention would be minimal (Shell, 1999).

The completions at Brutus will typically employ 4-1/2 inch tubing. The tubing size will restrict the flowrate somewhat but the flow could still be sizeable (35,000 barrels per day). If there is any restriction to the flow of the well at the surface, it may prolong the period of time that the well flows uncontrolled. However, if the well flows at a very high rate, the event may be shorter.

Pipeline Spills

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

B. Historical Spill Information

Storage and Transfer Operations Spills (Diesel)

The MMS's database on diesel spills that occurred from drilling operations conducted on the OCS from 1976 to 1985 was analyzed. These years were chosen because they appeared to be the most complete recording of these events. From 1976 to 1985, there were approximately 80 reported diesel spills > 1 bbl related to OCS drilling. There is no information available on diesel spills ≤ 1 bbl. Sixty of the 80 diesel spills (75%) in the MMS database occurred as a result of an accident during transfer operations. The majority of transfer accidents occurred due to human error of some type (personnel falling asleep, unmanned transfer operations, etc.) and, secondly, due to the malfunction or failure of the transfer equipment, which was sometimes due to weather conditions. Requirements now exist that reduce the risk of some of the transfer accidents historically caused by human error. Causes of the spills that were not associated with transfer mishaps were equally divided between equipment malfunctions/failures involving the fuel tanks on a rig and collisions involving supply vessels. Of the 80 spills > 1 bbl reported, 8 occurred due to collisions involving vessels. Difficulties with deepwater operations that could cause diesel spill events are not reflected in this data.

Historically, diesel spill sizes from OCS operations have ranged from < 1 bbl to 1,500 bbl. A vessel collision was the cause of the only diesel spill > 1,000 bbl to occur during drilling. In 1979, an anchor-handling boat collided with a drilling platform in the Main Pass Area and released 1,500 bbl of diesel. Of the 80 diesel spills > 1 bbl occurring from 1976 to 1985, approximately 65 involved spills > 1 bbl but < 50 bbl, 15 cases involved spills > 50 bbl. Of these 15 larger spills, only 10 were > 100 bbl, and only one was > 1,000 bbl (MMS, OCS Events File, 1995). The mode of these data is 2 bbl, the median spill is 5 bbl, and the average spill is 68 bbl (skewed due to the 1,500-bbl spill).

The likelihood of a diesel spill occurring from drilling operations is based on comparing the total number of diesel spills found in the MMS database with the number of OCS well starts reported for this same time period and by applying the Poisson process (USDOI, MMS, 1997a). During 1976-1985, the time period that includes the 80 spills, there were approximately 11,944 well starts reported for OCS leases (USDOI, MMS, 1997a). Applying these statistics to the drilling scenario proposed by Shell (i.e., the drilling and completion of 8 wells), there is a 5 percent probability that a diesel spill > 1 bbl would occur;

- a 4 percent probability that a diesel spill between 1 and 50 bbl would occur;
- a 1 percent probability that a diesel spill > 50 bbl would occur; and
- less than a 0.1 percent probability that a diesel spill > 1,000 bbl would occur.

Blowouts and Production-Related Spills

In order to enhance the prevention of blowouts, MMS has identified requirements for well control and blowout prevention equipment, procedures, and inspections as specified in 30 CFR 250.406-409 and 30 CFR 250.514-516.

From 1971 to 1995, a total of only 899 bbl of crude oil and condensate were spilled in 17 of the 101 production well blowouts that occurred from facilities and operations on the Federal OCS (USDOI, MMS, 1995). Of these blowouts, 45 occurred during development drilling, 18 occurred during production, 29 occurred during workovers, and 10 occurred during completion operations. Blowouts that occurred during the production phase accounted for the most oil released (726 bbl). From 1971 to 1995, there were 24,237 wells drilled; thus, the historical record indicates that there is a 17 in 24,237 chance per well (or 0.070% chance) for a blowout with a release of oil to occur. Since the historical MMS database reflects drilling in the shallower shelf waters and because of differences in deepwater drilling operations, it cannot yet be determined with any degree of certainty whether this same trend will continue in the deepwater areas of the OCS.

Data maintained since 1964 on spills of 1,000 bbl or greater from offshore platforms and pipelines have documented only 11 spills of 1,000 bbl or more from platforms on the OCS (all OCS areas included). The majority of these spills occurred due to bad weather conditions. This spill event data, in conjunction with the historic production of OCS leases, allow the estimation of a spill rate. This spill rate has not been uniform through time, and several revisions have been made (Nakassis, 1982; Lanfear and Amstutz, 1983; Anderson and Labelle, 1990 and 1994). The latest revisions in the spill rate found a decrease in the spill rate for platforms (Anderson and Labelle, 1990 and 1994). These reductions were attributed to improved safety practices in the oil industry. Based on historical data, MMS has estimated the rate at which spills occur from platforms for oil spills greater than or equal to 1,000 bbl as 0.45 spills per billion bbl produced.

The probability that an oil spill of 1,000 bbl or greater will occur from the proposed platform is estimated using a Poisson Distribution and using the spill rate of 0.45 spills per billion bbl produced (Anderson and Labelle, 1994). The other parameter needed to determine this probability would include the amount of oil produced (estimated to be 185 million barrels of oil over the 10-year life of the project), which in this case would be time dependent. A longer period of time would increase the probability because the amount of oil produced would increase. Using this information, the following table presents the time period, the amount of oil produced by the platform, and the probability of one or more spills of 1,000 bbl or greater occurring:

TIME	HYDROCARBONS PRODUCED (Bbbl)	PROBABILITY*
Month	0.0015	0.07%
Year	0.019	0.9%
10 Years	0.186	8.0%

*It should be noted that the probability of an oil spill depends very strongly on the volume produced.

The historical record shows that there have only been four large oil spills exceeding 10,000 bbl as a result of OCS activities (all OCS areas included)—of which two resulted from platforms. These two platform spills resulted from blowouts, which along with the Santa Barbara blowout incident, prompted the implementation of new and stringent operation regulations pertaining to drilling procedures, subsurface safety valves, and platform safety devices. Based on historical data, MMS has estimated the rate at which spills occur from platforms for oil spills greater than or equal to 10,000 bbl as 0.16 spills per billion bbl produced.

The probability that an oil spill of 10,000 bbl or greater will occur from the proposed platform is estimated using a Poisson Distribution and using the spill rate of 0.16 spills per billion bbl produced (Anderson and Labelle, 1990). The other parameter needed to determine this probability would include the amount of oil produced (estimated to be 185 MMBO over the 10-year life of the development), which in this case would be time dependent. A longer period of time would increase the probability because the amount of oil produced would increase. Using this information, the following table presents the time period, the amount of oil produced by the platform, and the probability of one or more spills of 10,000 bbl or greater occurring:

TIME	HYDROCARBONS PRODUCED (Bbbl)	PROBABILITY*
Month	0.0015	0.02%
Year	0.019	0.3%
10 Years	0.186	3.0%

*It should be noted that the probability of an oil spill depends very strongly on the volume produced.

The probability estimates do not reflect unforeseen natural events such as hurricanes or geologic events. Probabilities for up to 10 years are provided in the tables because the estimated life of the reserves is projected by the operator to be 10 years. Please note that the historical database used as the basis to the above discussion reflects drilling in the shallower shelf waters. Because of differences in deepwater drilling operations it cannot yet be determined with any degree of certainty whether this same trend will continue in the deep water areas of the OCS.

Pipeline Spills

For spills that occur in Federal waters and that are greater than or equal to 1,000 bbl, the spill rate is 1.32 spills/Bbbl of produced oil for OCS pipelines. This pipeline spill rate is based on the entire OCS production (transportation) record and all historic pipeline spill records (12 spills/9.1 Bbbl transported). Since details regarding the proposed oil and gas pipelines were not provided in this application, probabilities for a spill to occur from the pipelines that will be associated with the TLP cannot be determined at this time. .

C. Spill Volume(s) to be Analyzed

To comply with the requirements at 30 CFR 254, the operator has provided an estimated worst case spill volume for the proposed facility. The scenario provided by Shell looked at the estimated most likely blowout rate given the Brutus well's flow potential. The outcomes were weight averaged by Shell based upon their projections of the probabilities for occurrence (Shell, 1999). The following table provides Shell's estimates for the most likely blowout volume and duration during the development drilling mode, the workover/completion mode, the production mode, and the wireline mode.

Mode	Most Likely Rate (barrels per day)	Duration Days
Development Drilling	40,000	2
Workover/Completion	25,000	7
Production	15,000	20
Wireline	10,000	30

Source: Shell, 1999.

The resulting composite rate was 29,125 BPD with an expected duration of 8.1 days. When you add to this the volume contained in the storage tanks (3,293 bbl), the volume in the piping on the TLP (100 bbl), and the volume in the pipeline (4,000 bbl) that could be lost from the TLP in the event that a blowout occurs, the total volume that could be lost during the first day of this scenario would total 36,518 bbl of oil. Under Shell's scenario, the blowout could continue for another 7.1 days at a rate of 29,125 bbl/day. This EA will analyze only the 29,125 bbl/day release due to the relatively small amount of oil that would be lost on the first day due to storage. Since the volume of oil that will be analyzed for this EA as part of the blowout scenario is comparable to the contents of any of the tanks on the production facility and the supply vessels, and because the work will be conducted by semisubmersibles having average storage capacity for the Gulf of Mexico, this analysis will not consider, as a separate scenario, the loss of the stored or transferred hydrocarbons.

1. Vulnerability of Potentially Affected Resources to Hydrocarbon Spills

Subsurface Spills

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

Surface Spills

The Oil Spill Risk Analysis (OSRA), published as a supplement to OCS Report MMS 99-0010 (Price et. al., 1999), indicates that should a spill occur in the subject lease blocks and persist in the environment for 30 days, there is a relatively low probability (less than or equal to 8%) for the spill to impact one of the countries/parishes from Galveston County, Texas, to Plaquemines Parish, Louisiana. This same OSRA run indicates that there would be a less than 0.5 percent chance for a spill from the subject blocks to impact any shoreline area within 3 days and a 1 percent chance for a spill from this area to contact Terrebone Parish within 10 days.

2. Assumptions about the Characteristics and Fates of Spilled Hydrocarbons

Characteristics of Hydrocarbons

Information submitted by Shell indicates that a crude oil could have an API ranging from 27 to 36. The information submitted by Shell regarding the estimated chemical characteristics of the oil is included in Shell's submittals dated January 3, 2000, February 10, 2000, and February 23, 2000. It is assumed that a typical diesel fuel oil will be used during the proposed activities. Material Safety Data Sheets for the oils that will be stored in the tanks on the TLP were submitted with Shell's proposed plan, excluding diesel fuel.

Subsurface Spills

The form that a slick will take if released during a subsea blowout may be very different from oil spilled at the surface and may affect the residence time of the slick. Very little is understood about the chemical behavior, transport, and physics of the rising plume during a subsea blowout under the temperature and pressure conditions encountered in deep water. A recently completed modeling effort showed that hydrates might form from some of the gaseous components in a blowout fluid. A deepwater blowout study funded by MMS (S.L. Ross Environmental Research Ltd., 1997) modeled the fate of a release of 30,000 bbl of oil per day and 60 million cubic feet of gas per day during a deep water blowout. One of the scenarios modeled assumed a blowout in water depths greater than 900 meters. Blowouts at this depth are expected to result in a very fast conversion of all of the gas to hydrate, and the oil is expected to rise to the water surface due only to its buoyancy.

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

The MMS, in collaboration with industry, is currently funding a study that will provide an in-depth analysis of oil-spill behavior from subsurface well blowouts in deep water. A complete analysis of this issue cannot be completed until the results of this study effort are available.

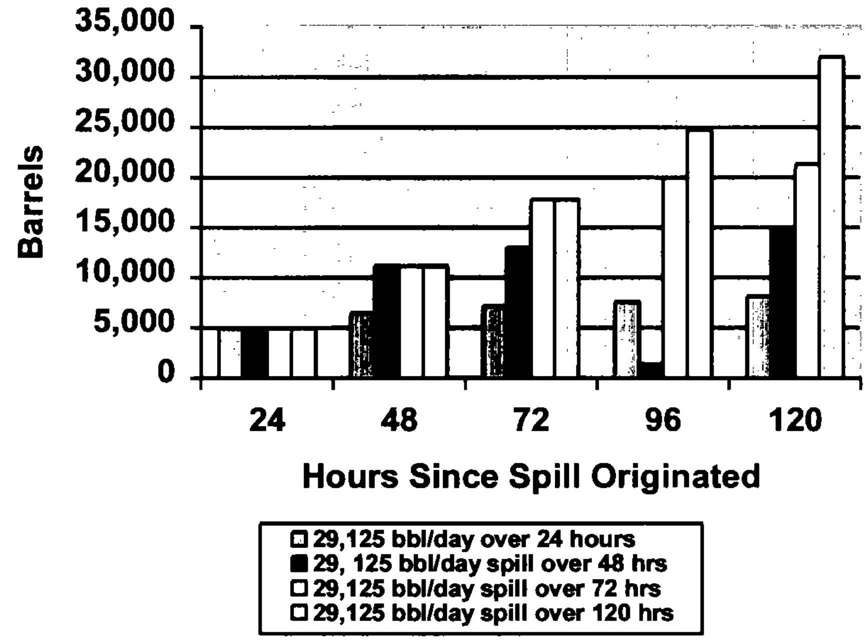
Surface Spills

The NOAA Automated Data Inquiry (ADIOS) calculations essentially predict the material balance of spilled hydrocarbons as a function of time assuming the spilled oil is not transported subsea. For the evaluation of this proposed action, the ADIOS program was run for several different scenarios.

Because the ADIOS model runs are limited to a maximum timeframe of five days, four spill scenarios were run in an attempt to determine trends that would assist in predicting the fate of an 8.1 day oil-spill event that could potentially spill at a rate of 29,125 bbl/day. An oil having chemical characteristics as similar as possible to the crude oil that the operator projected they might encounter during drilling was chosen as an input for these four scenarios. The representative oil used in these ADIOS model runs has an API gravity of 27.5. Since little information is available regarding the fate of oil that is either released at these water depths (approximately 3,000 feet) or that remains subsurface, for these scenarios, a surface slick of this volume was assumed.

The four ADIOS oil-spill scenarios assumed the continuous loss of 29,125 bbl of oil/day for various periods of time (e.g., 24 hours, 48 hours, 72 hours, and 120 hours) during a blowout occurring subsea (assuming all of the released oil surfaced) under conservative winter weather-conditions (20.1 degrees C sea surface temperature and low wind speeds (6 knots) with no frontal passages). The volume of oil lost per day in barrels is depicted in Figure 1 for each of these ADIOS model runs. All of the ADIOS model results showed that the majority of oil that was lost due to weathering occurred due to evaporation. The results indicate that very little oil was lost in any of the ADIOS model runs due to dispersion.

Figure 1. Volume of Oil Lost Per Day for Four ADIOS Spill Scenarios



As indicated in Figure 1, the volume of oil lost was consistent for each of the scenarios as long as oil continued to spill at 29,125 bbl/day. Figure 1 shows that approximately 5,000 bbl of oil was consistently lost within the first 24 hours for all of the spill scenarios. Results of those scenario runs involving 29,125 bbl/day spill inputs beyond 24 hours indicate that the slicks continued to weather at a rate of an additional 0.5 percent of the total volume spilled each day as long as the spill continued each day unabated. Once the spill source was contained, the scenario runs indicated that the slicks continued to weather at a rate of approximately 2 percent of the total volume spilled each day.

Figure 2. Volume of Oil Remaining on the Water Surface (29,125 bbl/day continuous spill for 8.1 days)

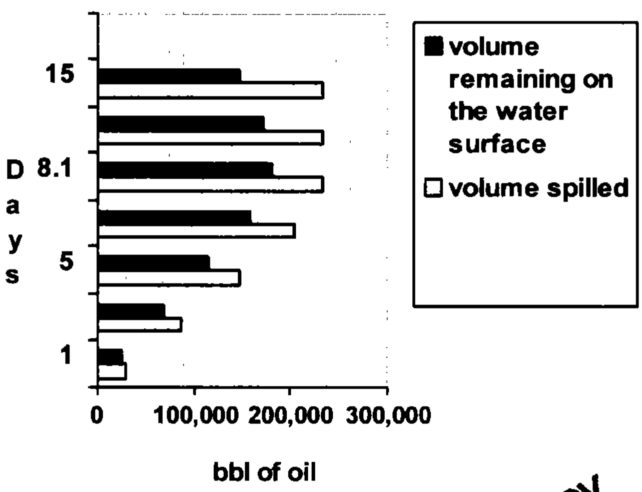


Figure 2 depicts the volume of oil that this agency estimates could remain on the sea surface as a result of a spill event involving a 29,125 bbl/day release of oil over 8.1 days. Based upon the above assumptions, for a scenario involving an 8.1 day oil release at a rate of 29,125 bbl/day, on day 15, approximately 147,470 bbl of a 234,000-bbl spill are expected to remain on the water surface after weathering.

As evident by the results of the ADIOS model runs and the information depicted in

Tables 1 and 2, oil spilled during a deepwater blowout event that could last 8.1 days would result in a large amount of oil remaining on the water surface probably for an extensive period of time, particularly if oil spilled at a rate of 29,125 bbl/day.

3. Hydrocarbon Spill Containment/Cleanup Capabilities and Effectiveness

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

The ability to respond to a spill that might occur in the deepwater areas of the OCS will vary dependent upon a number of factors. Among these factors are the chemical and physical characteristics of an oil, the volume of oil spilled, the rate of spillage, the weather conditions at the time of a spill, the source of the spill (e.g., TLP storage spill or surface or subsurface blowout), and the amount of time necessary for response equipment or chemical countermeasures to reach a spill site. Spills in deep water may be larger due to the high production rates associated with deepwater wells and the length of time it could take to stop the source of pollution (e.g., subsea blowout). In addition, response times to the deepwater locations may be longer than elsewhere in the Gulf of Mexico. However, the distance from shore (approximately 86 miles) will generally allow more time for cleanup efforts and natural dissipation of the oil to take place. As indicated in Section 2 of this analysis, the OSRA model results indicate that the probability of a spill occurring in the subject leases reaching one of the coastal countries/parishes within 30 days is low (less than or equal to 8%).

Subsurface Spill

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

The model results of a recently completed study (S.L. Ross Environmental Research, Ltd., 1997), which was discussed previously, indicated that slicks formed in those cases where the gas plume does not develop (in water depths greater than 900 m) will be narrower at the source than bubble plume slicks (assumed to occur in water depths ranging from 300-750 m) and more patchy. These slicks (where a gas plume does not develop) will be thin and as a result are not expected to be successfully contained and/or removed from the water surface through the typical mechanical oil-spill response booming and removal operations. Chemical dispersants appear to be the only likely viable spill response countermeasure that would be effective under these conditions. It is possible that natural dispersion of these slicks would alleviate the necessity for any response action for blowouts in some deepwater locations (S.L. Ross Environmental

Research, Ltd., 1997). The MMS is presently funding a study to provide an in-depth analysis of oil-spill behavior from subsea blowouts and subsea pipeline releases in deep water. The ability to properly determine appropriate spill response countermeasures to these deepwater events will depend upon the results of this study.

Since the application of dispersants may be the only feasible oil-spill response option to some deepwater spills, the availability and suitability of dispersant application in the deepwater environment is a concern. At present, the Oil Spill Removal Organizations (OSRO's) with whom Shell has contracts all have access to Airborne Support Inc. (ASI) located in Bourg, Louisiana. The ASI has a stockpile of 45,300 gal of the dispersant Corexit 9527 available for application by two DC-3 and one DC-4 aircraft. At a 20:1 application ratio, each DC-3 holds enough dispersant to spray a slick of approximately 476 bbl of oil, and the DC-4 can spray a 952-bbl slick. At this same 20:1 ratio, the 45,300-gal stockpile of dispersant available through ASI in Bourg, Louisiana, is sufficient to spray a 22,000-bbl oil spill; however, numerous sorties would be required to apply this volume of dispersant. Additional dispersant stockpiles are also available and additional supplies of Corexit 9500 can be manufactured by Exxon within 2-3 days after a request is made. However, it should be noted that the April 1998 Final Report of the Preparedness Partnership Project sponsored by the Texas General Land Office states that although a work group was initially tasked with looking into the capability of applying dispersants on a 250,000-bbl spill, the team quickly concluded that there was not enough equipment or dispersant stockpiled to respond to that large an incident (Texas General Land Office, 1998).

Surface Spill

Shell would be expected to mount a response strategy to effectively respond to a spill. Equipment that is contractually available to the operator through OSRO membership or contracts to be called out to respond to a spill situation can be obtained through the Marine Spill Response Corporation (MSRC) and/or the National Response Corporation (NRC). Initially, the operator plans to call out equipment from spill response equipment stockpiles in Fort Jackson and Lake Charles, Louisiana; Ingleside and Galveston, Texas; and Pascagoula, Mississippi. During a spill event, the operator would be expected to cascade in additional equipment as deemed necessary to respond to the spill. Estimated response times for this equipment to arrive onsite utilizing the spill equipment locations and staging areas identified by Shell are provided in Table 1.

Once all of the equipment identified by Shell is operational, the total recovery capacity onsite is estimated at 42,000 bbl per day. In the event that other equipment would be needed or in the event that some of the equipment would need replacing in order to support a long-term around-the-clock response effort, Shell could obtain additional equipment from other MSRC/NRC equipment bases located throughout the Gulf of Mexico, and from other OSRO's having stockpiles of equipment in the Gulf of Mexico. Response times for this equipment would vary dependent upon its location and the type of equipment transported.

Table 1

Estimated Response Times for Offshore Skimming/Containment/Storage Equipment Identified by Shell for Spill Response

Location of Equipment	Source	Amt./ Type	Staging Area	Derated Skimming Capacity (bbl)*	Storage Capacity (bbl)	Total Response Time
Fort Jackson, LA	MSRC	Louisiana Responder Transrec 350 skimmer	Fort Jackson, LA	10,500	4,000	13.5 hrs
	MSRC	1 Tank Barge	Fort Jackson, LA	N/A	44,700	24 hrs
Lake Charles, LA	MSRC	Gulf Coast Responder Transrec 350 skimmer	Lake Charles, LA	10,500	4,000	20 hrs
Galveston, TX	MSRC	Texas Responder Transrec 350 skimmer	Galveston, TX	10,500	4,000	22 hrs
		1 Tank Barge	Galveston, TX	N/A	56,900	38 hrs
Pascagoula, MS	MSRC	Mississippi Responder Transrec 350 Skimmer	Pascagoula, MS	10,500	4,000	25 hrs
		1 Tank Barge	Pascagoula, MS	N/A	40,300	49 hrs
		1 Tank Barge	Ingleside, TX			
TOTAL SKIMMING CAPACITY				42,000		
TOTAL STORAGE CAPACITY					198,200	

* The derated skimming capacity was determined using the USCG guidance requiring a reduction of the equipment's nameplate capacity by using a 20 percent efficiency factor in the calculations.

Table 2 compares the recovery capacity of the identified skimming equipment to the amount of available recovered oil storage capacity during the time frames required for this equipment to be onsite and operational.

Table 2

Offshore Spill Response Recovery Capacity

Hours Since Spill Originated	Volume (bbl) Remaining on Water Surface*	Calculated** Daily Recovery Capacity Onsite (bbl/day)	Recovered Waste Storage Onsite (bbl)
13.5 hrs	12,550	10,500	4,000
20 hrs	20,630	21,000	8,000
22 hrs	21,845	31,500	12,000
24 hrs	24,465	31,500	56,700
25 hrs	25,756	42,000	60,700
38 hrs	38,180	42,000	117,600
47 hrs	46,740	42,000	157,900
49 hrs	48,380	42,000	198,200

*The amount of oil remaining on the water surface was estimated by using the results of the ADIOS Model runs, assuming that cleanup did not occur.

**These estimates were determined using the USCG guidance using a 20 percent efficiency factor in the calculation.

As the above table indicates, approximately 198,200 bbl of recovered oil storage capacity could be onsite within 49 hours. Having sufficient recovered oil storage onsite in a timely manner is important since a lack of storage would limit the amount of oil that could be recovered despite the fact that all the necessary skimming and containment equipment may already be onsite. It is important for the skimming and containment equipment to be deployed and operational with sufficient storage capacity as soon as possible after a spill event occurs, as the slick could get away from a cleanup contractor. Once this occurs, the spill response would require the dedication of additional containment and cleanup equipment since isolated slicks could then need to be chased down. The lack of sufficient recovered oil storage onsite has historically been one of the factors that reduces the effectiveness of a spill response operation. In the event that a large multi-day spill response effort would be needed, the oil storage capacity identified in Shell's plan may need to be augmented. As members of MSRC and NRC, the operator has access to additional oil-spill storage capacity in the Gulf of Mexico. If necessary, additional recovered oil storage equipment could also be brought in from outside the Gulf of Mexico region.

Although this section has primarily focused on mechanical oil-spill response and because no single spill response method is 100 percent effective, it is likely that larger spills in deep waters under the right conditions will require the simultaneous use of all available cleanup methods (e.g., mechanical cleanup, dispersant application, and possibly insitu burning). The ADIOS model results discussed in Section 3 of this attachment indicate that there is a relatively short time frame or window of opportunity (40-47 hours) for the optimal use of both dispersants and insitu burning. Historically, mechanical recovery has typically only removed 10-15 percent of the volume spilled. On average, the application of dispersants has been effective historically on 33 percent of the oil that is treated. For example, by using these percentages one can estimate that for every 29,125 bbl of oil spilled each day approximately 2,912 bbl could be recovered by mechanical means and 1,884 bbl could be removed through dispersant application (assuming that 5,712 bbl of spilled oil is treated with dispersants – this assumes that nine sorties were flown per day and that the dispersant supply was available). Over 15 days, the estimated volume of oil that could be expected to remain on the water surface under this scenario would total 85,072 bbl out of the originally spilled 234,000 bbl.

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

Nearshore/Shoreline Protection and Cleanup Strategies

Shell contracted with Morris Environmental Inc. to provide a shoreline response guide that provides an overview of environmental resources found within the potentially impacted area and that outlines potential shoreline protection plans for these resources. In the event that any spilled oil actually makes landfall, the information will be used in conjunction with up-to-date guidance/information received from the appropriate Federal or State agencies to develop spill response action plans in the event that a spill occurs from the proposed operations. The shoreline response guide provides details of the response equipment (including skimmers, shoreline/nearshore containment boom), etc., that could be used by Shell in the event that a nearshore, onshore, and/or inland response may be necessary to respond to a spill that occurred during the proposed operations.

4. Description of the Affected Environment and the Potential Impacts from a Hydrocarbon Spill

Hydrocarbon Spill Analyzed

If an oil spill occurs, the probability of that spill contacting specific environmental resources mostly depends upon where the spill originates, the type of spilled hydrocarbons, and the seasonal, meteorological, and oceanographic conditions during and after the spill. Results of the Oil Spill Risk Analysis (OSRA) model show probabilities of contact to environmental resources from oil spills greater than 1,000 bbl. Based on the OSRA report published as a supplement to OCS Report 99-0010 (Price et al., 1999), should an oil spill happen in the lease block of the proposed action (Green Canyon Area, Block 158 located in Central Planning Area Oil Spill Launch Area C44) and persist in the environment for 30 days, there would be a 31 percent probability of the spill impacting land. This OSRA run indicates there is a 1–8 percent chance for the spill to impact specific counties/parishes segments within the area from Galveston County, Texas, to Plaquemines Parish, Louisiana, within 30 days. There is also a 1 percent chance for the spill to impact Terrebonne Parish, Louisiana, within 10 days, and a less than 0.5 percent chance for the spill to contact any other shoreline area within 3 days. The available OSRA model runs were limited to 30 days. Refer to Table 3 below for the probabilities of land contact by county/parish.

Table 3

Probabilities (expressed as percent chance) that an Oil Spill Starting within a Particular Launch Area in the Central Planning Area will Contact a County/Parish within 3, 10, or 30 Days (3/10/30)

County/Parish	State	Land Segment	Launch Area C44
Galveston	TX	10	-/-/1
Chambers	TX	10	-/-/1
Jefferson	TX	11	-/-/1
Cameron	LA	12	-/-/6
Vermilion	LA	13	-/-/4
Iberia	LA	14	-/-/4
St. Mary	LA	15	-/-/1
Terrebonne	LA	16	-/1/8
LaFourche	LA	17	-/-/3
Jefferson	LA	18	-/-/1
Plaquemines	LA	19	-/-/2

Potential impacts from an accidental release of oil from a high volume blowout is of concern; however, the historical database indicates that it is rare for such a pollution event to occur. For the period from 1971 to 1995, based on 24,237 wells drilled, there were 17 well blowouts that resulted in the release of oil (0.07% probability).

Shell provided MMS with estimates of the most likely spill volume and duration associated with a blowout from the proposed Brutus wells during the development drilling mode, the workover/completion mode, the production mode and the wireline mode. The resulting composite was 29,125 bbl day with an expected duration of 8.1 days. In the unlikely event that a blowout occurs, the total volume that could be lost over 8.1 days is approximately 234,000 bbl, excluding storage tanks volume (3,293 bbl), piping volume on the TLP (100 bbl), and pipeline volume (4,000 bbl) that could be lost from the TLP during the first day of the blowout. This is the scenario analyzed in this EA. On the 15th day (7 days after expected cessation of the blowout), the estimated volume of oil that could be expected to remain on the water surface would total 85,072 bbl out of the originally spilled 234,000 bbl, after taking into account hydrocarbon spill containment/cleanup capabilities and effectiveness for mechanical recovery an dispersant use, as well as weathering.

a. Birds

(1) Description of Birds

The offshore waters, coastal beaches, and contiguous wetlands from Galveston County, Texas, to Plaquemines Parish, Louisiana, are herein separated into six major groups: seabirds, shorebirds, marsh birds, wading birds, raptors, and waterfowl. Many species are mostly pelagic and, therefore, rarely sighted nearshore. The remaining species are found within coastal and inshore habitats (Clapp et al., 1982). Surveys show that Louisiana is a primary state in the southern and southeastern U.S. for nesting coastal and marine birds.

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). In the Gulf, there are three main groups of seabirds--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). Nesting seabirds on the Gulf include pelicans, cormorants, laughing gulls, eight species of terns, and black skimmers (Martin and Lester, 1991; Pashley, 1991).

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). 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).

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 some of 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).

Waterfowl belong to the taxonomic order Anseriformes and include swans, geese, and ducks. Many species usually migrate from wintering grounds along the Gulf Coast to summer nesting grounds in the north.

Endangered species such as the piping plover and brown pelican are found on the coast that may be contacted by an oil spill. Ingestion of oiled prey and the physical oiling of both adults and nestling are the primary effects of spilled oil on coastal and marine birds. Birds most vulnerable to oil are gregarious and spend most of their time on the water (NRC, 1985). Such birds, including the lesser scaup (*Aythya affinus*), may dive instead of flying away when disturbed. This waterfowl species may suffer high mortalities from a large oil spill happening when the birds gather in a group of about 100,000 individuals in Timbalier and Terrebonne Bays in late February and early March. Common merganser (*Mergus merganser*) wintering grounds include water in these bays, and these species retreats to the marsh when disturbed (Robert Helm, Louisiana Department of Wildlife and Fisheries, pers. comm.).

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: piping plover, bald eagle, brown pelican, and least tern. The piping plover (*Charadrius melodus*) is a migratory shorebird that is endemic to North America. This species remains in a precarious state given its low population numbers, sparse distribution, and continued threats to habitat throughout its range. The current range of the bald eagle is limited, with most breeding pairs occurring in Florida and Louisiana. The bald eagle is listed as threatened in the lower 48 states. The brown pelican (*Pelicanus occidentalis*) is one of two pelican species in North America. In recent years, there has been a marked increase in brown pelican populations along its entire former range. In coastal areas of Texas, Louisiana, and Mississippi, where populations are not secure, the brown pelican remains listed as endangered. The least tern (*Sterna antillarum*) is listed as endangered, except within 50 mi of the coast.

(2) Potential Impacts on Birds

A description of the oil spill associated with a hypothetical blowout from a proposed Brutus well, which is analyzed for potential impacts to resources in this SEA, is provided in Section 1.C. and Section 5 of this Appendix.

Very small quantities of oil have been found to produce mortality and developmental defects in avian embryos (Leighton, 1990). Toxicity can be acute, but long-term effects can also occur in exposed adults, chicks exposed to oil or fed contaminated food, and chicks hatched from eggs of exposed birds (Fry et al., 1985). 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 and weather), 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 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, raptors, 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). 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 and later provide recruits to the area affected by the spill (Cairns and Elliot, 1987; Trivelpiece et al., 1986; Samuels and Ladino, 1983/1984).

The external exposure of adult birds to oil/dispersant emulsions may reduce chick survival more than exposure to oil alone; however, successful dispersal of a spill will generally reduce the probability of exposure of coastal and marine birds to oil (Butler et al., 1988).

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. Any species that are low in density and scattered may be less likely to be affected by a point disturbance; however, a large oil spill is not a point disturbance.

Oil that remains offshore could impact sea ducks and other seabirds. Oil reaching low salinity water may affect estuarine waterfowl, and diesel entering estuarine bays could affect such birds there. The impacts on the nonlisted shorebirds just discussed above apply also to the piping plover, listed as threatened. This shorebird winters on the Gulf Coast away from the high-energy beaches.

Bald eagle's nests are found on the coast in the area of potential spill landfall, from Galveston County, Texas, to Plaquemines Parish, Louisiana. The American peregrine Falcon has recovered from its endangered or threatened status and is delisted. The brown pelican is listed as endangered in Louisiana, (USDOI, FWS, 1998). Impacts on brown pelicans and bald eagles would be the same as for unlisted seabirds, as analyzed above in this section.

b. Marine Mammals

(1) Description of Marine Mammals

Twenty-eight cetaceans, one sirenian, and one non-native pinniped (California sea lion) species have confirmed occurrence in the northern Gulf of Mexico. Cetaceans are divided into two major suborders: Mysticeti and Odontoceti (baleen and toothed whales, respectively).

Only two of the seven baleen whale species (Bryde's and minke) occurring in the Gulf are not listed as endangered or threatened. Of the 21 toothed whale species occurring in the Gulf, only the sperm whale is listed as endangered. The only member of the Order Sirenia found in the Gulf is the endangered West Indian manatee. California sea lions may exist in the northern Gulf of Mexico as feral individuals that probably escaped or were released from marine parks.

Cetacean distribution in the Gulf is influenced by both bottom depth and by the presence of mesoscale hydrographic features (cold-core and warm-core rings and confluences). The GulfCet studies have shown that cetaceans are concentrated along the upper continental slope (200-1,000 m water depth) and sighted less often over the abyssal regions (>2,000 m water depth). Cetaceans are observed frequently on the upper continental slope and tend to be associated with upwelling events (cyclones) and the confluence between cyclone and anti-cyclone pairs. These hydrographic features concentrate zooplankton and micronekton biomass, indicating richer concentrations of cetacean prey. Since cyclones in the northern Gulf are dynamic and usually associated with westward moving cyclone-anticyclone pairs, cetacean distribution will be dynamic. Bottlenose dolphins, Atlantic spotted dolphins, and possibly Bryde's whale, which typically occur on the continental shelf or along the shelf break, are outside of the major influences of eddies. Another preferential area for foraging is the area south of the mouth of the Mississippi River, which is a deepwater environment with locally enhanced primary and secondary productivity. For any given area in the offshore Gulf of Mexico, a description of marine mammals known to occur in that area is as much a function of survey effort as actual animal occurrences.

(a) Nonendangered and Nonthreatened Species

Baleen Whales

There are more records of Bryde's whale than of any other baleen whale species 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). Bryde's whale in the Gulf, with few exceptions, have been sighted along a narrow corridor near the 100-m isobath (Davis and Fargion, 1996; Davis et al., 2000). Most sightings have been made in the DeSoto Canyon region and off western Florida, though there have been some in the west-central portion of the northeastern Gulf.

Records of minke whales may represent strays from low-latitude breeding grounds elsewhere in the western North Atlantic (Mitchell, 1991).

Toothed Whales

Kogia

Dwarf and pygmy sperm whales are typically found in deeper waters (the continental shelf edge and beyond). *Kogia* has been found throughout the range of water depths and topographies in the Gulf (Mullin et al., 1991; Davis et al., 1998; Davis et al., 2000). The GulfCet I study found these animals in waters with a mean bottom depth of 929 m (Davis et al., 1998). Although *Kogia* have been sighted on the continental shelf at water depths less than 200 m, there is no evidence that they are regular inhabitants of continental shelf waters.

Beaked Whales

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', Blainville's, and Sowerby's beaked whales). In general, beaked whales are broadly distributed in waters over the lower slope and abyssal areas, with a bottom depth greater than 1,000 m in the oceanic northern Gulf (Davis et al., 1998; Davis et al., 2000). The Cuvier's beaked whale is probably the most common beaked whale in the Gulf (Jefferson and Schiro, 1997).

Delphinids

Bottlenose dolphins are the most common delphinid in the nearshore waters and outer edge of the continental shelf in the Gulf. There appear to be two ecotypes of bottlenose dolphins, a coastal form and an offshore form (Hersh and Duffield, 1990; Mead and Potter, 1990). The coastal or inshore stock(s) is genetically isolated from the offshore stock (Curry and Smith, 1997). Genetic data also support the concept of relatively discrete bay, sound, and estuary stocks (Waring et al., 1999). Bottlenose dolphins appear to have 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).

The Atlantic spotted dolphin is the only species, other than the bottlenose dolphin, that commonly occurs over the continental shelf in the Gulf (Mullin et al., 1991 and 1994a; Davis et al., 1998; Davis et al., 2000). This species typically inhabits shallow waters on the continental shelf within the 250-m isobath (Mullin et al., 1994a; Davis et al., 1998; Davis et al., 2000). This species appears to prefer shallow water with a gently sloping bottom typical of the Gulf of Mexico continental shelf, although it may also occur along the shelf break and upper continental slope (Davis et al., 1998).

Risso's dolphins in the northern Gulf have been frequently sighted along the shelf edge, along the upper slope, and most commonly, over or near the 200-m water depth contour just south of the Mississippi River in recent years (Würsig et al., 2000). A strong correlation between Risso's dolphin distribution and the steeper portions of the upper continental slope, which is most likely the result of cephalopod distribution along the continental slope (Baumgartner, 1997; Davis et al., 2000). Risso's dolphins have been sighted on the continental shelf at water depths less than 200 m (Mullin et al., 1994a; Davis et al., 1998).

GulfCet surveys have made many sightings of melon-headed whales, suggesting that this species is a regular inhabitant of the Gulf of Mexico (e.g., Mullin et al., 1994b). Most melon-headed whale sightings have been in deep waters, well beyond the edge of the continental shelf (Mullin et al., 1994b; Davis and Fargion, 1996). Melon-headed whales have been sighted almost exclusively west of the Mississippi River (Mullin and Hansen, 1999).

Pygmy killer whales do not appear to be common in the Gulf; most records are of strandings (Jefferson and Schiro, 1997). Pygmy killer whales in the Gulf are generally found in water depths of 500-1,000 m (Davis and Fargion, 1996).

Most killer whale sightings in the northern Gulf 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 are found almost exclusively in a broad area of the north-central Gulf (Mullin and Hansen, 1999). 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 more than 1,100 km) (O'Sullivan and Mullin, 1997).

The pantropical spotted dolphin is the most common cetacean in the oceanic northern Gulf (Mullin et al., 1994a; Davis and Fargion, 1996; Davis et al., 2000). Pantropical spotted dolphins are typically found in waters deeper than 1,200 m (Mullin et al., 1994a; Davis et al., 1998), over the lower slope, and in abyssal areas (Davis et al., 2000), but also have been sighted on the continental shelf (Mullin et al., 1994a).

The Clymene dolphin represents a significant component of the northern Gulf of Mexico cetacean population (Mullin et al., 1994c; Davis et al., 2000). Clymene dolphins are found widely distributed in the western and the northeastern Gulf slope waters (Davis et al., 2000). Clymene dolphins have been sighted in water depths of 612-1,979 m (Davis et al., 1998).

Striped dolphin sightings in the Gulf occur primarily over the deeper waters off the continental shelf, with a bottom depth ranging from 570 to 1,997 m (Davis et al., 1998).

Spinner dolphin sightings in the northern Gulf occur primarily over the deeper waters off the continental shelf with a bottom depth range of 526 to 1,776 m (Davis et al., 1998). Although sample sizes are small, most spinner dolphin sightings are east of the Mississippi River (Mullin and Hansen, 1999).

Rough-toothed dolphin sightings in the Gulf occur primarily over the deeper waters (950-1,100 m) off the continental shelf (Mullin et al., 1994a; Davis et al., 1998). Most of the rough-toothed dolphin sightings have been west of the Mississippi River (Mullin and Hansen, 1999).

Fraser's dolphin sightings in the northwestern part of the Gulf were in waters around 1,000 m deep (Davis and Fargion, 1996).

Short-finned pilot whales have been sighted almost exclusively west of the Mississippi River (Mullin and Hansen, 1999). There was one sighting of short-finned pilot whales in the EPA slope during GulfCet II, in the extreme western part of the study area (Davis et al., 2000). Short-finned pilot whales occur in the deeper slope waters with a mean bottom depth of 863 m (Davis et al., 1998).

Most false killer whale sightings in the Gulf have been made in oceanic waters greater than 200 m deep, although there have been sightings from over the continental shelf (Davis and Fargion, 1996). Although sample sizes are small, most false killer whale sightings have been east of the Mississippi River (Mullin and Hansen, 1999).

(b) Endangered and Threatened Species

Baleen Whales

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).

Records of the blue whale in the Gulf consist of two strandings on the Texas coast. 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).

For fin whales, 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 should be considered most likely to be of accidental occurrence in the Gulf (Jefferson and Schiro, 1997).

There have been occasional reports of humpback whales in the northern Gulf. 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).

Sperm Whale

The sperm whale is the most abundant large cetacean in the Gulf of Mexico; it has been sighted on most surveys conducted in deeper waters (Fritts et al., 1983a; Mullin et al., 1991; Davis and Fargion, 1996). Sperm whales are found primarily in deep waters beyond the edge of the continental shelf, frequently along the lower slope (1,000-2,000 m water depth), although there are a few records from over the shelf (Collum and Fritts, 1985; Mullin et al., 1994; Jefferson and Schiro, 1997). Sperm whales in the Gulf occur in waters with a mean bottom depth of 1,105 m (Davis et al., 1998). Mesoscale patterns in the biological and physical environment are important in regulating sperm whale habitat usage (Griffin, 1999). The GulfCet II study found that most sperm whales were concentrated along the slope in or near cyclones (Davis et al., 2000). Congregations of sperm whales are commonly seen off the shelf edge in the vicinity of the Mississippi River Delta (Mullin et al., 1994a; Davis and Fargion, 1996; Davis et al., 2000). Low-salinity, nutrient-rich water from the Mississippi River, which may contribute to enhanced primary and secondary productivity in the north-central Gulf, may explain the year-round presence of sperm whales south of the delta. It is likely that there is a resident population of sperm whales in the Gulf (Jefferson and Schiro, 1997), consisting of females, calves, and immature whales (Davis and Fargion, 1996; Weller et al., in press).

Manatee

Manatees are infrequently found (strandings and sightings) as far west as Louisiana and Texas (Powell and Rathbun, 1984; Rathbun et al., 1990; Schiro et al., 1998). Two subspecies of the West Indian manatee are recognized: the Florida manatee and the Antillean manatee (Domning and Hayek, 1986). 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). The manatees occasionally appearing in south Texas waters might be strays from Mexico rather than Florida (Powell and Rathbun, 1984). Manatees primarily use open coast (shallow nearshore) areas, and estuaries, and are also found far up rivers and streams. 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.

(2) Potential Impacts on Marine Mammals

A description of the oil spill associated with a hypothetical blowout from a proposed Brutus well, which is analyzed for potential impacts to resources in this SEA, is provided in Section 1.C. and Section 5 of this Appendix. Petroleum has 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, direct ingestion of petroleum and/or tar, and temporary displacement from preferred habitats or migration routes. Petroleum could affect marine mammals through various pathways: surface contact, inhalation, ingestion, and baleen fouling (Geraci, 1990). Direct contact with petroleum 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 petroleum and/or tar. The cetacean epidermis functions as an effective barrier to noxious substances found in petroleum. Fresh crude petroleum 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).

Evidence gathered from the studies of the *Exxon Valdez* spill indicates that petroleum spills have the potential to cause chronic (sublethal petroleum-related injuries) and acute (spill-related deaths) effects on marine mammals. Some short-term (0-1 month) effects of petroleum may be (a) changes in cetacean distribution associated with avoidance of aromatic hydrocarbons and surface hydrocarbons, changes in prey distribution, and human disturbance; (b) increased mortality rates from ingestion or inhalation of petroleum; (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 petroleum 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 petroleum; (c) decreased reproductive rate; and (d) increased rate of disease or neurological problems from exposure to hydrocarbons (Harvey and Dahlheim, 1994).

Reactions of free-ranging cetaceans to spilled hydrocarbons appears varied, ranging from avoidance to apparent indifference. In contrast to captive studies, bottlenose dolphins during the *Mega Borg* spill did not consistently avoid entering slick petroleum, which could increase their vulnerability to potentially harmful exposure to petroleum chemicals (Smultea and Würsig, 1995).

Spilled petroleum can also lead to the reduction or contamination of prey. Feeding strategies of cetaceans could lead to ingestion of petroleum-contaminated food or incidental ingestion of floating or submerged petroleum or tar. In general, the potential for ingesting petroleum-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.

As noted by St. Aubin and Lounsbury (1990), there has been no experimental study and only a handful of observations suggesting that petroleum has harmed any sirenian. There are four types of impacts to sirenians potentially caused by contact with hydrocarbons, including asphyxiation due to inhaled petroleum, acute poisoning due to contact with fresh petroleum, 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 hydrocarbons (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 manatees secretory activity of their unique gastric glands or harm intestinal flora vital to digestion (Geraci and St. Aubin, 1980). Petroleum 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 hydrocarbons (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 petroleum might affect the quality or availability of aquatic vegetation, including seagrasses, upon which manatees feed.

Indirect consequences of petroleum pollution on marine mammals are those effects that may be associated with changes in the availability or suitability of various foods. No long-term, effects from bioaccumulation of hydrocarbons have been demonstrated; however, a petroleum spill may physiologically stress an animal (Geraci and St. Aubin, 1980), making them more vulnerable to disease, parasitism, environmental contaminants, and/or predation.

Spill Response

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. Spill response activities include the application of dispersant chemicals to the affected area, which is designed to break up petroleum on the water's surface into minute droplets and then break down in seawater. Virtually nothing is known about the effects of petroleum dispersants on cetaceans, except that removal of the petroleum 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 hydrocarbon dispersant chemicals is considered to be low when compared to the constituents and fractions of crude petroleum and refined products, and studies have shown that the rate of biodegradation of dispersed hydrocarbons is equal to or greater than that of undispersed hydrocarbons (Wells, 1989).

c. Sea Turtles

(1) Description of 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.

The green turtle (*Chelonia mydas*) reaches 100 cm in carapace length and 150 kg in weight (USDOC, NMFS, 1990a). Reports of nesting in the northern Gulf are isolated and infrequent. Green turtles primarily occur in coastal waters, where they forage on seagrasses, algae, and associated organisms (Carr and Caldwell, 1956; Hendrickson, 1980). Green turtles in the Western Gulf are primarily restricted to the lower Texas coast where seagrass meadows and algae-laden jetties provide them developmental habitat, especially during warmer months (Landry and Costa, 1999).

The leatherback (*Dermochelys coriacea*) has an average adult curved carapace length of 155 cm with adult weight ranging from 200 to 700 kg (USDOC, NMFS, 1992). The only site in the continental United States where the leatherback regularly nests is the east coast of Florida (Meylan et al., 1995). This species is 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., 1996; Hughes et al., 1998). The leatherback's distribution is not entirely oceanic. It is commonly found in relatively shallow continental shelf waters in the northern Gulf of Mexico (Leary, 1957; Fritts et al., 1983b; Lohoefener et al. 1988, 1990; Collard, 1990; Davis et al., 2000). Based on a summary of several studies, Davis and Fargion (1996) concluded that primary habitat of the leatherback in the northwestern Gulf is oceanic (>200 m). Sighting locations are most probably correlated with oceanographic conditions and resulting concentrations of prey.

The nesting female hawksbill (*Eretmochelys imbricata*) averages about 87 cm in curved carapace length and can weigh up to 80 kg (USDOC, NMFS, 1993). The hawksbill is the least commonly reported sea turtle in the Gulf (Hildebrand, 1982). Texas and Florida are the only Gulf states where hawksbills are sighted with any regularity (USDOC, NMFS, 1993).

The Kemp's ridley (*Lepidochelys kempi*) adult weight is generally less than 45 kg and the straight carapace length is around 65 cm (USDOI, FWS and USDOC, NMFS, 1992). The Kemp's ridley sea turtle is the most imperiled of the world's sea turtles. In the Gulf, Kemp's ridleys inhabit nearshore areas, being most abundant in coastal waters from Texas to west Florida (Ogren, 1989; Marquez, 1990 and 1994; Rudloe et al., 1991). Kemp's ridleys display strong seasonal fidelity to tidal passes and adjacent beachfront environs of the northern Gulf

(Landry and Costa, 1999). There is little prolonged utilization of offshore habitats by this species. The adults of Kemp's ridley turtle usually occur only in the Gulf, but juveniles and immature individuals ranged between tropical and temperate coastal areas of the northwestern Atlantic (Marquez, 1990). Eggs are laid annually, primarily in Rancho Nuevo, Tamaulipas, Mexico (USDOI, FWS and USDOC, NMFS, 1992). Nesting in the U.S. occurs infrequently on Padre and Mustang Islands in south Texas from May to August (e.g., Shaver and Caillouet, 1998). With growth, the Kemp's ridley hatchlings can move voluntarily to shallow coastal waters, especially off western Louisiana and eastern Texas and off northwestern Florida, where benthic feeding occurs. The north and northeast portions of the Gulf are considered foraging habitat for juveniles, subadults, and post-nesting females (Ogren, 1989; Rudloe et al., 1991). The Kemp's ridley on the upper Texas and Louisiana coasts inhabits sandy and muddy bottoms, feeding on portunids and other crabs (Ogren, 1989; Shaver, 1991), and possibly on shrimp fishery bycatch (Landry and Costa, 1999).

The adult southeastern U.S. loggerhead sea turtle (*Caretta caretta*) has a mean straight carapace length of approximately 92 cm; the corresponding mean body mass is approximately 113 kg (USDOC, NMFS, 1990b). The loggerhead is probably the most common sea turtle species in the northern Gulf (e.g., Fritts et al., 1983b; Rosman et al., 1987; Lohoefener et al., 1990). Loggerhead nesting has been reported on Gulf Shores and Dauphin Island, Alabama; Petit Bois, Horn, and East Ship Islands, offshore Mississippi; and the Chandeleur Islands, Louisiana (Fuller et al., 1987; Lohoefener et al., 1990; Patrick, personal communication, 1997). Loggerhead nesting was reported at Biloxi, Mississippi, in 1991 (South and Tucker, personal communication, 1991). It is unknown whether the nesting sea turtles in Alabama, Mississippi, and Louisiana are genetically distinct subpopulations or are genetically similar to the Florida Panhandle Subpopulation (Bowen et al., 1993). Nesting in Texas occurs primarily on North and South Padre Islands, although occurrences are recorded throughout coastal Texas (Hildebrand, 1982). The banks off the central Louisiana coast and near the Mississippi Delta are important feeding areas (Hildebrand, 1982). In the Central Gulf, loggerheads are very abundant just offshore Breton and Chandeleur Islands (Lohoefener et al., 1990). 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 largely distributed in water depths less than 100 m (Shoop et al., 1981; Fritts et al., 1983b). Loggerheads were sighted throughout the northern Gulf continental shelf, near the 100-m isobath (>100 m) during GulfCet aerial surveys (Davis et al., 2000). Loggerheads were also sighted over very deep waters (>1,000 m). Loggerhead distribution is not as near-shore dependent as that of Kemp's ridley and green sea turtles (Landry and Costa, 1999).

(2) Potential Impacts on Sea Turtles

A description of the oil spill associated with a hypothetical blowout from a proposed Brutus well, which is analyzed for potential impacts to resources in this SEA, is provided in Section 1.C. and Section 5 of this Appendix. If an oil spill would occur, the severity of effects and the extent of damage to sea turtles would be characterized by geographic location, oil type, oil dosage, impact area, oceanographic conditions, meteorological conditions, and season. 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. Experiments on the physiologic and clinicopathologic effects of oil have shown that major body systems in sea turtles are 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; 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. 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). Oil might have a more indirect effect on the behavior of marine turtles. Reproductive success could be affected.

Although 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 petroleum as mandated by OPA 90. 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.

d. Fish Resources

(1) Description of 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 especially between the inshore and offshore waters. Characteristic fish resources are associated with the various environments and are not randomly distributed. High densities of fish resources are associated with particular habitat types. Approximately 46 percent of the southeastern United States wetlands and estuaries important to fish resources are located within the Gulf of Mexico (Mager and Ruebsamen, 1988). Consequently, estuary-dependent species of finfish and shellfish dominate the fisheries. Nearly all species significantly contributing to the Gulf of Mexico's commercial catches are estuarine dependent. Even the offshore demersal species are indirectly related to the estuaries because they influence the productivity and food availability on the continental shelf (Darnell and Soniat, 1979; Darnell, 1988).

The Gulf of Mexico provides more than 36 percent of the commercial fish landings in the continental United States and yielded the Nation's second largest regional commercial fishery by both weight and value in 1998 (total for all species: 1,578 million pounds and 784 million dollars). Commercially important species include the estuary-related species such as menhaden, shrimps, oyster, crabs, and sciaenids (drums). 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, 1997). Menhaden was the most valuable finfish species landed in 1998 with a total value of 56.9 million dollars.

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. Coastal pelagics would include mackerels, cobia, bluefish, amberjack, and dolphin. These species move seasonally. Deep waters of the Gulf of Mexico appear to be a significant spawning area for other commercially important pelagic species such as tuna and swordfish. Information on fish larvae from deepwater areas of the Gulf of Mexico is limited.

Additional information on individual species of finfish and shellfish and their life histories can be found in Section III.B.7 and III.C.2 of the Final EIS for Gulf of Mexico OCS Oil and Gas Lease Sales 169, 172, 175, 178, and 182 (USDOI, MMS, 1997).

(2) Potential Impacts on Fisheries

A description of the oil spill associated with a hypothetical blowout from a proposed Brutus well, which is analyzed for potential impacts to resources in this SEA, is provided in Section 1.C. and Section 5 of this Appendix.

Based on the last available OSRA model runs (Price et al., 1999), should an oil spill occur in the lease block associated with the proposed action (Green Canyon Area, Block 158 located in Central Planning Area Oil Spill Launch Area C44), there would be a 7 percent chance that a spill would impact the Central Gulf menhaden spawning grounds off the coast of Louisiana within 30 days.

There is no available modeling information on the resulting size and distribution of a surface oil spill with the volumes considered here. There is also no available information enabling the assessment of the potential fate of oil originating from the bottom in deep water, and this aspect is not addressed. The geographic range of a surface spill effect depends on the mobility of the resource (fish), the characteristics of the pollutant, and the tolerance of the resource to the pollutant in question (in this case hydrocarbons).

Adults

Regardless of spill size, adult fish are likely to actively avoid an oil spill, thereby limiting the effects and lessening the extent of damage (Baker et al., 1991; Malins et al., 1982). This behavior explains why there has never been a commercially important fish-kill on record following an oil spill. Observations at oil spills around the world, including the *Exxon Valdez* spill in Prince William Sound consistently indicate that free-swimming fish are rarely at risk from oil spills (NRC, 1985). The maximum observed concentration of crude oil 2 m below the slick from the Ixtoc I blowout was 10.5 ppm at a depth of 2 m (6.6 ft) below the sea surface (McAuliffe, 1987). Some recent work has demonstrated avoidance of extremely small concentrations hydrocarbons. Farr et al. (1995) reported the behavioral avoidance of dissolved concentrations of a PAH as low as 14.7μg/l by a species of minnow. In laboratory tests, the range of concentrations of crude oil or phenol causing sublethal injury to species of bivalves, polychaetes, and fish that live in the bays was 100 ppb to 100 ppm. (Capuzzo, 1987).

Adult fish must experience continual exposure to relatively high levels of hydrocarbons over several months before secondary toxicological compounds that represent biological harm are detected in the liver (Payne et al., 1988). The direct effects of spilled oil on fish occur through the ingestion of oil or oiled prey and through the uptake of dissolved petroleum products through the gills and epithelium by adults and juveniles (NRC, 1985). Upon exposure to spilled oil, liver enzymes of fish oxidize soluble hydrocarbons into compounds that are easily excreted in the urine (Spies *et al.*, 1982). Ordinary environmental stresses may increase the sensitivity of fish to oil toxicity. These stresses may include changes in salinity, temperature, and food abundance

(Evans and Rice, 1974; NRC, 1985). Migratory species, such as mackerel, cobia, and crevalle jack, could be impacted if oil spills covered large areas of nearshore open waters.

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

Eggs and Larvae

For OCS-related oil spills to have substantial effect on a commercial fishery resource, whether estuary dependent or not, eggs and larvae would have to be concentrated in the immediate spill area. This area could be very large considering the maximum blowout discharge volume. Oil components also would have to be present in highly toxic concentrations when both eggs and larvae are in the pelagic stage (Longwell, 1977). When contacted by spilled oil, floating eggs and larvae (with their limited mobility and physiology), and most juvenile fish are killed (Linden *et al.*, 1979; Longwell, 1977). However, fish over-produce eggs on an enormous scale and the overwhelming majority of them die at an early stage, generally as food for predators. It is likely that even a heavy death toll from a single large oil spill would not have a detectable effect on the adult populations, 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).

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

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

Impacts

A spill that could occur as a result of the blowout scenario described has the potential to affect commercial fishing in the Gulf. If spills were to occur, the effects on adult finfish or shellfish would likely be nonfatal and the extent of damage would be reduced due to the capability of adult fish and shellfish to avoid a spill. Commercial fishermen will actively avoid the area of a spill and the area where there are ongoing activities to control a blowout. Even if fish resources successfully avoid spills, tainting (oily-tasting fish), public perception of tainting, or the potential of tainting commercial catches from oil or dispersants will prevent fishermen (either voluntarily or imposed by regulation) from initiating activities in the spill area. This in turn could decrease landings and/or the value of catch for several months. However, Gulf of Mexico species can be found in many adjacent locations. Gulf commercial fishermen do not fish in one locale and have responded to past petroleum spills without discernible loss of catch or income by moving elsewhere for a few months.

Conclusions

There is no evidence at this time that commercial fisheries in the Gulf have been adversely affected on a regional population level by oil spills. However, a catastrophic blowout scenario could introduce substantial amounts of oil to surface waters over an extended period of time. Adult fish would likely avoid the area of a spill, but fish eggs and larvae within a potentially large area of the northern Gulf of Mexico would be killed. The greatest potential for impact would occur when oil contacted nearshore waters and estuarine environments. This area of impacted coastline could extend for hundreds of miles. If the blowout scenario analyzed did occur, impacts on fisheries within the area would have little effect on offshore fish resources.

e. Coastal Barrier Beaches and Associated Dunes

(1) Description of Coastal Barrier Beaches and Associated Dunes

Coastal barriers of the Central Planning Area of the Gulf of Mexico consist of relatively low landmasses 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 dome 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. For additional information, see page III-19 of Section III.B.1.a. of the Final EIS for Lease Sales 169, 172, 175, 178, and 182 (USDOI, MMS, 1997).

(2) Potential Impacts on Coastal Barrier Beaches and Associated Dunes

A description of the oil spill associated with a hypothetical blowout from a proposed Brutus well, which is analyzed for potential impacts to resources in this SEA, is provided in Section 1.C. and Section 5 of this Appendix.

The information below regarding potential impacts of oil spills on coastal barrier beaches and associated dunes and wetlands are based on analyses in the Final EIS for Lease Sales 169, 172, 175, 178, and 182 (USDOI, MMS, 1997).

Cleanup operations associated with large oil spills can affect the stability of barrier beaches more than the spill itself. If large quantities of sand were removed during spill cleanup operations, a new beach profile and sand configuration could 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 such as that found along the Louisiana coast. The State governments around the Gulf have recognized 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. 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. For tides to carry oil from a spill across and over the dunes, strong southerly winds would have to persist for an extended time prior to or immediately after the spill. Strong winds required to produce the high tides would also accelerate oil slick dispersal, spreading, and weathering, thereby reducing impact severity at the landfall site. Severe adverse impacts to dunes contacted by a spill is very unlikely, even during abnormally high water levels. In addition, a study in Texas showed that oil disposal on sand, and vegetated sand dunes had no deleterious effects on the existing vegetation or on the recolonization of the oiled sand by plants (Webb, 1988).

In conclusion, the proposed action is not projected to adversely alter barrier beach or dune configurations significantly as a result of related oil spills. Although the probability of an oil spill due to a blowout from the proposed action is very low based on historical records (0.07%), adverse impacts to coastal barrier beaches and associated dunes could result if a spill occurs. Due to the limitations of the oil-spill modeling efforts conducted for the spill from a hypothetical blowout from the proposed action, it is not possible to estimate the quantity of spilled oil that could potentially contact the barrier beaches and associated dunes. Therefore, calculating potential impacts to these features is not possible.

f. Wetlands

(1) Description of Wetlands

According to the U.S. Dept. of the Interior (Hefner et al., 1994), during the mid-1980's, 8 percent of Alabama (2,651,000 ac), 28 percent of Louisiana (8,784,000 ac), and 14 percent of Mississippi (4,365 ac) were considered wetlands. During the following 10 years, these three states' wetland areas decreased by 1.6, 5.6, and 4.6 percent, respectively. For additional information, see page III-21, Section III.B.1.b. of the Final EIS for Lease Sales 169, 172, 175, 178, and 182 (USDOI, MMS, 1997).

(2) Potential Impacts on Wetlands

A description of the oil spill associated with a hypothetical blowout from a proposed Brutus well, which is analyzed for potential impacts to resources in this SEA, is provided in Section 1.C. and Section 5 of this Appendix.

The information below regarding potential impacts of oil spills on wetlands are based on analyses in the Final Environmental Impact Statement for Gulf of Mexico OCS Oil and Gas Lease Sales 169, 172, 175, 178, and 182 (USDOI, MMS, 1997).

Various types of wetlands are scattered throughout the Louisiana coastal zone. Numerous investigators have studied the impacts of oil spills on wetland habitats in the Gulf area. Often, seemingly contradictory conclusions are generated from these impact assessments. Contradictions can be explained by differences in oil concentrations contacting vegetation, kinds of oil spilled, types of vegetation affected, season of year, pre-existing stress levels of the vegetation, soil types, and numerous other factors. In overview, the data suggest that light-oiling impacts cause plant dieback with recovery within two growing seasons without artificial replanting. Such 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).

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. 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 dieback 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 10 percent of the affected wetland area will be expected as a result of accelerated land loss 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).

Based on these studies, the following model was developed and was used to quantify impacts in the lease sale EIS cited above. For every 50 bbl of spilled oil that contacts wetlands, approximately 2.7 ha of wetland vegetation would experience dieback. 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 would be converted permanently to open-water habitat.

In conclusion, the proposed action is not projected to adversely alter wetlands significantly as a result of related oil spills. Although the probability of an oil spill due to a blowout from the proposed action is very low based on historical records (0.07%), adverse impacts to wetlands could result if a spill occurs. Due to the limitations of the oil-spill modeling efforts conducted, for the spill associated with a hypothetical blowout from the proposed action, it is not possible to estimate the quantity of spilled oil that could potentially contact wetlands. Therefore, calculating potential impacts to wetlands is not possible. However, if such a blowout occurs, and oceanographic and meteorological conditions are such that a large amount of oil contacts wetlands, severe adverse impacts could occur due to dieback and conversion to open water.

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