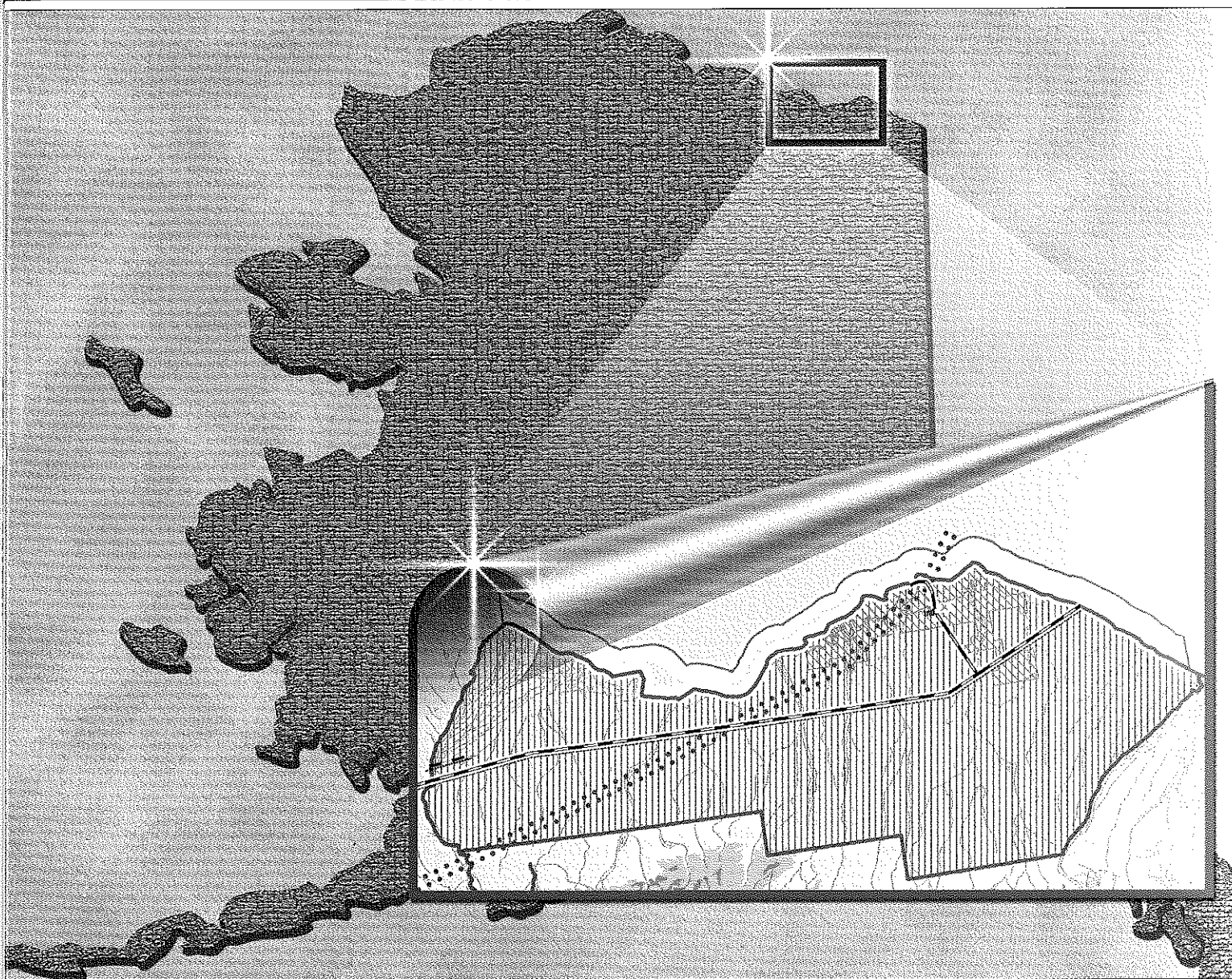


# OIL & GAS JOURNAL

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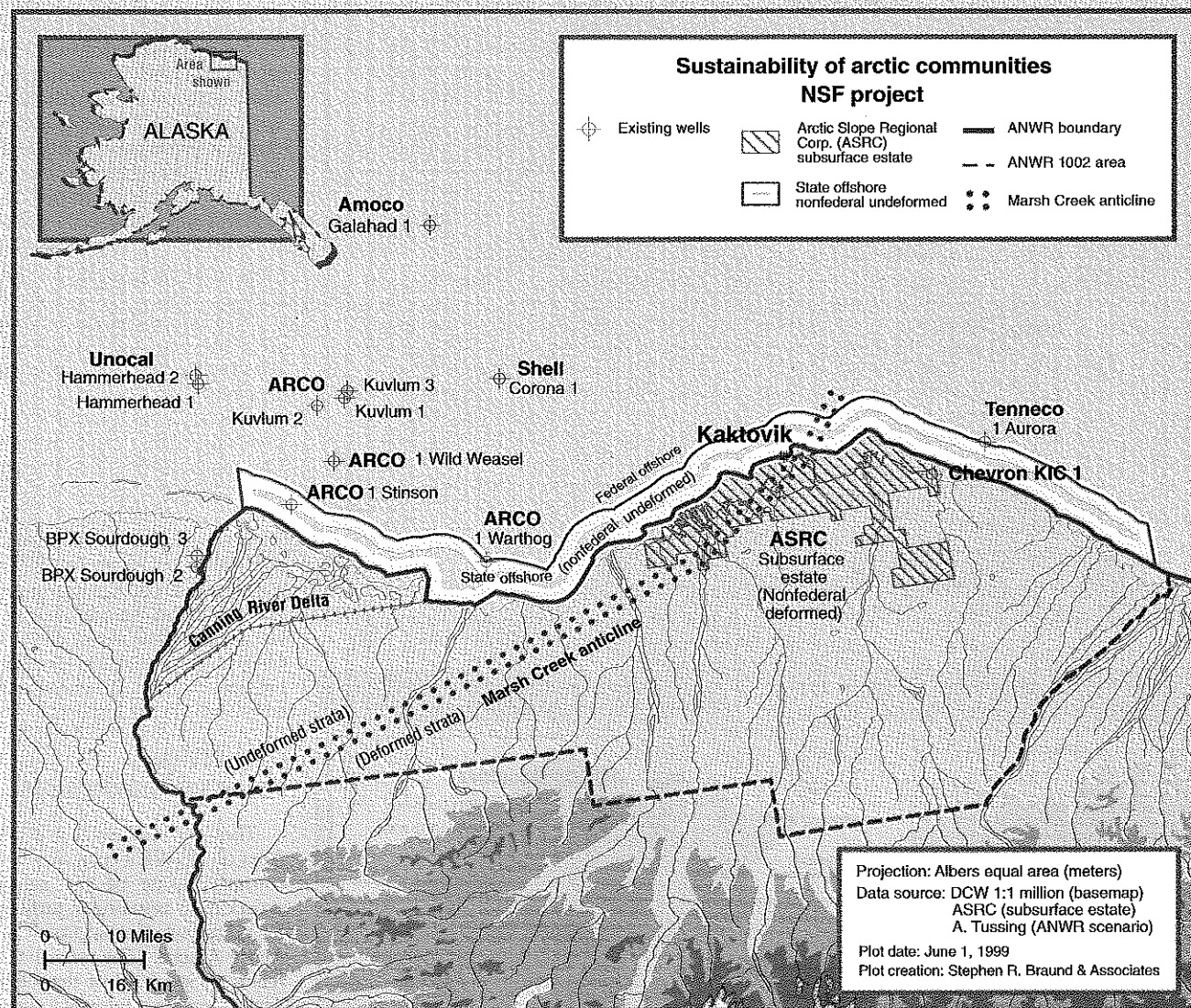
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LAND CLASSIFICATIONS AND EXISTING WELLS



Source: Original graphics from Stephen R. Braund & Associates

# Drainage pierces ANWR in Alaska study scenario

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A hypothetical scenario of petroleum industry activities adjacent to the 1002 Area of the Arctic National Wildlife Refuge (ANWR) suggests that development from leases under State of Alaska jurisdiction could drain reservoirs that extend under ANWR. An-

tipication of such drainage might in turn trigger Congressional authorization for limited surface development of trans-boundary fields.

This is the first in a series of five petroleum development scenarios culminating in industry activities throughout

the 1002 Area. The scenarios were developed for an interdisciplinary study of community sustainability in the Arctic funded by the National Science Foundation. The full model—which includes climate change, vegetation, caribou, subsistence hunting, community labor markets,



## OIL SCENARIO 1: DRAINAGE OF POOLS ON THE ANWR BORDER

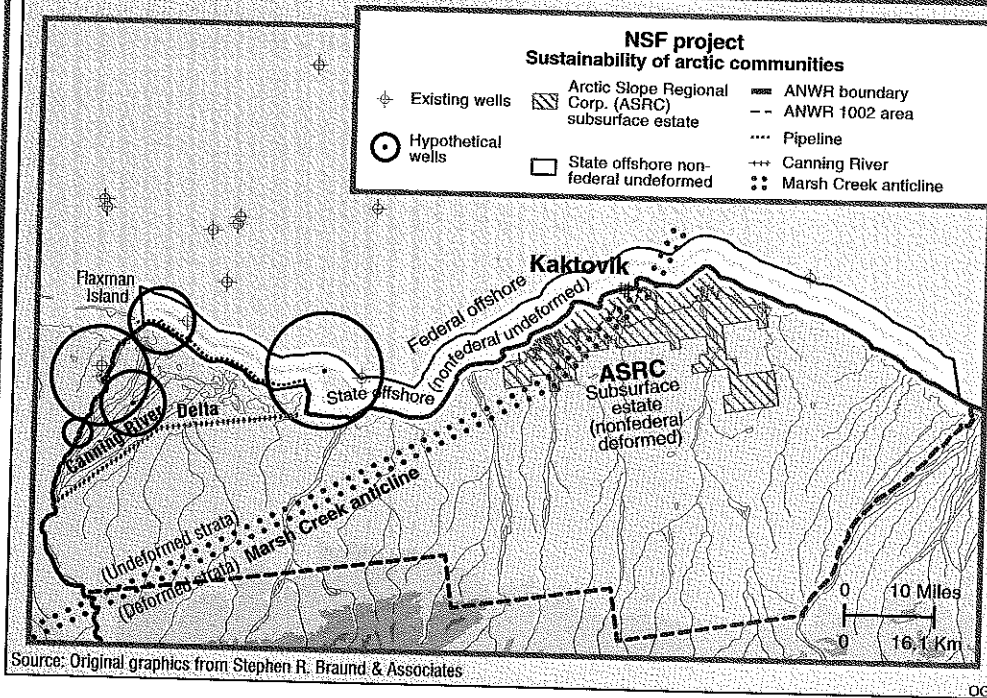


Fig. 2

hypothetical sequence in which they would be discovered and produced, represent only a single run of a Monte Carlo simulation model. This model was based on probability distributions for the occurrence of recoverable hydrocarbon, estimated by the U.S. Geological Survey and published in 1998.<sup>1</sup> The scenarios therefore do not purport to be "expected" values but only plausible in light of the USGS Assessment. The technical appendix to the USGS Assessment was released in April 1999 and was not available at the time the scenarios were developed.

Assumptions on field design and drilling and construction practices are based on the most recent Alaska North Slope operations: Arco's most westerly Alpine development and BP Exploration's (BPX) easternmost Badami development. The final scenario hinges on assumptions about continuing trends in technology that reduce future development costs and surface impacts.

## OIL SCENARIO 2: ASRC LANDS, CANNING DELTA, AND NORTH OF 70°

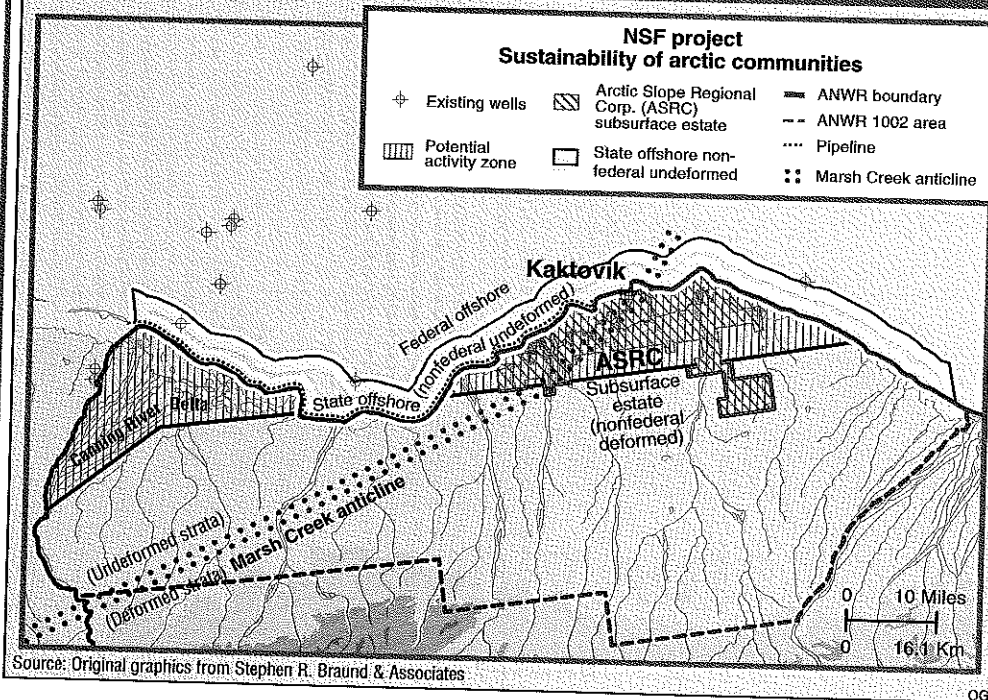


Fig. 3

### Land status, resource assessments

The 1.57 million-acre 1002 Area of ANWR's coastal plain contains some of the most prospective remaining targets for petroleum development in Arctic Alaska. (The term 1002 refers to Sec. 1002 of the 1980 Alaska National Interest Lands Conservation Act.) However, federal law currently prohibits exploration, development, or production of hydrocarbons in the entire 1002 Area, including enclaves of private (Alaska Native) mineral rights, pending specific approval by Congress.

Geophysical surveys and test drilling have nevertheless taken place within and especially on the margins of ANWR in the past, and a number of exploration wells have been drilled on its perimeter. Data from such sources stand behind recent estimates of hydrocarbons resources published by the USGS. However, the information remains too meager within the 1002 Area itself to make confident location-specific forecasts of potential production or the in-

and tourism development scenarios—is scheduled for release in September 1999. Details on the five scenarios are currently available at <http://www.taiga.net/sustain>

The 40-year scenarios are not offered as predictions, but as "science fiction."

stories combining the best available scientific information and a set of fictional but plausible assumptions to explore implications of a range of plausible outcomes. In each scenario, the locations and volumes of recoverable oil accumulations in and adjacent to ANWR, and the

Table 1

## MEAN EXPECTATIONS OF TECHNICALLY RECOVERABLE OIL BY LAND STATUS AND GEOLOGICAL SECTOR

Land category	Study area		Percentage of total area	Technically recoverable oil, million bbl	Percentage of total oil
	acres	Sq miles			
Undeformed federal	431,360	674	24.1	6,420	62.6
Undeformed nonfederal	172,032	269	9.6	2,330	22.7
Deformed federal	1,026,640	1,604	57.3	1,250	12.2
Deformed nonfederal	142,432	223	8.0	260	2.5
<b>Total</b>	<b>1,790,640</b>	<b>2,798</b>	<b>100.0</b>	<b>10,260</b>	<b>100</b>

Land category	Recoverable oil per square mile, 1,000 bbl	Mean number of large fields*	Total oil in large fields* — Million bbl —	Oil per large field* — Million bbl —	Thousand barrels per square mile in large fields*
Undeformed nonfederal	8,668	2.8	1,560	567	5,804
Deformed federal	779	2.3	960	414	598
Deformed nonfederal	1,168	0.1	220	2,200	989
<b>Total</b>	<b>3,667</b>	<b>11.9</b>	<b>6,710</b>	<b>562</b>	<b>2,398</b>

\* Accumulations of 256 million bbl or more.  
Source: USGS 1998 ANWR Assessment

vestment outlay and activity necessary to develop such potentials.

The "1002 Area" includes about 97,000 acres in the vicinity of Kaktovik on which the Arctic Slope Regional Corp. (ASRC) holds mineral title. ASRC is a for-profit Alaska Native regional corporation established under the Alaska Native Claims Settlement Act of 1981. The surface estate, owned by Kaktovik Inupiat Corp. (an ANCSA village corporation), is subject to the current Congressional prohibition against commercial oil and gas activity within the refuge. ASRC has leased most of its subsurface estate to BPX and Chevron, which drilled the "KIC" test well east of Barter Island.

State offshore acreage adjacent to ANWR—248,000 total acres—consists of a strip extending three miles from the shoreward boundary of the refuge into the Arctic Ocean. On the western end of this strip of submerged state acreage, two wells have been drilled and plugged without any announced commercial discovery. Another well has been drilled, plugged, and abandoned on the east end of the study area, on a federal lease just outside the outer jurisdictional boundary and five miles northeast of the KIC well. A few miles north of the outer boundary between state and federal acreage, ten wells have been drilled on federal offshore leases, with two discoveries of potentially commercial resources.

Survey and exploration activity on state lands immediately to the west of ANWR includes six wells within three miles and 19 wells within about 30 miles of the refuge boundary and at least two announced discoveries of potentially commercial hydrocarbons (Fig. 1).

### USGS 1998 assessment

The USGS divided its assessment area into four sectors.

Land status was classified as "federal" jurisdiction (the 1002 Area, less ASRC lands) and "non-federal" (state offshore lands, plus ASRC mineral inholdings in the 1002 Area). A geological distinction was made along the Marsh Creek anticline, separating "undeformed" (horizontal) formations to the north and west, and "deformed" (folded and fragmented) formations to the south and east. The anticline crosses the band of state offshore lands near the village of Kaktovik.

The USGS classification scheme allocates about one-third of the total acreage in the northwest corner of ANWR to the undeformed sector and the remaining two-thirds, including most of the ASRC lands, to the deformed sector. Table 1 summarizes the USGS assessments of total technically recoverable crude-oil volumes, and volumes in accumulations of 256 million bbl or more, in each of the four sectors of the study area.

### Relative attractiveness

The undeformed sector, which accounts for only 33.7% of the study area but 85.3% of the estimated recoverable oil, contains the more attractive exploration targets.

The USGS expected 9.6 large (256 million bbl or more technically recoverable) crude-oil accumulations to exist in the undeformed sector: about one for every 23,000 sq miles. In contrast, USGS expected only 2.6 million bbl in the much larger deformed sector: about one for every 395,000 sq miles. Likewise, the mean expected volume of recoverable oil per unit

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area in the undeformed sector is almost nine times the volume of oil expected in an equivalent area within the deformed sector. The USGS did not report a significant difference in mean size or distribution of sizes of oil accumulations.

The expected concentrations of oil do not differ significantly between the federal and non-federal parts of the undeformed sector, as measured by either the expected number of accumulations per unit area or the volumes of recoverable oil per unit area. Moreover, because the existing stock of geophysical and geological information is much richer on the nonfederal than on the federal part of the USGS study area, we infer that:

- Independently of their legal status, the undeformed sectors contain the more promising exploration targets for oil. (The April 1999 USGS Open File Report discloses that the deformed area is substantially more prospective for gas than for oil);

- This assessment is more reliable for the nonfederal (i.e., state offshore) part of the undeformed sector than for the federal, because of the richer geophysical information base and because of the existence of two test wells on the unde-

Fig. 4

## OIL SCENARIO 3: ONSHORE FACILITIES AND PERMANENT ROADS

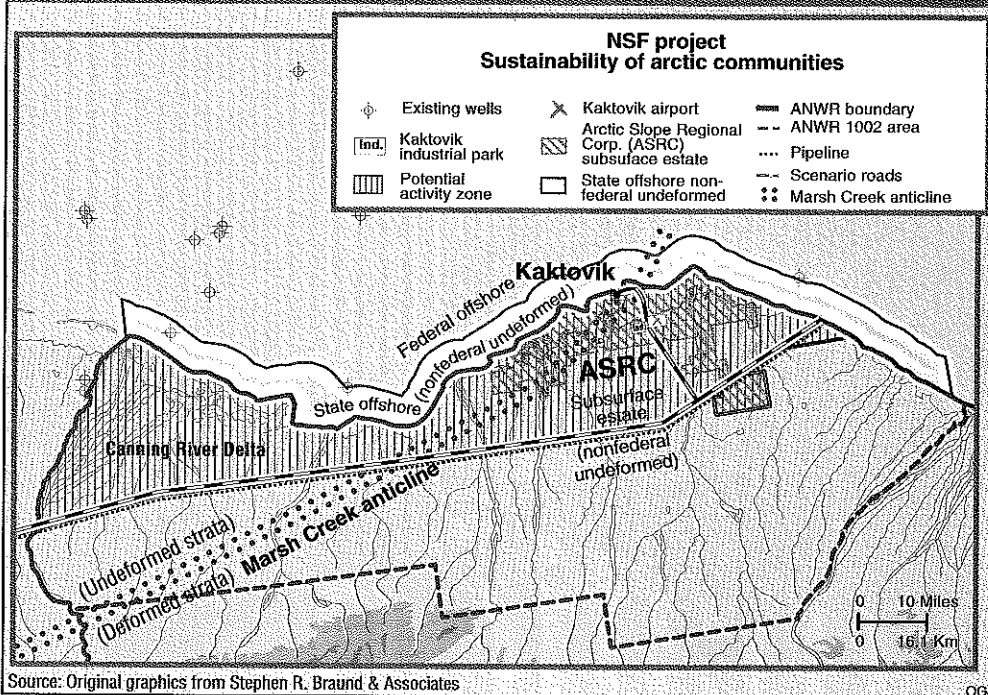
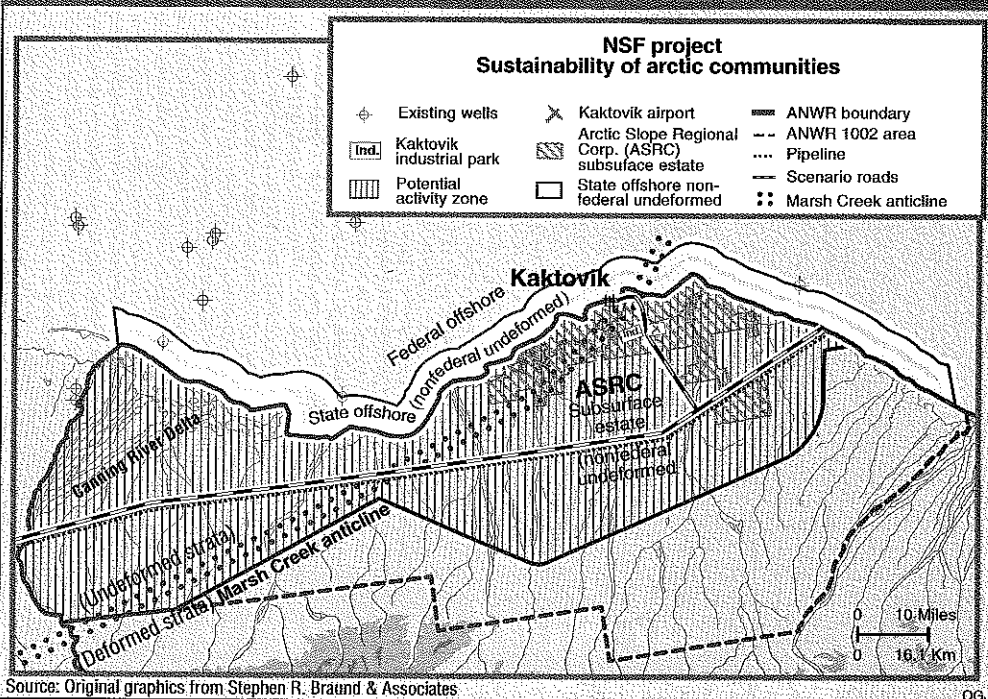


Fig. 5

## OIL SCENARIO 4: FULL 1002 LEASING



formed portion of the offshore state strip;

- Within the federal (i.e., ANWR) part of the undeformed sector, the USGS assessment is most reliable in the north-westerly corner—the Canning River Delta.
- On balance, the most attractive pe-

troleum exploration targets in the entire study area are likely to be the Canning Delta and its immediate vicinity, both within and outside ANWR.

### Apparent USGS pessimism

The USGS assessed the expected vol-

ume of “technically recoverable” resources in the total study area at 10.3 billion bbl, with a 95% probability the actual value is at least 5.7 billion bbl and a 5% probability that it is 16.0 billion bbl or more. Of the expected 10.3 billion bbl technically recoverable, moreover, only 6.8 billion bbl are expected to be found in accumulations containing at least 512 million bbl, deemed the “minimum commercially recoverable field size.”

More notably yet, the USGS estimates that *no* crude oil from the study area would be “economically recoverable” at a West Coast crude-oil market price of \$15/bbl or less (1996 dollars) and that only 3.3 billion of the 10.3 billion bbl technically recoverable would be economically recoverable at a price of \$20.

After averaging about \$11 in 1998, reported West Coast prices for Alaska North Slope (ANS) crude oil fell to \$9 in early 1999, rebounding to about \$16 in mid-May. Some analysts, including Philip Verleger, expect even higher prices over the next year or so,<sup>2</sup> and there are also those who still anticipate the imminent onset of the steep price rises which were widely predicted in the late 1970s and early 1980s.<sup>3</sup> Nevertheless, we are not aware of any mainstream forecasting authorities that now anticipate long-term delivered prices for ANS crude oil greater than \$15.

Taken at face value, the USGS assessment implies only a small probability that any crude oil resources at all will be developed, or produced from or immediately offshore of the ANWR 1002 Area. In particular, the study seems to rule out the discovery of “Prudhoe-size” accumulations of economically recoverable crude oil, i.e., ultimate reserves on the order of, say, 10 billion bbl. Combined with the probable geographic distribution of crude-oil accumulations within the study area, the USGS assessment implies that that little or no commercially recoverable crude oil will be found and developed on ASRC acreage or elsewhere in the deformed sector.