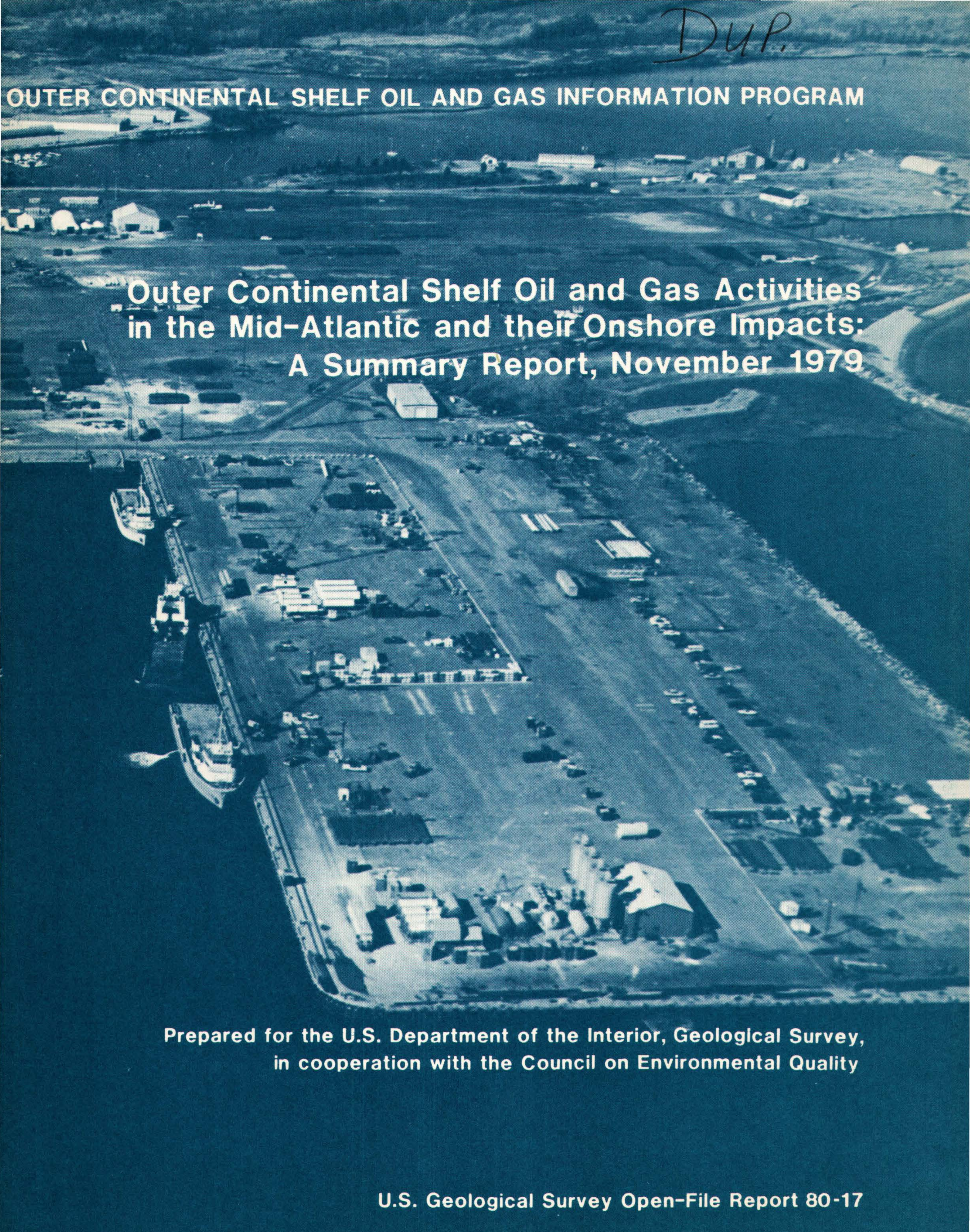

OUTER CONTINENTAL SHELF OIL AND GAS INFORMATION PROGRAM

# Outer Continental Shelf Oil and Gas Activities in the Mid-Atlantic and their Onshore Impacts: A Summary Report, November 1979

Prepared for the U.S. Department of the Interior, Geological Survey, in cooperation with the Council on Environmental Quality

U.S. Geological Survey Open-File Report 80-17

Cover illustration.--OCS support base at Davisville, Rhode Island. Photo by Chester Browning, Rhode Island Department of Economic Development.

# Outer Continental Shelf Oil and Gas Activities in the Mid-Atlantic and their Onshore Impacts: A Summary Report, November 1979

By George S. Macpherson and Charles A. Bookman

Prepared for the U.S. Department of the Interior, Geological Survey,
in cooperation with the Council on Environmental Quality,
under Contract No. EQ9AC006, by

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Copies of this Summary Report are available from:

Chief, RALI Program
U.S. Geological Survey
750 National Center
Reston, VA 22092.

For specific questions regarding the Summary Report, contact:

Mr. David A. Nystrom
Manager, OCS Oil and Gas Information Program
U.S. Geological Survey
750 National Center
Reston, VA 22092
(703) 860-7166.

**To receive Mid-Atlantic Summary Report updates, see the post card attached to the back cover.**

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At Rogers & Golden, Fritts Golden provided overall project management. Sandy Dechert designed and edited the report and supervised its production. Janis Bernstein did research and data analysis. Valerie Smith and Melanie Lundberg provided technical support.

## ABSTRACT

Outer continental shelf (OCS) activity in the Mid-Atlantic Region to date has been limited to exploratory drilling. The first rig began drilling in March 1978. More rigs quickly moved into the Region, and as many as nine were working at the same time for a brief period in January 1979. As of November 1979, nineteen exploratory wells and two stratigraphic test wells had been drilled by the oil companies. One of these test wells and three exploratory wells have had shows of natural gas, but none of the oil companies has yet announced that it has found enough gas to go forward with plans for production. Because of the somewhat disappointing results so far, exploratory drilling has declined. Only one company is currently operating a rig, and one other company has announced plans to begin drilling this winter.

The most recent risked estimates by the U.S. Geological Survey of undiscovered, economically recoverable oil and gas resources in the Mid-Atlantic tracts currently under lease are 8 million barrels of oil and 860 billion cubic feet of natural gas. The resource estimate for oil does not represent a commercially producible quantity. On the basis of the geologic information gained from wells completed to date and the huge capital costs of building a pipeline to bring the gas ashore, the natural gas estimate for currently leased tracts in the Mid-Atlantic Region appears to be short of a commercially producible amount.

To date, onshore impacts resulting from OCS exploration consist of two support bases: a helicopter base in Atlantic City, New Jersey, from which crews are flown out to the drilling rigs; and a support base in Davisville, Rhode Island, from which equipment and supplies are ferried out to the rigs by boat. It is expected that exploratory activity will remain close to present levels for at least the next six months; consequently, support activity at Davisville and Atlantic City for Mid-Atlantic OCS operations during the same period is expected to correspond to current levels.

## CONTENTS

## ILLUSTRATIONS



## TABLES

# INTRODUCTION

The United States is currently engaged in an effort to develop the oil and gas resources of the Outer Continental Shelf (OCS). The offshore activity must be supplied and supported from land, and the onshore activities required may have significant effects on the communities in which they occur. For example, oil and gas production might involve the expansion of existing transportation facilities and construction of new ones, and it might trigger an influx of workers and change employment patterns. These effects, in turn, could influence regional income, demand on public services, tax revenues, and air and water quality.

The need for planning to accommodate the onshore impacts of offshore oil and gas development has long been recognized. State and local governments need current information about offshore resources and related onshore activity to make these plans. The Outer Continental Shelf Lands Act Amendments of 1978 (Public Law 95-372) created an Outer Continental Shelf Oil and Gas Information Program (OCSIP). Under this program, the Director of the U.S. Geological Survey (USGS), in conjunction with the Director of the Bureau of Land Management (BLM), has prepared indices of information used by the Federal Government in its OCS decisionmaking process. The Atlantic, Gulf of Mexico, Pacific, and Alaska Indices have already been made available to the public. The Information Program also requires the Director of the USGS to make available to affected States a Summary Report of data and information designed to assist them in planning for the onshore impacts of potential OCS oil and gas development and production. The Mid-Atlantic Summary Report is the first in a series of regional Summary Reports. Others are currently under way for the South Atlantic, the Pacific (California), the Gulf of Mexico, and the Gulf of Alaska (including Lower Cook Inlet). Authorities and operating procedures for the OCSIP are detailed in the Federal Register of August 7, 1979 (30 CFR 252).

Each of the Summary Reports begins by presenting the most recent OCS oil and gas resource and reserve estimates. The magnitude and timing of OCS activity are discussed in chapter 2 of the report. The third chapter presents information on oil and gas transportation strategies, including those that are developed as part of the BLM's ongoing Intergovernmental Planning Program. Chapter 4 describes the nearshore and onshore activities that are occurring and/or probably will occur as a result of current and projected offshore activity.

The Summary Reports are designed to complement the environmental impact statement (EIS) process. Both attempt to predict the effects of future actions. However, they have substantially different perspectives. The purpose of a lease sale EIS is to ensure that a wide range of environmental factors are considered at an early stage of the planning process. In areas where no drilling or little drilling has taken place, it is difficult for EIS's to analyze long-range planning alternatives because very little is known about the hydrocarbon potential. Summary Reports, normally prepared after lease sale EIS's, have a much shorter planning horizon, describing current levels of activity and projecting activity and potential impacts for a six-month period. Another difference is that while the EIS resource and reserve estimates are based on all tracts offered for a lease sale, the Summary Report estimates have a narrower focus: they cover only tracts that have actually been leased.

Estimates presented in the Summary Reports reflect the most recent Federal Government information. Approximately every six months, a memorandum describing current levels of activity in the Region will be distributed. When events warrant, a revised Summary Report will be issued.

This is the first Summary Report describing offshore activity in the Mid-Atlantic Region, the area extending from the tip of Long Island, New York, to Cape Hatteras, North Carolina. (See figure 1, chapter 1, for a map of the Region.) The Report is based on all data collected by Federal agencies in the course of leasing and managing the Mid-Atlantic OCS; studies and reports of OCS activities that have been prepared outside the Federal Government; and conversations with Federal, State, and local government officials. Where possible, the OCSIP will consult with state agencies if additional information or clarification is requested. Recipients of this report who return the enclosed postcard will be sent updates and revisions.

Considerable effort has been devoted to defining OCS-related issues to be analyzed in the Summary Report for the Mid-Atlantic Region. Representatives of the OCSIP have discussed oil and gas activities directly with Federal officials, oil industry representatives, State and local officials, and other interested persons. In order to identify OCS-related issues and explain the Summary Report process, the OCSIP also convened a public meeting in Annapolis, Maryland, on November 20 and 21, 1978. Sixty-five persons attended the meeting. Twenty represented State and local governments. The concerns at this meeting resulted in the identification of issues to be treated in detail in this Summary Report.

A continuing concern of State and local officials is the nature and magnitude of onshore facilities that may locate in or otherwise affect their communities as a result of offshore development. The central issue is whether or not the Mid-Atlantic OCS has oil and gas in commercially attractive quantities. The Summary Report assists the States in their planning efforts by describing the activity that has occurred to date and projecting activity for the next six months.

Two lease sales have been held in the area: Sale 40, in 1976, and Sale 49, in 1979. Currently, 304,128 hectares (760,320 acres) are under lease. Exploration of the Mid-Atlantic Region by drilling has been in progress for almost two years, but no commercial discoveries have been announced: three exploratory wells and one stratigraphic test well have identified natural gas in undetermined amounts. So far, each estimate of the region's oil and gas resources has been lower than the one before. The Summary Report presents a background for discussion of this issue by explaining what resource estimates mean, how they are derived, what they can be used for, and how the process of exploring for oil and gas relates to the process of estimating resources. This explanation of the nature of resource estimates provides a basis for understanding the uncertainties of the Mid-Atlantic situation.

As exploration continues, our knowledge of the resource potential of the Mid-Atlantic will improve. In the event of a discovery of oil or gas in commercially attractive amounts, future editions of the Summary Report will include the most recent resource and reserve estimates, anticipated production curves, transportation strategies, and descriptions of nearshore and onshore support activity and production facilities.

# 1. OFFSHORE OIL AND GAS RESOURCES OF THE MID-ATLANTIC REGION

This chapter presents an overview of geological and geophysical data used to predict the presence or absence of petroleum resources in the Mid-Atlantic Region, an area defined by the Outer Continental Shelf Oil and Gas Information Program as extending from the tip of Long Island, New York, to Cape Hatteras, North Carolina. Figure 1 shows the extent of the Region. Its geological features of major interest are described in the first section of the chapter.

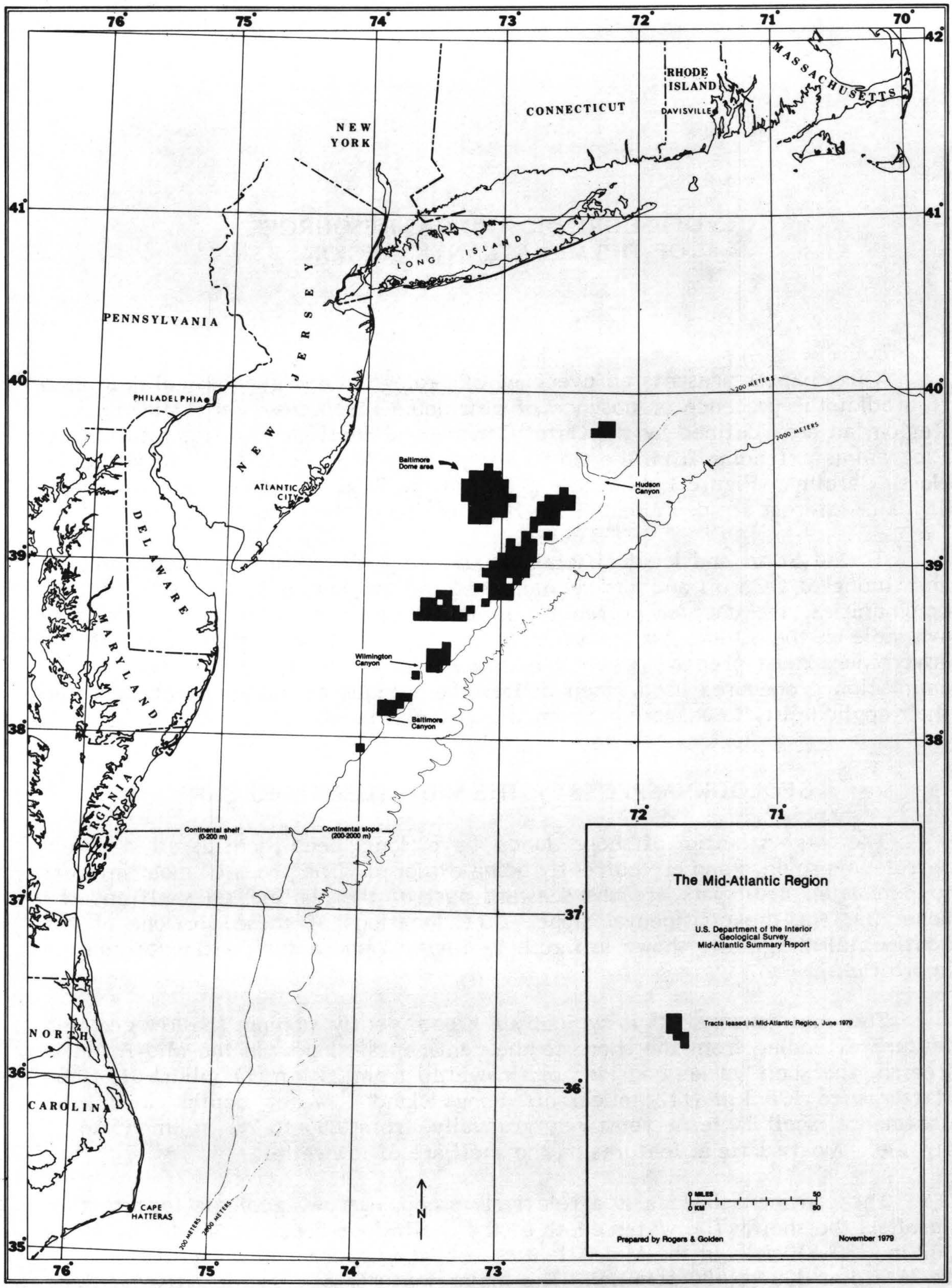
To aid State and local officials in assessing and predicting the magnitude and timing of OCS oil and gas development and the associated activity in their communities, the chapter presents a summary of the most recent information available on the oil and gas resources of the Mid-Atlantic Region. Because the government must prepare resource estimates for a variety of purposes and the estimation procedures used often differ, the various estimation processes and their applicability to onshore planning are also discussed.

## GEOLOGIC ASPECTS OF THE MID-ATLANTIC REGION

The Mid-Atlantic offshore lands have long been considered a likely petroleum province and are currently being explored. The areas of most interest to petroleum geologists are the seaward part of the continental shelf and the upper part of the continental slope. The locations of these portions of the continental margin are shown in figure 1. Figure 2 shows the continental margin in profile.

The continental shelf is typically a broad, gently sloping, shallow geologic feature extending from the shore to the continental slope. In the Mid-Atlantic Region, the shelf varies considerably in width, from 23 km (14 miles) off Cape Hatteras to 190 km (118 miles) off Long Island. Water depths above the continental shelf increase relatively gradually, from 0.95 to 2.1 m/km (5 to 11 ft/mile). Most surficial features on the shelf are of low relief.

The continental slope is a relatively steep, narrow geologic feature that parallels the shelf. The water depth at the shelf-slope break varies from 119 to 162 m (390-530 ft). In the Mid-Atlantic area, the upper slope has gradients of 19 to 76 m/km (100 to 400 ft/mile). The major features of the Mid-Atlantic slope




SOURCES: U.S. Geological Survey, 1979. Base from Bureau of Land Management.

FIGURE 1.--The Mid-Atlantic Region

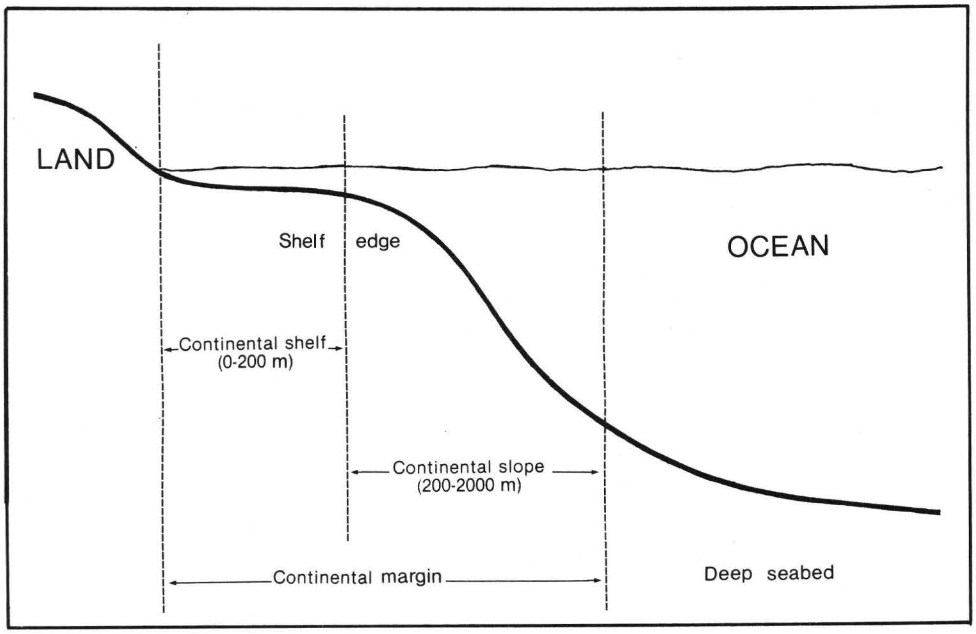



FIGURE 2.--Generalized cross section of the continental margin

are the large, deeply incised submarine canyons such as the Hudson, Baltimore, and Wilmington Canyons (see figure 1). These are extensions of cross-shelf channels.

The dominant subsurface feature of the continental margin is a deep sedimentary basin called the Baltimore Canyon Trough, which extends from Cape Hatteras northeastward approximately 500 km (300 miles) to Long Island. Its name is derived from the Baltimore Canyon, which is located near the center of the Trough.

The U. S. Geological Survey, which is responsible for estimating oil and gas resources, has found that the Baltimore Canyon Trough contains many of the specific conditions necessary for hydrocarbon accumulation. Various geological and geophysical investigations have been conducted. Extensive geophysical surveys have been made, and two continental offshore stratigraphic test (COST) wells have been drilled. The USGS also has access to privately owned information that oil companies have collected under permit from the government. Analysis of this public and proprietary information has enabled the USGS to develop a picture of the petroleum geology of the Mid-Atlantic OCS. A summary of current thinking is presented in appendix A.

The USGS's ability to provide accurate assessments depends on the quantity and quality of available scientific information about the Region and its potential resources. Although exploratory drilling has provided a better understanding of the geology of the area, it has not yet led to a proven commercial discovery. Geologists now believe that the Mid-Atlantic's greatest oil and gas potential is in deep water, to the east of the areas currently under lease for exploration and development.

Some geologic features and conditions may jeopardize offshore oil and gas exploration and development activities. High-risk conditions are classified as hazards; lower-risk conditions that can be mitigated more easily, as constraints. Not identifying, avoiding, or taking proper engineering precautions against geologic hazards could result in the failure of a structure. In areas where these conditions have been identified, special engineering procedures may be required or well locations may have to be changed. Hazards identified in the leased areas of the Mid-Atlantic Region include mass movement (slumping), shallow faults, and shallow gas deposits.

Constraints are usually considered merely developmental conditions: once they have been identified, existing standard design and engineering technology can be used to minimize their adverse effects. These second-order problems include such features and conditions as sand waves and erosion/scour, filled channels and lagoonal deposits, gassy sediments, potentially unstable slopes, and bottom objects or debris.

In preparation for OCS lease sales, the USGS conducts a detailed geophysical survey to delineate potential hazards and constraints on tracts to be leased. As a result of the USGS evaluation, the Secretary of the Interior may delete tracts from a sale or may impose stipulations on the development that can take place on a leased tract. In Mid-Atlantic Lease Sale 49, 27 tracts were deleted from the sale area because they showed evidence of mass movement of sediment. On several tracts that have shown evidence of partial slumping, the lessee is required to demonstrate that exploration and development operations can be conducted safely.

In the near future, a USGS research program will be undertaken to further describe geologic hazards on the upper continental slope. Specifically, side-scan sonar data and seismic reflection profiles will be obtained to provide information on the distribution and geometry of sediment slumping. In addition, slumps will be cored and recovered sediments will be evaluated for geotechnical and geological properties. Some in-situ geotechnical measurements of sediment strength will be obtained by means of shallow drilling. These data will provide additional information on the distribution, magnitude, geometry, and timing of major sediment slumps.

## ESTIMATING HYDROCARBON POTENTIAL

The simple question "How much oil and gas do we have?" is extremely difficult to answer. To appreciate the complexities of estimating hydrocarbon potential, one must understand the process by which petroleum resources are discovered and developed.

In estimating resources, assumptions are often made in order to account for uncertainties. For example, a resource estimate conditioned by the word **recoverable** takes into account the fact that physical and technological constraints dictate that only a portion of resources or reserves can be brought to the surface. An estimate of **economically** recoverable resources takes into account the cost of exploration and development and the market price of oil and gas. A third uncertainty stems from the probability that resources are, or are not, present in a given area. A **risked** resource estimate is one that has been modified according to the estimator's confidence in his or her estimate (i.e., "risked" to account for the probability that economically recoverable resources will actually be encountered within the area of interest).

Until a well has been drilled, investigators derive all knowledge of subsurface geology indirectly, from geological and geophysical data collected at the surface. The existence of hydrocarbons can only be confirmed by physical evidence produced by drilling. At this early stage of exploration in the Mid-Atlantic, there are no proven fields of oil or gas and it is only possible to estimate the Region's resources in terms of **undiscovered resources.** Undiscovered resources are quantities of oil and gas that have been estimated to exist outside known fields. Undiscovered resource estimates are made by identifying areas of resource potential on the basis of broad geological knowledge and theory. Using available data as a basis for further investigations, petroleum geologists then conduct a variety of geological assessments of the region. The geologists' data base may or may not include physical confirmation of the presence of resources by exploratory drilling. Although improvements in the geological and geophysical data base enable estimates to be refined, estimates of undiscovered resources are always matters of subjective, albeit expert, interpretation.

An exploratory well can provide valuable information for appraising resource potential. The porosity and permeability of rock samples extracted from the well can be analyzed in the laboratory. Any oil and/or gas found can be sampled and examined. To delineate the reservoir and determine if the accumulation is commercially attractive, a series of wells must be drilled.

After the commercial potential of a reservoir has been established, it is possible to calculate reserves. **Reserve** estimates are estimates of the portion of the identified resource that can be economically extracted. A preliminary estimate of reserves might be based on information obtained from several wells, or conceivably from a single well, and a map of the subsurface geology.

Estimates of reserves allow us to more nearly approximate the level of resource development activity that can be expected in an area than do risked estimates of economically recoverable resources. Site-specific planning for OCS development and production that a state or local government undertakes should be based on reserve estimates, if they are available. In the absence of a reserve estimate, the most appropriate figure to use is the estimate of risked, economically recoverable resources. This is a much less firm number, but it is the most useful resource estimate for generalized--as opposed to site-specific--planning because it has been modified by the likelihood of finding hydrocarbons in an area, as well as by the likelihood of any discovery being commercially attractive.

For additional information on the process of resource estimation, the reader may consult appendix B. It explains in greater detail how resource estimates are derived, what they mean, what they should be used for, and how the process of estimating resources relates to the process of exploring for oil and gas.

## RESOURCE AND RESERVE ESTIMATES

The USGS's most recent (June 1979) resource and reserve estimates for the Mid-Atlantic Region and for the offshore area currently under lease are presented in table 1. The regionwide estimates are included in order to provide a measure of the total petroleum potential of the Mid-Atlantic Region. It is important to understand that the regionwide estimates are based on interpretation of broad-scale geological data. They therefore provide only a first approximation of the total hydrocarbon potential of the Region.

TABLE 1.--Mid-Atlantic oil and gas resource and reserve estimates, June 1979

| | Oil (million barrels) | Gas (trillion cu. ft.) |
|---|---|---|
| Risked, economically recoverable resources | | |
| Mid-Atlantic Region | 530 | 4.11 |
| Mid-Atlantic leased lands (132 offshore tracts) | 8 | .86 |
| Reserves | 0 | 0 |

Source: U.S. Geological Survey, June 1979.

The estimate of resources on leased lands is based on the following information:

- the results of drilling 17 wells (15 exploratory wells and the two COST wells) plus seismic data;
- an assumption that the geologic traps that have been identified contain risked, economically recoverable quantities of hydrocarbons; and

- one gas discovery (flowing gas), one discovery of both oil and gas, and one gas show (traces) (June 1979).

This risked, economically recoverable resource estimate provides a basis for studies and preliminary planning for onshore impacts.

Reserve estimates approximate the cumulative production that can be expected from a discovery. For this reason, they provide a foundation for site-specific onshore planning. The entry for reserves is zero at this time because no discovery of oil or gas in commercially attractive amounts has yet been indicated in the Mid-Atlantic. Not all potentially attractive areas in the Mid-Atlantic have been explored; this reserve estimate only includes areas that have been leased.

The estimates provided here were formulated in June 1979. Since that time, there has been further OCS activity in the Mid-Atlantic, which is summarized in chapter 2.

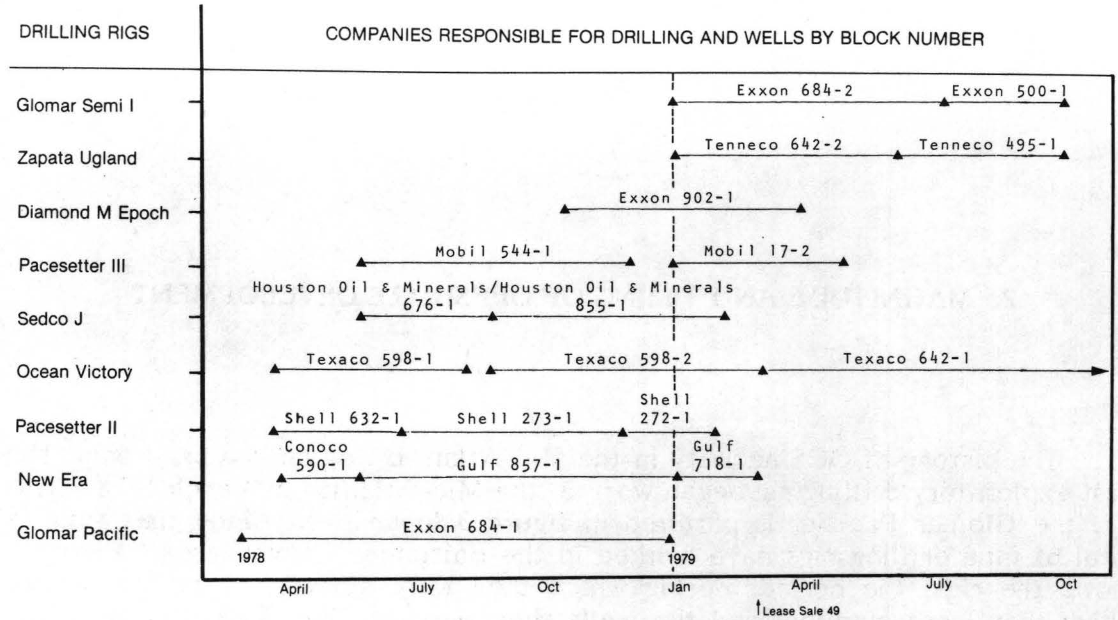
FIGURE 3.--Glomar Pacific, the first rig to drill on the Atlantic OCS

## 2. MAGNITUDE AND TIMING OF OFFSHORE DEVELOPMENT

The history of OCS activity in the Mid-Atlantic Region is a brief one. The first exploratory drilling rig began work in the Mid-Atlantic in March 1978. This rig, the Glomar Pacific, is pictured in figure 3 (opposite). Since that time, a total of nine drilling rigs have worked in the Baltimore Canyon area. Figure 4 shows the rigs, the periods during which they were active, the companies for which they were working, and the wells they were drilling, identified by block number.

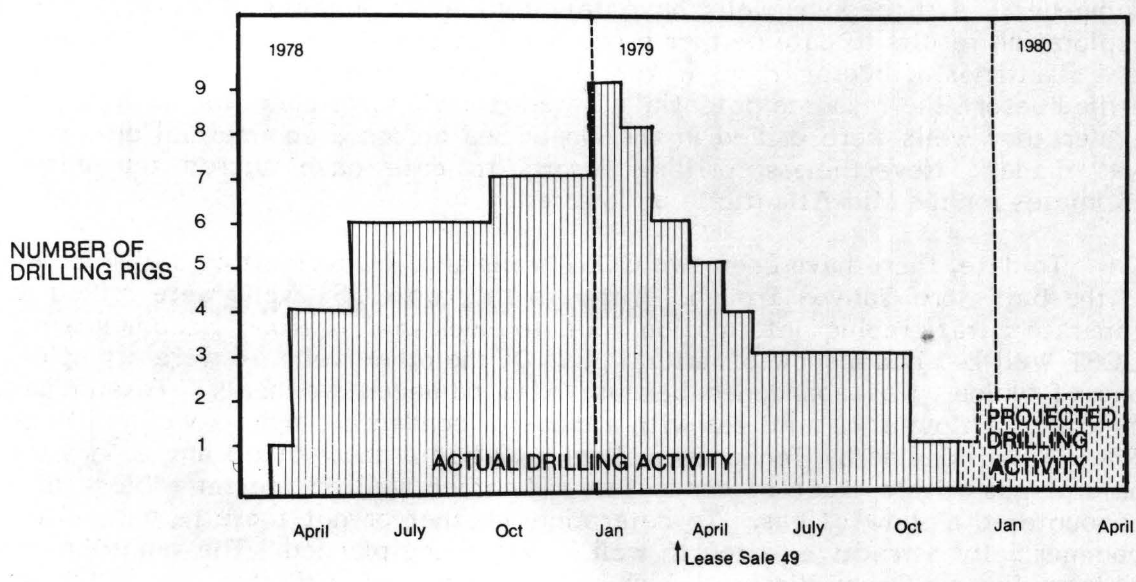
For a brief period during the winter of 1978-1979, all nine were active at the same time. From this peak, activity in the Mid-Atlantic has slowed considerably. Figure 5 shows the number of active rigs, by month, from March 1978 to the present and projects exploratory activity for the next six months on the basis of Applications for Permit to Drill (APD's). The pattern of rig activity suggests that the initial optimism of the oil companies has been somewhat dampened, as successive wells have failed to make a major discovery. The exploration results to date neither prove nor disprove the existence of commercial quantities of hydrocarbons in the Mid-Atlantic. Many wells will have to be drilled before the resource potential of the area is understood: for example, 51 exploratory wells were drilled in the North Sea before a commercial discovery was made. Nevertheless, drilling results to date have caused the initial estimates for the Mid-Atlantic to be lowered.

To date, there have been two COST wells and 19 exploratory wells drilled in the Baltimore Canyon Trough. Although the two COST wells were drilled to generate stratigraphic information, not to seek hydrocarbon accumulations, COST Well B-3 had a show of natural gas. Of the other wells, 16 were dry holes, one of which was abandoned because of a damaged wellhead. Texaco has measured a flow of natural gas with a trace of condensate from a well on Block 598. A well drilled by Tenneco on Block 642 had a show of oil and a show of natural gas with a trace of condensate. Another well on the same block also encountered a show of gas. To determine whether or not these resources are commercially attractive, a fourth well is now being planned. The semisubmersible drilling rig Ocean Victory, which has been involved in the activity on Blocks 598 and 642, is pictured in figure 6.




SOURCES: USGS, Conservation Division Atlantic area OCS well information memorandum, August 19, 1979, and weekly status reports.

FIGURE 4.--Duration of exploratory drilling in Mid-Atlantic Region to date, by rig

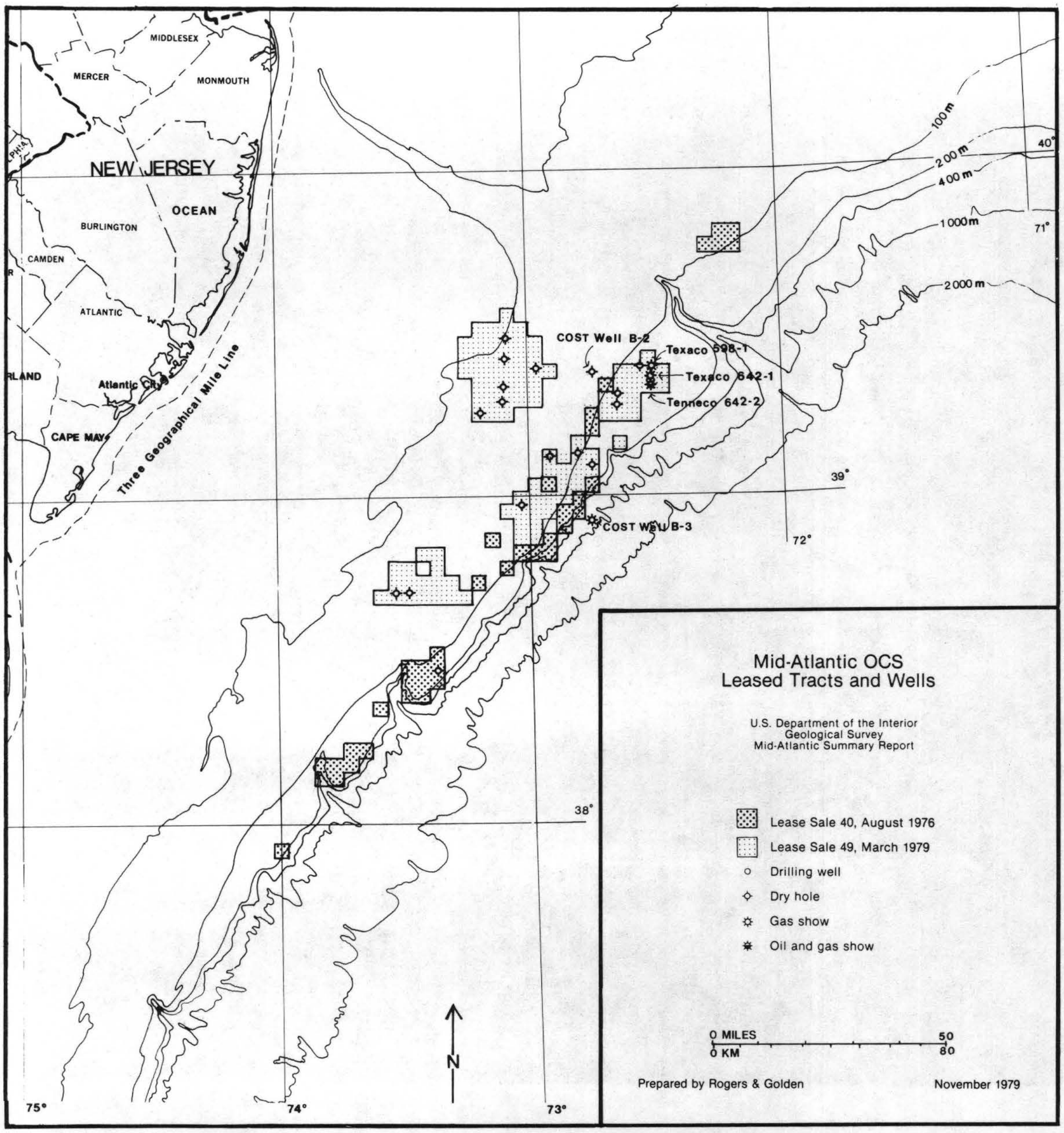



SOURCES: USGS, Conservation Division Atlantic area OCS well information memorandum, August 29, 1979, and weekly status reports.

FIGURE 5.--Number of actual and projected exploratory drilling rigs in Mid-Atlantic Region, by month, through April 1980

FIGURE 6.--Semisubmersible drilling rig Ocean Victory, which encountered shows of natural gas in the Mid-Atlantic OCS

Figure 7 shows the locations of the COST wells and exploratory wells and designates wells that were dry holes and those that had shows of gas and/or oil. So far, however, none of these tests has been sufficiently evaluated for any of the oil companies to file a Development Plan. If and when a company or companies announce that they have made a commercial discovery, and they file




SOURCE: U.S. Geological Survey, July 1979. Base from Bureau of Land Management, 1978b, scale 1:1,000,000 (approx.).

FIGURE 7.--Leased tracts and wells in Mid-Atlantic Region, November 1979

Development Plans, then revision of the reserve estimate may be appropriate. Such an announcement could come at any time. But until a discovery or discoveries are determined to be commercially attractive, it must be considered that there are no reserves of either oil or gas in the Mid-Atlantic Region.

The Environmental Impact Statement prepared for Lease Sale 49 (September 1978) projected a possible course of development for the Mid-Atlantic offshore. The EIS estimated that if hydrocarbons were found, the tracts offered for lease in Sale 49 would yield 152 million barrels of recoverable oil and 2.53 trillion cubic feet of recoverable gas. Based on this resource estimate, the environmental statement projected that oil and gas production would begin in 1987 and would continue until 2010, with peak production being reached in 1991. Peak production rates were assumed to be 42 thousand barrels per day of oil and 673 million cubic feet per day of gas. It was further assumed that the exploratory phase would require 51 wells and that 100 development wells would be drilled from four offshore platforms.

The resource estimates on which the EIS scenario for development was based are not directly comparable to the resource estimates presented in this Summary Report. First, the estimates used in this report were made more recently. They are based on much more data than was available at the time the EIS was published, including the results of drilling 17 wells on the Mid-Atlantic offshore. Second, the geographic areas covered by the EIS and this report differ. The EIS estimate covered all lands proposed for lease in Sale 49; the estimates presented in this report cover the offshore lands actually leased in Sales 40 and 49. Third, the method used for the EIS tends to produce larger estimates of resources than the process used for the Summary Report estimates. One methodological difference is that the EIS estimate does not take into account the possibility that the entire region may not contain any oil or gas.

Given the more recent resource estimates used here, it seems likely that there will be no production of oil from the tracts currently under lease. Eight million barrels of oil, if found at the water depth and distance offshore where present leases are located, is not commercially attractive. Revenues from this amount of oil would not cover the costs of transportation.

As for natural gas, the present risked, economically recoverable resource estimate of 860 billion cubic feet appears at the present time to be short of commercially producible, if it were found. It is difficult to say with a high degree of certainty whether this much natural gas would justify the cost of a pipeline, and thus be commercially attractive, because the estimate applies to all the leased tracts from both Sale 40 and Sale 49. These tracts are scattered over a broad area. If large and relatively concentrated accumulations of gas were found, they might be commercially producible. If the resources were scattered over all the tracts, they would not be.

Recently, Texaco has tested gas from wells on Blocks 598 and 642. Another delineation well is planned for Block 598. Tenneco has also tested gas on Block 642. (See figure 7.) If this area contains a commercial quantity of gas and a Development Plan is filed, a revised Summary Report will be issued.

For the present, however, there has been a marked decline in exploratory activity in the Mid-Atlantic. There are currently 34 leased tracts for which Exploration Plans have been approved, but no Applications for Permit to Drill have yet been filed for them. Texaco is the only company still drilling in the Region. One other company, Murphy Oil Corporation, has announced plans to begin new drilling this winter. Exploration is expected to continue, at present or slightly lower levels, until the next Mid-Atlantic lease sale, Sale 59, which is currently scheduled to take place in December 1981. It is expected that there will generally be no more than three rigs drilling in the Mid-Atlantic at any one time during the next two years. Difficulties encountered in drilling during the winter of 1978-1979 suggest that activity will fall off somewhat during the colder months due to icing and bad weather.

Industry's response to the Call for Nominations for Lease Sale 59 indicates a shift of interest to the blocks located in deeper waters, seaward of the tracts currently under lease.

## 3. OIL AND GAS TRANSPORTATION STRATEGIES

If commercially producible quantities of oil and gas are discovered in the Mid-Atlantic, they will have to be transported ashore for processing, refining, and distribution. The process of planning for and constructing the necessary transportation facilities is complex and expensive. Because of the intricacy of designing transportation strategies for oil and gas, it is desirable to begin planning as early as possible, before marketable discoveries of oil and gas have been made. The Bureau of Land Management takes a lead role in this transportation planning process through its Intergovernmental Planning Program for OCS Oil and Gas Leasing, Transportation and Related Facilities (IPP).

The transportation planning element of the IPP has four phases, each of which is related to various steps in the OCS leasing, exploration, and development sequence. Each phase is more detailed and more site-specific than the preceding one, and Phases III and IV are only begun in the event of a discovery of oil and/or gas in commercially producible quantities. The ultimate product is a set of completely detailed transportation management plans. A more detailed discussion of the IPP may be found in appendix C.

The IPP was officially activated on September 20, 1979, when final selection was made for the Regional Technical Working Group Committees. These working group committees are composed of Federal and State officials and representatives of industry and other special and private interests. The members of the Mid-Atlantic Regional Technical Working Group Committee are listed in table 2.

The IPP is in the early stages of the transportation planning process. Because there have been no discoveries of commercial quantities of oil or gas in the Mid-Atlantic, no Development Plans have been filed by oil companies. Until a Development Plan is filed, the IPP will limit itself to regional studies and the examination of regional transportation issues. The planning of more detailed oil and gas transportation strategies, including detailed pipeline corridor planning and the siting of pipeline landfalls, must await a commercial discovery of oil and/or gas.

Three States have undertaken transportation-related studies prior to and independent of the IPP process. The State of New Jersey currently has under contract a study to examine policy options regarding natural gas pipeline

TABLE 2.--Mid-Atlantic Regional Technical Working Group Committee

| Member | Affiliation |
|---|---|
| Frank Basile | Bureau of Land Management |
| Captain George Wood | U.S. Coast Guard |
| John Jimenez | Environmental Protection Agency |
| Bert Brun | U.S. Fish and Wildlife Service |
| Robert Goff | U.S. Geological Survey |
| Dr. Robert Lippson | National Oceanic and Atmospheric Administration |
| Dr. Robert Jordan | State of Delaware |
| Kenneth Schwarz | State of Maryland |
| Dr. Norbert Psuty | State of New Jersey |
| John Harmon | State of New York |
| Dr. Arthur Socolow | State of Pennsylvania |
| Edward Wilson | State of Virginia |
| Derickson Bennett | American Littoral Society |
| Germaine Gallagher | League of Women Voters of the United States |
| Dr. Joan Goldstein | Rutgers University |
| Fletcher Hartley | Interstate Natural Gas Association of America |
| Richard Hickman | American Petroleum Institute |
| David Keifer | Mid-Atlantic Fisheries Management Council |
| David Moore | New Jersey Conservation Foundation |
| Carl Sullivan | Atlantic States Fisheries Management Commission |

landfalls and corridors for four different types of coastal environments. This study is examining both the environmental and socioeconomic impacts of pipeline siting. The State of Delaware has under way a study to examine all the possible OCS-related impacts that might be expected to occur in the vicinity of Lewes, Delaware. This includes not only development likely as a result of support activity, but also development that might be anticipated from a pipeline landfall. The Commonwealth of Virginia is currently undertaking a study to locate sites for a deepwater port, a pipeline landfall, and a complex of four to six refineries which would also be available for OCS oil. The Commonwealth also recently completed a study that provides technical information on pipeline siting, landfalls, and construction requirements and the environmental effects of pipeline development. More information on State, local, and Federal OCS-related studies may be found in appendix D.

## 4. NATURE AND LOCATION OF NEARSHORE AND ONSHORE FACILITIES

The onshore effects of OCS activity in the Mid-Atlantic Region to date have been associated with support bases for the exploratory drilling that has taken place. The oil companies have concentrated their support activities in two areas: Atlantic City, New Jersey, and Davisville, Rhode Island. The activity in Atlantic City is relatively modest. Helicopters fly personnel to and from the rigs out of an existing airport, Bader Field. The base in Rhode Island is much more substantial, because all the supplies required on the rigs--drilling mud, cement, water, fuel, provisions, drill pipe, and casing--pass through Davisville.

### HISTORY AND CURRENT STATUS OF OCS-RELATED DEVELOPMENT

#### Atlantic City, New Jersey

All the personnel who work on the drilling rigs are ferried out and back by helicopters flying out of Atlantic City, New Jersey. Atlantic City was chosen as the base for helicopters because of its proximity to the offshore drilling area and because the required facilities were already there. The requirements of a helicopter support base are few. Petroleum Helicopters, Inc. (PHI), which has had contracts to service eight of the nine rigs that have worked in the Mid-Atlantic, has several acres of ground for its landing pads. The company has 1,170 square meters (13,000 square feet) of hangar space and maintains an office in a 650-square-meter (7,200-square-foot) trailer. These are all located at Bader Field, roughly two miles southeast of downtown Atlantic City.

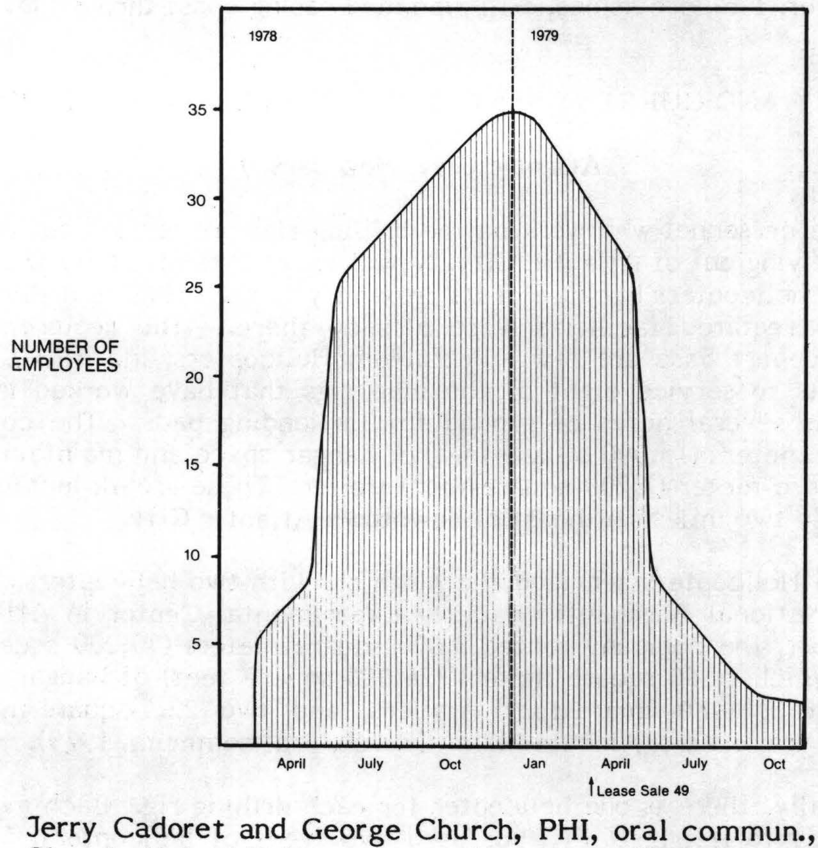
United Helicopters serviced the ninth rig with two helicopters, which flew out of the National Aeronautic Facility Experimental Center in Atlantic City. At the airport, the company rented 3,600 square meters (40,000 square feet) of land, upon which 2,160 square meters (24,000 square feet) of hangar space, two 43-square-meter (480-square-foot) trailers, and two 22.5-square-meter (250-square-foot) trailers were located (Jim Church, oral commun., 1979).

Generally, there is one helicopter for each drilling rig. Each averages one flight per day to its rigs. PHI has used two types of helicopters: the Puma, which carries 18 passengers and a crew of two; and the Bell 212, which carries nine passengers and a crew of two. The crews on the rigs work a 14-day on/off shift, on a rotating basis, i.e., the entire crew is not changed at one time.

Rather, some changes are made each day, so that half the crew of the rig is replaced every seven days.

From June 1978 to May 1979, United Helicopters employed seven pilots, five mechanics, and three other laborers. The latter two groups were hired locally. Because United Helicopters employees work a two-day on/one-day off shift, six pilots moved to Atlantic City from Connecticut or overseas; the other pilot commuted from Connecticut.

At the peak of drilling activity, PHI had eight helicopters at Bader Field. At that time, the company employed 12 pilots and eight mechanics. Like the crews of the drilling rigs, PHI employees work a 14-day on/off shift. Most commute from other parts of the country, although three pilots have moved to New Jersey. One radio operator and two mechanics were hired locally (Jerry Cadoret and George Church, oral commun., 1979). Each helicopter uses approximately 1,365 liters (300 gallons) of jet fuel per day. This fuel is purchased locally. Other local spending is $6,000 to $7,000 per month for motel bills and unspecified amounts for mechanics' tools and equipment. Figure 8 shows the curve for employment from March 1978, when PHI moved into Atlantic City, to the present.




SOURCES: Jerry Cadoret and George Church, PHI, oral commun., 1979; Jim Church, United Helicopters, oral commun., 1979.

FIGURE 8.—OCS support employment (helicopters) in Atlantic City, March 1978 to present

The number of persons working at the helicopter base does not present a significant demand for either permanent or transient housing in a community the size of Atlantic City. The much larger number of workers on the drilling rigs does not represent much housing demand either, as the great majority of these workers simply pass through Atlantic City on their way to their homes in other parts of the country, or else they were hired locally and already have homes in the area.

## Davisville, Rhode Island

The OCS support base at Davisville, Rhode Island, is a former Navy base that was used by the Seabees. It is adjacent to Quonset, a former Naval air station. Both facilities are in the process of being turned over from the Federal Government to the State of Rhode Island, and they are operated by the Rhode Island Port Authority. The two facilities are located on the western shore of Narragansett Bay, 32 km (20 miles) south of Providence and 32 km (20 miles) inland from the ocean. They are roughly 280 km (150 nautical miles) north-northeast of the nearest blocks in the Baltimore Canyon Trough area.

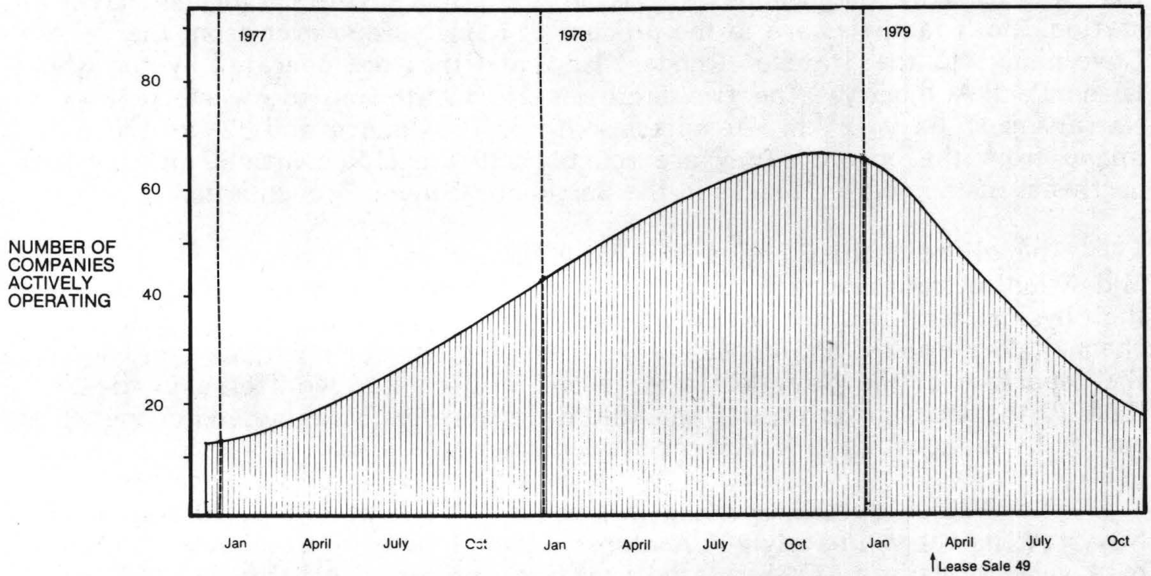
The oil companies chose Davisville/Quonset as the support base for the Mid-Atlantic from among a number of candidate sites for several reasons. First, the physical facilities are excellent, with good highway and rail access, a deep channel, large piers, and considerable onshore space for open storage. Second, the departure of the Navy left a large and well-trained workforce in the area. Finally, the local governments and the State were encouraging and cooperative, especially in view of the Navy's recent departure.

The OCS support base comprises about 1,200 hectares (3,000 acres). The Navy retains approximately 400 hectares (1,000 acres); the remainder is devoted to a variety of uses. OCS-related uses account for 62.4 hectares (156 acres). The bulk of this is open storage, but it includes 27,900 square meters (310,000 square feet) of warehouse space and 2,520 square meters (28,000 square feet) of office space.

Most of the support activity is at Davisville, but some of the office space is at Quonset. The work at Davisville consists mainly of supply boats shuttling food, water, fuel, drilling mud, cement, drill pipe, casing, and equipment out to the rigs, and bringing back refuse that cannot be disposed of at sea. The supply boats at Davisville are about 60 m (200 ft) long and 12.5 m (42 ft) wide, and they draw 3.5 to 5 m (12 to 16 ft) of water. Each rig may be serviced by two or three boats. A trip from Davisville to a rig may take 18 hours or more.

There are two piers at Davisville of 3.2 and 5.6 hectares (8 and 14 acres). The photograph on the cover of this report shows the Davisville piers. Each is served by rail. There are 1,220 m (4,000 linear ft) of bulkheading, and the water depth at pierside is 8.5 m (28 ft) at mean low water.

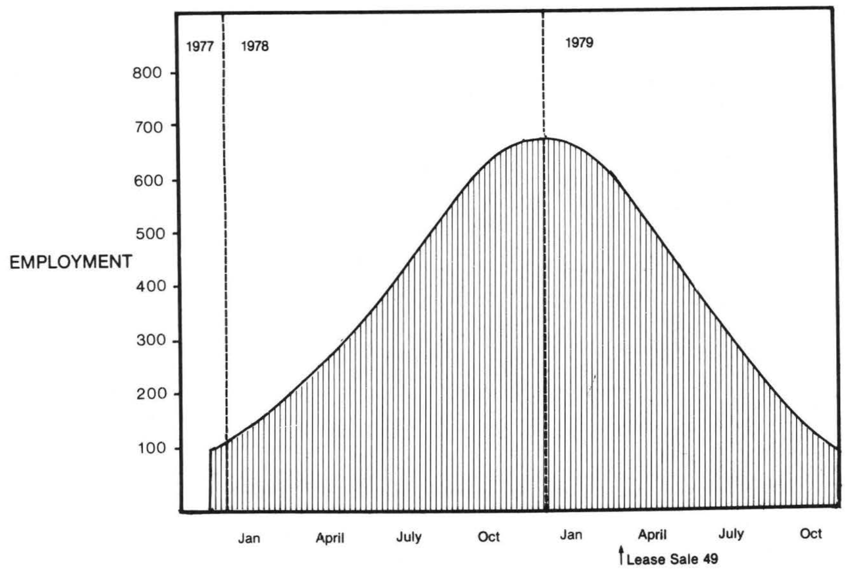
As many as 67 companies involved in OCS-related work have worked in Davisville at one time. These include seven major oil companies; 48 service companies that provide supplies such as drilling mud, cement, and food; six marine service companies, which operate the supply boats; and six exploration companies, which operate the drilling rigs. Figure 9 shows the timing of their presence at Davisville. Twelve companies began moving there at the end of 1976, in anticipation of drilling after Lease Sale 40. However, an injunction put off the beginning of exploratory drilling until 1977. Had there been no litigation surrounding Sale 40, the rising side of the activity curve would very likely have been steeper, with the peak of activity shifted to the left, occurring several months earlier. The falling side of the curve reflects the decline in exploratory activity discussed in chapter 2. Lease Sale 49 did not cause a surge of activity because of the discouraging results of exploratory drilling associated with Lease Sale 40.




SOURCE: Rhode Island Department of Economic Development, 1979.

FIGURE 9.--Number of companies operating at Davisville, Rhode Island, December 1976 to present

The level of activity at a support base is closely related to the level of drilling activity offshore. Thus, the curve for employment (figure 10) closely follows the curve of exploratory drilling, shown in figure 5. While companies began moving in and establishing offices at Davisville as early as December 1976, work did not really begin, and significant numbers of workers were not employed, until early 1978. From about 100 persons in early 1978, employment increased to a peak, at the end of that year, of 670 persons. It has since declined to approximately 141 (Rhode Island Department of Economic Development, 1979, table 2). These figures represent total direct employment, including both residents and nonresidents of Rhode Island. The State has calculated that wages paid to residents totaled close to $7.5 million for 1978, with the same amount paid as wages for secondary employment (Rhode Island Department of Economic Development, 1979, table 1). For 1979, the corresponding figures are slightly more than $1 million for direct wages to residents and another $1 million for wages in secondary employment.

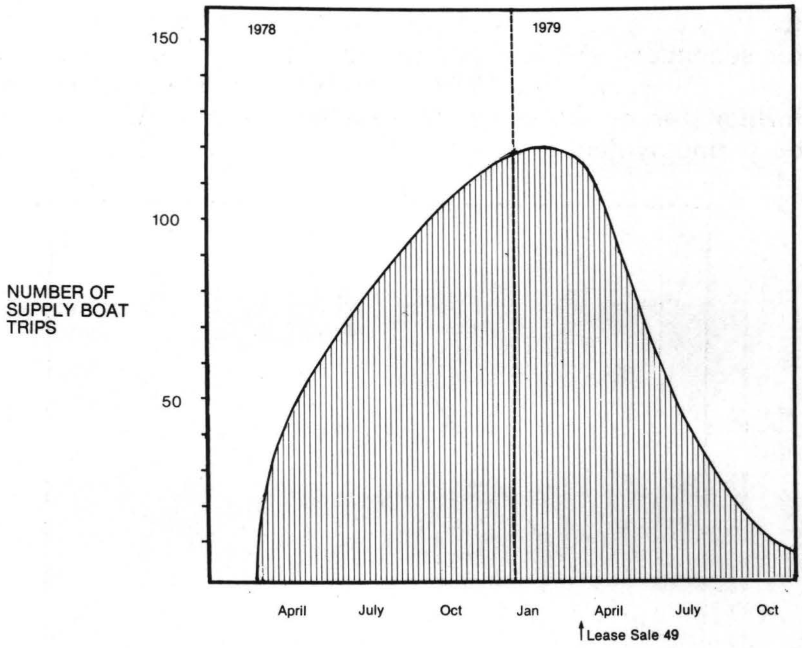



SOURCE: Rhode Island Department of Economic Development, 1979.

FIGURE 10.--Employment at Davisville and on drilling rigs of permanent and full-time temporary Rhode Island residents, December 1977 to present

A good index of the level of support at any given time is the number of trips made by supply boats. At present, with only one rig drilling in the Mid-Atlantic, there are only three boats working out of Davisville. During the winter of 1978-1979, there were as many as 22 at one time. The schedules of the supply boats vary from one company to another. Some prefer their boats to run back and forth between the rigs frequently; others prefer that each boat make only one trip per week. On the average, a total of 15 round trips per month for each drilling rig is a representative number. Figure 11 shows the number of supply boat trips, per month, from March 1978 to the present.

The impacts of such an abrupt beginning of support activity have been less at Davisville than would be expected elsewhere. Because the Navy had recently vacated most of its facilities at Davisville, the oil companies were able to move in without new construction. Unemployment was high as a result of the Navy's moving out, so OCS work took up some of the slack among both skilled and unskilled workers.




SOURCE: John Dana, Rhode Island Port Authority, oral commun., 1979.

FIGURE 11.--Supply boat trips from Davisville, Rhode Island, per month, March 1978 to present

When oil companies move into an area where they have not previously worked, they generally bring with them a core of experienced workers from other areas. It is customary in the oil industry for employees to work a 14-day on/off shift, so many workers commute from other parts of the country, staying in motels during their 14-day shift. While it is difficult to obtain accurate figures on what portion of the total work force these transients comprise, it is estimated that they were roughly 250 at the peak of activity, out of the peak total of 670 (Rhode Island Department of Economic Development, 1979, pp. 1-4). This number of persons has not had a significant effect on the local housing market, primarily because most commute from their home states. Another factor tending to mitigate the demand for housing is that adequate housing is readily available within a reasonable commuting distance of Davisville.

The support base appears to have presented no serious environmental problems. Quonset and Davisville have their own water system and Quonset has primary sewage treatment. The town of North Kingstown, in which Quonset and Davisville are located, has no municipal sewerage. Wastes brought back by the supply boats from the rigs, such as drill cuttings contaminated by oil, are trucked from Davisville about 800 km (500 miles) to a disposal facility in Buffalo, New York (Roger Buck, oral commun., 1979). If the amount of drilling were to increase substantially, this arrangement might cease to be practical. The most significant problem caused by the activity at Quonset and Davisville is traffic congestion on U.S. Route 1, the major highway running from Providence south along the western side of Narragansett Bay (Teree Lee Hartt, oral commun., 1979).

OCS activity has not been the principal cause of traffic problems in the area, however. General Dynamics' Electric Boat Division has a 60-hectare (150-acre) facility at Quonset, where it fabricates hulls for Trident submarines. It employs 5,000 persons on three shifts and is the largest private employer in the State. (The Navy remains the largest employer overall.) Thus, even at its peak of less than one thousand employees, OCS work has been far overshadowed in terms of dimensions and impacts by Electric Boat. This fact was mentioned by a number of persons interviewed.

The effect of OCS-related development at Davisville has been to partly fill the void created by the departure of the Navy. The facilities were waiting to be used, and Davisville could without difficulty support a higher level of activity than it has, even at the peak. In terms of employment, even the large Electric Boat facility has not been able to take up all the unemployment Rhode Island has experienced in recent years. Thus, it may be said that the most negative impact of OCS-related development to date has been its decline from the peak last winter, rather than its arrival in the first place.

## PROJECTED OCS-RELATED DEVELOPMENT

### Atlantic City, New Jersey

There is currently one drilling rig operating in the Mid-Atlantic. If the projections made in chapter 2 for future exploratory drilling are reasonably accurate, the number of drilling rigs will probably fluctuate seasonally between one and three. This would entail a level of activity close to or slightly higher than that at present. Given the most recent estimates, it seems most likely (though by no means certain) that between now and Lease Sale 59 in December 1981, levels of activity in Atlantic City will not exceed or even approach the peak of last winter.

### Davisville, Rhode Island

Projecting future levels of support activity is somewhat complicated by the fact that Davisville is likely to be the principal supply base for exploration in the North Atlantic as well as the Mid-Atlantic. Assuming that no further litigation takes place and that drilling begins in the North Atlantic in the near future, it will almost certainly be supported from Davisville. It is important to stress that no projection is being made here of that support activity. A projection of the activity likely as a result of drilling in the North Atlantic will be made in the separate Summary Report for the North Atlantic, which will be issued after Lease Sale 42. The projections for Davisville made here are only for activity in support of drilling in the Mid-Atlantic.

The pattern of support projected at Davisville between now and December 1981 is for a level of activity sufficient to support the one to three drilling rigs projected to be working in the Mid-Atlantic. This would require the same or slightly higher levels of employment and material as are there at present, while only one rig is drilling.

There are currently about 140 persons in OCS-related work at Davisville. This number is higher than might be expected, given that only one rig is drilling now. A number of service companies are keeping offices open in anticipation of drilling in the North Atlantic, and another rig is scheduled to start work this winter in the Mid-Atlantic (John Dana, oral commun., 1979). It is probably more accurate to assume that only 50 to 75 onshore personnel would be required to support each drilling rig. Therefore, onshore employment, exclusive of employment on the drilling rigs, may be expected to fluctuate between 50 to 75 and 150 to 225.

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U.S. Geological Survey, 1979, Outer continental shelf of the Mid-Atlantic from 35° to 41° north latitude: U.S. Geological Survey, scale 1:500,000.

## APPENDIX A. THE GEOLOGIC SETTING

### PETROLEUM GEOLOGY

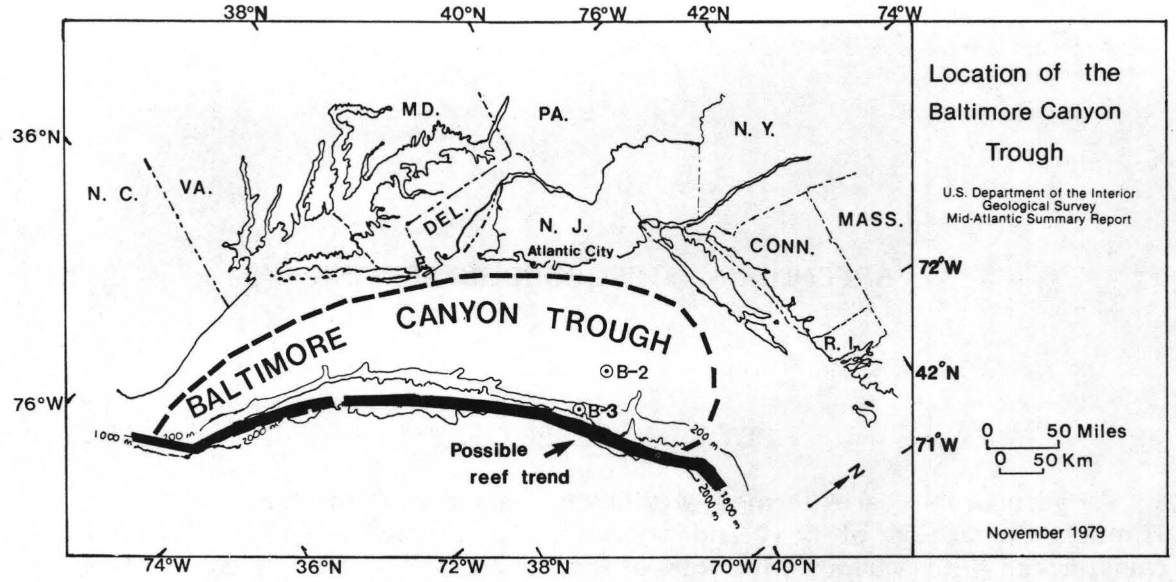
Hydrocarbons are formed within the upper part of the earth's crust. Through the action of heat and pressure, depositions of organic matter are transformed into various mixtures of crude oil and natural gas. The time between deposition of organic material and the formation of hydrocarbons is on the order of millions of years (Tissot and Welte, 1978, p. 198).

The occurrence of hydrocarbon accumulations depends on many factors: (1) an adequate thickness of sedimentary rocks; (2) the presence of source beds (rocks containing large amounts of organic matter); (3) a suitable environment for maturation of the organic matter into oil and/or gas; (4) porous and permeable reservoir rocks; (5) hydrodynamic conditions permitting the migration of hydrocarbons and their ultimate entrapment in reservoir rocks; (6) the area's having a thermal history that favors production and preservation of hydrocarbons; (7) formation of adequate geologic traps for accumulation of the hydrocarbons; and (8) suitable timing of petroleum generation and migration to ensure the entrapment and preservation of the hydrocarbons (Miller and others, 1975, p. 17).

In a prospective hydrocarbon province, geologists look for structural or stratigraphic traps, in which oil and gas can accumulate. Structural traps include anticlines, sediments draped over salt diapirs and other dome-like intrusions, and fault traps. Examples of stratigraphic traps are reefs and the truncated edges of porous strata. Traps may also be formed by a combination of structural and stratigraphic elements.

### THE MID-ATLANTIC OUTER CONTINENTAL SHELF

The dominant subsurface feature of the Mid-Atlantic outer continental shelf is an elongated basin called the Baltimore Canyon Trough (see figure 12). This feature extends from Cape Hatteras northeastward approximately 500 km (300 miles) to Long Island. It is thought to have formed approximately 200 million years ago.




SOURCE: Sara Jacobson, USGS, 1979.

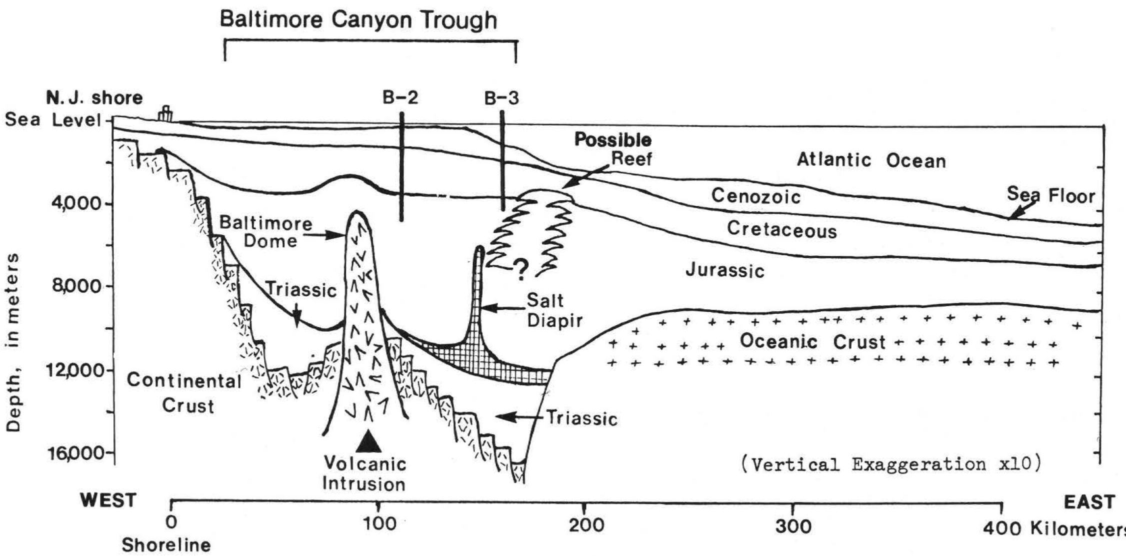
FIGURE 12.--Geological extent of the Baltimore Canyon Trough

Extensive seismic studies of the Baltimore Canyon Trough have been conducted. Prior to Lease Sale 40, the USGS obtained and evaluated 28,827 km (18,017 line miles) of seismic data; an additional 16,821 km (10,513 line miles) of seismic data were obtained and evaluated before Sale 49. Two Continental Offshore Stratigraphic Test (COST) wells have also been drilled. These are wells drilled in frontier areas by a consortium of companies, under the supervision of the U.S. Geological Survey, in order to gather geologic data before lease sales. COST Well B-2, on the continental shelf, was completed in 1976, prior to Sale 40, and COST Well B-3, on the upper continental slope, was completed in 1979, before Sale 49.

These investigations have revealed that the basin is infilled by thick layers of sediments. Their average thickness is 10,000 to 12,000 m (33,000 to 40,000 ft), with the deepest part of the basin containing as much as 13,700 m (45,000 ft) of sediments. Figure 13 is a cross section of the Baltimore Canyon Trough. Sedimentation appears to have started as soon as the basin formed: the presence of 200-million-year-old rocks has been inferred from seismic data. Geologists think that these oldest rocks were deposited in nonmarine environments and that they resemble sediments of like age encountered in wells drilled on the Scotian Shelf, southeast of Nova Scotia.

The oldest rocks penetrated by both Mid-Atlantic stratigraphic test wells are approximately 150 million years old. Analysis of the information from both COST wells has revealed that rocks ranging in age from approximately 95 to 150 million years were deposited in shallow marine to nonmarine environments.

Carbonates, sandstones, and shales are found in these sequences. Younger rocks ranging in age from 10 to 95 million years were deposited in deeper marine environments and consist mainly of calcareous shales and mudstones and fine-grained sandstones.




SOURCE: Sara Jacobson, USGS, 1979.

FIGURE 13.--Interpretive cross section of the Baltimore Canyon Trough

When the two wells are compared, it appears that sandstone and shale are the dominant rock types in the landward part of the basin. Seaward, carbonates increase in abundance in the deeper sections penetrated by the wells.

Geochemical studies of COST well samples have identified potential oil and gas source beds on the continental shelf as well as on the continental slope. In the vicinity of COST Well B-2, source beds are more likely to yield gas than oil. Source beds in the vicinity of COST Well B-3 appear to have both oil and gas potential (Amato and Simonis, 1979, p. 97). Thermal maturation of the sediments appears to have taken place only in the lower intervals in both wells.

Some of the sandstones found in the COST wells could provide excellent reservoir rocks for hydrocarbons. Shales could provide seals, helping the process of entrapment. The carbonates penetrated do not have good reservoir characteristics; however, the reservoir properties of these rocks may improve farther to the east, beneath the continental slope (Amato and Simonis, 1979, p. 97).

Within the Baltimore Canyon Trough, both structural and stratigraphic traps have been identified. The largest structural feature is the Baltimore Dome (Great Stone Dome), believed to be an igneous intrusion. Sediments draping over and abutting this intrusion have been postulated as possible hydrocarbon traps.

Other structural features that could provide adequate trapping mechanisms include a small, isolated dome southeast of the Baltimore Dome, normal faulting along the outer shelf-upper slope boundary, gentle doming above possible deep-seated salt diapirs, and/or draping over old fault blocks. Few stratigraphic traps have been identified within the area presently leased.

East of the area currently under lease, geophysicists have found seismic evidence of a structure, buried under 2,000 m (6,600 ft) of Cretaceous sediments, that could be an ancient reef. (See figure 12.) Ancient reefs are regarded as potential reservoirs for oil and gas because of their porosity and their usual location in proximity to deep basins containing sedimentary rocks rich in organic material and thus highly suitable for the generation of oil and gas. This structure east of the basin area is presently thought to be a paleo shelf edge and could provide adequate stratigraphic as well as structural traps. In addition, it may be similar to known oil-bearing structures in the Gulf of Mexico.

On the basis of geophysical traverses and COST well information, the structure appears to be 100 to 140 million years old. Its back edge may have been sampled by COST Well B-3. Almost continuous from Maine to Florida, the structure occurs in water depths ranging from about 600 to 2,000 m (2,000 to 6,600 ft) and averages 25 km (15 miles) in width. It is bordered by thick layers of potential source rocks, and appears to have a suitable seal above it. It is developed best along the seaward edge of the Baltimore Canyon Trough and, in fact, forms its eastern edge.

The U.S. oil and gas industry currently has the technological capability to conduct exploratory drilling in the deep waters of the continental slope where this structure has been located. The present state of development and production technology limits production in this area to about 300 m (1,000 ft) of water depth. The USGS estimates that production technology for deep-water depths of up to 2,000 m (6,600 ft) -- i.e., technology sufficient to allow operations over the structure--is well under way and will be available in 8 to 9 years (William H. Menard, oral commun., August 1979).

The USGS has estimated that the entire structure, from Maine to Florida, may contain as much as 2 to 15 billion barrels of petroleum (William H. Menard, oral commun., August 1979). This is a preliminary estimate of potential recoverable resources. Estimates of potential recoverable resources are calculated differently from the risked, economically recoverable resource estimates used in this document. Estimates of potential recoverable hydrocarbons are not suitable for site-specific onshore planning and are therefore not taken into account in chapter 4.

## SUMMARY OF GEOLOGICAL AND GEOPHYSICAL INVESTIGATIONS TO DATE

In reviewing the petroleum geology of the Mid-Atlantic in light of the specific requirements for hydrocarbon accumulation, several comments can be made. The Mid-Atlantic area contains thick layers of sedimentary rocks, including source beds capable of generating hydrocarbons. Maturation of some of these source beds has occurred, but only within the lowest intervals penetrated by the COST wells. Reservoir-quality sandstones have been found in the area. Structural and stratigraphic traps are present. Faulting and the presence of permeable rocks above thermally mature source beds would allow for migration of oil and gas.

It appears that the Mid-Atlantic Region has many of the characteristics that allow oil and gas to accumulate. However, the only way to verify that these events occurred in a sequence that would ensure the entrapment and preservation of hydrocarbons is to drill and confirm the presence of oil and gas. Chapter 2 presents the results of the drilling conducted to date.

# APPENDIX B. ESTIMATING OIL AND GAS RESOURCES

Before exploratory drilling, both the government and industry undertake analyses of geological basins to determine their oil and gas potential. The government uses different methods of analysis depending on the purpose of the estimate. Estimates are commonly made for preliminary tract selection for lease sales, environmental impact statement preparation, final tract selection for lease sales, and setting the value of tracts to be leased. The government regularly updates its data base for resource estimation by obtaining additional geologic and geophysical data. As more data is gathered, processed, analyzed, and interpreted, the resource estimate for a given area is updated to reflect the new data.

Prior to a lease sale, the process of estimating the amount of oil and gas in a potential reservoir or a lease sale area involves tremendous uncertainty. The USGS makes these estimates for a variety of purposes. Regionwide estimates are used to aid in the preparation of proposed lease sale schedules. More specific resource estimates are made for the lands that are tentatively selected to be offered for lease. Later estimates are made on a tract-by-tract basis to establish a dollar value for each tract offered. However, it should be reemphasized that estimates of undiscovered resources are extremely uncertain. The existence of resources cannot be confirmed until an area has been thoroughly explored by drilling.

## REGIONWIDE RESOURCE ESTIMATES

In the early stages of exploration, when some information concerning the gross interpretation of regional geology exists, it is necessary to use expert judgment based on minimal amounts of data in order to provide a basis for resource estimates. As more data become available, the resource estimates and the methods used become more refined. When data are abundant and detailed, the choice of method used will depend on the availability of the estimator's time, the effort involved, and the purpose of the resource estimate. The quality of the estimate, however, depends on the quality of the geophysical and geological data and studies upon which it is based.

Several resource estimation techniques are relied on in formulating basin resource estimates. Two of the most extensively used methods are volumetric analyses and performance rate methods. In general, volumetric techniques involve comparing prospective resource areas with known areas of production. Performance rate methods are based on the extrapolation of past experiences from historical data (such as discovery rates, drilling rates, and productivity rates), and on the fitting of past performances into logistic or growth curves by various mathematical derivations. Performance rate methods are not directly applicable to unexplored or nonproducing areas. In making resource estimates it is safest to apply at least two resource estimation techniques to every area as a means of checking and verifying the reasonableness of the estimates.

## TRACT-SPECIFIC RESOURCE ESTIMATES

Each tract nominated for leasing for exploration and developmentof oil and gas resources must be evaluated prior to the lease sale. After a lease sale, resource estimates are periodically updated.

Resource evaluations of leased tracts consist of three parts: a geophysical and geological evaluation of the potentially recoverable resources of possible hydrocarbon-bearing structures underlying the tract; an assessment of the risk that, for whatever reason, hydrocarbons are not, in fact, present in the quantities foreseen by the geologic evaluation; and an engineering and economic evaluation of the monetary value of those resources, taking the assessed risk into account.

Data available for resource estimation are seismic records, well data, and production histories from wells on tracts in or near the sale area. In the case of frontier areas, production histories of nearby wells are not available; the drilling histories of geologically analogous petroleum-producing basins may be used in this case. Once an area has been leased and exploratory drilling has commenced, the results of this drilling may allow updating of resource estimates. Changes in exploratory drilling and production techniques and costs may also necessitate the reevaluation of a tract.

The tract-specific resource estimates are derived by using a "Monte Carlo discounted cash flow computer program." In this program, geologic, engineering, and economic information is entered and used to calculate recoverable resources and an economic value for each tract. Some parameters, such as tract size, are entered as fixed values. Others, such as pay thickness and production rates, are given a range of values. Each variable is assigned a range of possible values. The program then randomly selects values for each variable and combines them with the fixed parameters to calculate a resource estimate and economic value. The process is run many times, and eventually a **mean resource estimate** and economic value are determined.

A "risk factor" is used to discount the mean resource estimate. The risk factor represents the probability that a particular trap will not contain a commercially attractive quantity of hydrocarbons. The risk factor is a subjective appraisal by a geologist, geophysicist, and engineer based on the data available to them. It is determined through a knowledge of an area's (or an analogous area's) exploration history, together with an assessment of how strongly the data indicate the presence of a trap, of source rocks, and of other elements that make a good prospect.

## RESERVE ESTIMATES

Reserves are the portion of identified resources that can be economically extracted. Before a reserve estimate can be made for a discovery, several wells must be drilled to delineate the volumes of oil and gas that have been discovered. Until a reserve estimate can be made, reserves are considered to be zero, even though resources may have been discovered.

Reserve estimates approximate the cumulative production that can be expected from a discovery. For this reason, they provide a solid basis for onshore planning.

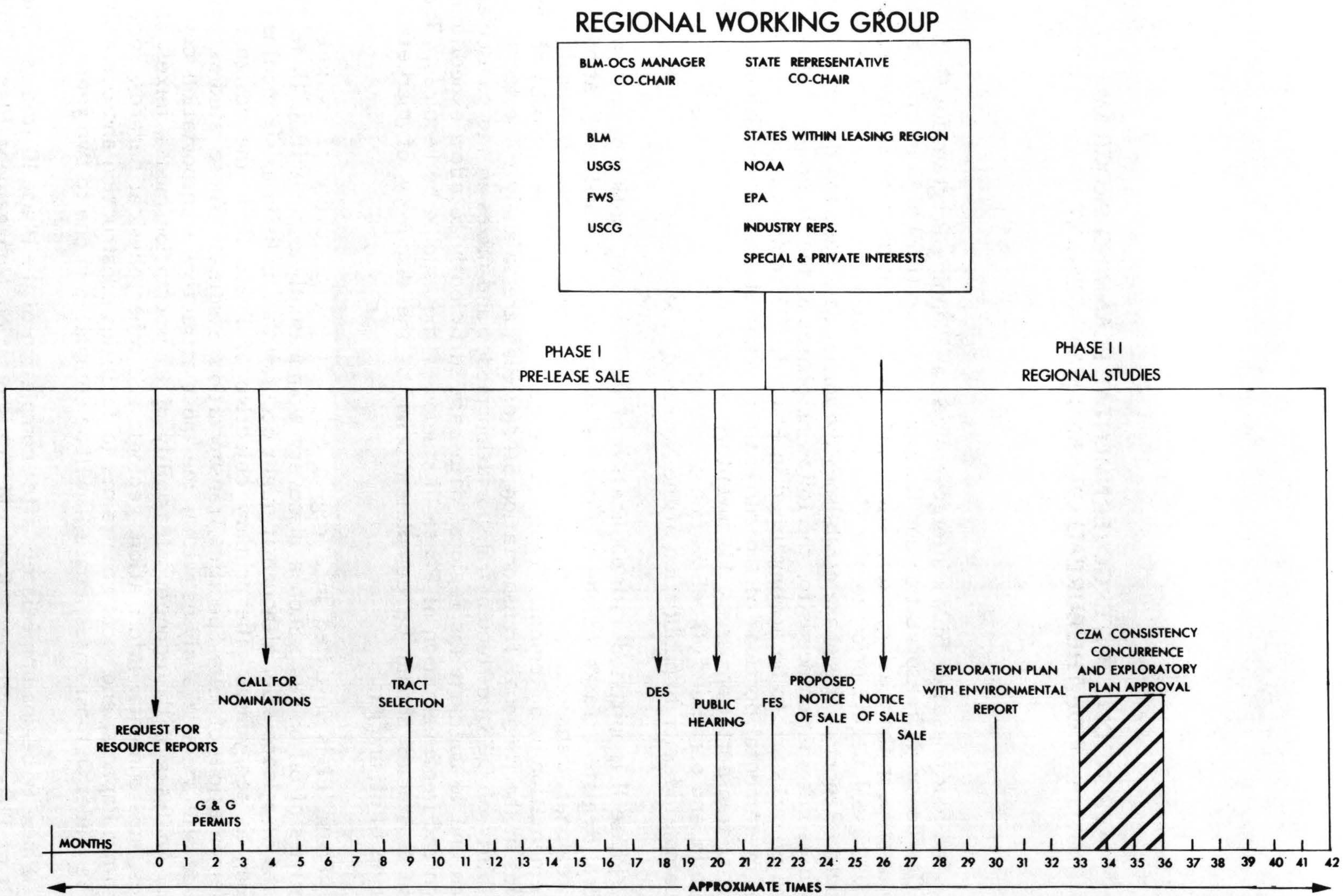
## APPENDIX C. INTERGOVERNMENTAL PLANNING PROGRAM OF THE BUREAU OF LAND MANAGEMENT

The four phases of BLM's Intergovernmental Planning Program for OCS Oil and Gas Leasing, Transportation and Related Facilities (IPP) are directly tied to various steps in the leasing, exploration, and development processes. (See figure 14.) Phase I begins prior to the Call for Nominations with the Request for Resource Reports. This phase establishes the initial data base for the region and identifies information needs for the following phases of the Program. A number of major tasks are to be accomplished in Phase I: (1) completion of applicable intergovernmental portions of the current preleasing steps; (2) identification of regional transportation issues; (3) inventory of potential transportation routes, landfalls, and ports; and (4) delineation of management information needs. Phase I is completed prior to publication of the Notice of Sale.

Phase II is initiated with publication of the Proposed Notice of Sale in the Federal Register. Tasks include (1) examination of the scope and implications of the regional transportation issues identified in Phase I, and (2) design and implementation of a Regional Transportation Studies Plan. The purposes of the studies in the Regional Transportation Studies Plan are to analyze the technical feasibility of OCS petroleum transportation modes and mixes in the particular region and to augment the regional data base sufficiently to allow expeditious design and implementation of Phase III studies, if they should be required. The Phase II studies should be completed prior to the discovery of marketable reserves of oil and gas.

Phase III is initiated in a region only after a discovery of marketable quantities of oil or gas. Such a discovery would usually occur within 18 to 54 months of a lease sale, although it might occur within as little as six months or as long as ten years. The primary objective of Phase III is the design and implementation of Site-Specific Transportation Studies. These studies will include site-specific analyses within the most attractive transportation corridors. Analyses of the economic feasibility of transportation modes, mixes, and routes, environmental information, geologic and other physical hazards, socio-economic impacts, and local constraints to facilities construction and operation will be made. In most cases, Phase III will be completed in one to two years.

Phase IV begins immediately after completion of the Phase III studies. The result of Phase IV will be a Regional Transportation Management Plan. This


REGIONAL WORKING GROUP
BLM-OCS MANAGER CO-CHAIR
STATE REPRESENTATIVE CO-CHAIR
BLM
USGS
FWS
USCG
STATES WITHIN LEASING REGION
NOAA
EPA
INDUSTRY REPS.
SPECIAL & PRIVATE INTERESTS
PHASE I
PRE-LEASE SALE
PHASE I I
REGIONAL STUDIES
REQUEST FOR RESOURCE REPORTS
G & G PERMITS
CALL FOR NOMINATIONS
TRACT SELECTION
DES
PUBLIC HEARING
FES
PROPOSED NOTICE OF SALE
NOTICE OF SALE
SALE
EXPLORATION PLAN WITH ENVIRONMENTAL REPORT
CZM CONSISTENCY CONCURRENCE AND EXPLORATORY PLAN APPROVAL
MONTHS
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
APPROXIMATE TIMES

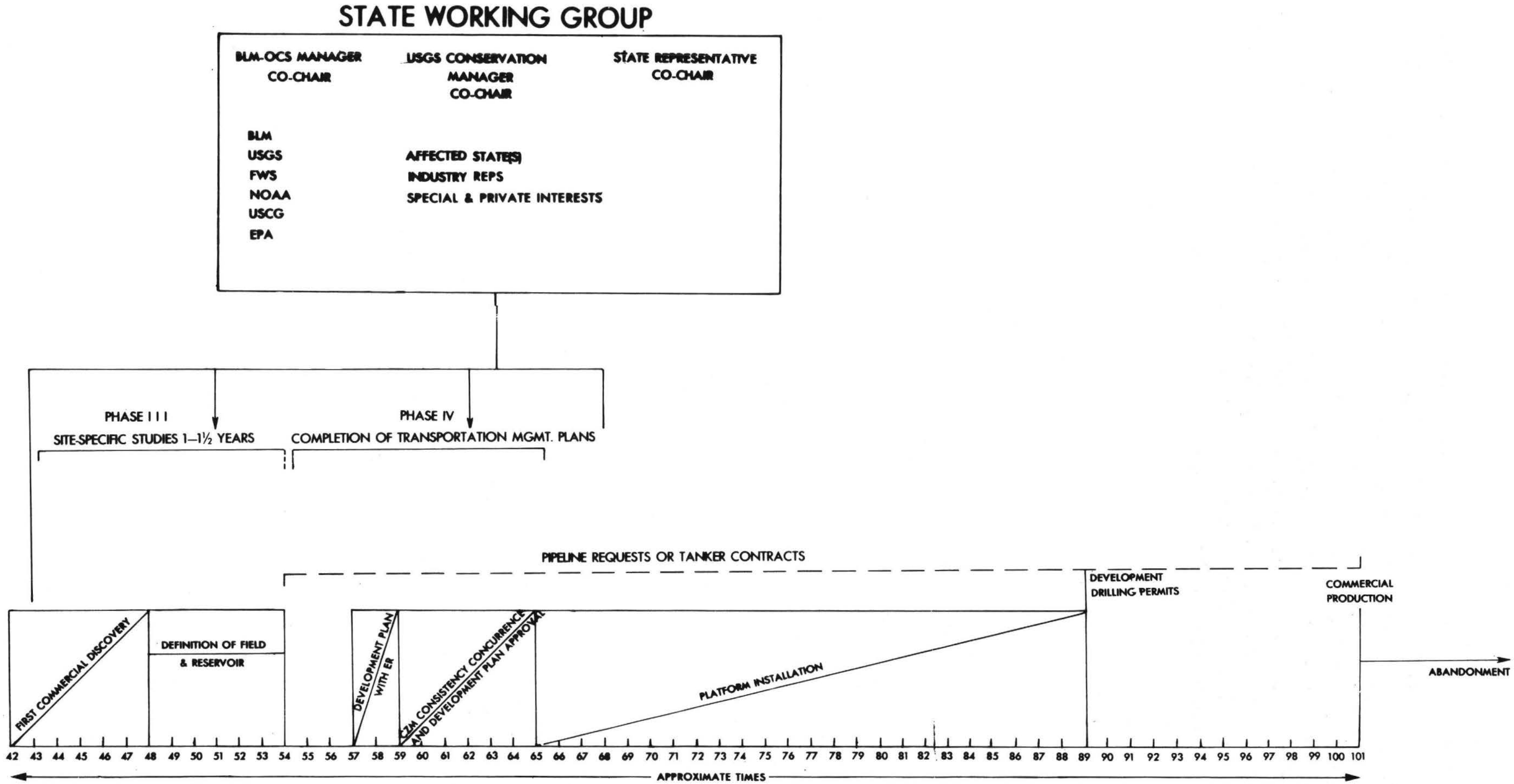



FIGURE 14.--Intergovernmental Planning Program for Leasing and Transportation of OCS Oil and Gas

Management Plan will provide (1) analysis and recommendations for discrete corridors and alternatives, including all transportation routes to onshore facilities or to offshore terminals serving as collection points for more than one production area; (2) identification of environmentally sound alternative areas for the location of onshore facilities; (3) any alternatives regarding surface vessel transportation; (4) a plan for monitoring of construction and operation, and any follow-up studies that may be required; and (5) any stipulations and use restrictions identified as applicable to rights-of-way. Phase IV should be completed in less than a year from the completion of Phase III and several months before submission of a Development Plan with a transportation component.

## APPENDIX D. FEDERAL, STATE, AND LOCAL OCS-RELATED STUDIES

### FEDERAL STUDIES (Bureau of Land Management)

The New York OCS Office of the Bureau of Land Management carries on an environmental studies program to provide information for the OCS minerals management decisionmaking process. A number of studies have already been completed for the Mid-Atlantic, and additional studies are planned for fiscal years 1980 and 1981. Completed studies may be reviewed at the New York OCS Office of the Bureau of Land Management, 26 Federal Plaza, Suite 32-120, New York, NY 10007.

#### Completed Mid-Atlantic Studies

Marine environmental implications of offshore oil and gas development in the Baltimore Canyon region of the Mid-Atlantic coast, Estuarine Research Federation, Wachapreague, Virginia, 1974, 504 p., appendices. Based on a meeting held at the University of Maryland, College Park, Maryland, December 2-4, 1974. Available from the Estuarine Research Federation, Wachapreague, Virginia, Publication ERF 75-1, $10.00.

The purpose of the Mid-Atlantic Conference Workshop was to review environmental information of the Region, the responsibilities of State and Federal agencies, and the best approach for assessing impacts associated with Mid-Atlantic oil and gas development. The Workshop recommended a comprehensive, interdisciplinary study of the region. Workshop comments were concerned with sampling schemes and sizes, standardization of equipment and methods, data management, and analysis of published and unpublished data.

A study of the socioeconomic factors relating to the outer continental shelf of the Mid-Atlantic Coast, College of Marine Studies, University of Delaware, 1974, 9 volumes (3 books), 1093 p., bibliography, and appendices. Available for review at the University of Delaware Morris Library, Newark, Delaware, 19711, (302) 738-2965; the Bureau of Land Management, New York

OCS Office; and available from the Congressional Information Service, Inc., 7101 Wisconsin Avenue, Washington, D.C. 20014.

A socioeconomic impact study was conducted for the Mid-Atlantic Region. The report compiles data files from State and Federal documents on economic factors and suggests methods for assessing socioeconomic impacts. Subjects included are target areas, petroleum, industrial-commercial activity, land use, demography, and recreation.

Travel economic impact model: Volume I, Final economic analysis methodology; Volume II, Final demonstration report, United States Travel Data Center, Washington, D.C., 1975, 2 volumes, 225 p., appendices. Available from the National Technical Information Service, 2585 Royal Road, Springfield, Virginia 22161, paper $5.50 (PB 249365/AS).

The Travel Economic Impact Model was developed to estimate the impact of travel activity by U.S. residents on national, state, and county economics. The disaggregated model was built on estimates of 15 travel expense categories, their impact on 13 types of travel-related retail businesses, and the business receipts, employment, personal income, and tax receipts that result. Volume I describes the model, including the limitations and methods for updating. Volume II is an application of the model that assesses the impact of OCS development on pleasure travel activity in 12 Mid-Atlantic coastal counties. "Pleasure travel" was considered because it is most apt to be altered by oil spills that may adversely affect the environment.

Environmental consequences of onshore activity in four New Jersey coastal counties resulting from offshore oil development, Narkus-Kramer, M., S. Ratick, and A. Watson, International Research and Technology, Arlington, Virginia, September 1975, 46 pp. Available from National Technical Information Service, 2585 Royal Road, Springfield, Virginia 22161, paper $4.00/microfiche $2.25 (PB-249 349/2GA).

The report estimates the increases in onshore air and water pollution that four New Jersey counties could expect from proposed OCS oil and gas development in the Mid-Atlantic. Estimates are based on economic projections for 1975, 1980, 1985, and 1990.

University seminar on pollution and water resources, Halasi-Kun, G.J. and K. Widmer, Columbia University, New York, New York, 1975, Vols. VII and VIII. Available for review at the Bureau of Land Management, New York OCS office.

In 1970 Columbia University established a seminar devoted to environmental problems of coastal and offshore areas. Sixteen articles in coastal geology, estuarine biology, hydrology, submarine ecology, and thermal pollution comprise the two volumes.

Middle Atlantic outer continental shelf environmental studies, Virginia Institute of Marine Science, Gloucester Point, Virginia, and U.S. Geological Survey, Woods Hole, Massachusetts, August 1977, 4 vols., approximately 1800 p., appendices and visuals. Available from National Technical Information Service, 2585 Royal Road, Springfield, Virginia, 22161, set of 4 volumes, $50 in paper (not available in microfiche) (PB 281295).

Between October 1975 and October 1976, the Virginia Institute of Marine Sciences conducted field studies in the Mid-Atlantic to collect and analyze chemical and biological data on conditions prior to oil and gas development; to assess the processes regulating biological communities; and to determine chemical constituent levels in the shelf environment. The results of the first year can be summarized: (1) the Mid-Atlantic waters are characterized by three water masses (coastal boundary layer, shelf water, and slope water); (2) eggs and larvae.of fishes and crustaceans are significant in the Spring neuston; (3) macrobenthos demonstrate little seasonality and were most dense on the outer shelf; and (4) local ridge and swale topography has a strong influence on the distribution of sediments on trace metals, hydrocarbons, organic nitrogen, and organic carbon in the sediments, and on benthic biota.

The USGS conducted geologic studies in the Mid-Atlantic OCS (Baltimore Canyon Trough) to survey potential geohazards, identify sediment movement and probable cause, determine minerology, and assess hydrocarbon levels in sediments and seston analyses. First-year results can be summarized: (1) geologic environmental hazarads in the area do not warrant withdrawal of lease tracts (Sale #40 area); (2) stress due to waves and currents associated with major storms, bottom sediment mobility, and inherent poor bearing capacity may pose problems; and (3) widespread dispersal of bottom sediment and suspended matter occurs, especially when major storm waves and currents are present. Recommended studies included determination of rates of sediment movement, assessment of engineering characteristics of the bottom and subbottom, further collection of data on suspended sediment flux, and continuation of monitoring for trace metal and hydrocarbon concentrations.

Summarization and interpretation of historical physical oceanographic and meteorological information for the Mid-Atlantic Region, Williams, R., and F. Godshall, National Oceanic and Atmospheric Administration, Washington, D.C., October 1977, 307 p. Available from National Technical Information Service, 2585 Royal Road, Springfield, Virginia 22161, paper $11.75/microfiche $3.00 (PB-277 104/AS).

Study objectives are to summarize meteorological and oceanographic data for the Mid-Atlantic Region, analyze the summarized data, and draw conclusions and offer recommendations for future work. Meteorological data used include historical records from National Weather Service coastal stations, standard marine surface observations from transient ships, and some meteorological buoy data. The main body of oceanographic data consists of salinity-temperature-depth (STD) and Nansen casts supplemented by ship-drift observations and current meter records. The surface wind field, which plays an important role in determining the movement of spilled oil and other pollutants, is described in detail. The physical characteristics of water masses in the Mid-Atlantic region, whose structure and variability are particularly relevant to the dispersion and advection of pollutants, are discussed and circulation features are analyzed.

Analysis of historical benthic macrofauna data from the Baltimore Canyon Trough, Radosh, D., A. Frame, T. Wilhelm, and R. Reid, National Marine Fisheries Service, Northeast Fisheries Center, Highlands, New Jersey, September 1978, 133 p. Available from the Bureau of Land Management, New York OCS Office, 26 Federal Plaza, Room 32-120, New York, New York 10007.

A benthic survey of two sites in the Baltimore Canyon Trough is presented. Surficial sediments are medium to fine sands. Heavy metal (Cd, Cr, Cu, Ni, Pb, Zn) concentrations in the sediments are low or undetectable and the benthic infauna is dominated by polychaetes and peracarid crustaceans. An assessment of possible impacts of oil-related activities on the shelf benthos is also presented.

Environmental consequences of onshore economic activity resulting from offshore oil and gas development in the Mid-Atlantic, Watson, A.L. and M. O'Farrell, International Research and Technology, Arlington, Virginia for Bureau of Land Management, Department of the Interior, 1978, 273 p., appendices. Available for review at Bureau of Land Management, New York OCS Office.

The report assesses the environmental impact of onshore economic activity resulting from potential offshore oil and gas development from OCS Sale No. 49 (second sale in the mid-Atlantic). The analysis is based on four hypothetical scenarios for several coastal counties, and the results are reported on a county-by-county basis. Increases in air or water pollutants greater than 10% are not estimated to occur as a result of this lease sale.

Middle Atlantic outer continental shelf environmental studies, Virginia Institute of Marine Science, Cloucester Point, Virginia, and U.S. Geological Survey, Woods Hole, Massachusetts, 1979, approximately 2000 p., 3 volumes (6 books), appendices and visuals. Available spring 1980 from National Technical Information Service, 2585 Royal Road, Springfield, Virginia 22161.

The second-year study by Virginia Institute of Marine Science was a continuation of the first year's work (see previous description). New tasks focused on the processes controlling benthic communities and on finfish distributions. The report synthesizes the data for both years of sampling. The results of both years can be summarized: (1) the water is characterized by a coastal boundary layer, shelf water, and slope water; (2) eggs and larvae of fishes and crustaceans are abundant in the spring neuston collections; (3) macrobenthos demonstrate little seasonality and are densest on the outer shelf; (4) local ridge and swale topography strongly influences the distribution of sediments, chemical constituents in the sediments, and benthic biota; (5) predation by demersal fish and epibenthic invertebrates is one factor which controls population levels; and (6) local ridge swale topography has little effect on the distribution of highly mobile demersal fishes. The second-year study also found that the "recovery rate" of a benthic community following a catastrophe is not simply a function of maturation time or longevity.

The second-year study by the USGS was a continuation of the first year's work. General objectives were to measure the rate of sediment mobility over the seabed and monitor resultant changes in bottom morphology and texture; to evaluate geotechnical properties of bottom and subbottom sediments and their potential hazard to oil and gas development; to determine the concentration, distribution, and flux of suspended particulate matter in the water column; and to determine the nature and distribution of high molecular weight hydrocarbons in the near-surface sediments at selected locations. In summary: (1) geologic environmental hazards in the area do not warrant withdrawal of lease tracts or preclude petroleum exploration or development, and (2) the probability of structural failures will be greatest during major winter storms or hurricanes. Recommended studies include continuing observation of currents and bottom conditions, assessing the kind and amount of suspended matter in the water column, determining the rate and depth of bottom sediment mixing, and identification and mapping of slumping and potential slump hazards on the upper continental slope.

### Completed North and Mid-Atlantic (Combined) Studies

Summary of environmental information on the continental slope--Canadian/United States Border to Cape Hatteras, North Carolina, Research Institute of the Gulf of Maine (TRIGOM) Portland, Maine. May 1976, 4 volumes, 1569 p., appendices. Available from National Technical Information Service, 5285 Royal Road, Springfield, Virginia 22161, paper $45 (PB-284 001-SET/ST).

This literature survey concentrates on the 200- to 2000-meter water depth of the outer continental slope from the Gulf of Maine to Cape Hatteras, North Carolina. Major topics included in this report are geological oceanography, meteorology, physical and chemical oceanography, submarine canyons, environmental quality, fisheries, ocean transport and hazards, archaeology and historic sites, and biological oceanography. The biological element is further broken down into phytoplankton, benthos, nekton, marine mammals, threatened or endangered species, and offshore birds.

A summary of environmental information on the continental shelf from the Bay of Fundy to Cape Hatteras, North Carolina, Center for Natural Areas, South Gardiner, Maine, December 1977, 3 volumes (5 books), 3000 p., bibliography and appendices. Available from the Bureau of Land Management, New York OCS Office.

The literature survey analyzes published, unpublished, and raw data from 1972 to 1977. Topics presented in the report are geology (nearshore and offshore), meteorology, physical oceanography, chemistry (hydrocarbons, trace metals, nutrients, pesticides, and radioactivity), phytoplankton, zooplankton, neuston, nekton, benthos, commercial fisheries, sport fisheries, benthic flora, marine mammals, marine birds, threatened or endangered species, microbiology, OCS uses, unique and endangered environments, and toxicity. The literature review also identifies data gaps and recommends studies to fill those gaps.

Establishment and operation of an East Coast continental shelf meteorological buoy monitoring network. NOAA/NDBO, Washington, D.C. Data tapes available at the Bureau of Land Management, New York OCS Office.

The objectives of this study are to establish a meteorological monitoring buoy network for the Atlantic Outer Continental Shelf. The buoys are providing data on near-surface wind speed and direction, air temperature, sea surface temperature, barometric pressure, and wind speed.

Summary and analysis of cultural resource information on the continental shelf from the Bay of Fundy to Cape Hatteras, Institute for Conservation Archaeology, Peabody Museum, Harvard University, 1979, 1000 p, visuals, appendices. Available for review in the New York OCS Office; and should be available spring 1980 from National Technical Information Service, 2585 Royal Road, Springfield, Virginia 22161.

The objectives of the study were (1) to review the late Quaternary geology of the area as it relates to cultural resources, (2) to assess and identify cultural resources located to date, (3) to determine the probability of resource occurrence by area and/or feature, (4) to identify potential pilot study areas, (5) to review present study techniques and recommend modifications of search and recovery techniques presently in use, and (6) to delineate significant data gaps. The study identifies various historic shipping zones and preserved archaeological zones on the OCS. The results of the geological review, the archaeological analysis, and the historic shipping assessment are integrated to develop cultural resource zones. The report also recommends management strategies for protecting cultural resources on the OCS.

### Studies proposed for 1980 funding

Effects of oil and noise on cetaceans (national study).

Assessment of geohazards and geotechnical properties (Mid- and North Atlantic).

Dominant physical canyon processes and their role in transmitting the effects of OCS activities to commercial epibenthic canyon fauna and corals (North and Mid-Atlantic).

Identification of marine mammal populations, habitats, and migration routes (North and Mid-Atlantic).

Economic cost to commercial and recreational fishing of oil spills (North Atlantic).

Interpretation of physical conditions and their application to pollutant transfer and biological resource modeling (North Atlantic).

Dominant physical slope processes and their role in transmitting the effects of OCS activities to continental slope benthos (Mid-Atlantic).

Evaluation of environmental and economic impacts of utilizing proposed pipeline corridors (Mid-Atlantic).

**Studies proposed for 1981 funding**

Effects of oil and operational discharges on finfish and shellfish (Mid- and North Atlantic).

Dominant physical slope processes and their role in transmitting the effects of OCS activities to continental slope benthos (Mid- and North Atlantic).

Effects of oil and noise on cetaceans (national study).

Assessment of geohazards and geotechnical properties (Mid- and North Atlantic).

Dominant physical canyon processes and their role in transmitting the effects of OCS activities to commercial epibenthic canyon fauna and corals (North and Mid-Atlantic).

Identification of marine mammal populations, habitats, and migration routes (North and Mid-Atlantic).

Centralization and utilization of regional environmental studies data (Mid- and North Atlantic).

Site-specific evaluation of environmental and economic impacts of utilizing proposed pipeline corridors in the Mid-Atlantic Region.

Literature survey on engineering techniques and mitigating measures (Mid- and North Atlantic).

Evaluation of environmental and economic impacts of utilizing proposed pipeline corridors in the North Atlantic.

Effects of oil on intertidal and nearshore subtidal communities (Mid- and North Atlantic).

Response of planktonic and benthic communities to effluents discharged during drilling operations (Mid- and North Atlantic).

Distribution and abundance of marine turtles (Mid- and North Atlantic).

Identification of nearshore and offshore bird populations (Mid- and North Atlantic).

Impacts of OCS-produced gas on the regional economy.

Impacts of OCS activities on seal populations.

Impacts of OCS oil and gas development on air quality (Mid- and North Atlantic).

Economic impact of oil spills on recreation and tourism (Mid- and North Atlantic).

Recreational fishing and utilization of habitat provided by platform placement on the OCS in the Mid-Atlantic.

Identification of pipe coating yard impacts.

## STATE STUDIES

A number of Mid-Atlantic States have done or are in the process of conducting studies on the possible impacts of OCS development. Requests for copies of State studies should be addressed to the State agencies for which the studies were done.

### Rhode Island

The redevelopment of Quonset/Davisville: an environmental assessment, for the Rhode Island Department of Economic Development, 1977, by the Coastal Resources Center of the University of Rhode Island, 200 p.

This study assesses the environmental impacts of redevelopment of Quonset and Davisville, concentrating on three development scenarios. The three scenarios assume a high find of oil and gas on Georges Bank, a medium find, and no find. The study concludes that a major redevelopment of Quonset/Davisville can be accomplished without significant adverse impacts on the environment.

Support bases for offshore drilling: the Port of New York potential, May 1977, for the New York State Department of Environmental Conservation, by the Port Authority of New York and New Jersey, 129 p.

Eight sites are identified as having potential to be used for OCS support bases, four in New York and four in New Jersey. The employment and economic effects of a support base on the New York area are projected. Employment and economic effects of a facility for constructing offshore drilling platform modules and components are also projected.

## Maryland

Assessing Maryland's prospects from OCS development: onshore support activities, October 1978, by the Office of Development Planning, Maryland Department of Economic and Community Development, 31 p.

This study makes an initial assessment of direct impacts on Maryland's economy of onshore support activities for exploratory drilling and production on the Mid-Atlantic OCS. It concludes that major onshore support facilities will not be built in Maryland, but that existing industries in the State may get contracts for repair, maintenance, and service work.

Maryland major facilities study, January 1978, for the Energy and Coastal Zone Administration of the Maryland Department of Natural Resources, by Rogers & Golden, Inc., and Alan Mallach/Associates, 4 volumes and executive summary.

Candidate areas for a number of types of major facilities, including OCS-related facilities, were found by identifying the locational factors required by each facility, and then identifying areas that fulfill all the factor requirements. The study also includes two assessment handbooks, one for environmental effects and one for economic, fiscal, and social effects. This study, conducted as part of Maryland's Coastal Zone Management Program, is not a policy document; rather, it was designed to provide information to decisionmakers.

## New Jersey

A study to identify corridors for a gas pipeline system, from landfall to junction with the interstate trunk system, in the southern half of New Jersey, forthcoming, for the Office of Planning and Policy Analysis of the New Jersey Department of Energy, by the Department of Geography and Environmental Engineering of Johns Hopkins University.

This study is developing a multi-objective location model based on a linear programming transshipment model. The model is designed to be able to focus on the relationships and tradeoffs among conflicting objectives, such as least cost vs. preservation of environmentally sensitive areas. Its purpose is to help the State analyze important implications of siting decisions for onshore OCS-related facilities.

## Virginia

Offshore pipeline corridors and landfalls in coastal Virginia, 1978, for the Virginia Coastal Resources Management Program, Office of the Secretary of Commerce and Resources, by the Virginia Institute of Marine Science, 2 volumes.

This study provides technical information on pipeline siting and construction requirements as well as on the potential environmental impacts associated with oil or gas pipelines. It is a technical planning document, and it makes no attempt to establish policy. The report concludes that there are few constraints for offshore pipeline corridors, but that a number of environmental and cultural factors constrain the location of pipeline landfalls.

A study to identify sites for a deepwater port, a pipeline landfall, and a complex of four to six refineries, forthcoming, by the Virginia Department of Commerce and Resources, OCS Activities.

The site identified for the refinery complex is 160 km (100 miles) inland. Refineries sited there could be used to refine OCS oil.

## LOCAL STUDIES

Serving the offshore oil industry: planning for onshore growth, Northampton County, December 1976, by the National Association of Counties, 55 p.

This is a case study of the onshore impacts of OCS-related energy development on a local community. The response of citizens and government in Northampton County, Virginia, to a construction company's plan to build a platform facility in their county is discussed. The study concludes that advance planning will assure that the impacts from OCS development will be positive, and it provides guidelines for managing growth induced by energy-related developments.

New Jersey county planning studies.

Twelve counties in New Jersey produced planning studies that evaluated the possible impacts of OCS activity within their borders and identified areas that might or might not be suitable for siting specific energy facilities. Authorized by Section 305 of the Coastal Zone Management Act, the Office of Coastal Zone Management of the New Jersey Department of Environmental Protection funded the studies of the following counties: Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, Hudson, Middlesex, Monmouth, Ocean, Salem, and Union.

## GLOSSARY

Definitions presented in the Glossary describe terms as they have been used in this Summary Report. The Glossary is intended for general reference only: for detailed descriptions of technical or specialized terms, the reader should seek a reference in the field of particular interest.

Sources used in compiling this glossary were the Mid-Atlantic Summary Report itself; the OCSIP Atlantic, Pacific, Gulf of Mexico, Alaska Indices; Webster's Third New International Dictionary; the American Geological Institute's Dictionary of Geological Terms; Langenkamp's Handbook of Oil Industry Terms and Phrases (2d ed.); the U.S. Department of the Interior, Fish and Wildlife Service's Steam Electric Power Plant Review Manual and Hydroelectric Power Plant Review Manual; and the Encyclopedic Dictionary of Exploration Geophysics.

**APD** - Application for Permit to Drill.

**Anticline** - An upfold or arch of stratified rock in which the beds or layers bend downward in opposite directions from the crest or axis of the fold.

**Baltimore Canyon Trough** - A deep sedimentary basin extending from Cape Hatteras northeastward to Long Island.

**Basin** - A depression of the earth in which sedimentary materials accumulate or have accumulated, usually characterized by continuous deposition over a long period of time; a broad area of the earth beneath which the strata dip, usually from the sides toward the center.

**BLM** - Bureau of Land Management.

**Block** - A geographical area, as portrayed on an official BLM protraction diagram or leasing map, that contains approximately 9 square miles (2,304 hectares or 5,760 acres).

**Calcareous** - Containing calcium or any calcium compound; consisting of calcium carbonate.

**Carbonate** - A group of minerals containing compounds of the radical $CO_3^{2-}$, or a rock composed primarily of such minerals, a limestone or dolomite.

**Casing** - Steel pipe used in oil wells to seal off fluids in the rocks from the bore hole and to prevent the walls of the hole from sloughing off or caving.

**Condensate** - Liquid hydrocarbons produced with natural gas which are separated from it by cooling and various other means.

**Consolidated** - Having become firm rock from a loosely aggregated or liquid condition through the effect of pressure, chemical action, or crystallization.

**Continental margin** - A zone separating the emergent continents from the deep sea bottom.

**Continental shelf** - A broad, gently sloping, shallow feature extending from the shore to the continental slope.

**Continental slope** - A relatively steep, narrow feature paralleling the continental shelf; the region in which the steepest descent to the ocean bottom occurs.

**COST** - Continental Offshore Stratigraphic Test

**Delineation well** - A well drilled subsequent to a discovery well in order to determine the geographic extent of an oil or gas field.

**Development** - Activities that take place following discovery of minerals in commercially attractive quantities, including but not limited to geophysical activity, drilling, platform construction, and operation of all directly related onshore support facilities; and that are for the purpose of ultimately producing the minerals discovered.

**Diapir** - A piercing fold; an anticlinal fold in which a mobile core, such as salt, has broken through the more brittle overlying rocks.

**Discovery** - A find of significant quantities of fluid hydrocarbons (cf. **show**).

**Dome** - A roughly symmetrical upfold, the beds dipping in all directions, more or less equally, from a point; any structural deformation characterized by local uplift approximately circular in outline, e.g., the salt domes of Louisiana and Texas.

**Drill cuttings** - Chips and small fragments of drilled rock that are brought to the surface by the flow of the drilling mud as it is circulated.

**Drill pipe** - Heavy, thick-walled steel pipe used in rotary drilling to turn the drill bit and to provide a conduit for the drilling mud.

**Drilling mud** - A special mixture of clay, water, or refined oil, and chemical additives pumped downhole through the drill pipe and drill bit. The mud cools the rapidly rotating bit; lubricates the drill pipe as it turns in the well bore; carries rock cuttings to the surface; serves as a plaster to prevent the wall of the bore hole from crumbling or collapsing; and provides the weight or hydrostatic head to prevent extraneous fluids from entering the well bore and to control downhole pressures that may be encountered.

**Dry hole** - A well drilled to a certain depth without finding commercially exploitable hydrocarbons.

**Economically recoverable resource estimate** - An assessment of the hydrocarbon potential that takes into account (1) physical and technological constraints on production and (2) the influence of costs of exploration and development and market price on industry investment in OCS exploration and production.

**EIS** - Environmental impact statement.

**Environmental impact statement** - A statement required by the National Environmental Policy Act of 1969 (NEPA) or similar State law in relation to any action significantly affecting the environment.

**Erosion/scour** - A loosening or dissolution of the seabed by high-velocity bottom currents, particularly those due to storms. Erosion and scour can mobilize sand and result in significant horizontal crest and trough displacements. Lateral migration of the crest can "strand" platform supports or wellhead plumbing by eroding the surrounding support materials.

**Exploration** - The process of searching for minerals. Exploration activities include (1) geophysical surveys where magnetic, gravity, seismic, or other systems are used to detect or imply the geologic conditions conducive to the accumulation of such minerals and (2) any drilling, whether on or off known geological structures. Exploration also includes the drilling of a well in which a discovery of oil or natural gas in paying quantities is made and the drilling of any additional well after such a discovery that is needed to delineate a reservoir and to enable the lessee to determine whether to proceed with development and production.

**Fault** - A fracture in the earth's crust accompanied by a displacement of one side of the fracture with respect to the other.

**Fault block** - A body of rock either completely or in part bounded by faults.

**Field** - An area underlain by one or more geologically related hydrocarbon reservoirs.

**14-day on/off shift** - A work pattern in which an employee works two weeks straight, then has two weeks off.

**Geochemical** - Of or relating to the science dealing with the chemical composition of and the actual or possible chemical changes in the crust of the earth.

**Geologic constraint** - A feature or condition posing difficulties for OCS operations that can be mitigated by design and engineering technology.

**Geologic hazard** - A feature or condition that, if undetected, may seriously jeopardize offshore oil and gas exploration and development activities and, once identified, may necessitate special engineering procedures or relocation of a well.

**Geologic trap** - An arrangement of rock strata involving their structural relations or varied lithology and texture that favors the accumulation of oil and gas.

**Geophysical** - Of or relating to the physics of the earth, including the fields of hydrology, oceanography, seismology, magnetism, radioactivity, and geology.

**Geophysical survey** - The exploration of an area in which geophysical properties and relationships unique to the area are measured by one or more geophysical methods.

**Geophysical traverse** - A survey line or series of connecting survey lines or a sequence of connecting profiles; seismic line.

**Geotechnical** - Of or relating to the study of the mechanical properties of soils or sediments. Used here in relation to the ability of the seabed to safely support man-made structures.

**Growth curve** - A graphic representation of the relative growth of a population during a sequence of similar-length periods.

**Hydrocarbon** - Any of a large class of organic compounds containing only carbon and hydrogen, comprising paraffins, olefins, members of the acetylene series, alicyclic hydrocarbons, and aromatic hydrocarbons, and occurring in many cases in petroleum, natural gas, coal, and bitumens.

**Igneous** - Relating to, resulting from, or suggestive of the intrusion or extrusion of magma or the activity of volcanoes.

**Incised** - Narrow or steep due to downward erosion; intersecting as a deep narrow cut.

**Intrusion** - A body of igneous rock resulting from solidification of the intruding magma; the plastic injection of masses of salt or shale into overlying rocks; magma, shale, or salt injected into overlying rocks.

**IPP** - Intergovernmental Planning Program for OCS Oil and Gas Leasing, Transportation and Related Facilities, Bureau of Land Management.

**Lagoon** - A shallow sound, channel, pond, or lake near or communicating with the sea or with a larger lake or a river.

**Land use** - The function for which people employ an area of land.

**Lease sale** - The public opening of sealed bids made after competitive auction for leases granting companies or individuals the right to explore for and develop certain minerals within a defined period of time.

**Line mile** - The linear distance of one mile by which geophysical surveys are measured. Such surveys are usually conducted in a grid pattern and the total mileage covered in crossing and recrossing the grid is expressed in terms of linear miles.

**Liquefaction** - Conversion of solid sediments into a mass which may have certain properties of a fluid.

**Logistic curve** - A curve representing a function involving an exponential and shaped like the letter S.

**Mass movement** - Unit movement of a portion of the land surface. Mass movement, or slumping, can occur where unconsolidated sediments are distributed over a steep gradient.

**Mid-Atlantic Region** - The offshore area extending from the tip of Long Island, New York, to Cape Hatteras, North Carolina.

**Mudstone** - A sedimentary rock made up of silt and clay-sized particles distinguished from shale by its lack of fissility.

**OCS** - Outer Continental Shelf.

**Outer Continental Shelf** - All submerged lands that comprise the continental margin adjacent to the U.S., which remains subject to Federal jurisdiction and control after enactment of the Submerged Lands Act (43 USC 1301 and 1302).

**OCSIP** - Outer Continental Shelf Oil and Gas Information Program.

**Organic matter** - Material derived from living organisms.

**Paleo** - Involving ancient forms or conditions.

**Permeability** - The capacity to be penetrated or diffused through; the ability to transmit fluids.

**Permeable** - Capable of being penetrated or diffused through.

**Petroleum** - An oily, flammable bituminous liquid that occurs in many places in the upper strata of the earth, either in seepages or in reservoir formations;

essentially a complex mixture of hydrocarbons of different types with small amounts of other substances; any of various substances (as natural gas or shale oil) similar in composition to petroleum.

**Platform** - A steel or concrete structure from which offshore wells are drilled.

**Porosity** - The capability to contain fluids within void spaces; the percent of open space in a rock.

**Porous** - Capable of containing fluids within void spaces.

**Primary sewage treatment** - The removal of solids from sewage.

**Production curve** - A curve plotted to show the relation between quantities produced during definite consecutive time intervals.

**Proprietary information** - Geologic and geophysical data and immediate derivatives thereof that cannot be released to the general public because of Federal law, regulations, or statutes, or because of contractual requirements.

**Province** - An area throughout which geological history has been essentially the same or that is characterized by particular structural, petrographical, or physiographical features.

**Recoverable resource estimate** - An assessment of oil and gas resources that takes into account the fact that physical and technological constraints dictate that only a portion of resources or reserves can be brought to the surface.

**Reef** - A sedimentary rock or part thereof built by sedimentary organisms, especially corals, and composed almost or exclusively of their remains.

**Refining** - Fractional distillation, usually followed by other processing (as cracking).

**Relief** - The elevations or inequalities of a land surface.

**Reserve estimate** - An assessment of the portion of the identified oil or gas resource that can be economically extracted.

**Reserves** - Portion of the identified oil or gas resource that can be economically extracted.

**Reservoir** - An accumulation of hydrocarbons that is separated from and not in communication with any other such accumulation.

**Resource** - Concentration of naturally occurring solid, liquid, or gaseous materials in or on the earth's crust.

**Rig** - Apparatus used for drilling an oil or gas well.

**Risked resource estimate** - An assessment of oil or gas resources that has been modified to take into account the estimator's confidence in his or her estimate (i.e., "risked" to account for the probability that economically recoverable resources will actually be found within the area of interest).

**Risked, economically recoverable resource estimate** - An assessment of oil or gas resources that has been modified to take into account (1) physical and technological constraints on production; (2) the influence of the costs of exploration and development and market price on industry investment in OCS exploration and production; and (3) the estimator's confidence in his or her estimate.

**Sandstone** - A sedimentary rock made up of sand that usually consists of quartz more or less firmly united by some cement (as silica, iron oxide, or calcium carbonate).

**Seabed** - The floor of a sea or ocean; land underlying the sea.

**Sediment** - Material or a mass of material deposited (as by water, wind, or glaciers).

**Sedimentary rocks** - Rock formed of mechanical, chemical, or organic sediment.

**Seismic** - Pertaining to, characteristic of, or produced by earthquakes or earth vibration; having to do with elastic waves in the earth.

**Seismic reflection profile** - A graphic representation of the seismic reflection data collected in a geophysical traverse.

**Seismic reflection survey** - A program for mapping geologic structures by creating seismic waves and observing their arrival times as they are reflected from discontinuities. The energy source for creating the waves is usually delivered to the earth for very short periods of time.

**Shale** - A fissile rock that is formed by the consolidation of clay, mud, or silt, has a finely stratified or laminated structure parallel to the bedding, and is composed of minerals that have been essentially unaltered since deposition.

**Show (of gas or oil)** - A find of a trace of hydrocarbons (cf. **discovery**).

**Side-scan sonar** - A method for locating irregularities on the seabed (rock outcrops, pipelines, shipwrecks, boulders, and variations in bottom sediments).

**Slumping** - (See **mass movement**).

**Source bed** - Rocks containing large amounts of organic matter that is transformed into hydrocarbons.

**Stratum (pl., strata)** - A tabular mass or thin sheet of sedimentary rock or earth of one kind formed by natural causes and made up usually of a series of layers lying between beds of other kinds.

**Stratigraphic trap** - A reservoir, capable of holding oil or gas, that is formed from a change in the character of the reservoir rock. Such a trap is harder to locate than a structural trap because it is not readily revealed by geological or geophysical surveys.

**Structural trap** - A reservoir, capable of holding oil or gas, that is formed from crustal movements in the earth that fold or fracture rock strata in such a manner that oil or gas accumulating in the strata are sealed off and cannot escape. In some cases "structure" may be synonymous with structural trap.

**Subsidence** - Movement in which there is no free side and surface material is displaced vertically downward with little or no horizontal component; a sinking of a large part of the earth's crust.

**Subsurface geology** - The study of structure, thickness, facies, correlation, etc. of rock formations beneath land or sea-floor surfaces by means of drilling for oil or water, core drilling, and geophysical prospecting.

**Summary Report** - Document prepared by the Department of the Interior pursuant to 30 CFR 252.4 that is intended to inform affected State and local governments as to current OCS reserve estimates, projections of magnitude and timing of development, transportation planning, and general location and nature of nearshore and onshore facilities.

**Supply boat** - Vessel that ferries food, water, fuel, and drilling supplies and equipment to a rig and returns to land with refuse that cannot be disposed of at sea.

**Surficial** - Of or relating to the earth's surface.

**Tract** - The geographical and legal extent of a single lease area; a convenient way of numbering blocks offered for sale so that they can be sequentially numbered in the process of offering.

**Trap** - A geologic feature that forms a reservoir enclosing and preventing the escape of accumulated fluids (hydrocarbons or water).

**Truncated** - Terminated abruptly as if cut or broken off.

**Unconsolidated** - Loose, soft, or liquid.

**Undiscovered resources** - Quantities of oil and gas estimated to exist outside known fields.

**USGS** - U.S. Geological Survey.

**Wellhead** - The top of a well; structure built over the top of a well.

**Well log** - A record of the progress made in drilling an oil well, including notes on formations penetrated, their depth, thickness, physical properties, and, if possible, contents.

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Outer Continental Shelf Oil and Gas Information Program: Mid-Atlantic Summary Report

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