

State of Alaska  
Department of Natural Resources  
Division of Geological and Geophysical Surveys  
and  
Department of Commerce and Economic Development  
Division of Economic Enterprise

ALASKA OIL AND GAS DEVELOPMENT ADVISORY BOARD

This study is in response to AS 38.06, Sec. 38.06.070 (2) that the board shall consider "the existence and extent of present and projected local and regional needs for oil and gas products and by-products, the effect of state or federal commodity allocation requirements which might be applicable to those products and by-products, and the priorities among competing needs."

This report is preliminary. Input data and results have not been thoroughly checked and reviewed. Demand outputs have not had economic parameters applied for industrial expansion.

Alaska Open File Report 92

FUTURE ALASKAN NATURAL-GAS DEMAND

A Study for the Alaska Oil and Gas  
Development Advisory Board

By P.L. Dobey, G.A. Bewley and R.M. Klein  
October 1975

ALASKA ROYALTY OIL AND GAS DEVELOPMENT ADVISORY BOARD

Pouch M

Juneau, Alaska 99811

Telephone: (907) 465-2400

Chairman: Guy R. Martin, Commissioner  
Department of Natural Resources

Executive Director: William C. Fackler

Board Members: Sterling Gallagher  
Richard Lyons  
Don Triplehorn  
Arlon Tussing

## CONTENTS

	<u>Page</u>
Introduction. . . . .	1
Method. . . . .	1-2
High-development scenario . . . . .	11-12
Low-development scenario. . . . .	16

## ILLUSTRATIONS

<u>Figure</u>	<u>Page</u>
1. Historical natural gas consumption. . . . .	4
2. Speculative Alaska population projections . . . . .	6
3. Scenario - basic population, high growth. . . . .	8
4. Scenario - basic population, medium growth. . . . .	9
5. Scenario - basic population, low growth . . . . .	10
6. Scenario - high-development scenario. . . . .	13
7. Scenario - high-development graph . . . . .	14
8. Scenario - low-development flow chart . . . . .	17
9. Scenario - low-development graph. . . . .	18
10. Cumulative royalty natural gas & remaining committed natural gas. . .	26
11. Alaskan natural gas demand & royalty natural gas. . . . .	27

## TABLES

<u>Table</u>	<u>Page</u>
1. Natural gas consumption and production, 1972-1974 <sup>1</sup> . . . . .	3
2. Speculative Alaska population projections . . . . .	5
3. Future natural gas demand based on population projection <sup>1</sup> . . . . .	7
4. Natural gas demand - high-development scenario. . . . .	15
5. Natural gas demand - low-development scenario . . . . .	19

TABLES (cont.)

<u>Table</u>	<u>Page</u>
6. Pipeline-corridor fact sheet. . . . .	20
7. Hydroelectric fact sheet. . . . .	21
8. Electrical-power-generation fact sheet. . . . .	22-23
9. Industry fact sheet <sup>1</sup> . . . . .	24-25
10. Alaskan natural gas demand analysis . . . . .	28

## INTRODUCTION

A natural gas demand study for the Alaska Oil and Gas Development Advisory Board was undertaken in response to AS 38.06. Procedures for this analysis are the same as those described in Division of Geological and Geophysical Surveys open-file report 91, Future Oil Demand in Alaska. Therefore, a discussion of the computer probability procedures will not be given.

Three base-line future gas demands and two development demand scenarios are presented. The development scenarios represent the probable "decision range" of future natural gas demand in Alaska.

Actual future gas consumption will depend on many factors, including national and state policy. Decisions made by the state government concerning disposition of its royalty gas will have an effect on the ultimate quantity of gas consumed in Alaska. Therefore, it is better to consider future natural gas demand as a time-dependent variable that moves within the limits established by the high-population development and low-development probability scenarios. Additional scenarios and computer runs can be made for detailed studies of specific problems.

## METHOD

Natural gas demand can be divided into three main categories: gas used for heating, gas used for electric power generation, and gas used by industry (table 1, fig. 1). Basic population projections for Alaskan residential and commercial (nonindustrial) natural gas demand have been made from population projections provided by the Institute for Social Environmental and Government

Research (table 2, fig. 2), and from the 1974 natural gas use per capita for heating and electrical power generation. These basic natural gas demand projections have been calculated for high-, medium-, and low-growth probabilities; they form the basis for the development of further scenarios (table 3, figs. 3-9).

Two interpretative probability scenarios are presented in this report, a high-development scenario (p. 11) and a low-development scenario (p. 16). The Royalty Board may request any further scenarios it requires.

The Division of Economic Enterprise of the Alaska Department of Commerce and Economic Development provided industrial data and development scenarios for this study. Other agencies and organizations who provided assistance or data for the study were:

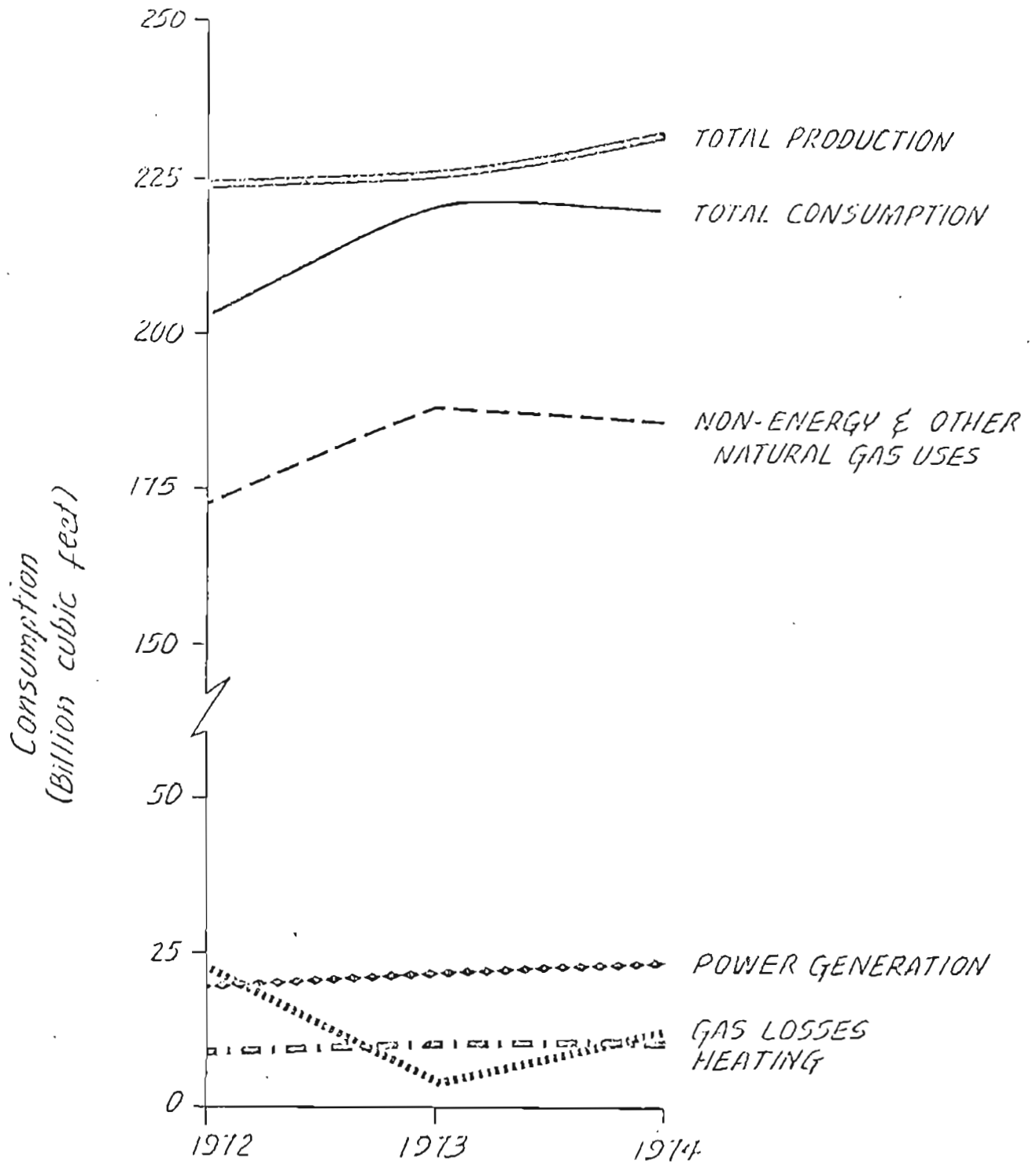
- Alaska Department of Revenue
- Alaska Division of Oil and Gas
- El Paso Natural Gas Company
- Alaska Power Administration
- Institute for Social Economic and Government Research
- Dow Chemical Corporation
- Kaiser Cement and Gypsum Corporation
- Collier Carbon and Chemical Company
- Anchorage Natural Gas Company
- Chugach Electric Company

Table 1. Natural gas consumption and production, 1972-1974<sup>1</sup>

	1972			1973			1974		
POPULATION	322,115			330,300			350,700		
NATURAL GAS	Thousand cubic feet	Total consumption (%)	Total production (%)	Thousand cubic feet	Total consumption (%)	Total production (%)	Thousand cubic feet	Total consumption (%)	Total production (%)
Power generation	19,979,433	10	9	22,125,927	10	10	23,574,300	11	10
Heating	9,461,934	5	4	10,128,782	5	4	10,354,253	5	5
Subtotal	29,441,367	15	13	32,254,709	15	14	33,928,553	16	15
Oil & gas industry									
<u>In-state</u>									
Oil & gas production <sup>2</sup>	90,506,649	45	40	106,005,793	48	47	101,179,216	46	44
Other	86,603			209,680			247,975		
	<u>90,593,252</u>			<u>106,215,473</u>			<u>101,427,191</u>		
<u>Export</u>									
Gas liquefaction	60,005,622	40	37	61,122,268	37	37	62,491,912	38	36
Ammonia-urea plant	21,637,106			20,472,746			21,013,109		
	<u>81,642,728</u>			<u>81,595,014</u>			<u>83,505,021</u>		
Subtotal	172,235,980	85	77	187,810,487	85	84	184,932,212	84	80
Total consumption	201,677,347	100	90	220,065,196	100	98	218,860,765	100	95
Gas loss	22,444,648	---	10	4,442,056	---	2	12,344,896	---	5
Total	224,121,995	---	100	224,507,252	---	100	231,205,665	---	100
NATURAL GAS LIQUIDS	<u>Barrels</u>			<u>Barrels</u>			<u>Barrels</u>		
Propane sold in Alaska	Incomplete			318,230			350,569		
Extraction plants									
Butane	594,426			712,370			696,352		
Propane	12,138			98,348			95,966		

1. All gas from Cook Inlet unless otherwise indicated; Cook Inlet gas has 1005 Btu per cubic foot.

2. Includes some Prudhoe Bay gas.



HISTORICAL NATURAL GAS CONSUMPTION

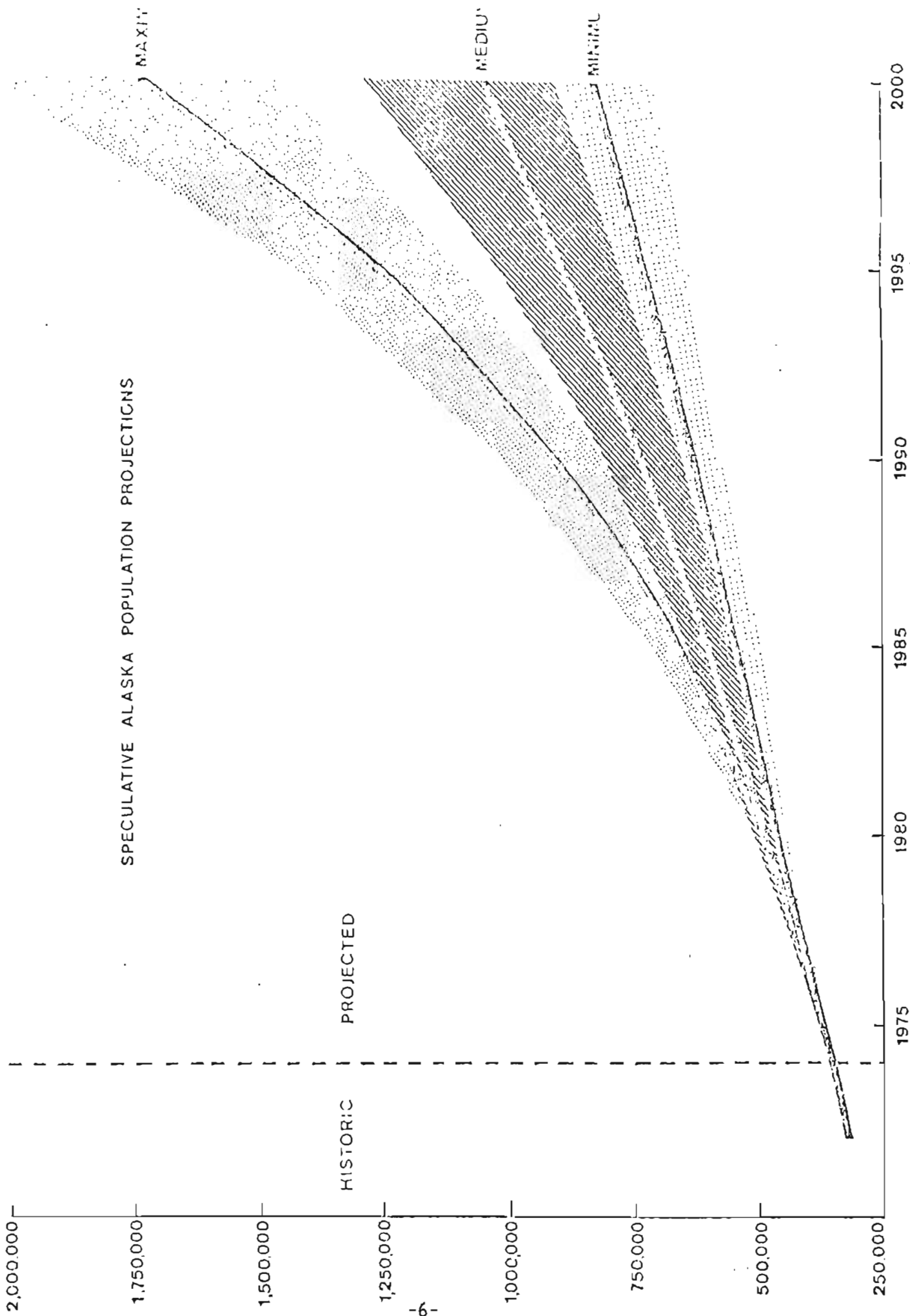
FIGURE 1



Table 2. Speculative Alaska Population Projections.

	<u>Minimum</u>	<u>Medium</u>	<u>Maximum</u>
1980	490,300	510,000	510,000
	468,600	487,700	487,700
	446,600	465,600	465,600
1985	580,900	649,600	714,600
	536,300	595,500	657,400
	493,000	542,900	602,100
1990	682,000	810,500	1,013,700
	627,500	729,600	908,300
	573,600	653,600	810,900
1995	800,668	1,022,040	1,438,440
	721,625	892,301	1,255,270
	636,696	774,516	1,092,282
2000	939,984	1,288,793	2,041,146
	829,869	1,091,284	1,734,784
	706,733	917,801	1,471,304

Projected by DGGs; other data supplied by Institute for Social, Economic and Government Research.

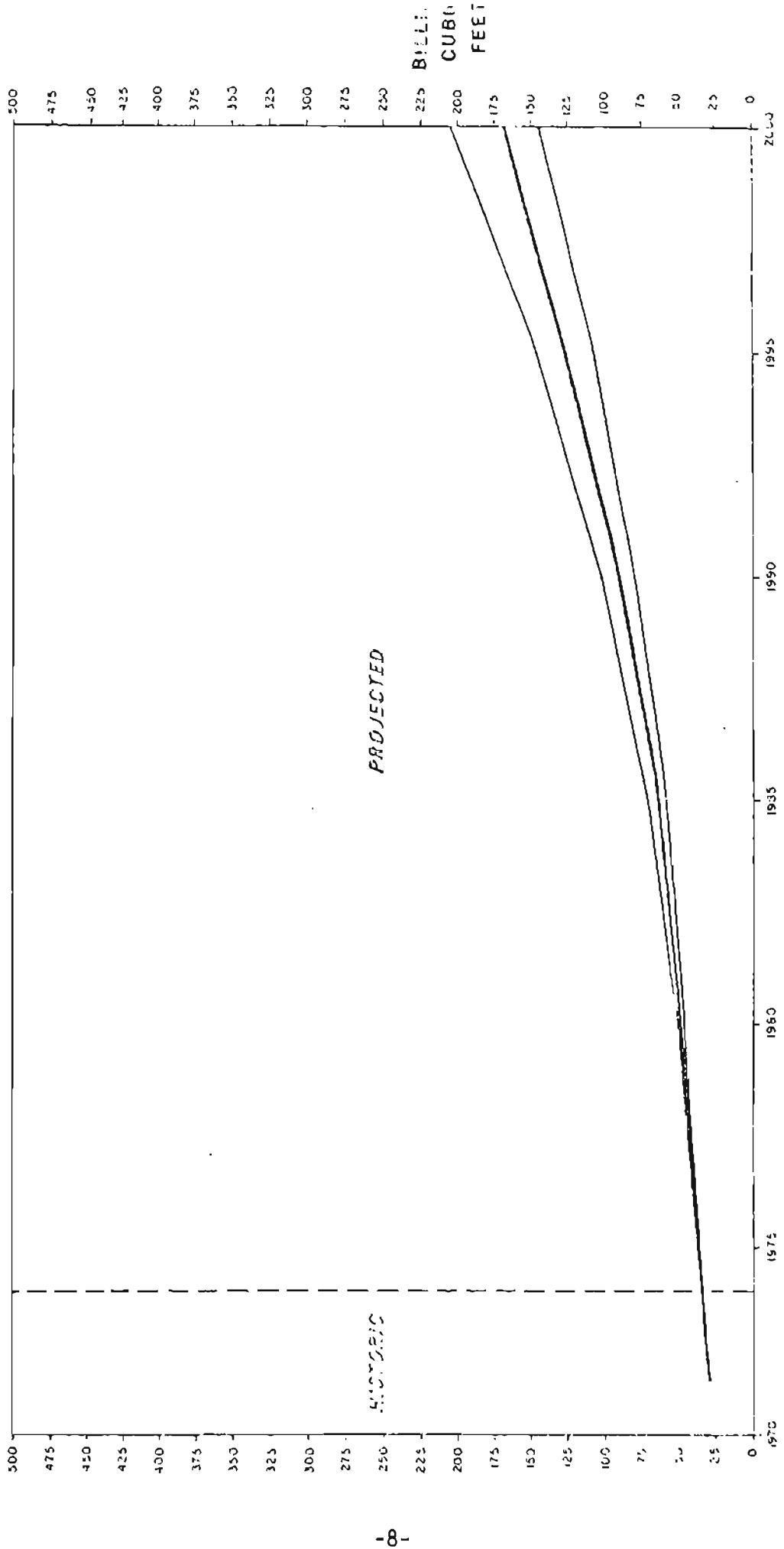


SPECULATIVE ALASKA POPULATION PROJECTIONS

Table 3. future natural gas demand based on population projection.<sup>1</sup>

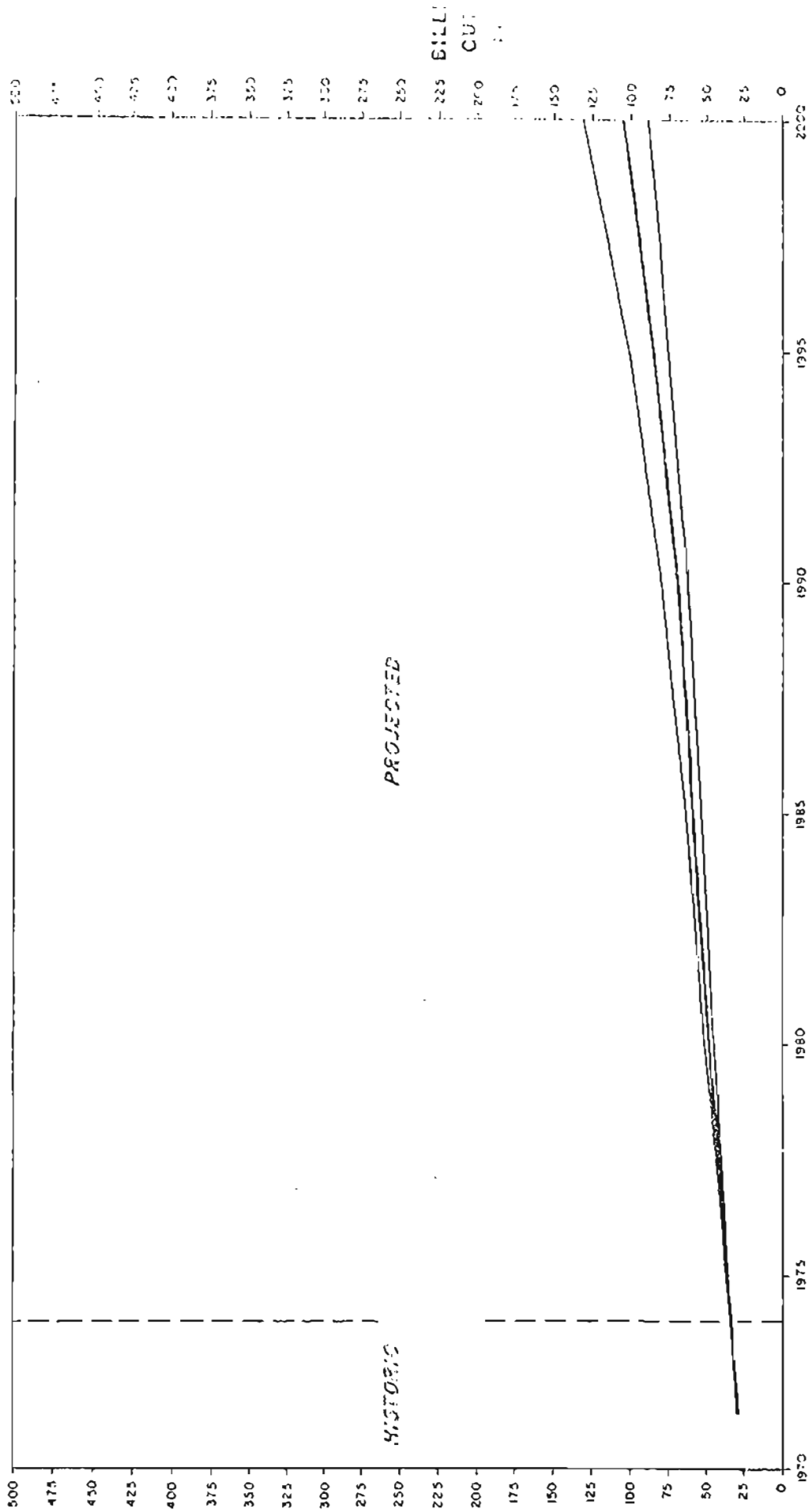
	(Billion cubic feet per year)					
	<u>1974</u>	<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>1995</u>	<u>2000</u>
High Growth	-	50.3	71.0	101.5	145.1	205.7
	33.9 <sup>2</sup>	47.9	63.5	90.8	126.6	167.6
	-	45.5	58.7	79.7	107.1	144.9
Medium Growth	-	50.3	64.8	81.3	101.9	131.5
	33.9 <sup>2</sup>	47.9	59.1	70.7	86.3	105.3
	-	45.5	53.1	63.5	75.6	89.3
Low Growth	-	48.5	57.4	68.0	80.0	94.0
	33.9 <sup>2</sup>	45.5	51.8	60.7	71.4	81.8
	-	43.5	48.1	55.8	61.8	68.8

1. These figures are based solely on population projections. They do not include the possible demand along the pipeline corridor, the Devils Canyon project, or any other considerations which may alter demand. For alterations on these basic demand figures, refer to specific scenarios.
2. In the groups of these figures, the most likely figure is bracketed by the 5% and 95% probability range figures.



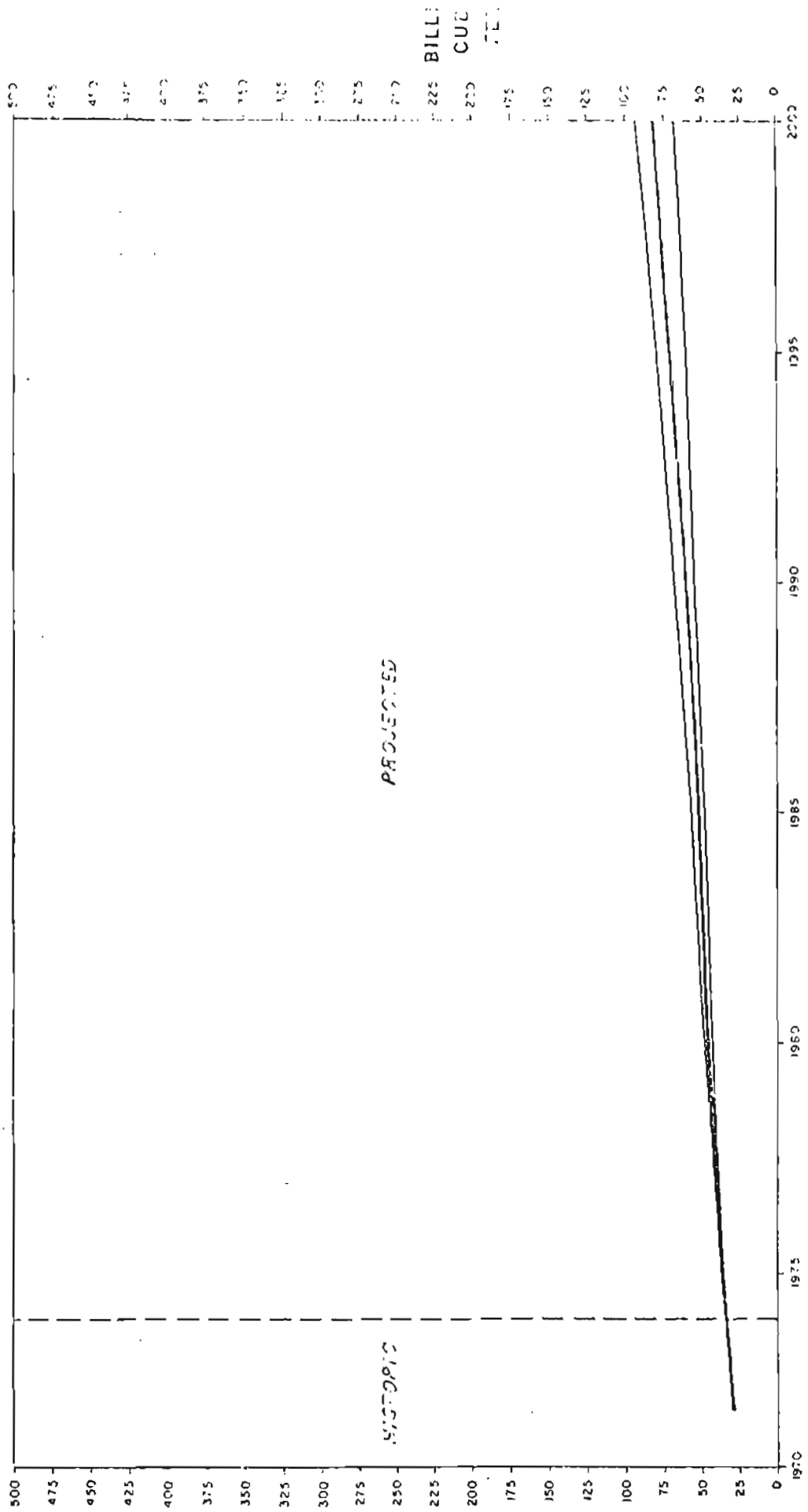
PROJECTED ALASKAN GAS DEMAND  
 BASIC POPULATION  
 HIGH GROWTH

FIGURE 3



PROJECTED ALASKAN GAS DEMAND  
 SCENARIO T4-G  
 BASIC POPULATION MEDIUM GROWTH

FIGURE 4



PROJECTED ALASKAN GAS DEMAND  
 SCENARIO T5-G  
 BASIC POPULATION - LOW GROWTH

FIGURE 5

## HIGH-DEVELOPMENT SCENARIO

In the development of a scenario there are four main categories to consider (figs. 6, 7; table 4). A brief explanation of each follows.

Population Choices: These are the basic-population-demand projections. There are three choices--high- (table 4), medium-, and low-growth (table 5). High-growth was chosen for this scenario.

Pipeline Choices: The choice for the Prudhoe Bay gas pipeline is between two routes--Canadian or Alaskan. The Alaskan route was chosen for this scenario; therefore, it was assumed that gas would be available to the pipeline corridor. Because this in turn would create an additional demand for gas along the corridor, the basic-population demand projection (table 6) was modified accordingly.

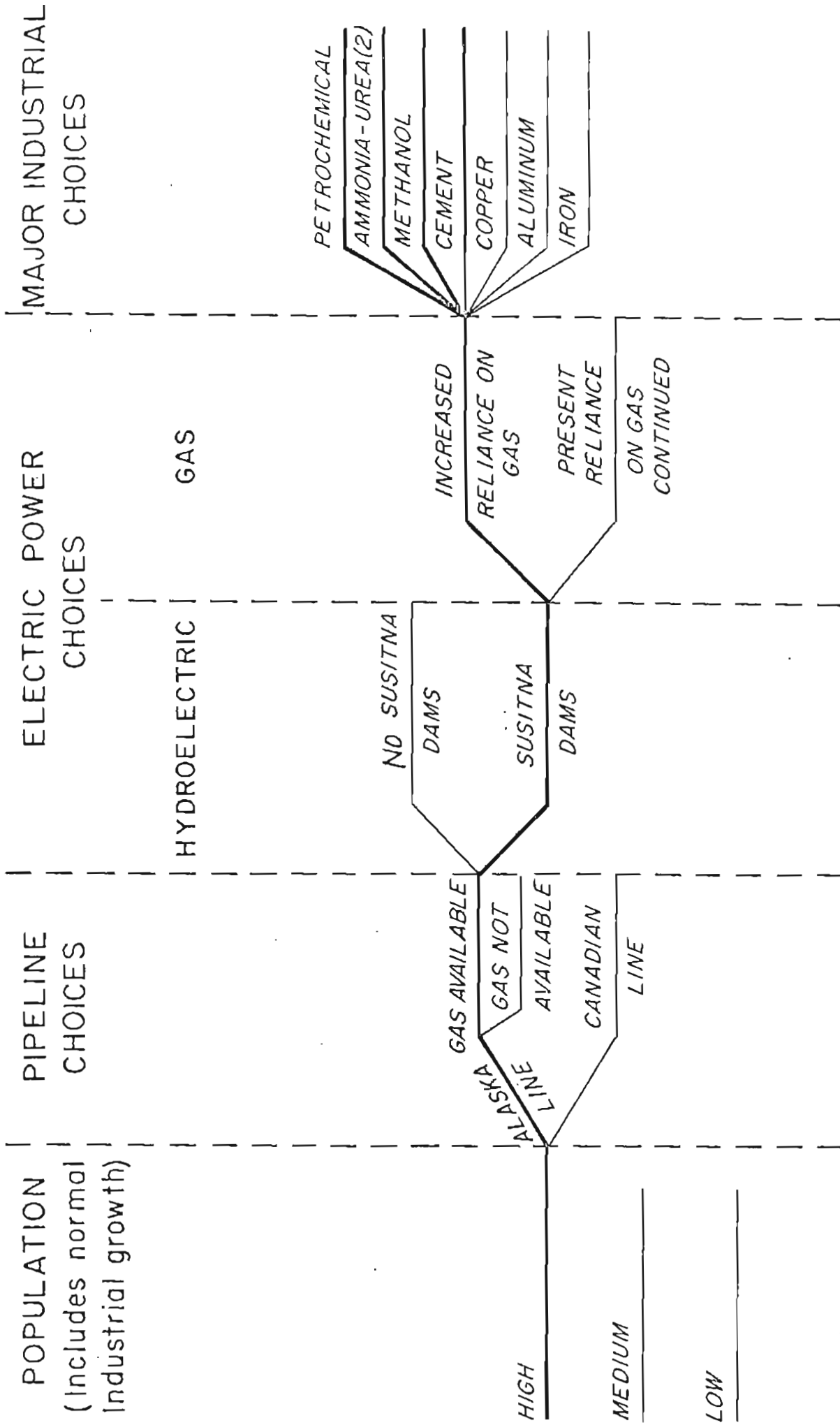
Electrical-Power Choices: Two main modes of power generation have been considered in future electrical-power sources--hydroelectric and gas. The choice in the hydroelectric category (table 7) is whether to include the Upper Susitna project. The other choice is electrical power generated by gas (table 8). If the percentage of power generated by gas continues to increase, it will be necessary to add the additional demand for gas to the basic-population demand projection. Both the Susitna project and an increasing reliance on gas were chosen for this scenario.

Industrial Choices: With the assistance of the Division of Economic Enterprise, a list of possible industrial uses for natural gas was compiled (table 9). An industrial model is also being prepared for each industry by the Division

of Economic Enterprise. The following schedule was decided on:

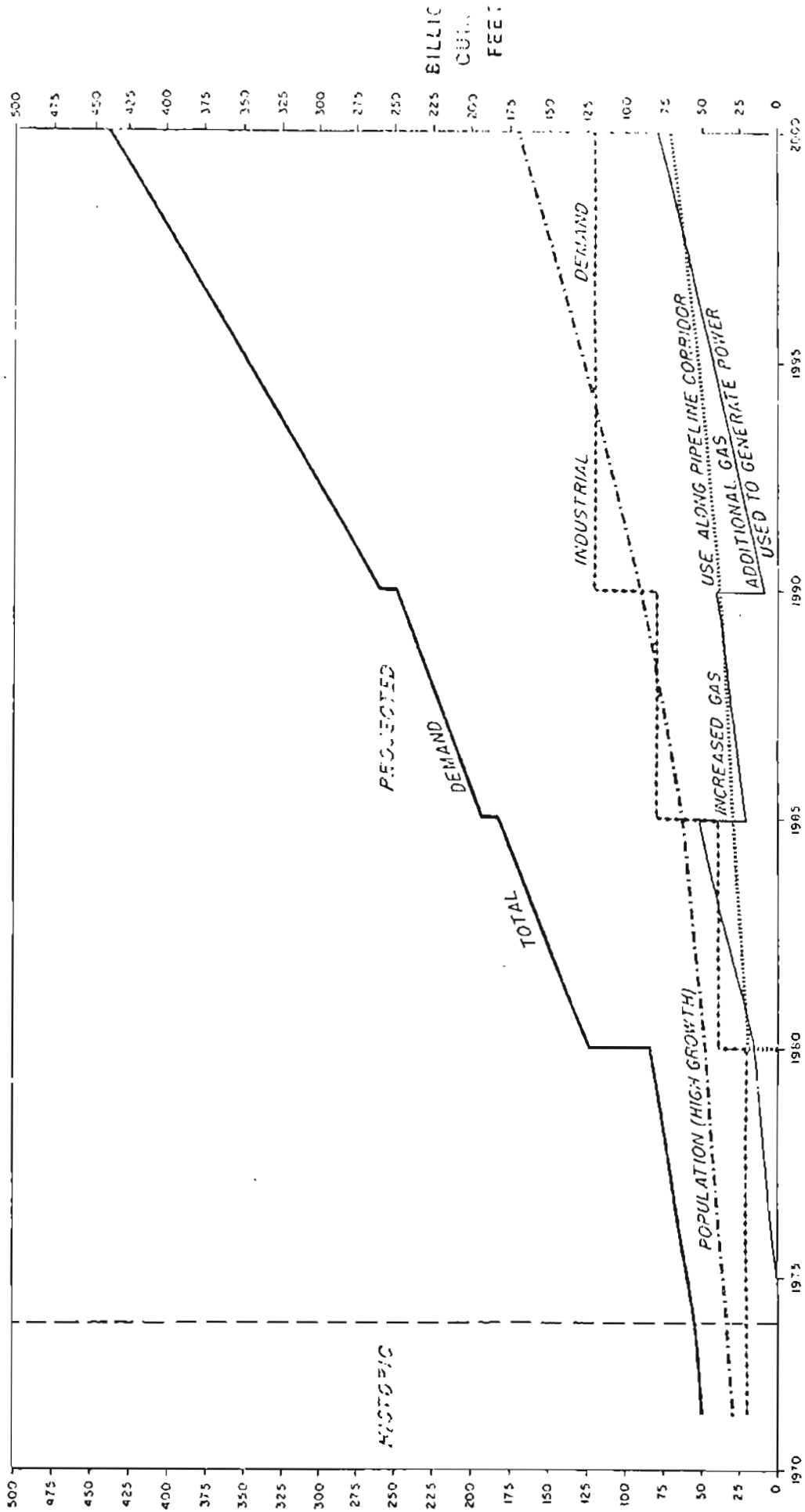
Petrochemical complex	-	1985
Methanol plant	-	1985
Cement plant	-	1985
Ammonia-Urea	-	Present plant expanded and a new one built in 1990.





PROJECTED NATURAL GAS DEMAND FOR ALASKA  
HIGH-DEVELOPMENT SCENARIO

FIGURE 6



PROJECTED ALASKAN GAS DEMAND  
HIGH-DEVELOPMENT SCENARIO

FIGURE 7

Table 4. Natural gas demand  
High-development Scenario

(Billion cubic feet per year).

	<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>1995</u>	<u>2000</u>
High growth - basic-population projections (most likely figures):					
	+47.9	+63.5	+90.8	+126.6	+167.6
Additional gas use along Pipeline Corridor: <sup>1</sup>					
	+19.6	+27.5	+38.1	+ 52.5	+ 72.5
Subtracting effects of Susitna dams: <sup>2</sup>					
	0	-30.6	-61.3	- 61.3	- 61.3
Adding effects of continued increasing reliance on gas for power generation: <sup>3</sup>					
	+16.9	+51.9	+70.0	+105.1	+140.1
Additional Industries: <sup>4</sup>					
Petrochemical		+15.0	+15.0	+ 15.0	+ 15.0
Ammonia-Urea <sup>5</sup>	+40.0	+40.0	+80.0	+ 80.0	+ 80.0
Methanol		+24.0	+24.0	+ 24.0	+ 24.0
Cement		<u>+ 1.5</u>	<u>+ 1.5</u>	<u>+ 1.5</u>	<u>+ 1.5</u>
Total industry	40.0	80.5	120.5	120.5	120.5
Total demand	124.4	192.7	258.1	343.4	439.4

1. See pipeline corridor fact sheet for explanation.

2. Assuming dams completed and full operation by 1990, half by 1985. See hydroelectric fact sheet for explanation.

3. See electrical-power-generation fact sheet for explanation.

4. See industrial fact sheet for explanation.

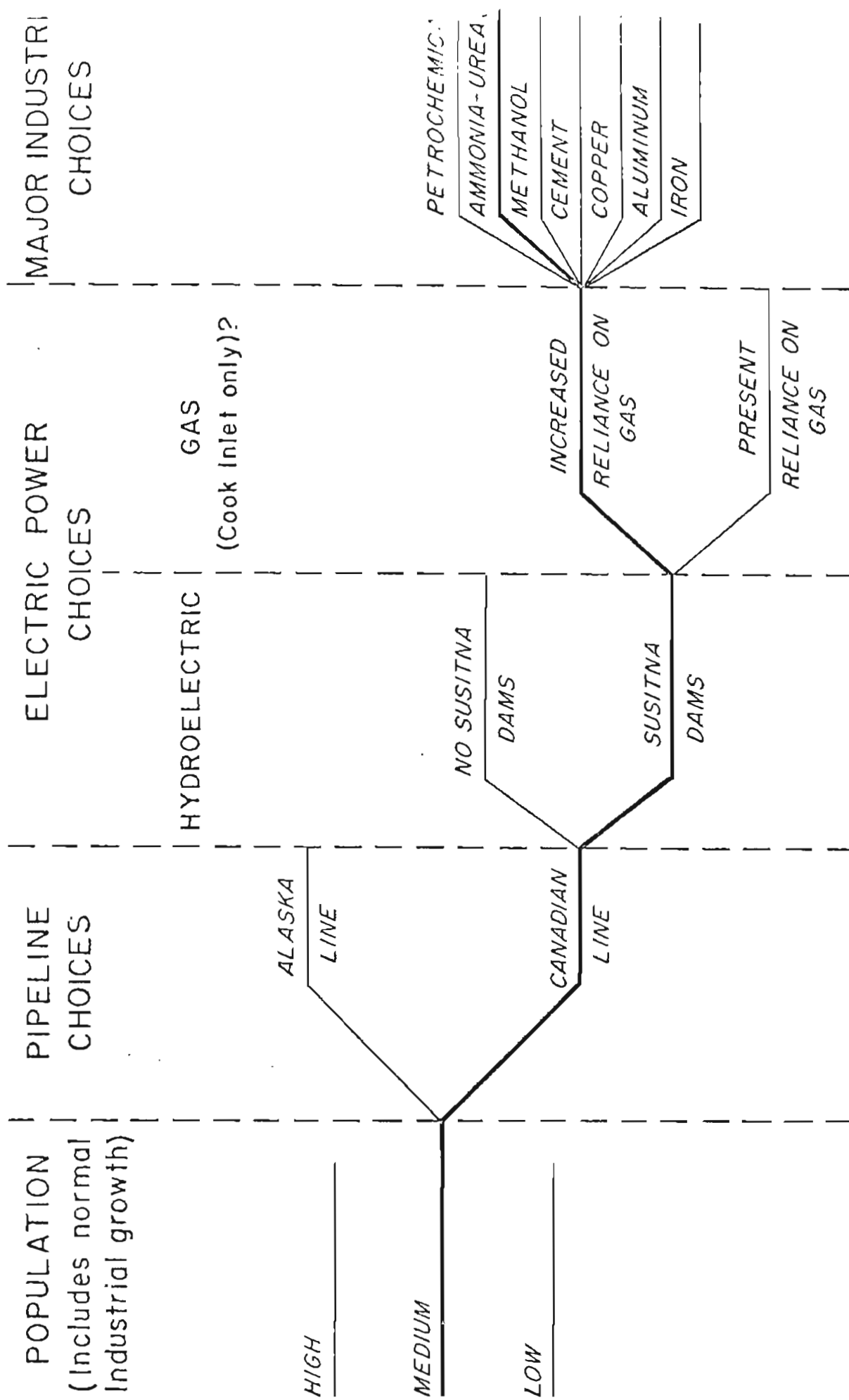
5. This includes two plants, both at 40 bcf/year--the planned expansion of the existing plant and new one of the same size.

## LOW-DEVELOPMENT SCENARIO

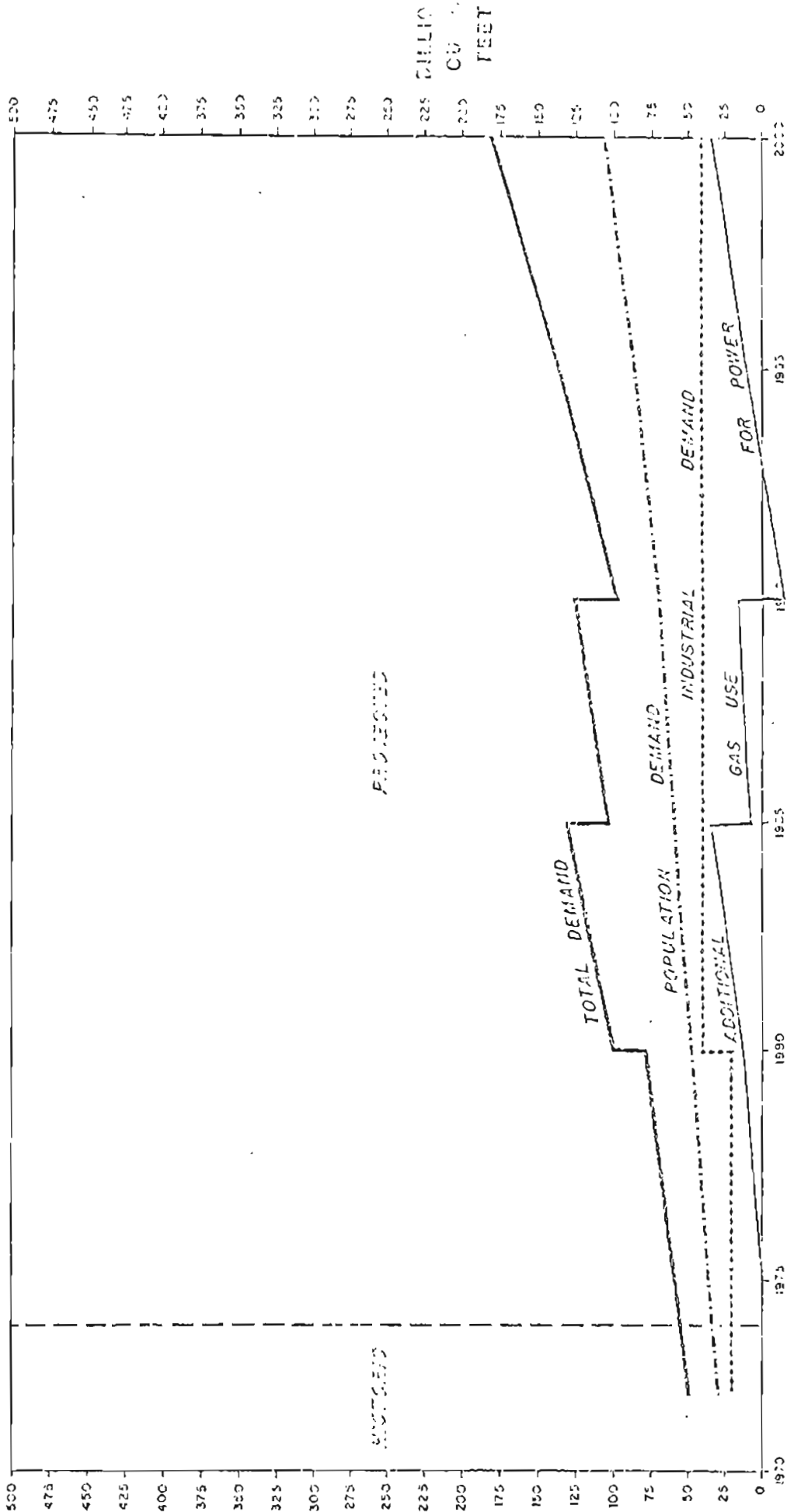
For this scenario the following choices were made:

- Population - Medium growth
- Pipeline - Canadian route
- Electrical power - Susitna project completed; continued increasing reliance on gas
- Industry - Only present ammonia-urea plant and its planned expansion

Figures illustrate the development and the results of this scenario.



PROJECTED NATURAL GAS DEMAND FOR ALASKA  
LOW-DEVELOPMENT SCENARIO



PROJECTED ALASKAN GAS DEMAND  
LOW-DEVELOPMENT SCENARIO

FIGURE 9

Table 5. Natural gas demand  
Low-development scenario

(Billion cubic feet per year).

	<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>1995</u>	<u>2000</u>
Medium growth - basic-population projections (most likely figures):					
	+47.9	+59.1	+70.7	+86.3	+105.3
Additional gas use along Pipeline Corridor: <sup>1</sup>					
	0	0	0	0	0
Subtracting effects of Susitna dams: <sup>2</sup>					
	0	-30.7	-61.3	-61.5	- 61.3
Adding effects of continued increasing reliance on gas for power generation: <sup>3</sup>					
	+12.5	+35.5	+46.6	+71.5	+ 96.4
Additional Industries: <sup>4</sup>					
	40.0	40.0	40.0	40.0	40.0
Total Demand	100.4	103.9	96.0	136.5	180.4

1. See pipeline corridor fact sheet for explanation.
2. Assuming dams completed and full operation by 1990, half by 1985.  
See hydroelectric fact sheet for explanation.
3. See electrical-power-generation fact sheet for explanation.
4. See industrial fact sheet for explanation.

Table 6. Pipeline-Corridor fact sheet.

(Billion cubic feet per year).

Additional gas use: Fairbanks area to Valdez-Cordova area

	<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>1995</u>	<u>2000</u>
High growth	-	27.6	38.1	52.5	72.5
Medium growth	19.6	23.4	28.6	34.9	42.6
Low growth	-	20.0	23.0	26.5	30.5

Method: El Paso projected values for 1980 and 1985. Projections for 1990, 1995, and 2000 were made by DGGG using growth factors determined by increases in population.

Growth factors determined by population increases

<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>1995</u>	<u>2000</u>
35%	38%	38%	38%	38%
22%	22%	22%	22%	22%
4%	17%	15%	15%	15%

El Paso growth factors for 1985 projection

<u>Annual Pct.</u>	<u>Per 5 years</u>
8-14	40-70
4- 7	20-35
0- 4	0-20



Table 7. Hydroelectric fact sheet.

Upper Susitna project<sup>1</sup>

7,000 mm kwh/yr firm energy  
 (0.00876 mcf/kwh)  
 61.3 bcf/yr natural gas

Therefore, the Upper Susitna project could reduce the amount of gas used in power generation at most by 61.3 bcf/yr.

Key Hydroelectric Resources of Alaska

<u>Project</u>	<u>Stream</u>	<u>Annual Firm Energy KWH X 10<sup>6</sup></u>
Agashashok	Noatak River	820
Holy Cross	Yukon River	12,300
Ruby	Yukon River	6,400
Rampart	Yukon River	34,200
Porcupine	Porcupine River	2,320
Woodchopper	Yukon River	14,200
Yukon-Taiya <sup>2</sup>	Yukon River	21,300
Crooked Creek	Kuskokwim River	9,400
Chakachamna	Chakachatna River	1,600
Devil Canyon <sup>3</sup>	Susitna River	7,000
Watana		
Vee		
Denali		
Bradley Lake <sup>4</sup>	Bradley River	368
Wood Canyon	Copper River	21,900

Hydro projects which might effect natural gas power generation.

1. (mm kwh/yr - millions of kilowatt hours per year; mcf/kwh - thousands of cubic feet per kilowatt-hour; bcf/yr - billions of cubic feet per year.
2. Development of Yukon-Taiya would diminish energy potential of downstream sites on the Yukon River.
3. Four units of Upper Susitna project.
4. Authorized project.

Source: Alaska Power Administration

Tabel 8. Electrical-power-generation fact sheet  
 Additional effects of continued increasing reliance on gas for power generation

Summary chart: Additional gas required for power generation

(Billion cubic feet per year)

	<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>1995</u>	<u>2000</u>
High growth	16.9	51.9	70.0	105.1	140.1
Medium growth	12.5	35.5	46.6	71.5	96.4
Low growth	10.1	27.0	33.8	43.0	52.2

Source: Alaska Power Administration data and DGGG calculations.

Method: (1) Alaska Power Administration projected possible doubling of the percentage of installed capacity of natural gas by 1985.

Installed Capacity (%)

	<u>1973</u>	<u>1985</u>
Natural gas	35	59-74
Oil	29	17
Coal	24	19-4
Hydro	12	5

Therefore, it was assumed that by 1985 there could be a possible doubling of the percentage of power generated by natural gas.

(2) Alaska Power Administration projected required kwh/year for 1980, 1990, and 2000 for high, medium, and low growth. Projections for 1985 and 1995 interpolated by DGGG.

	<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>1995</u>	<u>2000</u>
Power gas generated (%) (present: 40%)	60	80	80	80	80
Additional	20	40	40	40	40
Projected requirements (mm kwh):					
	9,660	14,830	20,000	30,000	40,000
	7,130	10,310	13,290	20,400	27,510
	5,790	7,725	9,660	12,280	14,900

Table 8. Electrical-power-generation fact sheet  
 Additional effects of continued increasing reliance on gas for power generation  
 (continued)

Additional required (mm kwh):

1,932	5,932	8,000	12,000	16,000
1,426	4,084	5,316	8,160	11,004
1,158	3,090	3,864	4,912	5,960

<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>1995</u>	<u>2000</u>
-------------	-------------	-------------	-------------	-------------

Additional gas required (bcf):

16.9	51.9	70.0	105.1	140.1
12.5	35.5	46.6	71.5	96.4
10.1	27.0	33.8	43.0	52.2

Note: Conversion factor of 0.00876 mcf/kwh derived from:

$$1 \text{ kwh} = 9,895 \text{ Btu at } 34\% \text{ efficiency}$$

$$1 \text{ cf} = 1,130 \text{ Btu}$$

therefore, 0.00876 mcf/kwh

Table 9. Industry fact sheet<sup>1</sup>

Aluminum: 19.71-59.13 billion cubic feet per year

75,000 tons/yr  
30,000 kwh/ton  
2,250 mm kwh/yr  
(.00876 mcf/kwh)  
19.7 bcf/yr

150,000 tons/yr  
30,000 kwh/ton  
4,500 mm kwh/yr  
(.00876 mcf/kwh)  
39.42 bcf/yr

225,000 tons/yr  
30,000 kwh/ton  
6,750 mm kwh/yr  
(.00876 mcf/kwh)  
59.13 bcf/yr

Assumption: All power generated by natural gas.

Copper smelter: 5.5 billion cubic feet per year

150,000 ton/yr  
15 mm cf/day  
5.5 bcf/yr

Cement plant: 1.5 billion cubic feet per year

1 mm bbl/yr  
4 mm cf/day  
1.5 bcf/yr

Iron-ore pellet plant: 8.2 billion cubic feet per year

Five million tons of ore pellets/year  
105 megawatt power requirements

1. These figures were supplied by the Department of Commerce and Economic Development (October 7, 1975 memorandum).

Table 9. Industry fact sheet<sup>1</sup>  
(continued)

Methanol plant: 24 billion cubic feet per year

Source: Celanese Corp.

This is a large (world-size) unit which uses natural gas as a feed stock to produce antifreeze, solvents, and other chemical products.

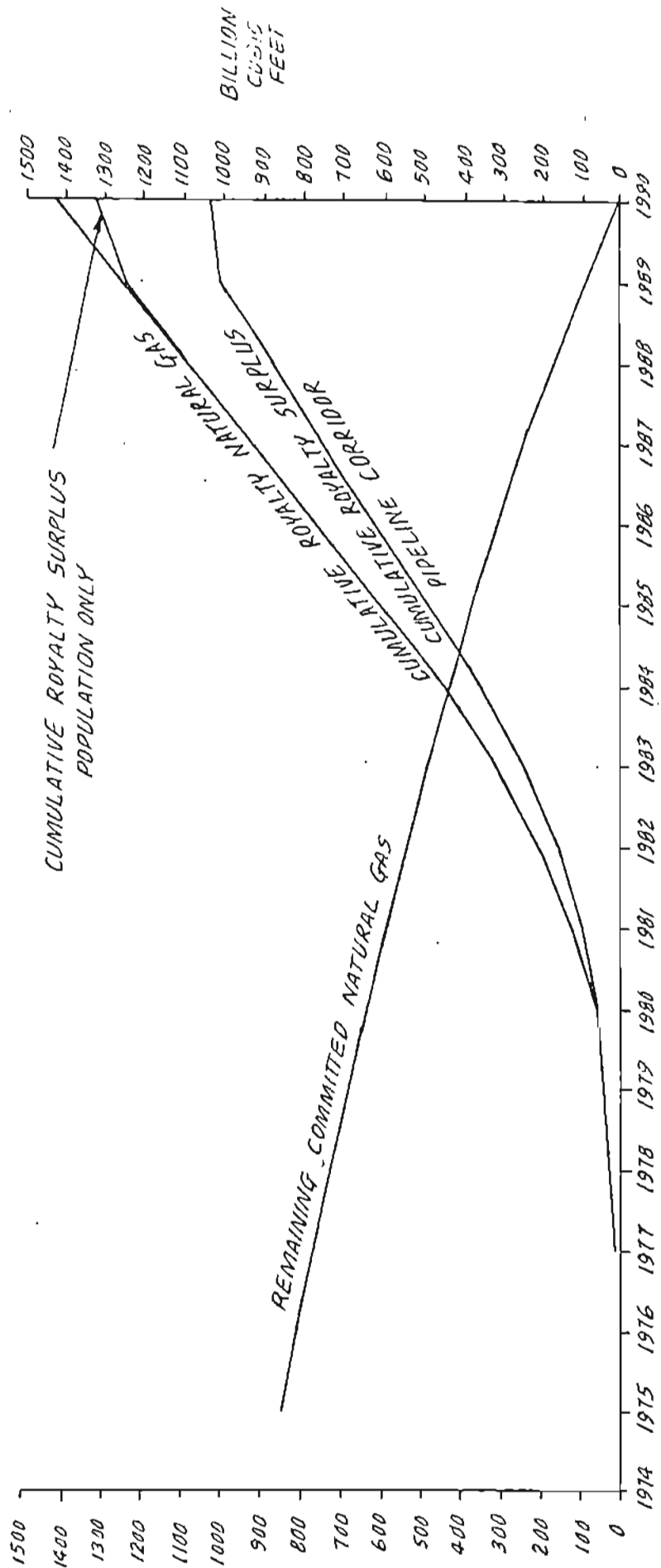
Ammonia-urea plant: 40 billion cubic feet per year

Source: Union-Collier

Polyethylene and ethylene glycol plant: 15 million cubic feet  
per year methane

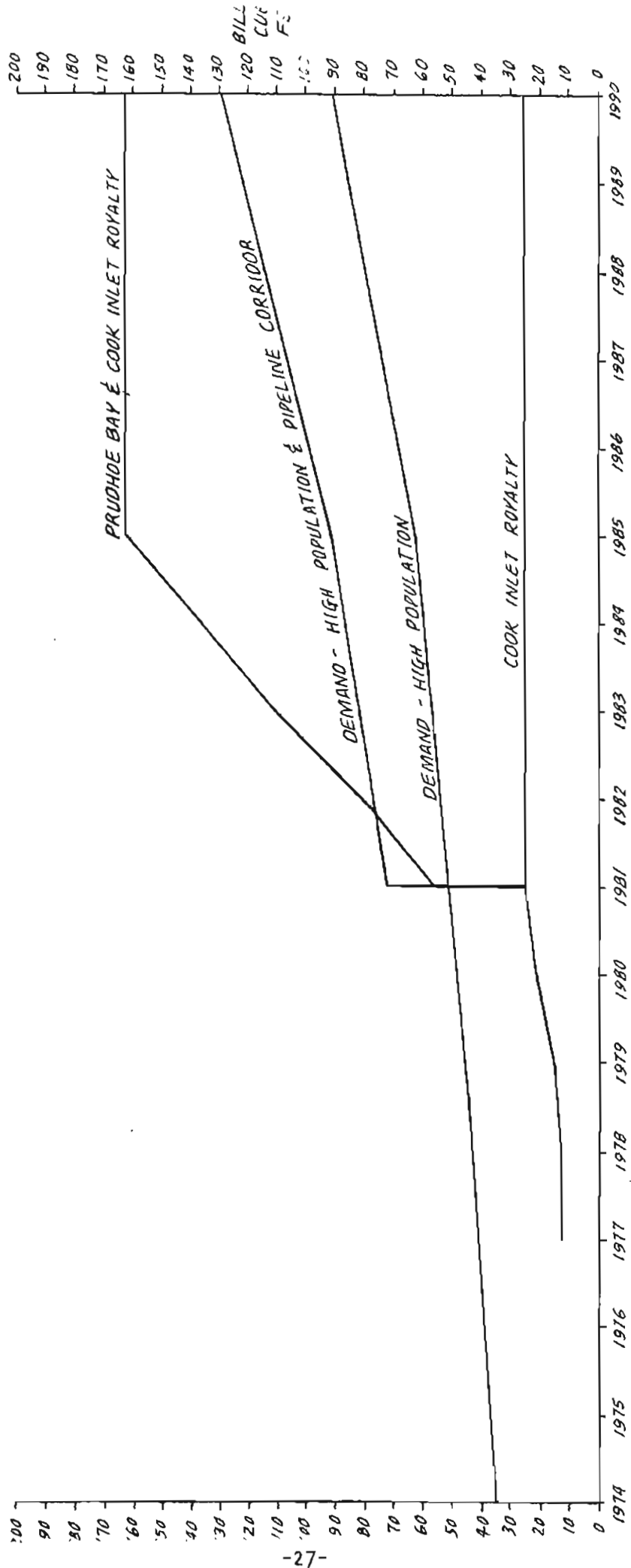
35 million cubic feet  
per year ethane

1. These figures were supplied by the Department of Commerce and Economic Development (October 7, 1975 memorandum).



CUMULATIVE ROYALTY NATURAL GAS & REMAINING COMMITTED NATURAL GAS

FIGURE 10



ALASKAN NATURAL GAS DEMAND & ROYALTY NATURAL GAS

FIGURE 11

Table 10. Alaskan natural gas demand analysis

Natural Gas in Billions of Cubic Feet

Years	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Cumulative Total
1. Demand-High Population	33.9	36.2	38.6	40.9	43.2	45.6	47.9	51.0	54.1	57.3	60.4	63.5	69.0	74.4	79.9	85.3	90.8	972.0
2. Demand-Pipeline Corridor								21.2	22.8	24.4	26.0	27.6	29.7	31.8	33.9	36.0	38.1	291.5
3. Demand-High Population and Pipeline Corridor	33.9	36.2	38.6	40.9	43.2	45.6	47.9	72.2	76.9	81.7	86.4	91.1	98.7	106.2	113.8	121.3	128.9	1263.5
4. Cook Inlet Royalty				13.0	13.4	15.6	21.7	25.0	25.1	25.2	25.4	25.6	25.5	25.6	25.7	25.8	25.8	318.4
5. Prudhoe Bay Royalty								30.0	55.0	85.0	110.0	137.0	137.0	137.0	137.0	137.0	137.0	1102.0
6. Total Royalty				13.0	13.4	15.6	21.7	55.0	80.1	110.2	135.4	162.6	162.5	162.6	162.7	162.8	162.8	1420.4
7. Cumulative Royalty				13.0	26.4	42.0	63.7	118.7	198.8	309.0	444.4	607.0	769.5	932.1	1094.8	1257.6	1420.4	1420.4
8. Total Committed Natural Gas	843.4 (January 1, 1975)																	
9. Cumulative Committed Natural Gas Used		36.2	74.8	115.7	158.9	204.5	252.4	303.4	357.5	414.8	475.2	538.7	607.7	682.1	762.0	843.4	843.4	843.4
10. Cumulative Royalty Surplus (Above High Population Only)				13.0	26.4	42.0	63.7	118.7	198.8	309.0	444.4	607.0	769.5	932.1	1094.8	1253.7	1325.7	1325.7
11. Cumulative Royalty Surplus (Above 1 and 2)				13.0	26.4	42.0	63.7	97.5	154.8	240.6	350.0	485.0	617.8	748.6	877.4	1000.3	1034.2	1034.2
12. Remaining Committed Natural Gas		843.4	807.2	768.6	727.2	684.5	638.9	591.0	540.0	485.9	428.6	368.2	304.7	235.7	161.3	81.4		