R E V I E W D R A F T

(CHAPTER IV OF MAP BOOK ISSUES IN ALASKA'S DEVELOPMENT)

DEVELOPMENT OF ALASKA'S PETROLEUM RESOURCES

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The history of economic development in Alaska suggests a recurring pattern of generally unguided internal responses to overwhelming external forces of change, the benefits of which have flowed disproportionately to "outsiders." In what respects and to what extent will the new era of development, based on the production of potentially vast petroleum resources, prove to be different? Will Alaska leaders and institutions have greater leverage in determining the nature, rate, and consequences of economic development than they have been able to exert in the past? If, in the petroleum era, the state government is a major owner of the resources and the great wealth they represent, there might be reason to expect that now the State of Alaska can effectively negotiate if not independently chart its future course of growth and capture its fair share of the benefits. But even as new opportunities for doing so apparently emerge, the whole set of circumstances in which significant choices may be made is also being transformed. In effect, after registering the experiences of the past and learning something from them, one finds that the rules, the players, and the stakes of the game keep changing.

The State of Alaska is not the sole, or even the dominant resource owner, nor can Alaska be insulated from national and world forces which shape energy development policies. The federal government, now as in the past, is the biggest landlord and resource manager in Alaska and likely will remain pre-eminent in the future. Native corporations created under the Alaska

Native Claims Settlement Act are also aggressively establishing their places in the development process. And as federal and state governments and Native corporations, in pursuit of their often divergent objectives, look toward development of the resources they own, they are bringing the international petroleum industry, which has its own complex of interests, into the process. Thus, it is not clear what the future patterns of economic change in Alaska will look like or in what ways they will differ from those of the past. What does seem clear is that the scale of development will be much larger, and the consequences at least as far-reaching, as any previously experienced.

This chapter focuses on petroleum development and its direct implications for Alaska growth and change. It consists of four major sections: the first reviews petroleum development to the present time, the second presents estimates of the resource potential, the third discusses national energy demands and policies, and the fourth provides alternative projections of the future of Alaska petroleum development.

A. Review of Alaska Petroleum Development

1. Early Years[1]

The Prudhoe Bay discovery by Atlantic-Richfield in 1968 and the $900 million North Slope lease sale in 1969 in one step placed Alaska in the top ranks of oil-rich regions of the United States and the Western Hemisphere. But neither oil nor oil on the North Slope were previously unknown in Alaska. Oil seeps were observed as early as 1853 on Cook Inlet's western shore and, in the early 1900's, oil seeps on the Arctic coast east of Barrow were observed by Eskimos and traders. Systematic investigations of these Arctic coast seeps began in 1921 when the Standard Oil Company explored and attempted to stake claims to potential oil lands at Cape Simpson. These efforts ended when major discoveries in Oklahoma and Texas diverted industry attention from the potentials of this remotest of frontier areas. However, President Harding in 1923 designated 37,000 square miles of the North Slope as Naval Petroleum Reserve No. 4. The U.S. Geological Survey and the Navy explored Pet 4 between 1944 and 1953, concluded that a major petroleum province existed, and then abandoned their North Slope exploration program.

Petroleum exploration in other parts of Alaska also began early in the century. Wildcat wells were drilled in 1902 near Cold Bay on the Alaska Peninsula and in the Katalla district on the coast of the Gulf of Alaska east of Cordova. A small commercial discovery was made at Katalla, and a refinery was built in 1911. About 150,000 barrels of oil were produced from the Katalla field before the operation ended when the refinery burned down in 1931. Nearly three decades later a modern petroleum industry emerged in Alaska after the Richfield Oil Company's discovery of oil in 1957 at Swanson River on the Kenai Peninsula.

2. From Kenai to Prudhoe

There were three high production wells on the Kenai Peninsula by 1959, and exploration and development activities were extended to offshore Cook Inlet, where additional oil and gas fields were brought into production. At the end of the 1960's, five fields in the Kenai-Cook Inlet province were producing oil and nine fields were producing natural gas. By then, too, wildcat activities were scattered elsewhere throughout Alaska. Increasingly during the 1960s, however, exploration interest had been attracted to the North Slope, centering on Prudhoe Bay east of Pet 4. After Atlantic-Richfield's discovery, Alaska oil quickly became synonymous with Prudhoe Bay oil in most quarters inside and outside the state.

Nonetheless, for the Alaska economy, Kenai-Cook Inlet oil and gas production was an increasingly dominant factor in the 1960s. As measured by the wellhead value of production, petroleum had moved ahead of the fisheries and forest products industries by 1969. Wellhead value of oil and gas produced rose from $1.3 million in 1960 to $219 million in 1969, an amount almost as much as the value of fisheries and forest products combined and half of the value of total natural resources production in Alaska.

Further value was added by processing. A small refinery and petrochemical complex--consisting of two petroleum refineries producing a total of 40,000 barrels per day of jet, diesel, and heating fuels, an ammonia and urea plant, and a plant liquifying 135 million cubic feet of natural gas per day for transport to Japan--was established on the Kenai Peninsula near the Cook Inlet fields.[2]

By the end of the decade, and spurred in 1968 and 1969 by the North Slope discovery and lease sale, all major oil firms active in the state had set up regional headquarters in Anchorage. Most petroleum industry employment, however, was accounted for by contractor and service firms through which the major oil companies conduct their exploration and development operations. Many small companies supplying drilling, transportation, consulting, and construction services were distributed between the Anchorage and Kenai areas, while firms directly concerned with development and production activities were concentrated close to the producing fields on the Kenai Peninsula. Other small companies established headquarters in Anchorage and Fairbanks.

Levels and trends in petroleum production, state petroleum revenues, and petroleum industry-based employment and income indicate the steadily growing role of the industry in Alaska's economy during the 1960s and early 1970s, before a new and much higher plateau was reached with the start of construction of the trans-Alaska pipeline in 1974.

Crude Oil and Gas Production: Alaska in 1974 ranked eighth among the oil-producing states behind Texas, Louisiana, California, Oklahoma, Wyoming, New Mexico, and Kansas. Alaska's total 1974 production of 72 million barrels of oil, virtually all of which was from the Kenai-Cook Inlet fields, was only about 6 percent of first-ranked Texas oil production. Alaska ranked eleventh among the gas producing states, behind the previously named oil producing states as well as West Virginia, Arkansas, and Mississippi. Gross Alaska gas production of 231 million thousand cubic feet (MCF) in 1974 was only about 3 percent of that of the leading producer, Texas. Within Alaska, however, the growth in production throughout the 1960s and early 70s was a central feature in the state's economic development pattern. (Table 1.)

Value of Oil and Gas Production: The value of crude oil as it emerges from the well ("wellhead value") is calculated by subtracting the costs of transporting the oil from its price at the refinery. The wellhead value of gas, on the other hand, is a federally regulated price. The wellhead value of oil and gas produced in Alaska increased from $1.3 million in 1960 to $251 million in 1970. As a proportion of the total value of natural resources production in Alaska (including other minerals, fisheries products, forest products, furs, and commercial agricultural products), the value of oil and gas production rose from .7 percent in 1960 to 46 percent in 1970 (Table 2.)

State Oil and Gas Revenues: The major sources of state government oil and gas revenues are lease bonuses, royalties and production taxes (based on wellhead values), and the state's share of the federal government's rents and royalties from federal lands in Alaska. Since the early 1960s, revenues from petroleum activities have contributed a significant portion of total state government revenues. Oil and gas income as a percentage of state revenues has varied from 6 percent in fiscal 1961 to 82 percent in fiscal 1970, the year of the North Slope lease sale. However, bonuses from lease sales are unpredictable one-time payments and should be distinguished from other, more stable sources of petroleum industry-related income. Excluding bonuses, the state revenue pattern is much less volatile, with petroleum revenues varying from 4 percent of total state revenues in 1961 to a high of 18 percent in 1969. (Table 3.)

Mainly due to the North Slope lease sale, bonus payments have amounted to more than three times as much as all other direct sources of petroleum revenues to the state. The $900 million North Slope sale itself accounts for nine-tenths of the billion dollars total the state has received from all lease sales since statehood in 1959. The next highest cumulative dollar amounts have come from state royalties, totalling about $169 million from 1959 through 1974. After North Slope oil starts to flow in 1977 or 1978 and peak production rates are reached a few years later, total annual revenues from this source alone will likely exceed the cumulative total of all petroleum revenues received by the state during the first fifteen years of statehood.

Petroleum Industry Output, Employment, and Wages and Salaries: An earlier chapter of this report describes growth and change in Alaska's gross state product, that is, the total market value of all goods and services produced in the state, between 1961 and 1973. There it was shown that the mining sector of the economy--primarily oil and gas--was the outstanding growth sector during the period in real, or constant dollar, terms. The real output value of the oil and gas industry rose from $29 million in 1961 to a peak of $358 million 1969, accounted for one-third of the state's total real GSP growth over the 1961-1973 period, and increased its share of total real output from 4.3 percent in 1961 to 13.6 percent in 1973. (Table 4.)

However, it was also shown that, despite this dramatic expansion, the industry's direct impact on employment and income from wages and salaries was very limited. The major reason for this discrepancy is that exploration and production processes in the petroleum industry require relatively few workers. Even during the peak year of 1969, only 3,200 workers, or 2.5 percent of total employment in the state, were employed in the oil and gas industry. (Table 5.) Because of the small number of workers, industry wages and salaries of $52.7 million in that peak year represented only 4.9 percent of total wage and salary payments in the state. (Table 6.)

Thus, while petroleum development clearly has been a major factor in Alaska's economic growth, the industry's own growth in employment and wage and salary payments has not been an important component of the overall expansion. Rather, it was the indirect effects of oil exploration and development and revenues from oil production that promoted growth in other industries, particularly state and local government and the support sectors.

The revenues that will accrue to the state from North Slope and other new oil and gas production, and the state's expenditure and investment decisions, will be among the major determinants of economic and social change in Alaska in the years ahead. But before North Slope oil could flow and state petroleum revenues rise to unprecedented levels, a pipeline and related transport facilities had to be built. As it happened, pipeline construction was delayed for over four years after the 1969 lease sale.

3. 1969-1974 Developments

In the years between the 1969 North Slope lease sale and the 1974 construction start on the trans-Alaska pipeline, two major legal blocks to pipeline construction were removed. Further, world and national developments affecting the supply and price of oil and other forms of energy not only contributed to ending the period of delay, but created strong new forces for expanded and more rapid production of Alaska's onshore and offshore petroleum resources.

The first legal obstacle to pipeline construction was the freeze on virtually all Alaska land transactions because of Alaska Native land claims and related court injunctions. The second was a suit, based on requirements of the National Environmental Policy Act of 1969 and right-of-way width limitations of the Mineral Leasing Act of 1920, brought against the Secretary of the Interior by national environmentalist organizations. The reinforcing effect of both of these obstacles was to prevent the Secretary of the Interior from granting necessary pipeline rights-of-way and construction permits to the oil companies.

In December, 1971, the first of these obstacles was removed when Congress passed the Alaska Native Claims Settlement Act, which provided land and money grants to Native regional and village corporations. The act thus cleared the way for the Secretary of Interior to designate a pipeline corridor and to withdraw lands for that purpose. While the settlement act included provisions, generally supported by environmentalist organizations, authorizing the Secretary to withdraw 80 million acres of land for additional national parks, wildlife refuges, forests, and wild and scenic rivers in Alaska, it did not remove environmentalist objections and legal challenges to the granting of pipeline right-of-way and construction permits. The environmentalists' suit, Wilderness Society et. al. v. Secretary Morton, still remained to be decided in the federal courts.

The Circuit Court of Appeals for the District of Columbia handed down its decision in February, 1973. Avoiding the NEPA question, the court ruled that the Secretary lacked authority to grant rights-of-way across federal lands for large oil and gas pipelines because the Mineral Leasing Act of 1920 explicitly limited the width of such rights-of-way to only 25 feet on either side of a line. Trans-Alaska pipeline construction, together with a haul road and related facilities, would require at least 100 feet. Thus, after the Supreme Court refused to review the case, it was left to Congress to amend the Leasing Act and to deal with the NEPA issue, which would otherwise remain the grounds for further litigation.

The most critical event during the early 1970's affecting Alaska petroleum development was the onset of the international energy crisis. Fuel shortages and a price explosion world-wide and in the United States were caused by several factors, the roles and weights of which are likely to be debated for a long time to come. Important among these factors were: (1) rates of domestic (and world) energy demand increasing much faster and supplies increasing much slower than forecast by the industry; (2) a peaking of proved domestic oil reserves in the mid-1960's and declining rates of production of natural gas; (3) increasing environmental regulatory restraints on oil production (e.g. shutdown of the Santa Barbara offshore fields), on uses of high sulfur coal, and on other forms of energy production, distribution, and use; and (4) growing U.S. dependence on imports, particularly on oil from Middle Eastern and other members of the Organization of Petroleum Exporting Countries (OPEC) cartel. These and related conditions reinforced the growing oligopoly power and aggressiveness of the cartel, especially of its Arab members who exploited their control of oil as a "weapon" in international politics, and made possible a quadrupling of world oil prices in 1973 and 1974. The vulnerability of U.S. markets was underscored in the fall and winter of 1973-74 by the Arab embargo in the aftermath of the 1973 Arab-Israeli war.[3]

Whatever the causes of the crisis, these events precipitated or gave strong new impetus to federal government actions on a broad front to meet the short term supply crisis and to establish longer term energy development and conservation policies. Among these actions were, at the end of 1973, amendments to the Mineral Leasing Act right-of-way provisions and passage of the Trans-Alaska Pipeline Authorization Act. The Leasing Act amendments authorized the Secretary to grant wider rights-of-way and the Pipeline Act effectively exempted the trans-Alaska pipeline from further procedural delays under NEPA. Declaring that "The early development and delivery of oil and gas from Alaska's North Slope to domestic markets is in the national interest because of growing domestic shortages and increasing dependence upon insecure foreign sources,"[4] Congress removed the final obstacle to construction. Permits were soon granted and construction of the trans-Alaska pipeline began in the spring of 1974.

These were not the only crisis-related actions at the federal level having major consequences for Alaska petroleum development. In January 1974, President Nixon announced that the Interior Department would lease 10 million acres of Outer Continental Shelf (OCS) lands in 1975, including large areas off Alaska's coastline. An OCS leasing schedule, proposed by the federal Bureau of Land Management in 1974, would include areas of lower Cook Inlet and the northeast Gulf of Alaska in 1975, and additional areas in the Gulf, Bering Sea, Beaufort Sea, Bristol Bay, and Chukchi Sea in subsequent years through 1978. Further, the Navy Department in 1974 reactivated its exploration of Naval Petroleum Reserve No. 4, initiating a 10,000 line-mile seismic program and the drilling of 26 exploration wells. Finally, the

Bureau of Land Management in the same year undertook a "primary corridor system" study in Alaska to provide for the reservation of easements across public and prospective Native lands, with particular emphasis on transport needs for "high value energy resources" development.[5] Authority for the corridor study--which should be viewed as an adjunct to and in support of federal energy development policies--was provided in the same legislation that had removed the legal blocks to construction of the trans-Alaska pipeline.

Thus, by early 1974, interests in Alaska petroleum resources and prospects for large scale development had multiplied. Now, it was not only the state and major oil companies focussing on the North Slope, but also the federal government looking to the development of both onshore and offshore lands as a means of increasing domestic energy supplies and reducing dependence on imports, as well as Native regional corporations making plans to exploit the commercial values of lands, including oil and gas resources, granted them by the settlement act.

Estimates of potential Alaska onshore and offshore oil and gas supplies, distribution of ownership of these resources, and projections of national energy demands and federal policies likely to ensure a high level of Alaska petroleum development are presented in the following sections.

B. Alaska Petroleum Resource Potential

1. Introduction

Estimates of the total amount of oil and gas left to be discovered and produced in the United States are highly volatile and speculative. While estimates of future discovery and production rates are also highly uncertain, the greatest uncertainty is associated with estimates of resources yet to be discovered and produced, particularly in frontier areas. Thus, estimates of the undiscovered recoverable oil and gas resources[6] of Alaska and its Outer Continental Shelf are subject to great fluctuation. Yet, despite recent major reductions of estimates of these resources in Alaska and elsewhere in the U.S., Alaska and its Outer Continental Shelf continue to be identified as the nation's most promising targets for petroleum exploration and development, and the sources of the largest potential additions to U.S. petroleum supplies.

2. Recent Estimates of Resource Potential

The United States Geological Survey in 1974 estimated the nation's undiscovered recoverable oil and gas resources at 200 to 400 billion barrels of oil and 1,000 to 2,000 trillion cubic feet of gas. The State of Alaska's Division of Geological and Geophysical Survey, conservatively adapting the USGS estimates for Alaska and its Outer Continental Shelf, estimated Alaska's undiscovered renewable onshore and offshore resources at 76 billion barrels of oil and 440 trillion cubic feet of gas--about 25 percent and 30 percent, respectively, of the U.S. totals[7]. (Table 7.)

In May, 1975, USGS announced a drastic revision downward of its 1974 estimates for the U.S. and its major oil and gas regions, including Alaska.[8] The new estimates for the U.S. were 50 to 127 billion barrels of oil and 322 to 655 trillion cubic feet of gas. Of these totals, Alaska and its OCS accounted for 12 to 49 billion barrels of oil and 29 to 132 trillion cubic feet of gas, or about one-third and one-sixth, respectively, of the U.S. totals. (Table 8.)

The basic reason for the great differences between the 1974 and 1975 estimates is that the USGS shifted to different and much more conservative methods of estimating resources and presenting results in 1975. As noted by USGS in its 1975 report, the revised results "should be regarded as a first attempt to apply new methods to available information." USGS further noted that "these resource estimates are subject to revision as methodology improves, better data are acquired, technology changes, changing economic conditions are taken into account, and as deepwater areas are incorporated into the appraisal."[9]

The largest part of the difference between the 1974 and 1975 estimates of Alaska's potential was accounted for by reductions in estimates for "totally unexplored" areas in the western OCS (Bering Sea) and most of the central third of Alaska's land mass. In such areas, according to USGS, "the lack of discovered indigenous or adjacent recoverable hydrocarbons renders uncertainty sufficiently great that probability judgments at either high or low levels are weakened."[10] In the face of high uncertainty, USGS opted for estimates several times lower than its previous ones, especially for these areas.[11] USGS further emphasized the conservatism of its estimates by indicating that no attempt was made to appraise offshore potential beyond a depth of 200 meters, and, perhaps more importantly, that all estimates assume "price-cost relationships and technological trends generally prevailing in the recent years prior to 1974."[12]

The following discussion of Alaska oil and gas resource potential is based on the State Division of Geological and Geophysical Survey's 1974 estimates rather than USGS's 1975 revised estimates. This is appropriate for our purposes and can be done without significantly affecting the analysis because:

1. In both high and low sets of estimates, Alaska onshore and off-offshore resources account for a very substantial proportion of total U.S. resources and are therefore prime targets for exploration and development.[13]

2. The alternative projections of Alaska oil production through 1990 presented later in this chapter are not inconsistent with the low set of estimates.

3. The Division of Geological and Geophysical Survey provides estimates by basins and provinces, and relates them to potential federal, state, and Native corporation land ownership patterns; these data and estimates, not provided in the 1975 USGS report, are needed for making estimates (presented below) of federal, state, and Native ownership shares of the resources.

4. The estimated <u>proportionate</u> shares of federal, state, and Native ownership are not significantly affected by USGS's revised estimates.

5. The revised USGS estimates are intended to be very conservative in any case, and especially as they apply to Alaska and OCS frontiers.[14]

The above discussion refers to undiscovered recoverable resources. Another quite different set of estimates is calculated by the American Petroleum Institute, the industry's major trade association. These are estimates of "proved oil reserves," which are defined as "the estimated quantities of crude oil which geological and engineering data demonstrate with reasonable certainty to be recoverable from known reservoirs under existing economic and operating conditions."[15] These estimates are based exclusively on known deposits and assume no new discoveries, "extensions" of the estimates based on more complete knowledge of discovered fields, or "revisions" of the estimates based on improved recovery, lower costs, or higher oil prices. It should be noted that, together, extensions and revisions typically increase initial estimates of proved reserves in a newly discovered field by a factor of three to ten during the lifetime of the field.[16]

Proved reserves of U.S. crude oil in 1973 totaled about 35 billion barrels. Alaska's share of this was about 10.5 billion barrels or 30 percent of the U.S. total. North Slope discoveries accounted for almost 10 billion barrels of Alaska's proved oil reserves, and Cook Inlet for the remainder. Proved reserves of U.S. natural gas totaled about 250 trillion cubic feet (TCF). Alaska's share of this was about 30 TCF or 12 percent of the Total (Table 9). Again, the great bulk of Alaska's proved reserves was accounted for by North Slope reserves of 26 TCF.

3. Alaska Resource Potential

The Division of Geological and Geophysical Survey of Alaska's Department of Natural Resources in 1974 estimated the speculative recoverable resources[17] of oil and gas for each onshore basin and offshore petroleum province of the state (Table 10). Speculative onshore oil resources are estimated at 26 billion barrels, and offshore (mostly Outer Continental Shelf) at 50 billion barrels, for a total of 76 billion barrels. Speculative onshore natural gas resources are estimated at 96 TCF, and offshore at 344 TCF, for a total of 440 TCF.

"Discovered" resources, consisting of 10.5 billion barrels of oil and 29.7 TCF natural gas, are the North Slope-Prudhoe Bay proved reserves, together with the relatively small amounts of Cook Inlet proved reserves, as noted earlier. While classified as a "giant" oil and gas field, Prudhoe Bay represents only 11 percent of total speculative recoverable oil and 6 percent of the gas on the lands and Outer Continental Shelf of Alaska.

The Division comments as follows on its estimates of speculative recoverable resources:

> Estimates of this type are subject to a high degree of error. However, the figures are considered to be conservative, as they assume an average distribution of reserves based on reasonable and moderate limits of other producing areas. Historically, calculations of this type do not take into consideration the possibility of discovering giant oil fields. Thus, the discovery of Prudhoe Bay; the possibility of 14 billion barrels of oil in the Marsh Creek anticline in the Arctic National Wildlife Refuge (Hartman, 1973), the large structures in the Gulf of Alaska and the large sedimentary province in the Bering Sea all suggest that there is a much better than average chance that Alaska contains a number of giant oil fields. It is therefore considered that pessimistically the figures could be 25% too high, but with the addition of a few giant oil fields they may be 50% too low.[18]

Below, we attempt to allocate these estimated onshore and offshore oil and gas resources among the three major resource owners: the state of Alaska, the Native corporations, and the federal government. The estimated totals--26 billion barrels of oil and 96 TCF gas onshore, and 50 billion barrels of oil and 344 TCF gas offshore--are used as median estimates within a range of plus or minus 25 percent, rather than plus 50 and minus 25, as suggested by the Division.

4. Estimated State, Native, and Federal Shares

The method of allocating Alaska's estimated speculative recoverable resources between state, Native, and federal owners is essentially as follows:

1. The Division's estimated total onshore and offshore oil and gas resources are used as "control" figures, and a high-low range of plus or minus 25 percent is applied.
2. The Division's estimates of eventual proportions of oil and gas potential lands (onshore) under state, Native, and federal ownership are taken into account.[19]
3. Available estimates of oil resources in major federal withdrawals (Naval Petroleum Reserve No. 4 and Arctic National Wildlife Range) are used to estimate a minimum federal share.
4. Other factors affecting the allocation (e.g., state lands remaining available for leasing on the North Slope, pending land selections by Native corporations and the State) are identified to assist in establishing reasonable ranges.

5. Shares of speculative recoverable gas resources are assumed to be in the same proportions as the shares of oil.

a. Shares of Onshore Resources

Table 11 shows estimated state, Native, and federal shares of onshore resources. Below is more detailed explanation of the factors on which the estimates are based.

Federal share: The federal share of onshore resources is estimated at 12 to 22 billion barrels of oil and 45 to 80 TCF natural gas. This represents about two-thirds of total onshore speculative recoverable oil and gas resources. Included in the federal share are Pet 4 resources and Arctic Wildlife Range. The Arctic Wildlife Range includes the Marsh Creek anticline, which may hold 14 billion barrels of oil (see above quote), or something between 6 and 20 billion barrels.[20] Pet 4 oil resources have been estimated by Navy Department sources at from 10 to 33 billion barrels,[21] which we consider quite optimistic given the present state of knowledge about the Reserve. Finally, the federal government is likely to own approximately two-thirds of oil and gas potential lands in Alaska after completion of land allocations under the Alaska Native Claims Settlement Act and the Statehood Act.[22]

Native share: The Native share is estimated at 4 to 6 billion barrels of onshore oil resources and 15 to 22 TCF of onshore gas resources. This is about one-fifth of total onshore speculative recoverable resources. Included in the Native share are oil and gas potential lands withdrawn for Native selection on the North Slope, Selawik, Yukon-Koyukuk, Bethel, and Yukon-Kandik basins. If the Native corporations were to select all of the oil and gas potential lands available to them, they would own over one-fourth of all onshore oil and gas potential lands.[23] However, it is unlikely that their maximum share of oil and gas resources will be as high as one-fourth because (1) state selections and other federal withdrawals have pre-empted most of the oil and gas lands of greatest estimated potential and (2) Native selections will be guided to some extent by criteria (e.g., subsistence use) other than oil and gas potential.

State share: The state share of onshore speculative recoverable resources is estimated at 3 to 5 billion barrels of oil and 12 to 18 TCF of natural gas. This is about one-sixth of the total onshore speculative resources. Included are oil and gas potential lands south of Prudhoe Bay, west of Pet 4, onshore Bristol Bay, and onshore Gulf of Alaska. State oil and gas potential lands patented, tentatively approved, and applied for now amount to slightly less than one-tenth of all onshore oil and gas potential lands. The state proportion of resources is estimated to be higher than the state proportion of oil and gas potential lands because (1) early state selections (including Prudhoe Bay) gave high priority to potential oil and gas values and the state, therefore, selected the most promising known lands, and (2) the state may select additional oil and gas potential lands that are not selected by Natives or that are otherwise made available for state selection after action by Congress on existing federal withdrawals.

b. Shares of Offshore Resources

Table 12 shows estimated state and federal shares of speculative offshore oil and gas resources. The offshore area includes areas under state ownership within the three-mile limit of the territorial sea, and areas under federal ownership on the Outer Continental Shelf beyond the three-mile limit.

Federal share: The federal share of offshore speculative recoverable resources is estimated at 35 to 58 billion barrels of oil and 237 to 396 TCF of natural gas. This represents about nine-tenths of total offshore resources.

State share: The state share of offshore resources is estimated at 3 to 5 billion barrels of oil and 21 to 34 TCF of natural gas. This share, about one-tenth of total offshore resources, is significantly larger than the proportion of oil potential offshore areas that fall within the three-mile territorial limit of state ownership. However, the relatively larger state share of resources is predicated on (1) the extension of the onshore North Slope Basin into the Beaufort and Chukchi territorial seas, and (2) the extension of highly promising Gulf of Alaska geological structures into state offshore lands. Further, although the state's proportion of total offshore resources may be substantially less than one-tenth, the likely potentials of the territorial Beaufort Sea, Gulf of Alaska, and other state offshore areas seem sufficient to justify the estimate of 3 to 5 billion barrels of oil in absolute if not relative terms.

c. Shares of Total Resources

Table 13 sums total onshore and offshore speculative recoverable oil and gas resources, with breakdowns of total estimated state, Native, and federal shares. As indicated, the 57 to 96 billion barrels of oil and the 330 to 550 TCF of natural gas span a range of plus or minus 25 percent centering on the Division of Geological and Geophysical Survey's "conservative" point estimates of 76 billion barrels of oil and 440 TCF of natural gas. The state's 6 to 10 billion barrels of oil and 33 to 52 TCF of gas represent about 10 to 15 percent of total onshore and offshore speculative recoverable resources; the Native corporations' 4 to 6 billion barrels of oil and 15 to 22 TCF of gas, about 5 to 10 percent; and the federal government's 47 to 80 billion barrels of oil and 282 to 476 TCF of gas, about 80 to 85 percent.

5. Recapitulation

The speculative recoverable oil and gas resources in Alaska and its adjacent seas may account for as much as one-third or more of total undiscovered U.S. supplies of crude oil and natural gas. The bulk of these potential resources is likely to be found on the Outer Continental Shelf, where federal policies will govern their exploration and production. At the same time, most of the estimated onshore petroleum resources of Alaska are also believed to lie beneath lands owned and managed by the federal government. Estimates of state and Native corporation oil and gas resources are small by comparison, and there is presently little indication that either owns the equivalent of another Prudhoe Bay.

C. National Energy Demands and Policies

1. Introduction

If the potential petroleum resources of Alaska and its Outer Continental Shelf constitute a substantial proportion of total U.S. speculative resources, then Alaska and adjacent OCS oil and gas production is likely to contribute a similarly large proportion of the domestic supplies needed to meet national energy demands in the years ahead. Though U.S. energy demands may grow at rates lower than those of the recent past, demands will increasingly need to be met through the discovery and production of resources on frontiers both geographic and technological.

As a result of the 1973-74 energy crisis, the U.S. government is now moving rapidly to implement a policy of accelerated exploration and development of domestic energy supplies, with primary emphasis on petroleum, in order to reduce dependence on insecure oil imports and ultimately to achieve national energy "self-sufficiency." Both government and industry look to the geographic frontiers--Alaska and Outer Continental Shelf areas--as the major sources of new domestic oil and gas production beginning in the 1980s. Because of long research and development leadtimes, high costs, and uncertainties, alternative sources of energy at the technological frontiers--geothermal, solar, synthetic, oil shale and others--are not expected to be commercially significant until the 1990s or beyond. Nuclear power development has been slowed by technological and safety factors. Thus, for at least the foreseeable future, pressures for the development of Alaska and OCS petroleum resources are likely to remain very intense, and the implications of this for Alaska's future growth are far reaching.

2. Nature of the Energy Crisis

Between 1950 and 1973, the United States changed from a net exporter of energy resources to an importer, and at the end of the period, depended on foreign sources for 15 percent of its total energy supplies. Most of these imports were oil, with imported oil constituting 35 percent of U.S. oil supplies. OPEC nations supplied one-third, or about 2 million barrels per day, of these oil imports. During the 1950s and 60s, U.S. energy use more than doubled while the population increased by only slightly more than one-third. Between 1950 and 1965, the average annual rate of increase in energy consumption in the U.S. was 3.5 percent. Between 1965 and 1973 the rate or increase rose to 4.5 percent.[24]

In 1973, total U.S. energy consumption was 75.6 quadrillion British thermal units (quads), while domestic production was 62.0 quads (Table 14). The shortfall of 13.6 quads was met primarily by oil imports or approximately 6.3 million barrels per day (MMBD).[25] Thus, as noted by the Ford Foundations's Energy Policy Project, "the roots of our energy troubles go back to trends in production and consumption of energy that have persisted for some time."[26] The resulting shortfall in domestic production and growing dependence on imports set the stage for the 1973-74 Arab-OPEC quadruping of oil prices (from about $2.50 to $10 per barrel) and the embargo of oil exports to the United States.

The current "energy crisis," then, is not due to a world shortage of oil. (This is not to say that there may not be significant shortages in the longer term.) Rather it stems primarily from U.S. dependence on a critical margin of imported supplies priced several times higher than costs and that have been, and can be again, withheld for political reasons.[27] The stated policy of the Ford Administration is therefore to develop as rapidly as possible new domestic supplies of oil and gas, which may eventually be sold at prices lower than present OPEC oil rates, but high enough to provide U.S. energy producers with the necessary investment incentives. Moreover, as pronounced by President Ford in his 1975 State of the Union address, the goal of U.S. policy is not only to achieve self-sufficiency, but ultimately to "develop our energy technology and resources so that the United States has the ability to supply a significant share of the energy needs of the free world by the end of this century."[28] That the goal may be unreachable neither changes the consequences of striving for it nor reduces the pressure for intensified exploration and development.

3. Projections of U.S. Demand

Some sources project annual growth rates of U.S. energy demand between now and 1985 at levels comparable to those prevailing during the several years preceding the Arab embargo, or 4 to 5 percent. Others project substantially lower rates of growth. At the low end, rates of 1 to 2 percent have been considered possible though not necessarily likely, and would require very stringent conservation and demand management measures. The differences in projections are attributable essentially to varying judgements about such broad factors as the future state of the economy, as well as more specific and technical factors such as the sensitivity of energy demands to energy prices or the practicability and effectiveness of various energy development, conservation, and demand management policies. In virtually all cases, however, if the United States is to become less rather than more dependent on imports, substantial new domestic energy supplies--with major emphasis on oil and gas--will need to be found and developed, and prices will need to be maintained at levels sufficient to make this economically feasible.[29]

In terms of "base case" projections, that is, generally assuming "business as usual" without significant policy interventions, three estimates of 1985 U.S. energy demand are shown in Table 15. Growth rates of these magnitudes--from 3 to 4 percent--imply that, to reduce dependence on imports, there must either be accelerated development of domestic resources, or stringent conservation to reduce the rates of growth, or some combination of each. In fact, alternative energy "strategy scenarios" are built on just such options. The Federal Energy Administration, whose base case forecasts of demand are lower than most others previously published, generally concludes that domestic supply will fall considerably short of domestic demand unless (1) high prices are maintained and (2) major additions are made to supplies.[30] And mainly because of technological constraints, leadtime requirements, and environmental restrictions associated with other sources of energy, these additions must come largely from new and expanded supplies of petroleum.

4. Prices and Production

The Federal Energy Administration has made estimates of alternative levels of 1985 world oil prices, which provide a range within which U.S. policy decisions affecting domestic supply, demand, and prices are assessed. FEA's price estimates are based primarily on projections of world oil supply and demand, and assumptions about the economic and political behavior of Middle East OPEC countries, for these countries "dominate the world export market now, and will probably continue to set future world oil prices."[31] Of necessity, the analysis assumes that more or less imponderable events that could drastically affect the world price of oil, such as a world depression, will not occur.

FEA bases its analysis of 1985 world price levels on an assessment of:

1. projected import needs of major oil consuming nations in 1985 at world prices of $4, $7, and $11 per barrel;[32]
2. projected export capacities of Middle East countries in 1985;
3. production capabilities of those OPEC countries that may not be able to "absorb" all of the revenues generated at alternative world prices; and
4. alternative expectations about the capability of these countries to maintain the cohesion necessary to cut back production and fix prices.

The findings of the FEA analysis are that at $4 oil, world import demand would exceed OPEC's capacity to supply it; that OPEC countries with the most limited capacities to absorb revenues would need to forego only 22 percent of their <u>growth</u> in production capacity in order to maintain a $7 price; and that to maintain an $11 price, these countries would need to restrict production to present levels, which would require strong cohesion in the cartel. Based on these findings, FEA concludes that:

> in the Base Case, by 1985, a $7 price is likely, a price between $4 and $7 is possible, but unlikely, and action by OPEC to maintain a price close to $11 is possible although this will be affected by politics rather than economics. Therefore, throughout this [Project Independence] report each [alternative U.S. energy] strategy is evaluated at two price levels, $7 and $11 per barrel. The higher price brings us close to self sufficiency with a minimum of new Government

action, while the lower price can provide a large degree of independence provided that relatively strong Federal action is taken.[33]

The oil price question, however, presents a dilemma for U.S. policymakers. While the present OPEC-determined prices may be considered extortive, substantially lower prices could be destructive of U.S. policy aims. In order to assure the higher prices that could dampen domestic demand, encourage new domestic production, and thereby reduce or eliminate dependence on imports, direct government action would be necessary to counteract any precipitous drop in prices that could result either from deliberate action by OPEC or from a breakdown of the OPEC cartel. Thus, U.S. policy alternatives include various forms of price maintenance, with most attention currently being given by the Ford Administration to establishing a floor price and imposing tariffs on imports. The minimum price range generally believed necessary by the Administration is \$7 to \$9 per barrel.[34]

Table 16 summarizes the results of the FEA evaluation of alternative energy strategies at the two price levels of \$7 and \$11 per barrel in 1985. In all cases at \$7 world prices the U.S. would remain dependent on imports, including imports from "insecure sources." At prices between \$7 and \$11, independence might be achieved through successful application of one or a combination of accelerated supply and conservation and management strategies.[35]

Principal differences between the "business as usual," or base case, strategy and the accelerated supply strategy are that, under the latter, there would be higher levels of OCS leasing and drilling, the Naval Petroleum Reserves (including Alaska's Pet 4) would be opened, and there would be substantial advances in enhanced recovery technology. The conservation and demand management strategy includes a variety of measures affecting automobile efficiency and use, thermal efficiency in homes and offices, and the substitution of coal and coal-fired electric power for petroleum and natural gas. In terms of the FEA analysis, prices under $11 and less than optimum success of the accelerated supply and conservation strategies would result in more or less substantial gaps between domestic production and consumption.[36] Further, particularly for purposes of this discussion, it should be noted that under all strategies, "literally all the new oil production forecast comes from frontier areas in Alaska and the Atlantic OCS, or from improved tertiary recovery techniques."[37]

5. Implications for Alaska

The above discussion clearly shows that Alaska petroleum development plays a leading role in U.S. energy strategy scenarios. As shown in Table 17, Alaska, in FEA projections, is considered the major new source of oil in both business-as-usual and accelerated supply scenarios by 1985. Under the former, North Slope fields would supply most of the 3 million barrels per day from Alaska; under the latter, Naval Petroleum Reserve No. 4 would provide an additional 2 million barrels. Because of longer development leadtimes, relatively limited production (under 1 million barrels per day) is projected for Alaska OCS areas in 1985. Alaska oil production would nonetheless increase from less than 2 percent of total domestic production in 1974 to more than 25 percent in 1985.

While production levels and timetables undoubtedly will vary from FEA estimates, there is no doubt that Alaska's petroleum potential is a critical factor and that current and emerging national energy policies are depending heavily on it. Accordingly, FEA analysts comment as follows on prospects for petroleum development in Alaska:

> The implications of these production possibilities are immense. Developing oil and gas production to these levels would likely require another 48-inch oil pipeline; two gas pipelines; and depending on the routes chosen, sizeable numbers of tankers. Both Trans-Alaska and Mackenzie Valley pipeline routes may well be used. Moreover, the development of the Alaskan OCS area would require additional transportation facilities. Certain processing facilities could be required for both the North Slope and the OCS: at a minimum, some gas processing and additional LNG facilities would be needed. Moreover, a heavy investment in supplier and infrastructure facilities, primarily internal transportation, would be required to support these energy industry investments. This development of Alaskan resources would, however, have to take full account of environmental considerations.
>
> Some risk of damage to the human and natural environment is an inseparable part of almost any energy development activity. In Alaska, these risks are especially high. Most of Alaska is a pristine wilderness characterized by permafrost, fragile terrain, very low temperatures, severe winter weather, and is subject to earthquakes. Offshore and onshore development, especially transportation, involve greater risks than those encountered in most other oil and gas producing areas. Economic development of Alaska's petroleum and other mineral resources will change the face and way of life in Alaska, even if it were undertaken in an environmentally sound manner. For example, roads to service pipelines will open up vast areas of Alaskan wilderness to hunters, fishermen, and other recreational developments.
>
> The problem in the context of Project Independence is how to develop the vast oil and gas supplies in Alaska and their required processing and transportation facilities in a timely and environmentally acceptable manner....[38]

6. Major Uncertainties

All projections of energy supply, demand, and prices are surrounded by major uncertainties and, for purposes of analysis, assumptions are made as a way of coping with uncertainties. For example, the FEA assumes that demand is rather highly sensitive to price, that undiscovered domestic reserves are close to the lower end of the relatively high range then estimated by the United States Geological Survey (200 to 400 billion barrels of oil), and that many potential economic, logistical, and political problems that might impede exploration and development economics and timing can be substantially overcome. Thus, effective government policies are also assumed. Some of these policies are designed to control uncertainties that are more or less controllable (e.g., minimum price policies to counteract possible major short-run declines in world oil prices), and others are designed to minimize negative effects of uncertainties that are more or less uncontrollable (e.g., conservation and demand management measures to hedge against the possibility that adequate new supplies will not be forthcoming either because they do not exist or because they are not discovered within a given time frame).

Since major uncertainties that come into play (1) may not be controllable at all, (2) are not necessarily either reinforcing or offsetting, and (3) yet tend to be highly interrelated, FEA and similar estimates and projections are extremely difficult and hazardous to make. Major uncertainties affecting U.S. energy projections may be summarized as follows:

1. Amount of undiscovered resources and rates of discovery--Uncertainties involving projections of "undiscovered resources in as yet totally unexplored provinces and the finding rate per foot of exploratory drilling are so great that numerical estimates of this type are highly speculative."[39]

2. World and U.S. oil prices--These are directly determined by potentially volatile market factors of world supply and demand as well as by the highly uncertain political behavior of OPEC countries and by U.S. government price policies.

3. Sensitivity of demand to price--If demand is less sensitive to price than assumed, then the U.S. in the short run will be much more dependent than anticipated on oil imports and possibly more vulnerable to embargoes.
4. Economics and timing of field exploration and development--Here, a wide range of "micro" factors, including competition for available labor, material, and capital, and government field conservation, tax, and related policies can significantly affect exploration and production levels and schedules in specific areas.
5. Technology--Projections of domestic oil production, such as those made by FEA, are in part dependent on secondary and tertiary recovery techniques that have yet to be applied commercially; much greater technological uncertainties are, of course, associated with the longer range commercial development of other forms of energy such as solar and geothermal.
6. Access to resources--Factors here include the terms and conditions of government leasing policies and environmental regulation, together with as yet unresolved political conflicts between OCS-impact states and the federal government.
7. Facilities and transport--Limited availability of port facilities, tankers, pipelines, refineries, and other handling and processing capacities could result in bottlenecks significantly slowing the pace of petroleum development in some strategic areas, such as Alaska.

Currently, the greatest uncertainties and most intense controversies revolve around estimates of undiscovered domestic oil and gas resources and of discovery rates.[40] As recently reported by a federal energy policy study group:

> The largest uncertainty and sensitivity in our domestic energy supply concerns the future amount of economically-useful conventional oil and gas. Their discovery will depend principally on U.S. leasing policy and good luck. This means that the supply outlook in 1985 will depend overwhelmingly on whether the U.S. discovers more giant and super-giant oil fields--most likely in Alaska and the Outer Continental Shelf.[41]

The above comment focuses primarily on uncertain discovery rates. These can be affected to some extent by government policy, i.e., through rapid and massive leasing activity--which is basically the present federal policy. A more fundamental constraint and uncertainty is the total amount of domestic oil and gas resources remaining to be discovered. If the more pessimistic estimates of these resources (100 billion barrels or less rather than USGS's earlier estimates of 200-400 billion barrels) are correct, or if federal policy makers are persuaded to accept the premise that they are correct (which adds yet another layer of uncertainty), then the whole policy strategy of accelerated development of conventional oil and gas resources may need to be reassessed.

The argument here is that rapid development of more limited resources will result in accelerated exhaustion, and therefore greater rather than less dependence on imports in the period before more exotic alternative energy sources can be commercially produced. Since oil shale, synthetic fuels from coal, geothermal power, and solar power are not expected to contribute significantly to the nation's energy supply until the end of the century or beyond, the depletion of oil and gas might make the U.S. a great deal more dependent on imports in the future than it is now. Thus, it is argued, if the pessimistic estimates of domestic resources are correct--or if the premise is adopted as a basis for policy--then to minimize energy dependence and vulnerability, a rational course would be to limit oil and gas production, impose stringent restraints on consumption, and attempt to speed development of the alternative sources.[42]

A further complicating dimension is added to this argument by the current excess of world oil supply over demand, and recent discoveries of "secure" supplies of oil in the North Sea, Mexico, and elsewhere, which together might help support the U.S. through short term (or even longer term) domestic shortages without rapid development of domestic supplies. Moreover, accelerated OCS leasing would not in any case result in significant production until after 1985, by which time some analysts expect that "worldwide supplies will grow sufficiently in excess of demand so that the consuming countries could dispense with supplies from any single exporting country.... The U.S., in particular, would be able to do without any oil production originating from OPEC nations."[43]

Compounding the difficulty of assessing the various arguments about undiscovered domestic resources are the conflicting interests and values represented in the controversy. Indeed, an unusual array of interests opts for relatively conservative assumptions about the amount of oil and gas remaining to be found: industry spokesmen, whose low estimates are consistent with a continuing high price strategy; conservationists, who fear potential environmental damages of a rapid OCS development policy; members of Congress, many of whom are at least skeptical of industry and Administration energy policy positions and whose constituencies in OCS states may stand to lose more than gain from rapid leasing and development; and some petroleum geologists and other experts, whose professional values and identifications incline them toward greater caution in estimating "speculative" reserves in the absence of "hard facts." Further, there are defenders of a rapid exploration and development program, including both industry and government officials, who want to have it both ways: if estimates are low, this means greater efforts must be made at least to find the undiscovered resources; if estimates are high, this helps justify more rapid development and use of the resources.

Our purpose in this discussion has not been to attempt to identify all of the uncertainties bearing upon national energy policy or to deal exhaustively with any of them. Rather, it has been to suggest the range and complexity of the factors affecting national energy assessments, the demand for Alaska and OCS oil and gas resources, and prospects for their development during the next fifteen years.

7. Conclusion

If the federal government continues to pursue the objective of energy self-sufficiency, or at least the reduction of imports, and this effort is supported by a policy of price maintenance, then Alaska and OCS oil and gas resources will remain in very high demand and they will be commercially developed for sale at prices within a range of at least \$7 to \$11 per barrel at the refinery. At present, this prospect seems reasonably likely, although it is qualified by a broad array of uncertainties and assumptions, some of which are more volatile and sensitive than others.

D. The Future of Alaska Petroleum Development

1. Introduction

Production of the proved oil reserves at Prudhoe Bay alone is expected to result in up to $1 billion in new revenues annually to the State of Alaska by 1980. This contrasts with total state revenues from state sources of about $300 million in 1975. The new Prudhoe Bay revenues will be based on production of 1.75 million barrels of oil a day. This production rate contrasts with about 200,000 barrels a day from Cook Inlet in 1975, which is only 11 percent of estimated Prudhoe Bay production in 1980. Thus, bringing Prudhoe on stream may result in a four-fold increase in total state revenues and a nine-fold increase in Alaska oil production within the next five years.

But Prudhoe is apparently only the beginning of truly large scale petroleum development in Alaska. The state government probably has substantial additional petroleum resources that can be developed; Native corporations are likely to acquire title to significant resources of their own; and, most importantly, the federal government is commited to massive development of its own far larger potential resources on Alaska's Outer Continental Shelf and possibly elsewhere on federal lands in the state. Some of these additional resources would likely be developed without federal intervention, if only because of the Native corporations' interest in realizing the largest possible returns on their newly acquired lands, and because of the production and transport facilities and industrial momentum generated by the Prudhoe Bay discovery. But the energy crisis of 1973-74, the price explosion, and the national drive toward energy "self sufficiency" added a powerful new stimulus to U.S. domestic petroleum development, with special emphasis on Alaska resources. As previously indicated, Alaska, including OCS, oil and gas may constitute a third or more of total U.S. undiscovered oil and gas resources. Accordingly, the Ford Administration's Project Independence looks to Alaska and its Outer Continental Shelf for the single largest increment of new oil and gas supplies to meet national energy demands by 1985. Federally inspired petroleum development in Alaska, in turn, will likely trigger greater production from state and Native lands both by lowering the cost of development through provision of basic infrastructure, including transport facilities, and by forcing the state and the Native corporations to compete in the oil leasing market.

As a result, by 1985, Alaska may very well be producing the five or more million barrels of oil a day projected for the state by Project Independence, and possibly eight million barrels a day may be produced from Alaska lands and offshore areas by 1990. Further, in terms of revenues from petroleum development on its own and on Native lands, the state may double, and possibly triple, the annual $1 billion in revenues it will realize from Prudhoe Bay alone. Finally, the new employment and escalated levels of government income and expenditures implied by these developments will mean increases in general economic activity, in population, and in associated public policy problems and opportunities well beyond what most Alaska policy makers have so far contemplated.

The following discussion establishes the framework needed for projecting growth that will be stimulated by alternative levels of petroleum development and related leasing, taxation, and expenditure policies. After a review of the setting for development and of basic elements of policy, these alternatives are presented in the form of three cases, or "scenarios," which show employment, revenue, and other effects of "limited," "accelerated," and "maximum" petroleum development in Alaska through 1990.

2. Policy Setting and Process

Alaska petroleum development will result from and reflect a complex interaction of federal, state, Native corporation, and industrial objectives and interests. In some cases these objectives and interests will be compatible and even reinforcing, and, in others, they will conflict. Critical elements of the petroleum policy setting and process can be identified under the headings of developmental interactions; short term and long term considerations; national, state and Native interests; range of choice open to state policy makers; and uncertainties peculiar to Alaska.

a. Developmental Interactions

Petroleum development decisions in Alaska do not and will not occur independently and in isolation from one another. The decision to open and develop a major field, say, by the state, brings a chain reaction of further decisions and actions by the state and other interests in Alaska petroleum development. Decisions to develop or not to develop in given areas by one party can facilitate or hinder the developmental programs of other parties.

The general pattern of interdependency is illustrated by some existing and potential cases:

1. State leasing of Prudhoe Bay resulted in windfall revenues in 1969, which immediately led to major increases in state expenditures and expectations of substantial new revenues and expenditures to come. With the delay in pipeline construction a "fiscal gap" opened and the state was forced to consider further moves, including additional leasing, to obtain increased revenues. Even without the gap, however, additional leasing on the North Slope or its offshore areas by the state and the Arctic Slope Regional Corporation would likely occur anyway because Prudhoe Bay developments has made such leasing appear relatively easy, attractive, and profitable. A high-capacity trans-Alaska oil pipeline will facilitate further leasing by the Native Corporations as well as the state. It has already stimulated plans to build a refinery near Fairbanks. Further, a gas line from Prudhoe is to be built, and its prospective construction and operation has added its own impetus, including the stimulation of interest in using the gas to develop a processing and manufacturing industry in Alaska--assuming the gas line also traverses the state.

2. "Opening up" the North Slope has made the Beaufort Sea a prime area for leasing by both State and federal governments. It has also directed increased attention to the potentials of Pet 4 and to the equally significant potentials of the Arctic Wildlife Range. (A gas pipeline across or adjacent to the Range might be viewed as a further wedge for such development.) Any substantial new field development onshore or offshore would require an additional oil line, and this would be a near certainty if Pet 4 were opened. The added transport capacity, in turn, might make further state,

Native, and federal leasing economically feasible onshore and offshore west of Pet 4, possibly including Chukchi Sea OCS areas.

3. Western onshore and offshore developments generally, however, are more likely to be initiated under the federal government's accelerated OCS leasing program. If Chukchi and Bering Sea areas are leased and major discoveries are made, western Alaska oil and gas pipelines would be necessary, and they, in turn, would provide the means for transporting oil and gas from Native lands in western onshore areas which probably could not otherwise be developed, again assuming commercial discoveries are made on such lands. Further, given the checkerboard pattern of state and Native land holdings that will occur under the terms of the Alaska Native Claims Settlement Act, the state might find it desirable and necessary to protect its interests by leasing in western areas of the state as well.

These examples are by no means exhaustive of the range of potential interactions, nor are they complete in themselves. Other kinds of interactions might well occur in other areas, for example, the Gulf of Alaska, where petroleum structures are believed to straddle the three mile territorial limit between state and federal offshore areas. Federal leasing might therefore force as well as facilitate adjacent state leasing. In any case, one set of consequences of linked decisions and actions such as these is to greatly increase employment, personal income, state revenues and expenditures, and population. This is a process that once in motion, beings to feed on itself: growing expectations and needs for public and private facilities and services by an expanding population, and increasingly higher levels of spending by public and private sectors, provide the rationale and the continuously renewed impetus for further petroleum development activities, which, as we have tried to illustrate, will often force or facilitate each other directly.

b. Short Term and Long Term

Policy making for Alaska petroleum development is occuring within a context of short term pressures and long term consequences and uncertainties. We have discussed in a previous section national and international energy supply and demand factors bearing on petroleum development in Alaska. The nation's short term (through the mid-1980's) petroleum supply problem--essentially, dependence on high priced imports subject to Arab embargo--has resulted in the federal policy of rapid leasing, exploration, and development of new domestic resources. This has placed great pressure on development of Alaska and OCS oil and gas, even though major new suppies would not be available until the presumed end of the crisis period. Thus, the actions to produce major supplies from Alaska over the longer run are the result of a crisis which conceivably could be met by other means, including new imports from secure sources, before substantial Alaska supplies come on stream. This leaves the prospects for major development of Alaska resources largely to be determined by federal policy makers whose import, price, and development policies could drastically change within the next five to ten years. However, it seems more likely that the short term crisis has ensured accelerated development of Alaska and other domestic resources, if only to help protect the U.S. against future vulnerability after the current crisis period has passed.

A different dimension of short term and long term factors is represented by the phases of exploration, development, and operation of oil fields, and construction and operation of transport facilities, including pipelines. In general, the construction, exploration, and development activities, involving rapid increases in employment, cause short term economic booms, while operations---(production and transport of oil and gas), although requiring comparatively little employment, bring about the truly significant long term economic impacts through the generation and expenditure of public revenues with their multiplier effects in the economy. This perspective would apply without qualification in Alaska if Prudhoe Bay and the trans-Alaska pipeline were the only significant construction and development activities in sight. However, with the prospect of several potentially large fields being explored and developed and additional pipelines being constructed over the next ten to fifteen years and more, Alaska may experience a series of "short term" booms which overlap for several years with the long term impacts from state expenditure of even larger amounts of new oil revenues.

A third set of short and long term factors is introduced by the state's prospective fiscal gap, as noted earlier. Here, the significance is that short term actions to close the gap could have important long term consequences, particularly if completion of the pipeline is delayed beyond 1977 and the state is forced to raise revenues by means that either further accelerate petroleum development (e.g. additional leasing), mortgage or sell its future resources (e.g., sales of options on Prudhoe Bay royalty oil and gas), or lead the oil industry to bid less for Alaska leases or direct more attention to other areas and lease sellers (e.g. new and increased taxes). On the other hand, these concerns are much more likely to be truly short term than the others mentioned and, further, the effects of the state's immediate fiscal decisions are likely to be very limited relative to the context of large scale development within which they will be effected and over which the state has relatively little control.

c. National, State and Native Interests

The overriding national interest in Alaska and OCS petroleum resources is to find and develop them rapidly and to assure the availability of the port, pipeline, and related facilities necessary to deliver them to processors and markets. As pointed out by the Federal Energy Administration, however, Alaska and other coastal states

> are concerned with the environmental, social and economic effects of OCS development. There will be certain adverse environmental effects associated with OCS drilling and production. These effects will vary by area. For example, development in areas with extreme weather and seismic conditions, such as Alaska, have much greater risks of environmental damage than other areas, and production may be precluded or seriously limited. The onshore effects of OCS development may be particularly significant. An infrastructure of maintenance facilities, refineries, petrochemical plants, construction and supporting services may result from nearby OCS production.[44]

FEA also acknowledges that accelerated OCS leasing may "mean that more tracts receive few bids and lower bids per tract, and hence there is a threat to the leasing goal of a return of fair value to the public."[45] For Alaska in particular, with several promising onshore and near shore areas under state ownership, this might also mean fewer and lower bids for tracts offered for sale by the state. Thus, the State of Alaska shares with other coastal states an interest in delaying or possibly reducing proposed OCS leasing schedules, and in obtaining maximum shares of the revenues generated by OCS leasing and production. Alaska Native corporations, on the other hand, while also competing in the leasing market, might well benefit from federal lease sales in the Bering and Chukchi Seas, for, as previously indicated, the value of their presumably limited resources would increase and their development would be facilitated by the industrial infrastructure accompanying OCS development. In general, the competition of federal, state, and Native lease sellers in Alaska could mean that their returns from Alaska and OCS oil and gas resources will be less than would have been realized through individual sales spread over a longer time period, or without each other's competition.

It is very unlikely that the federal administration will agree to, or that Congress will allow, substantial OCS revenue sharing with the coastal states anywhere near the proportions (25 percent, 37 1/2 percent) currently proposed by Alaska and other members of Congress. For Alaska, revenue sharing at such levels would eventually mean transfers from the federal treasury in the hundreds of millions of dollars per year, which is clearly an unrealistic prospect. Therefcre, in the petroleum development scenarios set forth below, we project an alternative of relatively limited OCS revenue sharing, which may take the form of direct grants for demonstrated impacts. It is possible, however, that the combined resistance of the coastal states to rapid and large scale OCS leasing, together with logistical, technical and economic obstacles inherent in the schedules themselves, will result in delaying or reducing the proposed leasing program. Thus, our three scenarios include the alternatives of limited, accelerated, and maximum OCS as well as other leasing in Alaska, and we analyze these alternatives separately.

There are also substantial differences between state and Native corporation interests in Alaska petroleum development, and the most important of them have already surfaced. First is their competing claims to potential petroleum lands, which was an element of the land claims movement, is reflected in the land allocations of the settlement act, and is still being negotiated and compromised. Second is the issue of oil and gas taxation, which emerged in recent state legislation to tax oil and gas reserves in place, and is very likely to rise again each time the state proposes to increase oil and gas production taxes. Third is the question of state land use planning and controls, which, from the Native corporation point of view, poses threats to the unfettered development of their potential oil and gas lands and of the transport, storage, and processing facilities they will require. This third set of differences was and remains quite prominent in the conflict between the state administration and the Native corporations and other local interests over the establishment of a coastal zone management program, and it will continue to effect state efforts to initiate land and water use planning and controls on a statewide basis. Coastal zone management is similarly a focus of state and federal conflicts over the OCS leasing program, and for similar reasons.

d. Range of Choice

Viewing the federal government and Native Corporations as more or less autonomous actors, the fundamental question implicit in our whole discussion of Alaska petroleum development may be posed as follows: What is the effective range of choice open to state policy makers as they attempt to control or manage the level, rate, quality, and distribution of economic and population growth in Alaska? A major purpose of this report is in fact to provide a base and contribute to the development of an analytical framework for dealing with this question, which, stated so broadly, may not be directly answerable. What can be done, however, is to establish a range of potential levels and rates of growth generated by petroleum development, and indicate key decisions about leasing, taxation, state government spending and saving, and related matters that might be made to influence the course of Alaska's future growth.

The three scenarios below represent a range of alternatives intended to bracket the direct effects of what is likely to be done by federal, state, and Native corporate policy makers in the field of petroleum development. Obviously, only a portion of this field is controlled by the state and, from what we have said so far, it should be clear that the state government is not entirely free to determine its course even in its own area of "control." Yet, knowing something about the range of probable developments and some of the critical effects, it becomes possible to anticipate magnitudes and rates of state-wide and regional growth and identify points at which critical decisions might be made, even if largely in response to forces of growth set in motion by the more or less uncontrollable actions of others. Subsequent chapters of this report.

contribute further to the development of the framework for policy making by identifying basic alternatives for fiscal policy, integrating them with the petroleum development alternatives, projecting Alaska's potential paths of growth, and discussing some of the main issues and prospects implicit in the projections.

e. Uncertainties

There are several levels and kinds of uncertainty affecting Alaska petroleum development, and we have already dealt with some of the most important of them. First is the international energy outlook which is shaped by both politics and economics. Second is national energy supply, demand management, and price policies, which are being determined largely in response to the international politics of oil. Third is a range of factors associated with the resources themselves and their development: estimates of undiscovered oil and gas, discovery rates, and timing and rates of production. Fourth is a number of contingencies more or less peculiar to Alaska.

These latter uncertainties relate to the unresolved status of ownership of Alaska lands and some offshore areas which affects access to the potential resources and the availability of transportation routes and facilities. The Division of Geophysical and Geological Survey of the Alaska Department of Natural Resources estimated in 1974, for example, that approximately 96 percent of the oil potential lands of the state were then unavailable for leasing because of land withdrawals under the Alaska Native Claims Settlement Act together with previous federal withdrawals for park, refuge, hydroelectric power project, and other purposes.[46] Land allocations and titles are, however, now being established under the settlement act and the statehood act, and Congress will have completed most of the other land designations required under the settlement act by 1978. Our projections, therefore, assume that this source of present uncertainty will be largely removed within the next few years. There will be other, more difficult land ownership problems remaining to be resolved in subsequent years, including federal and state conflicts over determinations of offshore boundaries, and overlapping federal, state, and Native conflicts relating to definitions of navigable waters and the designation of transportation corridors across lands owned or claimed by each.

In general, land ownership issues do not appear to pose long term or major barriers to Alaska oil development. Relatively few petroleum potential lands apparently are affected; to the extent that they are, we assume that the ownership issues will be resolved under the pressure to bring Alaska and OCS oil and gas to market. Establishment of transportation corridors across certain federal lands (parks, refuges, wilderness areas) as well as Native and state lands, may at least be delayed, however, and this prospect is implicitly accounted for by the alternative rates of development included in the scenarios below.

3. State, Federal, and Native Leasing

A previous section of this chapter ("Alaska Petroleum Resource Potential") presented estimates of the potentially recoverable undiscovered oil and gas resources of Alaska onshore and offshore areas, and attempted to allocate ownership of these resources to the State of Alaska, the federal government and Native corporations. Here, for purposes of constructing the scenarios set forth below, we identify known or likely leasing priorities of the resource owners, taking into account the phenomenon of developmental interaction or interdependency discussed earlier. This, together with the data on resource potential, will provide the basis for estimating the timing, locations, and sizes of potential lease sales by the owners, as depicted in the scenarios.

a. State Leasing

While the "go slow" posture of the current state administration contrasts with that of previous administrations, there is, as a result of circumstances, apparent continuity in the scheme of leasing priorities.[47] Early leasing is likely to take place in the major area of the state already opened to petroleum development, the North Slope and its offshore areas. The state has in fact begun studies in preparation for a Beaufort Sea sale offshore of Prudhoe Bay. Next might come areas adjacent or near to prospective federal OCS sale areas in the Gulf of Alaska. Depending on federal activities, particularly in Pet 4 and the Chukchi Sea, further state sales would be possible in the areas west of Pet 4, northwestern offshore areas, and lastly, offshore Bristol Bay. Taking proved and promising state lands into account, we would group prospective state leasing areas as follows, ranking them roughly in terms of both probability of leasing and the order in which they might be leased over time.

Group I - Beaufort Sea
North Slope Uplands

Group II - Gulf of Alaska (onshore and offshore)
West of Pet 4

Group III - Chukchi - Hope Basin (offshore Kotzebue Sound)
Bristol Bay

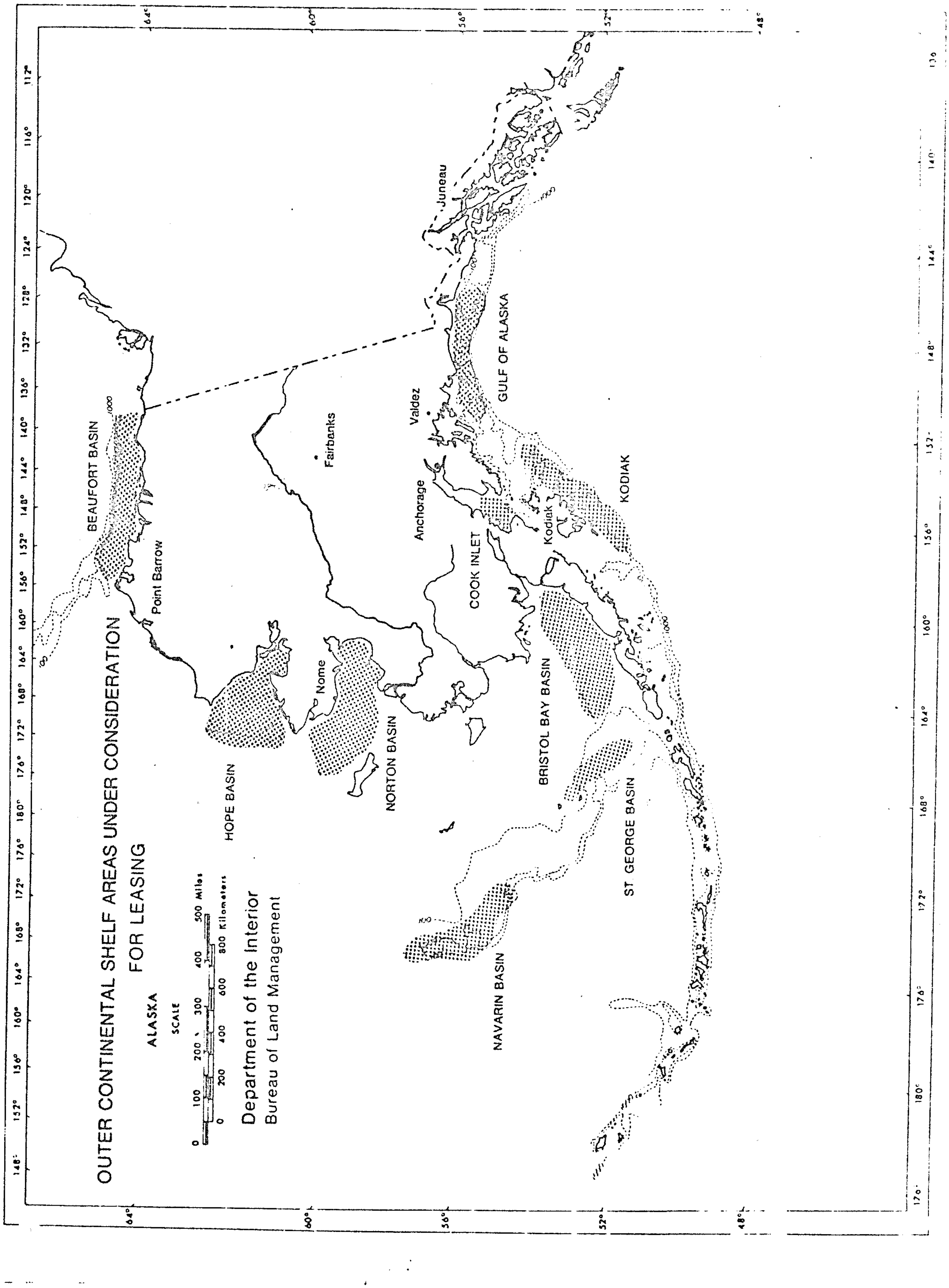
State as well as Native corporation leasing activity is likely to pivot on federal leasing on the Outer Continental Shelf and elsewhere in Alaska.

b. Federal Leasing

The federal Bureau of Land Management announced a schedule of proposed OCS lease sales in November 1974.[48] The schedule included nine potential sales in Alaska offshore waters (see map on next page):

1. Lower Cook Inlet--August 1975
2. Gulf of Alaska (northeast)--November 1975
3. Bering Sea (St. George)--October 1976
4. Gulf of Alaska (Kodiak)--December 1976
5. Beaufort Sea--September 1977
6. Outer Bristol Basin--October 1977
7. Bering Sea (Norton Basin)--July 1978
8. Gulf of Alaska (Aleutian Shelf)--September 1978
9. Chukchi Sea (Hope Basin)--December 1978

This proposed schedule is subject to hearings, impact reviews under the National Environmental Policy Act, final determinations by the federal agencies involved, and other preparation for actual sales. The schedule, therefore, is by no means fixed, and, in view both of coastal state objections and of the perhaps overly optimistic rapid pace of leasing assumed, we would


OUTER CONTINENTAL SHELF AREAS UNDER CONSIDERATION
FOR LEASING
ALASKA
SCALE
0 100 200 300 400 500 Miles
0 200 400 600 800 Kilometers
Department of the Interior
Bureau of Land Management
BEAUFORT BASIN
Point Barrow
HOPE BASIN
Nome
NORTON BASIN
Fairbanks
Anchorage
Valdez
Juneau
COOK INLET
GULF OF ALASKA
Kodiak
KODIAK
BRISTOL BAY BASIN
ST GEORGE BASIN
NAVARIN BASIN

(7)

expect either delays in the schedule or reductions in the number of areas leased or both.[49]

In addition to OCS leasing, the federal government is also moving toward possible development of Naval Petroleum Reserve No. 4, as previously noted. The Federal Energy Administration's Project Independence Report assumed development of the Reserve and production of up to 2 million barrels of oil a day in 1985 under its "accelerated supply" scenario.[50] The "accelerated development" scenario below incorporates an assumption of Pet 4 development, but modifies the projected production rate so that the peak daily flow of 2 million barrels is not reached until 1989. As we assume little or no significant federal revenue sharing from OCS development, we assume no federal sharing from development of Pet 4.

While the Marsh Creek anticline of the Arctic National Wildlife Range east of Prudhoe Bay is believed to contain resources of the magnitude of Prudhoe Bay itself, it is assumed that the Range will not be opened to development, at least within the fifteen year time frame of our scenarios. Any move to open the Range undoubtedly would face strenuous objections by conservationists, and might in any case require significant diversion of industry manpower, equipment, and funds commited to other areas in Alaska and elsewhere.

Federal leasing plays a particularly critical role in our scenarios for Alaska petroleum development and might appropriately be characterized as the "lead." Why this is so has already been suggested in the previous discussion of developmental interactions and interdependencies and of state leasing.

The federal government's leasing will increase the attractiveness to industry of nearby state and Native lands, tend to force the state's hand, and assure the provision of necessary transport facilities. For the Native corporations, this last effect is especially crucial. The opening of Pet 4 would likely necessitate a second North Slope oil pipeline, which, particularly if extended far enough west, would make production from additional Native and state areas feasible. Chukchi and Bering Sea OCS leasing would require western Alaska oil and gas pipelines, which, in turn, would make possible the development of Native lands in the Yukon-Koyokuk and Bethel Basins. It is on such developments that Native corporations must depend, assuming that their holdings are not otherwise commercial, which is a reasonable assumption at least for the present.

c. Native Leasing

Seven of the twelve regional Native corporations are known either to have entered into exploration agreements with major oil companies or are negotiating to do so.[51] The Arctic Slope Native Corporation has agreements with Standard Oil of California, Union-Amoco, and Texaco; NANA (Northwest Alaska Native Association) with Standard Oil of California; Calista Corporation with Shell Oil; Ahtna Corporation with Amoco; and Bristol Bay Native Corporation with Phillips Petroleum; and Koniag, Inc. with Standard Oil of California. In addition, Doyon Limited is reported to be negotiating one or more agreements.

The potential petroleum areas in which Native corporations will own lands may be grouped similarly to the state lands above, in general order of the timing and probability of leasing. However, since much less is known about Native lands than most of the prime areas that have been considered for leasing by the state, our ranking is extremely speculative except as it applies to North Slope holdings.

Group I - South of Prudhoe Bay
West of Pet 4
Yukon-Kandik Basin
Copper River Basin

Group II - Selawik Basin (Kotzebue)
Yukon-Koyokuk Basin
Bethel Basin

Group III - Bristol Bay Basin (onshore)
Upper Eastern Alaska Peninsula

Since the main purpose of all of these rankings is to assist in establishing parameters for state, federal, and Native corporation petroleum development activity, it is not critical that the rankings accurately predict the specific timing and locations of leasing that will occur. It is sufficient for present purposes that they provide a basis for determining alternative overall magnitudes of state, federal, and Native leasing, and reasonable estimates of the time ranges in which leasing may take place.

4. Taxes and Royalties

The most important, longer term sources of direct state income from petroleum development are production taxes and royalty payments. Oil production taxes are on a sliding scale, are subject to increases, and, at present rates, average about 7.5 percent of wellhead value. The royalty rate on both gas and oil is set generally at 12.5 percent, but could be raised in some future leases to match the federal rate of 16 2/3 percent. For purposes of raising revenue, both the production tax and the royalty accomplish the same thing, but the tax can be increased and applied to all production in the state at any time by the legislature, while the royalty rate is fixed in all existing lease contracts. Thus, the production tax is the state's primary means of increasing its recurring oil revenues from producing fields. The royalty raises other, more complex issues because the state has the option of taking its royalty share of oil and gas production either in cash or in kind.

The gas production tax rate is currently set at four percent of the wellhead value of the gas, and the latter is a federally regulated price from which transport costs are deducted before the tax rate is applied. It is possible that, with expected high costs of transporting North Slope gas to markets by any route, there will be little or no value left to tax at the wellhead.[52] In any case, even assuming a taxable wellhead value of from 30 to 50 cents per thousand cubic feet (MCF) and high production rates, both tax and royalty revenues from North Slope gas would still be only a relatively small fraction of the revenues from the production of North Slope oil.[53] Therefore, our assumption is that the royalty rates and the tax rates (for which we project increases) applied to oil production on the North Slope and elsewhere on state taxable lands will adquately account for the relatively small amounts of revenues likely to be derived from the production of gas.

In addition to production taxes and royalties, the state also receives small rentals on non-producing leases; revenues from a 20 mill property tax on facilities and equipment used for the exploration, production, and transport of oil and gas, including pipelines; and 90 percent of the rentals and royalties from federal lands in Alaska. Federal sharing is in relatively small amounts (averaging about $7 million a year for the statehood period), does not apply to OCS lands, and it can safely be assumed that it will not apply to Pet 4 in the future. Finally, the state legislature recently enacted a 20 mill tax on oil and gas in place (tax on reserves) to help fill the fiscal gap in 1976 and 1977 before North Slope oil begins to flow. This tax, expected to raise about $250 million a year from the Prudhoe Bay field, is intended to expire in 1978, after which time oil companies may credit these payments against subsequent state production tax assessments.

The projections of state petroleum revenues below explicitly take into account production taxes (on both state and Native lands), royalties, the 20 mill property tax, a possible 10 percent share of federal royalties on OCS leases (or its equivalent), and bonus payments from projected state lease sales. The limited revenues from rentals and from other federal sharing are disregarded. As for the 1976-1977 tax on reserves, we will simply assume that it, in combination with other measures such as leasing and sales of options on future state royalty oil and gas, does effectively assist in closing the state's short term fiscal gap.

a. Production Tax Increases

We are assuming increases in the state's production tax rate from the present 7.5 percent to 12 percent in 1978, 15 percent in 1980, and 20 percent in 1982, but no increase in the 12.5 percent royalty rate.[54] The assumption of tax increases is being made principally for these reasons:

1. The before tax profits (more precisely, "economic rent") left in the hands of the oil companies after subtracting production costs from the wellhead value of Alaska oil are likely to be great enough to easily absorb some significant tax increases; present oil prices, and certainly increased prices, would all but invite the state to take a larger share of the huge profits apparently anticipated by the industry.

2. Even with oil prices lower than what might reasonably be assumed today, profits are still likely to be substantial, while the state would have the incentive to compensate for lower wellhead values with higher production taxes; we are making a similar trade off in our projections.
3. Expectations for massive increases in state revenues and expenditures already exist in Alaska; one way or another they are likely to be met, so long as there is no hard, persuasive evidence that the oil companies "cannot afford" to pay the bill.
4. The flow of large volumes of valuable North Slope oil beginning in 1977 or 1978 is likely to contribute to a political climate for significant tax increases; at the same time, the state will be facing increasingly greater demands for public facilities and services from a rapidly growing population attracted to Alaska by large scale petroleum development.

The critical element here is the probable level of industry profits from Alaska oil. This is an extremely controversial subject involving many unknowns. Nonetheless, it is possible to derive a rough approximation of the probable magnitude of the industry's before tax profits from Prudhoe Bay. In 1971, economist M. A. Adelman estimated capital costs per barrel of Prudhoe Bay oil of 11.5 to 16.7 cents, and operating costs of 6 to 9 cents, for a total cost of 18 to 26 cents per barrel.[55] With inflation and higher costs of capital, manpower, and materials, Adelman's cost estimates might well be doubled, but to be safe, we would quadruple his high estimate to a total production cost of one dollar per barrel. Then, assuming pipeline and marine transport costs of $4 per barrel,[56] a production rate of 1.75 million barrels a day, and alternative prices of oil, we can calculate industry before tax "profits" from Prudhoe Bay alone to range from $1.3 to $3.8 billion annually by 1980:

I. $11 (price per barrel) - $4 (transport cost) = $7 (wellhead value) - $1 (production cost) = $6 (profit per barrel) X 1.75 (MMBD's production) X 365 (days) = $3,833 million (before tax annual industry profits)

II. $9 (price per barrel) - $4 (transport cost) = $5 (wellhead value) - $1 (production cost) = $4 (profit per barrel) X 1.75 (MMBD's) X 365 (days) - $2,555 million (before tax annual industry profits)

III. $7 (price per barrel) - $4 (transport cost) = $3 (wellhead value) - $1 (production cost) = $2 (profit per barrel) X 1.75 (MMBD's) X 365 (days) = $1,278 million (before tax annual industry profits)

We are in no position to say what the state's "fair share" of these speculative potential profits might be. However, we can calculate the state revenues that would be obtained from Prudhoe Bay production at combined tax and royalty rates of 20 percent (present rate) and of 32.5 percent (assumed 1982 rate), and at three different prices of oil (Table 18). The per barrel distribution of industry before tax profits, state shares at 20 percent and 32.5 percent, and the industry share after payment of state production taxes and royalties is shown in Table 19. The state's share of the $6 profit from an $11 barrel of Prudhoe Bay oil would be $1.40 at a 20 percent tax-royalty rate, and $2.28 at a 32.5 percent rate, leaving $4.60 and $3.72, alternatively, in industry hands. With $7 oil, the state's share of $2 in profit would be 60 cents at a 20 percent rate and 98 cents at a 32.5 percent rate, leaving $1.40 and $1.02, alternatively, for industry. (These are, of course, very modest tax-royalty rates in comparison with the 70 to 80 percent shares of $8 to $10 "profits" taken by Arab oil countries, where extremely high volume-low cost production maintains stong industrial incentives even under these high tax conditions.) Such figures strongly suggest that, as the owner of the resource, the state would not be imposing an unfair burden on the industry with a combined tax and royalty rate of 32.5 percent (or possibly more), even if the refinery price of oil falls to $7 per barrel, which is considerably below the current price (excluding import tariffs) of about $11.

All of this is unavoidably speculative, however, and a number of important factors have been disregarded: estimates based on Prudhoe Bay cannot be extrapolated directly to other, smaller fields with different production characteristics;[57] we have not taken federal policies into account, including the changing tax structure and the pressure for massive investments in new exploration and development activity by industry; and different companies would be affected differently by a given level of taxes and royalties. However, our assumptions and estimates are conservative for the most part and leave a relatively wide margin to allow for error; it does not, therefore, seem unreasonable to speculate that the analysis may be applied to some extent to state taxable lands beyond the Prudhoe Bay field, particularly if oil prices hold about where they are or continue to rise.

The prospects for some significant production tax increases seem less uncertain than the future price of oil. We have therefore chosen to balance more conservative assumptions about the price of oil, under which there is likely to be a federally maintained price floor, with less confining assumptions about production tax increases in order to derive a plausible range of state revenues over time in our three development scenarios below. Others are invited to choose different cost-price-tax parameters and, since the calculations are relatively simple, may easily trace out their effects on state revenues, which is the main point of the present exercise.

b. Royalty Oil and Gas

The question of state policy with respect to uses of royalty oil and gas can be dealt with briefly, not because it is a simple matter or because we dismiss it as unimportant. Rather, it is because little or no basis presently exists for anticipating any significant in-state uses of the oil and gas that the state may take in kind instead of in cash payments from the producing companies. Our assumption is, therefore, that virtually all of the state's 12 1/2 percent royalty rights to oil and gas from state lands will be taken in cash or, perhaps more likely, sold by the state in export markets, and these revenues are added to the revenues from production taxes on the remaining 87 1/2 percent sold directly to the producing companies.

To the extent that royalty oil and gas is sold for residential, commercial, industrial, or other uses in Alaska, the amounts are likely to be small relative to the huge amounts which will constitute the state's royalty shares.[58] In the absence of thorough industrial development studies, it has to be assumed that a combination of small markets, competitive sources of power (e.g., Fairbanks refinery, coal resources, Susitna River hydroelectric development, etc.) high plant construction and transport costs, and demand for Alaska oil and gas in outside markets severely restricts the amount of royalty oil and gas that would be used in Alaska. Such studies would need to determine the extent to which state subsidies may be required to support local uses, including home heating, power generation, refining, petrochemical manufacturing, and other forms of consumption and processing. Further, it would be necessary to take full account of social and environmental costs associated with in-state processing and manufacturing, and determine, for a variety of potential uses, the net benefits and costs to the State of Alaska.

5. Three Scenarios

The preceding sections have outlined the background of Alaska petroleum development, described the broad policy context, and identified many of the assumptions that must be made in order to make projections of development and its consequences in future years. This section presents those projections in the form of three hypothetical development scenarios for the years 1974 to 1990.

The primary purpose of the scenarios is to provide state and other Alaska policy makers with a useful framework for planning by identifying major petroleum development decisions that might be made and some of the critical inter-related effects of those decisions. It must be emphasized, however, that we are not trying to predict the future. In fact, it is not at all likely that any of the scenarios will happen exactly or even largely as described. There are simply too many variations on and combinations of reasonably foreseeable factors, while the unforeseeable are by definition unknown. Moreover, the reality of development will undoubtedly be more like an uneven, "fits and starts" process than like the smooth, sequential set of events that the scenarios tend unavoidably to suggest. But, fortunately, the usefulness of the scenarios does not require that one or another of the hypothetical sequences of events actually occurs as described--in this respect, only plausibility or reasonableness of the key elements and their interractions is required. For the purpose of the scenarios is not to predict future events, but to provide a rational, quantitative basis for generating a range of likely outcomes of alternative rates of petroleum development, regardless of the actual combination of factors and events that eventually produces a given set of them. Further, since the key elements of the scenarios are explicit, they can easily be revised by anyone whose sense of plausibility or reasonableness is offended, providing that the "rule of internal consistency" is observed in doing so. (The rule of internal consistency says that if you change one important element of a scenario, make sure you consider the possible effects of this change on other interrelated elements, and revise them accordingly.) Finally, all of the uncertainties and assumptions previously discussed should be considered integral, qualifying parts of the scenarios.

Thus the scenarios present a range of plausible futures and outcomes of petroleum development; they show how different rates and magnitudes of development generate significantly different levels of state revenues and direct employment in the construction and petroleum industries in Alaska. These revenue and employment projections, in turn, are essential to further analyses of the state's fiscal policies and economic outlook. Finally, using computer models of Alaska's economy, we present and broadly assess the effects of alternative petroleum development, fiscal policy, and other decisions on statewide and regional economic and population growth through 1990.

a. Basic Assumptions

The development scenarios are built directly upon three sets of assumptions relating to oil prices and wellhead values, production rates and state tax-royalty rates, and construction and petroleum (mining) employment.

Alternative Prices and Wellhead Values: Following the Federal Energy Administration, we are assuming that refinery prices of oil will range between \$7 and \$11. Specifically, we are assuming alternative prices of \$7, \$9, and \$11. Also assumed are average transport costs of \$4 per barrel.[59] This gives wellhead values, upon which state taxes and cash royalties are assessed, of \$3, \$5, and \$7 per barrel.

Production Rates and State Revenues: It is assumed that oil production rates from start-up to peak for new OCS, onshore, and nearshore fields will generally be in accordance with the production schedules shown in Table 20. Wellhead values and production rates provide the basis for deriving estimates of state revenues. We assume that the state production tax rate will increase from 7.5 percent in 1974 to 12 percent in 1978, 15 percent in 1980, and 20 percent in 1982, and that the royalty rate will remain at 12.5 percent (Table 21). It is further assumed that the state will receive the equivalent, either in the form of revenue sharing or direct grants, of 10 percent of the federal government's 16 2/3 percent royalty revenues from OCS production, and that the state will not receive any share of OCS lease bonuses or of revenues from Pet 4.

Discovery rates and levels of peak production assumed from new fields depend only in part on the State Division of Geological and Geophysical

Surveys' estimates of speculative undiscovered resources presented earlier. Selection of areas for leasing in each of the scenarios is consistent with the Division's identifications of oil potential areas, as well as with the section on "Federal, State and Native Leasing" above. However, projections of cumulative production from new fields through 1990 are in all cases far below the minimum estimates of recoverable resources which we allocated to state, federal, and Native corporation land owners.[60] Thus, we have tried to insulate our development scenarios from the controversy over estimates of undiscovered U.S. resources, which have recently been fluctuating rather wildly.

Apart from production, the state also receives pipeline property tax revenues and lease bonuses. We assume that pipeline property tax revenues (varying by scenario) will accrue to the state generally in accordance with the estimates shown in Table 22. Estimates of bonus payments are provided for each state lease sale in each scenario.

Employment: Field exploration, development, and operations, and pipeline and port facility construction and operations will generate substantial new employment in Alaska. We assume that field employment in onshore, nearshore, and OCS development areas will generally follow the schedules presented in Tables 23 and 24, and that oil and gas pipeline employment will approximate the schedules shown in Tables 25 and 26.[61]

The timing and locations of lease sales and production start-up years vary of course among the different scenarios, and are indicated separately for each.

b. Limited Development

In this minimum case, present developments are carried forward, a few additional petroleum fields are opened near existing areas, and the federal OCS leasing program is limited to the Gulf of Alaska. Petroleum development in Alaska is thus confined to a north-south axis, with the North Slope on one end and Cook Inlet and the Gulf of Alaska on the other. Some Native corporation oil lands within hook-up distance to the trans-Alaska pipeline are leased and brought into production.

Existing Cook Inlet production continues at about 200,000 barrels a day and declines to 150,000 barrels by 1982. The trans-Alaska pipeline is completed and Prudhoe Bay production begins in 1978 at an average rate of 1.2 million barrels a day, reaching a peak flow of 1.75 million barrels in 1980. A trans-Canada gas pipeline is constructed between 1979 and 1981 (see Table 26, Schedule B, for employment estimates). Only limited additional state, federal, and Native corporation leasing takes place.

State Leasing: The state leases in areas already opened or near areas of existing development.

1. Beaufort Sea--A Beaufort sale takes place in 1976 and the state receives a minimum of $150 million in bonuses. Field employment starts a year later (Table 23, Schedule B). Production begins in 1980, peaking in 1987 at 260,000 barrels a day.[62]
2. North Slope Uplands/South of Prudhoe--One or more sales take place in 1977, with total bonuses of $100 million. Additional field employment begins in 1978 (Table 23, Schedule C). Production starts in 1980, with a total peak flow of 200,000 barrels a day in 1987.

Federal Leasing: The federal government, having won the jurisdictional dispute with the state over lower Cook Inlet, leases there as well as in the Gulf of Alaska.

1. Lower Cook Inlet--A sale takes place in 1976. Employment effects begin a year later (Table 23, Schedule C). Production starts in 1980, reaching a peak of 200,000 barrels a day in 1987.
2. Gulf of Alaska East--The first of a possible series of sales in the northeast Gulf occurs in 1977. Field employment begins a year later (Table 24, Schedule A). Production starts from one or more sales areas in 1983 and rises to nearly 700,000 barrels a day by 1990.
3. Gulf of Alaska West--This sale in the Kodiak OCS area, takes place in 1978. (Other sales in the general area may follow.) Field employment begins in 1979 (Table 24, Schedule A, combined with Gulf East employment and not counted separately). Production starts in 1984, increasing to over 300,000 barrels a day by 1990.

Native Leasing: Native corporations with oil potential lands on the North Slope, in the Interior, and possibly elsewhere begin to lease land for development.

1. North Slope Uplands--These lands are leased in 1976, with employment beginning in 1977 (Table 23, Schedule C). Production starts in 1979, peaking at 200,000 barrels a day in 1986.
2. Yukon-Kandik/Copper River--One or more sales take place in 1977, and employment of field workers begins a year later (Table 23, Schedule C). Production starts in 1980, with a peak flow of 200,000 barrels a day in 1987.

Effects of Limited Development: Total production from state, federal, and Native lands reaches 2 million barrels a day in 1980, over 3 million barrels in 1985, and nearly 4 million barrels in 1990 (Table 27). Most of this production is from state lands, given the Prudhoe Bay start, long leadtimes for OCS development, and relatively limited Native corporation activity. The state receives annual recurring revenues (excluding bonuses) of $1.1 billion in 1980, $1.6 billion in 1985, and $1.7 billion in 1990, assuming a wellhead value of $5 per barrel (Table 28). Total employment in construction and petroleum mining is about 5,000 in 1980, 6,200 in 1985, and 7,200 in 1990 (Table 29).

c. Accelerated Development

The accelerated development case includes all of the activities and effects described in the preceding limited development scenario. Major increases in petroleum development occur in this second scenario primarily because the federal government opens Pet 4 to leasing. Thus, new petroleum areas are opened up in the northwest, onshore and offshore, and a second North Slope oil pipeline is constructed. The assumption is that this pipeline will follow a route through Canada, either across the Arctic slope or south to Fairbanks and then down the highway corridor. Construction of the line begins in 1981 and its Alaska portion is completed within a few years (see Table 25, Schedule B for employment estimates). An "acceleration" of development activity through leasing occurs as follows.

State Leasing: The state follows the federal government into the Gulf of Alaska and is subsequently drawn back to the north and to the northwest when the federal government looks to Pet 4 and the prospect of another oil pipeline.

1. Gulf of Alaska Onshore/Nearshore--A sale (or sales) in 1977 results in $200 million in bonus payments. Employment of field workers commences in 1978 (Table 23, Schedule B). Production starts in 1981 and reaches a peak flow of 400,000 barrels a day in 1987.
2. Beaufort/Chukchi--One or more sales of Beaufort and/or Chukchi Sea leases are held in 1979, with bonuses totalling $100 million. Field workers are employed in 1980 (Table 23, Schedule C). Production starts in 1983 and peaks at 200,000 barrels a day in 1989.
3. West of Pet 4--Leases are sold in 1980, bringing the state $100 million in bonuses. Field employment begins in 1981 (Table 23, Schedule C). Production starts in 1983, reaching a peak flow of 200,000 barrels a day in 1989.

Federal Leasing: The federal government holds another sale in lower Cook Inlet, extends its OCS program to the southern Bering Sea, opens Pet 4 and further extends OCS leasing to the northern seas.

1. Lower Cook Inlet--A sale is held in 1977, and field workers are employed beginning in 1978 (Table 23, Schedule C). Production starts in 1981 and peaks at 200,000 barrels a day in 1987.
2. South Bering Sea--Leases are sold, perhaps for tracts in the St. George or Outer Bristol Bay Basin, in 1978. Field employment begins in 1979 (Table 24, Schedule B). Production starts in 1984 and rises to over 300,000 barrels a day by 1990.
3. Pet 4--The first major sale is held in 1979 and field workers are employed beginning in 1980 (Table 23, Schedule A). Production starts

in 1983 and reaches a peak of 2 million barrels a day in 1989.

4. Beaufort/Chukchi--One or more sales are held in either or both of these OCS areas in 1979. Workers are employed in 1980 (Table 24, Schedule B). Production starts in 1985 and rises to about 180,000 barrels a day by 1990.

Native Leasing: The Arctic Slope Regional Corporation's plans for further leasing on the North Slope are facilitated by nearby federal and state developments.

1. West of Pet 4/North Slope Uplands--One or more sales are held in 1979 and possibly later, with employment activity beginning a year later (Table 23, Schedule C). Production starts in 1982 and peaks at 200,000 barrels a day in 1988.

Effects of Accelerated Development: Total oil production from Alaska and OCS areas remains at 2 million barrels a day in 1980, but rises to 5 million barrels in 1985, and to 7.7 million barrels in 1990 (Table 27). Production from federal lands has caught up with and exceeded production from state lands by the late 1980s. Production from Native lands is very small by comparison. At a $5 wellhead price, the state's recurring revenues from petroleum development total $1.1 billion in 1980, $2 billion in 1985, and $2.3 billion in 1990 (Table 28). Total employment in construction and petroleum mining is about 5,000 in 1980, over 10,000 in 1985, and nearly 12,000 in 1990 (Table 29).

d. Maximum Development

This scenario represents the maximum rate of petroleum development that might occur in Alaska and, in effect, the fulfillment of the current federal scenario for Alaska. It includes all activities described in both the limited and accelerated cases, hypothesizes additional leasing through 1982, and projects the effects of all developments through 1990.

As in the accelerated case, the federal government opens new regions to development, with Native corporations and the state following the federal lead. In this case, the federal government leases heavily in the Bering Sea[63] and the Hope Basin of the Chukchi Sea. This, in turn, necessitates construction of an oil pipeline and a gas pipeline running from north to south in western Alaska. It is assumed that both lines would begin near Kotzebue in the Alaska. It is assumed that both lines would begin near Kotzebue in the northwest and possibly terminate on the western shore of lower Cook Inlet. Construction of the oil pipeline and related facilities would begin in 1982 and be completed in 1985-86 (see Table 25, Schedule A, for oil pipeline employment estimates). Gas line construction would take place between 1985 and 1988-89 (see Table 26, Schedule A for gas pipeline employment estimates). Availability of the pipeline, port, and processing facilities would make additional leasing activity in new western areas possible for Native corporations and the state.

<u>State Leasing</u>: The state, influenced by federal leasing in western and northwestern OCS areas, opens new areas to leasing offshore near Kotzebue (Hope Basin) and in the Bristol Bay area.

1. <u>Chukchi-Hope Basin</u>--A lease sale is held in 1981, with bonuses of $100 million. Field workers are employed beginning in 1983 (Table 23, Schedule C). Production starts in 1985 and rises to 180,000 barrels a day by 1990.

2. Bristol Bay Onshore/Offshore--A sale in 1982 brings $100 million in bonus payments. Employment begins in 1983 (Table 23, Schedule C). Production starts in 1986 and reaches 160,000 barrels a day by 1990.

Federal Leasing: The federal leasing program on Alaska's Outer Continental Shelf is being completed more or less as planned in 1974, though it is four years behind the schedule originally proposed.

1. Bering Sea--A major Bering sale (or sales) is held in 1980 in either one or more of the Norton Sound, Outer Bristol, and Navarin Basins. Field workers are employed a year later (Table 24, Schedule A). Production starts in 1986 and rises to 760,000 barrels a day by 1990.
2. Chukchi Sea--Leases are sold in the Hope Basin of the Chukchi Sea in 1981. Field workers begin arriving in 1982 (Table 24, Schedule B). Production starts in 1987 and reaches 280,000 barrels a day by 1990.
3. Bering Sea--Another large Bering sale (or sales) is held in 1982. Field workers arrive in 1983 (Table 24, Schedule A). Production starts in 1988 and increases to about 320,000 barrels a day in 1990.

Native Leasing: Federal lease sales on the western Outer Continental Shelf and the prospect of transport facilities bring Native petroleum lands in the west into the market.

1. West of Pet 4--A sale is held in 1980. Field workers are employed in 1981 (Table 23, Schedule C). Production starts in 1983 and peaks at 200,000 barrels a day in 1989.
2. Selawik/Yukon-Koyokuk/Bethel--Sales take place in one or more of these basins in 1981 with employment beginning a year later (Table 23,

Schedule C). Production starts in 1985 and increases to 180,000 barrels a day by 1990.

3. Selawik/Yukon-Koyokuk/Bethel--Further sales take place in 1982 and field employment begins in 1983 (Table 23, Schedule C). Production starts in 1986 and rises to 160,000 barrels a day by 1990.

Effects of Maximum Development: Total production of oil is at 2 million barrels a day in 1980, 5.2 million barrels in 1985, and nearly 10 million barrels in 1990 (Table 27). Production from federal lands is now substantially ahead of the combined production from state and Native lands. However, production from Native lands in 1990 is nearly double that produced during the same year in the previous scenario. Recurring petroleum revenues to the State of Alaska total $1.1 billion in 1980, $2.2 billion in 1985, and nearly $3 billion in 1990, at a $5 per barrel wellhead price (Table 28). Employment in construction and petroleum mining soars from 5,000 in 1980 to 18,000 in 1985, and to over 23,000 in 1990.

6. Conclusion

Alaska has large oil and gas resources, the nation needs them, and the aim of the federal government and of industry is to get them. The State of Alaska and the Native corporations also have interests in the development of Alaska's petroleum resources, although they are not always or necessarily compatible with each other or with national interests. However reinforcing or conflicting these interests and policies may be, the probability is great that Alaska's petroleum resources will be developed on a grand scale within a relatively short period of time.

Petroleum development will bring more jobs, more money, and more people; it will mean more pipelines, more roads, and more processing and port facilities; it will result in greater pressures on housing and community services, on land, water, and wildlife, and on other renewable and non-renewable natural resources. It will also mean a bigger, and possibly stronger, state government having at least the financial capacity to influence the rate, and possibly the composition and distribution, of growth in Alaska. But this capacity may be quite limited: First, a process of development that generates its own requirements and pressures for further development is apparently already in motion. Second, federal government and Native corporation activities are largely beyond the control of state government for legal and political reasons, and the key petroleum development policy decisions will be made by federal, not state, policymakers. Thus, the State of Alaska may have a greater capacity to speed the rate of growth by what it does with its own resources and wealth than to slow the rapid pace of development otherwise attributable to federal and Native corporate actions as well as to the momentum already generated by past state government actions.

The following chapters deal with some of the critical choices the state may yet make, the ranges of economic and population growth that may occur, and some of the main consequences and future prospects that emerge from our analysis.

FOOTNOTES

[1]Adapted in part from Alaska Public Policy, Gordon S. Harrison, ed. (Fairbanks: Institute of Social, Economic and Government Research, University of Alaska, 1971), pp. 31-2, 182-3. Also see Ernst W. Mueller, "Alaskan Oil--The Energy Crisis and the Environment," Arctic Bulletin, Vol. 1, No. 5, pp. 185-6.

[2]The crude gasolines produced by the refineries are shipped to California for further refining or are blended with imported products to produce motor fuels for use in the state. A small asphalt plant is associated with one of the refineries. Another firm pipes nautral gas from the Kenai fields to Anchorage.

[3]See pp. 4-21 to 4-22 for further discussion of the nature of the energy crisis.

[4]Sec. 202(a), Trans Alaska Pipeline Authorization Act, P.L. 93-153, November 16, 1973.

[5]Bureau of Land Management Department of the Interior, Multimodal Transportation and Utility Corridor Systems in Alaska, Washington, D.C., October 1974.

[6]"Undiscovered recoverable resources" are defined as those economic resources, yet undiscovered, which are estimated to exist in favorable geologic settings. "Economic" in this context refers to the feasibility of recovery within a given set or price-cost and technological parameters or doncitions.

[7]U.S. Geological Survey, News Release, March 26, 1974; Division of Geological and Geophysical Survey, Alaska Department of Natural Resources, Energy and Mineral Resources of Alaska and the Impact of Federal Land Policies on Their Availability--Oil and Gas, Alaska Open File Report 50, Anchorage, Alaska, June 1974. (Hereinafter Open File Report 50.)

[8]U.S. Department of the Interior, News Release, May 7, 1975.

[9]U.S. Geological Survey, Geological Estimates of Undiscovered Recoverable Oil and Gas Resources in the United States, Geological Survey Circular 725, Washington, D.C., June 1975, p. 48.

[10]Ibid., p. 27.

[11] The single greatest difference concerned the Bering Sea. The State Division of Geological and Geophysical Survey's 1974 estimate was 27 billion barrels of oil while USGS's 1975 estimate was 1 to 4 billion barrels. For this and other differences, see Ibid., p. 33.

[12] The report continues: "The higher price-cost ratios existing in 1975, if they should continue or increase even higher, would likely increase the estimates of both undiscovered recoverable resources and reserves significantly--some economists think perhaps by half again." (Ibid., p. 1.)

[13] It appears that the new low estimates are in fact being used to support arguments for intensification of the federal government's OCS exploration and development program, which focuses heavily on Alaska. In a press release accompanying the USGS report, the USGS Director, Dr. V. E. McKelvey, states that although the new estimates are substantially lower than the 1974 estimates, "they do not change the projections made by the Project Independence Blueprint Oil Task Force [discussed in this chapter below] which showed that increased production could be obtained under prices of $11 per barrel, and under policies that would encourage increased exploration and recovery.... The new estimates... indicate that if exploration is accelerated these sources alone would be adequate to meet the Blueprint projection.... I want to emphasize also that the estimates of recent years--high and low ones alike--all carry the same important messages: much more oil remains to be found if exploration is encouraged; the amount remaining in places is a large target to future development; frontier areas are an important part of our potential; and even if we are lucky in exploration, we will soon have to start shifting to other sources of energy as the mainstay of our supply." (U.S. Department of the Interior, News Release, June 20, 1975.)

[14] The problem of estimating undiscovered oil and gas resources is discussed further at pages 4-30 to 4-33 and 4-60 below. Also see Robert Gillette, "Oil and Gas Resources: Academy Calls USGS Math 'Misleading'," Science, Vol. 187, No. 4178 (February 28, 1975), p. 723. The article discusses differences between the U.S. Geological Survey's March 1974 official estimates of 200-400 billion barrels of oil and 1000-20000 trillion cubic feet of gas, and the National Academy of Science February 1975 estimates of 113 billion barrels of oil and 530 trillion cubic feet of gas as reported in Mineral Resources and the Environment (National Academy of Sciences, Washington, D.C., February 1975).

[15] API definition quoted in Arlon Tussing, et. al., Alaska Pipeline Report (Fairbanks, Alaska" Institute of Social, Economic and Government Research, University of Alaska, 1971), p. 66.

[16]U.S. Senate, Committee on Interior and Insular Affairs, Federal Lands Right-of-Way Act of 1973, Report, 93 Congress, 1 Session, Report 93-207, June 12, 1973, p. 24.

[17]"Speculative recoverable petroleum resources are here defined as those petroleum resources which are completely undiscovered, and which after discovery can reasonably be expected to be produced using present technology and economic conditions." (Division of Geological and Geophysical Survey, Open File Report 50, p. 2.) "Speculative discoverable resources" and "undiscovered recoverable resources" (note 6 above) are essentially equivalent terms.

[18]*Ibid.*

[19]Division of Geological and Geophysical Survey, Open File Report 50, Part II, "Land Resource Evaluation (Availability of Oil and Gas in Alaska)."

[20]D.C. Hartman, "Arctic National Wildlife Range Geology and Mineral Resources," Paper prepared in the Alaska Department of Natural Resources, January 1972, p. 5.

[21]Anchorage Daily Times, February 21, 1975

[22]Division of Geological and Geophysical Survey, Open File Report 50, Part II.

[23]Division of Geological and Geophysical Survey, Open File Report 50, p. 21.

[24]Ford Foundation, Exploring Energy Choices, a Preliminary Report of the Ford Foundation's Energy Policy Project (Washington, D.C., 1974), p. 1.

[25]*Ibid.* 2 MMBD = 1 quad.

[26]*Ibid.*

[27]Proved world reserves of oil as of January, 1974 totaled 628 billion barrels, but 350 billion, or 56%, of these barrels were in Middle East OPEC countries. (*Ibid.*, p. 76.)

[28]Quoted in Richard S. Frank, "Ford Seeks Price Guarantees for Fuel to Aid U.S. Development," National Journal Reports, Vol. 7, No. 10 (March 8, 1975), p. 357.

[29] See Federal Energy Administration, _Project Independence Report_, Washington, D.C., November 1974, pp. 23-35 _et passim_, and Ford Foundation, _Exploring Energy Choices_, pp. 39-53.

[30] See FEA, _Project Independence Report_, p. 34 _et passim_.

[31] FEA, _Project Independence Report_, p. 23.

[32] All prices are in constant mid-1973 dollars, and refer to values at the "refinery gate," which are wellhead values plus transportation costs. Taking transportation into account, these prices are equivalent to Persian Gulf prices of $3, $6, and $9 per barrel. (FEA, _Project Independence Report_, p. 23.)

[33] FEA, _Project Independence Report_, p. 25.

[34] See Frank, "Ford Seeks Price Guarantees," pp. 359-60. To encourage development of higher cost alternative energy sources, such as solar or geothermal, different price mechanisms at a higher tier are being considered. They include a variety of more focussed direct and indirect subsidies, such as tax breaks, R and D grants, and guaranteed purchase, to energy producers.

[35] Two of the important variables on which FEA's analysis is based are the elasticity of demand for energy in relation to price and estimates of domestic petroleum reserves remaining to be discovered and produced. FEA's assumptions about these variables have been criticized as being too "optimistic," that is, demand is less elastic and reserves are more limited than previously assumed. It should be noted that any FEA errors in this regard tend to work for rather than against intensified exploration for Alaska and OCS petroleum resources. Therefore, for purposes of determining the extent of national demand for Alaska and Alaska-OCS petroleum resources, which is the concern of the present discussion, FEA's assumptions may be considered "conservative."

[36] There are other significant uncertainties affecting the FEA analysis which will be discussed below.

[37] FEA, _Project Independence Report_, p. 13.

[38] _Ibid._, pp. 71-72.

[39] _Ibid._, p. 82.

[40] See discussion pp. 4-12 to 4-13 concerning conflicting estimates of undiscovered domestic oil and gas resources. Also, "Senate Study Predicts U.S. Oil 'Exhaustion'," Science, Vol. 187, No. 4181 (March 21, 1975), p. 1064, comments on a recently released draft report of the National Ocean Policy Study under the U.S. Senate Commerce Committee.

[41] Arlon R. Tussing, "Report of a Panel on Oil Import Problems and National Security," at Mitre Corporation, McLean, Virginia, September 4, 1974.

[42] See "Senate Study Predicts Oil "Exhaustion'," p. 1064.

[43] Tussing, "Report of a Panel on Oil Import Problems and National Security," p. 3, referring to "several recent studies," including the MIT Energy Laboratory's Project Independence study.

[44] Federal Energy Administration, Project Independence Report, p. 73.

[45] Ibid.

[46] Division of Geological and Geophysical Survey, Open File Report 50, p. 8.

[47] The current state administration has not as yet announced a lease sale schedule. The previous administration, in November 1974, announced a schedule which included lower Cook Inlet, Beaufort Sea, North Slope Uplands, Gulf of Alaska, and Selawik Basin in that order.

[48] BLM news release, November 14, 1974.

[49] Congress is also considering proposals to separate OCS exploration and development-production phases, which could require a "pause" to allow the gathering of extensive information about field sizes and other characteristics before operations begin. See Arthur J. Magida, "Coastal States Seek Changes in OCS Leasing Policy," National Journal Reports, Vol. 7, No. 7 (February 15, 1975), pp. 229-239.

[50] FEA, Project Independence Report, p. 83.

[51] See "Regional Corporation Leaders Describe Plans," Alaska Industry (June 1974), pp. 47, 63-65; Alaska Department of Economic Development, A Performance Report of the Alaskan Economy, Vol. 3, No. 1, p. 15; Alaska Information Service, The Alaska Economic Report, Anchorage, April 18, 1975.

[52]Alaska Department of Law, "Recommendations of Gas Pipeline Task Force," Memorandum from Attorney General Avrum M. Gross to Governor Jay S. Hammond, April 2, 1975.

[53]At 30 cents per MCF, production of 3.5 million MCF per day, and a total state tax and royalty share of 20 percent, revenues would total $77 million per year and at 50 cents per MCF, $128 million. Such production would not be achieved until several years after North Slope oil revenues had already risen to over $1 billion annually.

[54]The state has the option of imposing oil production taxes as a percentage of wellhead value or as a cents per barrel levy. The latter option was enacted by the legislature in 1972 to place a floor under tax revenues if wellhead values were to drop precipitously. Since we are assuming increases in production taxes once North Slope oil comes on stream, and secondarily because oil prices and wellhead values are not likely to plunge, we are using the percentage rates to project state revenues.

[55]M. A. Adelman, Paul G. Bradley, and Charles A. Norman, Alaska Oil: Cost and Supply (New York: Praeger, 1971), pp. 21-23.

[56]In the fall of 1974, the Director of the State Division of Oil and Gas estimated total transport costs at $3.25 per barrel--a $2.75 pipeline tariff and a 50 cents marine transport charge. This estimate was linked to a pipeline construction cost estimate approaching $6 billion. (In 1969, the cost of the pipline was estimated at under $1 billion.) The transport cost estimates given by the State official were apparently based on information provided by the chairman of Standard of Ohio, a company that owns rights to a large share of Prudhoe Bay reserves. (Fairbanks Daily News-Miner, October 24, 1974; also personal communication with Homer Burrel, Director, Division of Oil and Gas, Alaska Department of Natural Resources, October 31, 1974.) In 1971, the Interior Department's pipeline impact report estimated total transport costs at from 70 cents to $1.01 per barrel. (U.S. Department of Interior, An Analysis of the Economic and Security Aspects of the Trans-Alaska Pipeline, Vol. II, Washington, D.C., December 1971.) It should be noted that the transport "cost" also includes Alyeska Pipeline Company profit, which will be based on a federally regulated rate of return, and that increasing volumes of oil through the pipeline will mean lower per barrel transport costs, which should help offset increasing pipeline construction costs.

[57]A production cost per barrel of $1 most certainly cannot be applied to OCS oil, which is likely to cost as much as $3 per barrel, (Arlon R. Tussing, statement at Alaska Growth Policy Council meeting, Anchorage, Alaska, April 2, 1975). OCS oil, however, is not taxable by the state and is not included in this analysis.

[58] From the North Slope alone, the state will have rights to 250,000 barrels of oil a day at peak production of 2 million barrels through the trans-Alaska pipeline. A U.S. Senate study in 1974 concluded that all but about 50-60,000 barrels would be sold outside of Alaska. There is no indication that in-state markets could absorb additional oil from other state lands. (U.S. Senate, Committee on Interior and Insular Affairs, "Preliminary Report--The Alaska Pipeline, West Coast Surpluses, and Crude Oil Exports," Memorandum from Arlon R. Tussing, Chief Economist, to Henry M. Jackson, Chairman, in Congressional Record, July 31, 1974, p. S13989.) As for royalty gas, high risks and limited markets for in-state uses are indicated in Arlon R. Tussing, "Analysis of Transportation Proposals for North Slope Natural Gas," Report to State of Alaska, Office of Attorney General, March 31, 1975, at pages 39-43.

[59] As noted earlier, total transport costs were estimated at $3.25 in 1974. Even with continuing pipeline construction cost escalation, and taking account of marine transport costs, our assumption of a $4 transport cost may still be on the generous side. Further, we are adopting this figure as the average transport cost of all Alaska oil.

[60] Excluding production from proved reserves (Prudhoe Bay and Cook Inlet), we project cumulative production from state, federal, and Native lands in 1990 at 3.6, 8.4, and 2.2 billion barrels, respectively, in the maximum development case. This compares with our low estimates of speculative recoverable resources on state, federal, and Native lands of 6, 47, and 4 billion barrels, respectively.

[61] Field employment schedules for petroleum mining do not include administrative support positions, which are likely to be concentrated in Anchorage. These additional positions are assumed to total about 10 percent of the field employment, and they are accounted for in the statewide and regional employment projections presented in Chapter below.

[62] Refer to Table 20 for appropriate production schedule in all cases.

[63] As noted earlier, revised estimates of undiscovered recoverable oil by USGS in 1975 included a drastic reduction of the previous estimate for the Bering Sea, among other unexplored frontier areas. Acceptance of the low estimate has the effect of reducing the present probability of the maximum development scenario.

Table 1

ALASKA CRUDE OIL AND GAS PRODUCTION
1959-1974

Year	Barrels of Oil	Thousands of Cubic Feet of Gas (MCF)
1959	186,590	158,920
1960	577,999	309,341
1961	6,326;501	1,680,414
1962	10,259,110	3,753,284
1963	10,739,964	11,021,061
1964	11,053,872	12,113,754
1965	11,131,271	12,543,445
1966	14,364,432	41,656,264
1967	28,913,488	63,068,508
1968	66,145,673	100,355,409
1969	74,315,218	148,367,750
1970	83,614,089	218,542,157
1971	78,784,865	229,455,608
1972	73,562,103	224,122,475
1973	73,139,415	224,507,252
1974	72,243,504	231,219,282

Source: Division of Oil and Gas, Alaska Department of Natural Resources

Table 2

WELLHEAD VALUES (IN $1,000s) OF OIL AND GAS, 1960-1970, AND TOTAL OIL AND GAS VALUES AS PERCENT OF TOTAL VALUES OF ALASKA NATURAL RESOURCES PRODUCTION

Year	Oil	Gas	Total Value	Percent of Total Resources Production
1960	$ 1,230	$ 30	$ 1,260	.72%
1961	17,652	129	17,781	8.04
1962	31,187	467	31,654	12.74
1963	32,650	1,111	33,761	14.02
1964	33,627	1,719	35,346	12.71
1965	34,073	1,799	35,872	11.27
1966	44,083	6,335	50,418	13.63
1967	88,187	7,268	95,455	26.97
1968	186,695	4,388	191,083	36.78
1969	210,372	8,364	218,736	43.85
1970	232,829	18,164	250,993	45.71

Sources: Division of Oil and Gas, Alaska Department of Natural Resources, and Alaska Public Policy, p. 78, Table 2.

Table 3

STATE REVENUES FROM PETROLEUM INDUSTRY,
1961-1973

Year	Petroleum Revenues (In Millions)	Percent of Total Revenues	Percent, Excluding Bonuses
1961	$ 4.2	6.0%	3.9%
1962	26.0	28.7	8.1
1963	27.9	26.6	11.5
1964	15.0	11.4	8.1
1965	16.6	11.0	7.4
1966	21.7	14.2	7.7
1967	21.6	12.8	8.1
1968	43.9	24.2	13.7
1969	34.7	18.5	18.1
1970	936.9	81.7	15.0
1971	47.5	13.3	13.2
1972	49.3	12.9	12.5
1973	50.3	12.7	10.9

Source: State of Alaska, Annual Financial Reports, 1961-1973.

Table 4

OIL AND GAS INDUSTRY AND TOTAL ALASKA
INDUSTRY REAL GROSS PRODUCT, 1961-1973
(In Millions of Dollars)

Year	Oil and Gas	Total	Percentage Oil and Gas
1961	$ 29.3	$ 680.7	4.3%
1962	34.4	699.8	4.9
1963	39.2	722.8	5.4
1964	43.6	778.4	5.6
1965	42.0	829.8	5.1
1966	66.7	904.4	7.4
1967	172.9	999.8	17.3
1968	233.3	1,161.8	20.1
1969	357.8	1,305.1	27.4
1970	313.6	1,370.9	22.9
1971	265.2	1,391.4	19.1
1972	212.3	1,342.5	15.8
1973	190.8	1,403.5	13.6

Table 5

EMPLOYMENT IN OIL AND GAS INDUSTRY
AND IN ALL ALASKA INDUSTRIES, 1961-1973

Year	Oil and Gas	Total	Percentage Oil and Gas
1961	598	100,209	.6%
1962	684	102,513	.7
1963	738	106,090	.7
1964	761	109,080	.7
1965	661	115,130	.6
1966	942	117,596	.8
1967	1,602	121,684	1.3
1968	2,152	123,603	1.7
1969	3,218	130,765	2.5
1970	2,640	136,367	1.9
1971	2,090	140,684	1.5
1972	1,792	144,043	1.2
1973	1,671	150,351	1.1

Table 6

OIL AND GAS INDUSTRY WAGES AND SALARIES
AND TOTAL ALASKA WAGES AND SALARIES, 1961-1973
(In Millions of Dollars)

Year	Oil and Gas	Total	Percentage Oil and Gas
1961	$ 6.2	$ 538.3	1.2%
1962	7.3	557.1	1.3
1963	8.1	589.3	1.4
1964	8.5	670.4	1.3
1965	8.3	722.1	1.1
1966	12.5	777.3	1.6
1967	24.2	867.2	2.8
1968	34.3	947.3	3.6
1969	52.7	1,080.9	4.9
1970	47.1	1,217.1	3.9
1971	38.9	1,315.2	3.0
1972	34.6	1,447.1	2.4
1973	33.3	1,564.0	2.1

Table 7

ESTIMATED ALASKA UNDISCOVERED RECOVERABLE OIL AND GAS RESOURCES AS A PROPORTION OF TOTAL U.S. UNDISCOVERED RECOVERABLE RESOURCES, 1974

	Billions of Barrels of Oil			Trillions of Cubic Feet of Gas		
	Low	Med	High	Low	Med	High
United States	200	300	400	1000	1500	2000
Alaska	57	76	96	330	440	550
Alaska Percentage	29%	25%	24%	33%	29%	28%

Sources: U.S. Geological Survey, News Release, March 26, 1974; Division of Geological and Geophysical Survey, Alaska Department of Natural Resources, Energy and Mineral Resources of Alaska and the Impact of Federal Land Policies on Their Availability--Oil and Gas, Alaska Open File Report 50 (Anchorage, Alaska, June 1974).

Table 8

ESTIMATED ALASKA UNDISCOVERED RECOVERABLE RESOURCES AS A PROPORTION OF U.S. UNDISCOVERED RECOVERABLE RESOURCES, 1975

	Billions of Barrels of Oil			Trillions of Cubic Feet of Gas		
	Low	Mean	High	Low	Mean	High
Onshore						
United States	37	56	81	264	377	506
Alaska	6	12	19	16	32	57
Alaska Percentage	16%	21%	23%	6%	8%	11%
Offshore						
United States	10	26	49	42	107	181
Alaska	3	15	31	8	44	80
Alaska Percentage	30%	58%	63%	19%	41%	44%
Totals*						
United States	50	82	127	322	484	655
Alaska	12	27	49	29	76	132
Alaska Percentage	24%	33%	39%	9%	16%	20%

*Statistical means are additive; high-low range values are not. Therefore, some distortion is involved in deriving Alaska high-low percentages.

Source: U.S. Geological Survey, Geological Estimates of Undiscovered Recoverable Oil and Gas Resources in the United States, Geological Survey Circular 725, Washington, D.C., June, 1975, Tables 4 and 5, pp. 28-31.

Table 9

ESTIMATED ALASKA PROVED RESERVES OF CRUDE OIL AND GAS AS A PROPORTION OF TOTAL U.S. PROVED RESERVES, 1973

	Billions of Barrels of Oil	Trillions of Cubic Feet of Gas
United States	35	250
Alaska	10.5	29.7
Alaska Percentage	30%	12%

Sources: Gillette, "Oil and Gas Resources"; Federal Energy Administration, Project Independence Report; Division of Geological and Geophysical Survey, Open File Report 50.

Table 10

ESTIMATED SPECULATIVE RECOVERABLE RESOURCES

OF OIL AND NATURAL GAS IN ALASKA

Basin/Province	Barrels of Oil (in billions)	Cubic Feet of Gas (in trillions)
ONSHORE		
Cook Inlet	.93	6.67
Copper River	.16	1.20
Yukon-Kandik	1.67	11.37
Gulf of Alaska	1.60	11.60
Bristol Bay	.94	6.83
Kotzebue	.30	2.19
North Slope	15.50	41.80
Yukon-Koyukuk	3.44	9.31
Bethel	1.30	3.50
Other	.16	1.08
Subtotal	26.0	95.5
OFFSHORE		
Cook Inlet	1.60	11.68
Gulf of Alaska	7.20	52.60
Kodiak Island Province	2.40	17.50
Bering Sea Province	27.40	200.00
Kotzebue	.39	2.84
Hope Province	1.80	13.00
Chukchi Province	6.60	33.00
Beaufort Province	2.70	13.50
Subtotal	50.1	344.1
Total Speculative	76.1	439.6
Discovered (but not produced)	10.5	29.7
Grand Total	86.6	469.3

Source: Adapted from Division of Geological and Geophysical Survey, Open File Report 50, Table 1, p. 5.

Table 11

ESTIMATED STATE, NATIVE, AND FEDERAL SHARES OF ONSHORE SPECULATIVE RECOVERABLE OIL AND GAS RESOURCES

	Billions of Barrels of Oil			Trillions of Cubic Feet of Gas		
Ownership	Low	Med	High	Low	Med	High
State	3	4	5	12	14	18
Native	4	5	6	15	18	22
Federal	12	17	22	45	64	80
Totals	19	26	33	72	96	120

Table 12

ESTIMATED STATE AND FEDERAL SHARES OF OFFSHORE SPECULATIVE RECOVERABLE OIL AND GAS RESOURCES

	Billions of Barrels of Oil			Trillions of Cubic Feet of Gas		
Ownership	Low	Med	High	Low	Med	High
State	3	4	5	21	28	34
Federal	35	46	58	237	316	396
Totals	38	50	63	258	344	430

Table 13

ESTIMATED STATE, NATIVE, AND FEDERAL SHARES OF TOTAL ONSHORE AND OFFSHORE SPECULATIVE RECOVERABLE OIL AND GAS RESOURCES

	Billions of Barrels of Oil			Trillions of Cubic Feet of Gas		
Ownership	Low	Med	High	Low	Med	High
State	6	8	10	33	42	52
Native	4	5	6	15	18	22
Federal	47	63	80	282	380	476
Totals	57	76	96	330	440	550

Table 14

U.S. ENERGY SUPPLIES, 1973

Source	Quads	Percentage of Supplies
Oil	34.7	46%
Natural Gas	23.6	31
Coal	13.5	18
Hydropower	2.9	4
Nuclear	.85	1
TOTALS	75.6	100%

Source: Ford Foundation, Exploring Energy Choices, pp. 69, 74.

Table 15

BASE CASE ESTIMATES OF U.S. ENERGY DEMAND, 1985

	Demand (in quads)	Annual Growth Rate 1972-85
Federal Energy Administration	109.1	3.1%
Ford Foundation	115.0	3.6%
National Petroleum Council	124.9	4.2%

Source: Adapted from FEA, Project Independence Report, p. 27.

Table 16

U.S. OIL PRODUCTION, CONSUMPTION, AND IMPORTS UNDER ALTERNATIVE ENERGY STRATEGIES, 1985, IN MMBDs

Strategies	Production	Consumption	Imports
At $7 World Prices			
Business as Usual	12.0	24.5	12.5
Accelerated Supply	17.0	24.5	7.5
Conservation	12.0	22.0	10.0
AS + Conservation	17.0	22.0	5.0
At $11 World Prices			
Business as Usual	15.0	18.5	3.5
Accelerated Supply	20.0	18.5	-
Conservation	15.0	16.0	1.0
AS + Conservation	20.0	16.0	-
1973 (for comparison)	10.9	17.2	6.3

Source: Adapted from data presented in FEA, Project Independence Report, pp. 30-34, 81-83.

Table 17

POTENTIAL RATES OF DOMESTIC OIL PRODUCTION, ALASKA AND OTHER U.S., 1985, IN MMBDs AT $11 OIL

Production Area	1974	Business as Usual 1985	Accelerated Supply 1985
Alaska	0.2	3.0	5.3
North Slope	---	2.5	2.5
Southern Alaska (including OCS)	0.2	0.5	0.8
Naval Petroleum Reserve #4	---	---	2.0
Lower 48 Outer Continental Shelf	1.4	2.6	4.3
Gulf of Mexico	1.3	2.1	2.5
California OCS	0.1	0.5	1.3
Atlantic OCS	---	---	0.5
Onshore - Lower 48 States	8.9	9.1	9.9
Conventional fields and new primary fields	6.9	3.4	3.5
New secondary	---	2.4	2.4
New tertiary	---	1.8	2.3
Natural gas liquids	2.0	1.5	1.6
Naval Petroleum Reserve #1	---	---	0.2
Heavy Crude Oil and Tar Sands	---	0.3	0.5
Total Potential Production	10.5	15.0	20.0

Source: FEA, Project Independence Report, Table II-9, p. 83.

Table 18

INDUSTRY BEFORE TAX PROFITS AND STATE REVENUES FROM PRUDHOE BAY OIL AT $11, $9, AND $7 PER BARREL, WITH STATE SHARE OF WELLHEAD VALUE AT 20 PERCENT AND 32.5 PERCENT

Refinery Price per Barrel	Annual Industry Profits (in millions)	Annual State Revenues* (in millions)		Revenues as % of Profits	
		At 20%	At 32.5%	At 20%	at 32.5%
$11	$3,833	$894	$1,453	23%	38%
9	2,555	639	1,038	25	41
7	1,278	383	623	30	49

* The calculation is as follows: Wellhead value ($7, $5, $3) x daily production rate (1.75 MMBD's) x 365 x combined state share (20%, 32.5%) = state revenues from production taxes and royalties

Table 19

PER BARREL DISTRIBUTION OF STATE AND
INDUSTRY SHARES OF ESTIMATED VALUES OF PRUDHOE BAY OIL

Refinery Price	Wellhead Value	Industry Before Tax Profit	State Share		Remaining Industry Share	
			At 20%	At 32.5%	At 20%	At 32.5%
$11	$7	$6	$1.40	$2.28	$4.60	$3.72
9	5	4	1.00	1.63	3.00	2.37
7	3	2	.60	.98	1.40	1.02

Table 20

PETROLEUM PRODUCTION SCHEDULES

	Percentages of Peak Production	
Year[1]	Schedule A[2]	Schedule B[3]
1	5%	10%
2	10	30
3	18	50
4	28	70
5	38	80
6	46	90
7	53	100
8	58	100
9	63	100
10	68	100
11	73	100
12	78	100

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[1]From start-up production year.

[2]For OCS fields, based on data presented in Council on Environmental Quality, OCS Oil and Gas -- An Environmental Assessment, Vol. 4 (Washington D.C.: Government Printing Office, 1974), Appendix I, "OCS Oil and Gas Recovery," Exhibit I-3, Offshore Development Timetable for Gulf of Alaska - High Recovery, P. 1-7.

[3]For onshore and nearshore (state territorial waters) fields. Author's estimates.

Table 21

ASSUMED STATE TAX AND ROYALTY RATES, 1974-1990

Year	Royalty	Prod. Tax	Total
1974	12.5%	7.5%	20.0%
1975	12.5	7.5	20.0
1976	12.5	7.5	20.0
1977	12.5	7.5	20.0
1978	12.5	12.0	24.5
1979	12.5	12.0	24.5
1980	12.5	15.0	27.5
1981	12.5	15.0	27.5
1982-90	12.5	20.0	32.5

Table 22

PIPELINE PROPERTY TAX SCHEDULES
(in thousands of dollars)

Year	Gas Lines		Oil Lines	
	Trans-Alaska	Trans-Canada	Trans-Alaska	Trans-Canada
1	$ 690	$ 60	$ 3,900	$ 680
2	1,477	120	13,300	2,160
3	16,903	2,760	42,400	13,850
4	37,244	6,120	70,700	23,230
5	54,822	8,130	80,900	23,990
6	67,912	9,490	87,500	24,450
7	71,987	10,000	92,500	25,700
8-15	71,987	10,000	92,500	25,700

SOURCES: Institute of Social, Economic and Government Research, "Impact on the Alaska Economy of Alternative Gas Pipelines," A Report Prepared for the Aerospace Corporation, April, 1975; State of Alaska, Department of Revenue; Author's estimates.

Table 23

ONSHORE/NEARSHORE FIELD EMPLOYMENT SCHEDULES

Numbers of Workers

Year	Schedule A[1]	Schedule B[2]	Schedule C[3]
1	1300	820	330
2	1300	820	330
3	1400	880	350
4	1500	940	380
5	1100	690	280
6	900	570	230
7	600	380	150
8	600	380	150
9	600	380	150
10	500	320	130
11	500	320	130
12	450	280	110
13	450	280	110
14	450	280	110
15	450	280	110

[1] For "high recovery" fields. Adapted from Arlon Tussing, et al., Alaska Pipeline Report Fairbanks: Institute of Social, Economic and Government Research, 1971, Table IV-5, pp. 81-2

[2] For "medium recovery" fields. Author's estimates.

[3] For "low recovery" fields. Author's estimates

Table 24

OCS FIELD EMPLOYMENT SCHEDULES

	Number of Workers	
Year	Schedule A[1]	Schedule B[2]
1	140	140
2	280	280
3	410	410
4	760	550
5	1460	760
6	2550	970
7	3220	1180
8	3870	1460
9	4170	1740
10	4470	1750
11	4770	1620
12	5070	1760
13	5090	1900
14	5120	2050
15	5170	2100

[1] For "high recovery" fields, based on data presented in Council on Environmental Quality, OCS Oil and Gas -- An Environmental Assessment, Vol. 4 (Washington, D.C.: Government Printing Office, 1974) Appendix I, Exhibit I-3, I-7.

[2] For "low recovery" fields, Ibid., Exhibit I-4, p. I-8

Table 25

OIL PIPELINE EMPLOYMENT SCHEDULES

	Number of Workers	
Year	Schedule A[1]	Schedule B[2]
1	3300	500
2	7100	1070
3	6500	980
4	1800	270
5	1200	180
6	600	90
7-15	300	50

[1] For trans-Alaska oil piplines, including road, terminal and related facilities. Adapted from Mathematical Sciences Northwest, Inc., A Study of the Economic and Sociological Impact of Construction and Initial Operation of the Trans-Alaska Pipeline, Vol. II, September 1972, Tables 3 and 11, pp. 30, 39.

[2] For a trans-Canada oil pipeline from vicinity of Naval Petroleum Reserve No. 4. Author's estimates.

Table 26

GAS PIPELINE DIRECT EMPLOYMENT SCHEDULES[1]

Years	Number of Workers: Schedule A[2]	Number of Workers: Schedule B[3]
1	1480	140
2	6070	570
3	8200	720
4	4960	40
5	2530	40
6-15	620	40

[1] From data provided by El Paso Alaska Company and Alaskan Arctic Gas Pipeline Company, as reported in Institute of Social, Economic and Government Research, "Impact on the Alaska Economy of Alternative Gas Pipelines," A report prepared for The Aerospace Corporation, April, 1975.

[2] For a trans-Alaska gas pipeline, including terminal, liquefaction plant, and related facilities.

[3] For a trans-Canada gas pipeline.

Table 27 Petroleum Production from State, Federal and Native Lands, 1974-1990

(in thousands of barrels per day)

Year	I. LIMITED DEVELOPMENT				II. ACCELERATED DEVELOPMENT				III MAXIMUM DEVELOPMENT			
	State	Federal	Native	Total	State	Federal	Native	Total	State	Federal	Native	Total
1974	200			200	200			200	200			200
1975	200			200	200			200	200			200
1976	200			200	200			200	200			200
1977	200			200	200			200	200			200
1978	1390			1390	1390			1390	1390			1390
1979	1680		20	1700	1680		20	1700	1680		20	1700
1980	1966	20	80	2066	1966	20	80	2066	1966	20	80	2066
1981	2048	60	160	2268	2088	80	160	2328	2088	80	160	2328
1982	2130	100	240	2470	2250	160	260	2670	2250	160	260	2670
1983	2222	200	300	2722	2462	500	360	3322	2462	500	380	3342
1984	2268	310	340	2918	2668	1080	440	4188	2668	1080	500	4248
1985	2314	456	380	3150	2834	1696	520	5050	2854	1696	640	5190
1986	2360	644	400	3404	3000	2372	560	5932	3080	2472	780	6332
1987	2360	824	400	3584	3080	2864	580	6524	3240	3114	900	7254
1988	2360	980	400	3740	3120	3320	600	7040	3360	3870	1020	8250
1989	2360	1112	400	3872	3160	3740	600	7500	3460	4660	1100	9220
1990	2360	1214	400	3974	3160	3916	600	7676	3500	5280	1140	9920

Table 28 Petroleum Revenues to State Government, 1974-1990, Including State Royalties, Production Taxes on State and Native Lands, 10% of Federal Royalties, and Pipeline Property Taxes

(in millions of dollars)

Year	I. LIMITED DEVELOPMENT $3 Wellhead	$5 Wellhead	$7 Wellhead	II. ACCELERATED DEVELOPMENT $3 Wellhead	$5 Wellhead	$7 Wellhead	III. MAXIMUM DEVELOPMENT $3 Wellhead	$5 Wellhead	$7 Wellhead
1974	$ 48	$ 48	$ 48	$ 48	$ 48	$ 48	$ 48	$ 48	$ 48
1975	62	62	62	63	63	63	63	63	63
1976	86	86	86	86	86	86	86	86	86
1977	116	116	116	116	116	116	116	116	116
1978	480	695	910	480	695	910	480	695	910
1979	573	843	1113	573	843	1113	573	843	1113
1980	735	1105	1474	735	1105	1474	735	1105	1474
1981	778	1175	1573	791	1197	1602	791	1197	1602
1982	950	1456	1962	1001	1539	2077	1005	1543	2081
1983	998	1536	2074	1116	1723	2330	1133	1744	2354
1984	1025	1581	2137	1227	1901	2576	1282	1966	2649
1985	1053	1627	2202	1315	2048	2781	1420	2175	2931
1986	1077	1668	2258	1396	2182	2969	1556	2395	3234
1987	1080	1673	2266	1439	2253	3067	1675	2577	3479
1988	1083	1678	2272	1466	2298	3130	1783	2740	3697
1989	1086	1682	2278	1487	2334	3181	1868	2870	3872
1990	1087	1685	2282	1491	2339	3188	1915	2940	3964

Table 29 Direct Employment in Construction and Petroleum Mining, 1974-1990

Year	I. LIMITED DEVELOPMENT			II. ACCELERATED DEVELOPMENT			III MAXIMUM DEVELOPMENT		
	Construction	Mining	Total	Construction	Mining	Total	Construction	Mining	Total
1974	3300	1860	5160	3300	1860	5160	3300	1860	5160
1975	7100	1860	8960	7100	1860	8960	7100	1860	8960
1976	6500	1960	8460	6500	1960	8460	6500	1960	8460
1977	1800	3540	5340	1800	3540	5340	1800	3540	5340
1978	1240	4040	5280	1240	4040	5280	1240	4040	5280
1979	970	4180	5150	970	4180	5150	970	4180	5150
1980	720	4270	4990	720	4270	4990	720	4270	4990
1981	---	4270	4270	500	8440	8940	500	8910	9410
1982	---	4550	4550	1070	8770	9840	4370	10180	14550
1983	---	5090	5090	980	9600	10580	8080	12100	20180
1984	---	5600	5600	240	9720	9960	6740	12910	19650
1985	---	6200	6200	140	10350	10490	3420	14510	17930
1986	---	6400	6400	40	10470	10510	7210	16190	23400
1987	---	6660	6660	---	11130	11130	8600	18150	26750
1988	---	6880	6880	---	11910	11910	4960	20720	25680
1989	---	7140	7140	---	11990	11990	2530	21890	24420
1990	---	7160	7160	---	11730	11730	520	22940	23460