This paper was produced as backup for a larger study of crude oil alternatives for all of the northern tier states. This larger study was sponsored by the Federal Energy Administration. The data in this report was the best available at the time the report was written. However, the supply situation of the region is dynamic and events subsequent to the first publication may make certain parts of this report obsolete.

Second printing - September, 1976.

Implications for Minnesota of Canadian Crude Oil Export Curtailments

This study examines the impacts of impending Canadian crude oil curtailments to Minnesota. Monthly deliveries of petroleum products by product pipelines, barges, trucks, rails and the four Minnesota area refineries were charted for 1974. Statistical data was obtained from the Minnesota Department of Engineers, and the Minnesota Energy Agency's Market Share Report(M.E.A. Form 1000).

Canadian crude oil curtailments will have a direct impact on the four Minnesota area refineries. Historically, these refineries have received the majority of their crude oil from Canada. In 1974, some 88 percent of their crude oil supplies were Canadian:

Refinery	Location	1974 Average Daily Runs (Barrels/Day)	Proportion of Crude Runs From Canadian Sources(percent)
Koch	Pine Bend, Minnesota	82,000	79
Ashland	St. Paul Park, Minnesota	55,955	89
Conoco	Wrenshall, Minnesota	21,077	100
Murphy	Superior, Wisconsin	28,536	100
Total:		187,668	88

Source: U.S. Bureau of Mines, Mineral Industry Survey, "Petroleum Refineries in the U.S. and Puerto Rico," (Jar. 1, 1974 refinery capacities).

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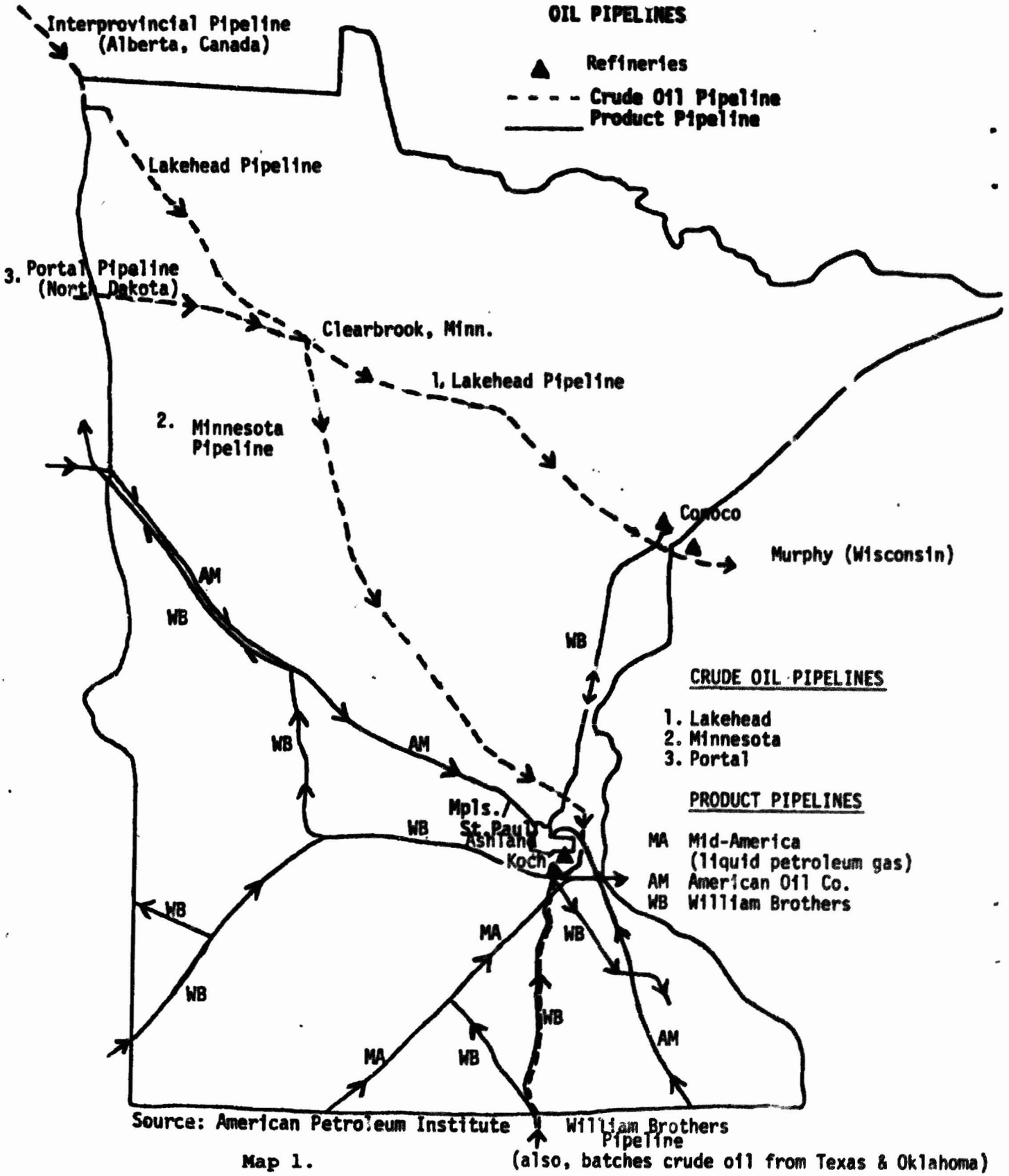
* Research Analyst, Forecasting & Impact Analysis, Minnesota Energy Agency, St. Paul, Minnesota.


OIL PIPELINES
Refineries
Crude Oil Pipeline
Product Pipeline
Interprovincial Pipeline
(Alberta, Canada)
Lakehead Pipeline
3. Portal Pipeline
(North Dakota)
Clearbrook, Minn.
1. Lakehead Pipeline
2. Minnesota
Pipeline
Conoco
Murphy (Wisconsin)
AM
WB
WB
WB
AM
Mpls./
St. Paul
Ashland
Koch
WB
WB
MA
WB
WB
MA
WB
WB
AM
CRUDE OIL PIPELINES
1. Lakehead
2. Minnesota
3. Portal
PRODUCT PIPELINES
MA Mid-America
(liquid petroleum gas)
AM American Oil Co.
WB William Brothers
Source: American Petroleum Institute
William Brothers
Pipeline
(also, batches crude oil from Texas & Oklahoma)

Map 1.

Four pipeline companies supply these refineries with crude oil (Map 1). The first pipeline, originating in Alberta, pumps Canadian crude through the Interprovincial Pipeline to Northwestern Minnesota. Lakehead Pipeline, the U.S. portion of this system, then supplies all of the crude oil used by Conoco and Murphy. The second pipeline, Minnesota Pipeline, is a subsidiary of Koch and carries Canadian crude to Ashland and Koch through a connection with Lakehead at Clearbrook, Minnesota.

The domestic crude oil used by Ashland and Koch is carried by the third pipeline company, Portal Pipeline, from North Dakota. In 1974, Portal Pipeline supplied about 6% of Ashland's crude oil and about 12% of Koch's. The fourth pipeline company, Williams Brothers, transported about 9% of Koch's crude oil in batches through its product pipeline from Kansas during the winter months.

The remaining domestic crude oil is carried into the state from southern sources by barges. By mid-March, barges begin transporting crude oil from Illinois, Missouri, Kentucky, Louisiana, Texas and Alabama. Nearly all of this crude goes to Ashland Refinery, but it comprises only 5% of its total crude supplies. Barges carry crude oil, as well as finished petroleum products, up the Mississippi until early December.

The average runs of the Minnesota area refineries were around 200,000 barrels per day during 1972-74 (Table 1).

TABLE 1

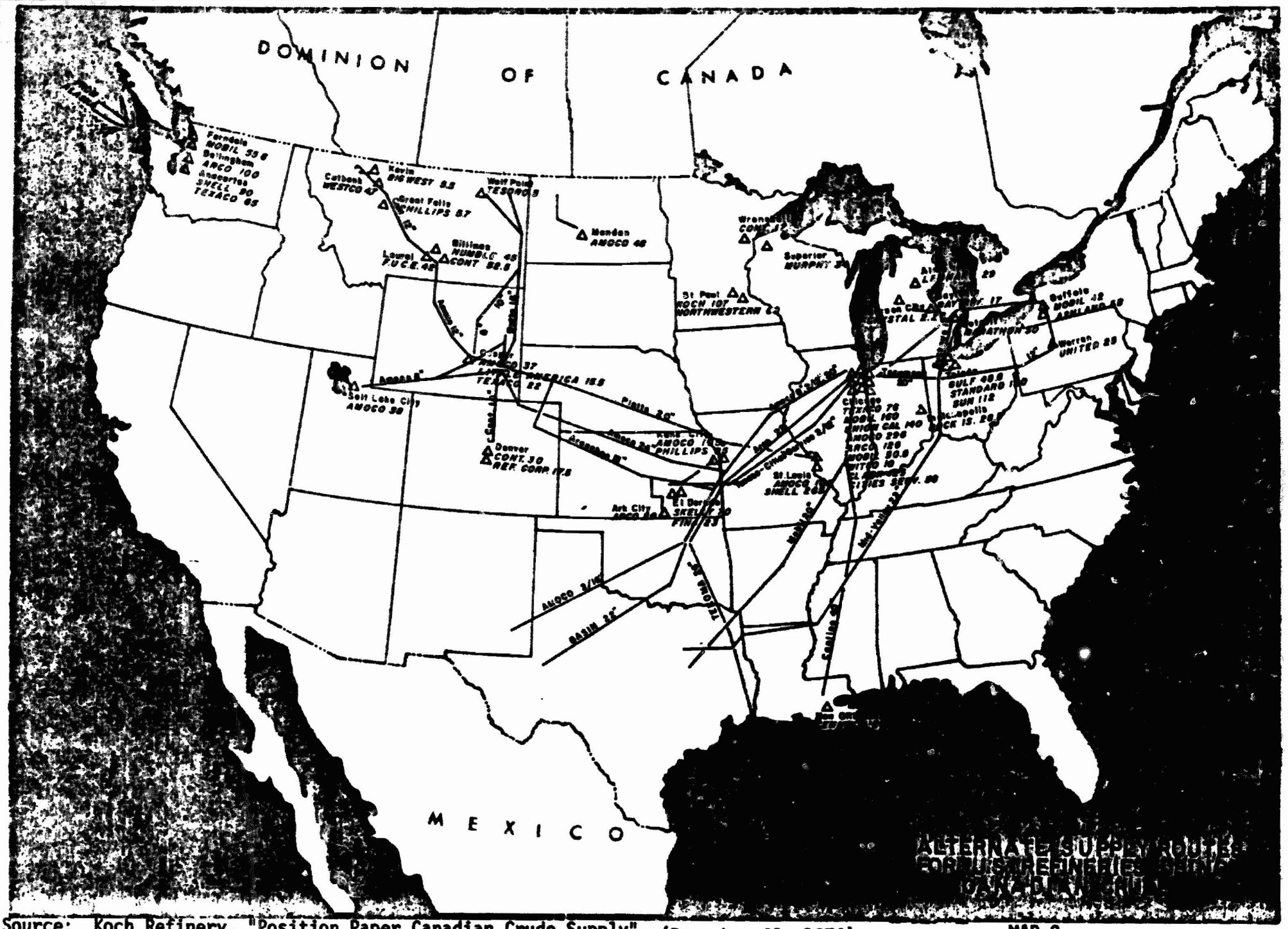
MINNESOTA AREA REFINERIES

		REFINERY CAPACITY*	AVERAGE DAILY RUNS	PERCENT OF CAPACITY	AVERAGE CANADIAN CRUDE	PERCENT OF RUN
KOCH	1972	96,500	91,314	94.6	79,500	87
	1973	97,900	93,500	100.6	86,500	87.8
	1974	106,990	82,100	76.7	65,200	79.4
(Nov '74-Oct '75)	Base Period	109,800	84,700	77.1	67,900	80.1
ASHLAND	1972	49,350	51,000	103.3	45,760	89.7
	1973	58,800	57,940	98.5	53,170	91.7
	1974	66,000	55,955	84.7	49,830	89
	Base Period	67,143	52,980	78.9	45,040	85
CONOCO	1972	17,000	18,737	110.2	18,737	100
	1973	20,000	19,022	95.1	19,022	100
	1974	23,500	21,077	89.6	21,077	100
	Base Period	23,500	20,529	87.3	20,529	100
MURPHY	1972	33,000	31,518	95.5	31,518	100
	1973	35,500	36,264	102.1	36,264	100
	1974	37,000	28,536	77.1	28,536	100
	Base Period	45,400	23,406	51.5	23,406	100
TOTALS	1972	195,850	192,569	98.3	175,515	91.1
	1973	212,200	211,726	99.7	194,956	92
	1974	233,490	187,668	80.3	164,643	87.7
	Base Period	245,843	181,615	73.8	156,875	86.3

* Refinery capacity as of January 1 from U.S. Bureau of Mines statistics.

These refineries operated at close to full capacity in 1972 and 1973, but were down to 80% of capacity in 1974, and 74% of capacity during the FEA base period (Nov. '74-Oct. "75). About 70 percent of refinery output was sold in Minnesota during the high production years of 1972 and 1973. The other 30 percent was delivered to neighboring areas of western Wisconsin, northern Iowa, eastern North Dakota and South Dakota. In 1974, a combination of reduced refinery runs and smaller proportion of output dedicated to Minnesota (55%) required a 25% increase in petroleum products shipped into the state.

Without substantial alternate sources of crude oil, the four Minnesota refineries are highly vulnerable to Canadian export policies (Map 2). Entitlements can temper the effect of rising Canadian crude prices, but supply curtailments will immediately result in lower refinery runs. In order to avert serious economic disruption in Minnesota due to impending curtailments to these refineries, increasing amounts of refined petroleum products should be shipped into the state. This means larger deliveries for product pipelines, barges, ships, trucks and rail. In addition, it will be necessary to increase the volume of domestic crude presently being shipped by barge and pipelines so refineries can maintain economic operation levels. Reciprocal trade agreements between refineries and their Canadian counterparts, i.e. exchanging U.S. crude at selected points for



Source: Koch Refinery, "Position Paper Canadian Crude Supply", (December 31, 1974).

MAP 2.

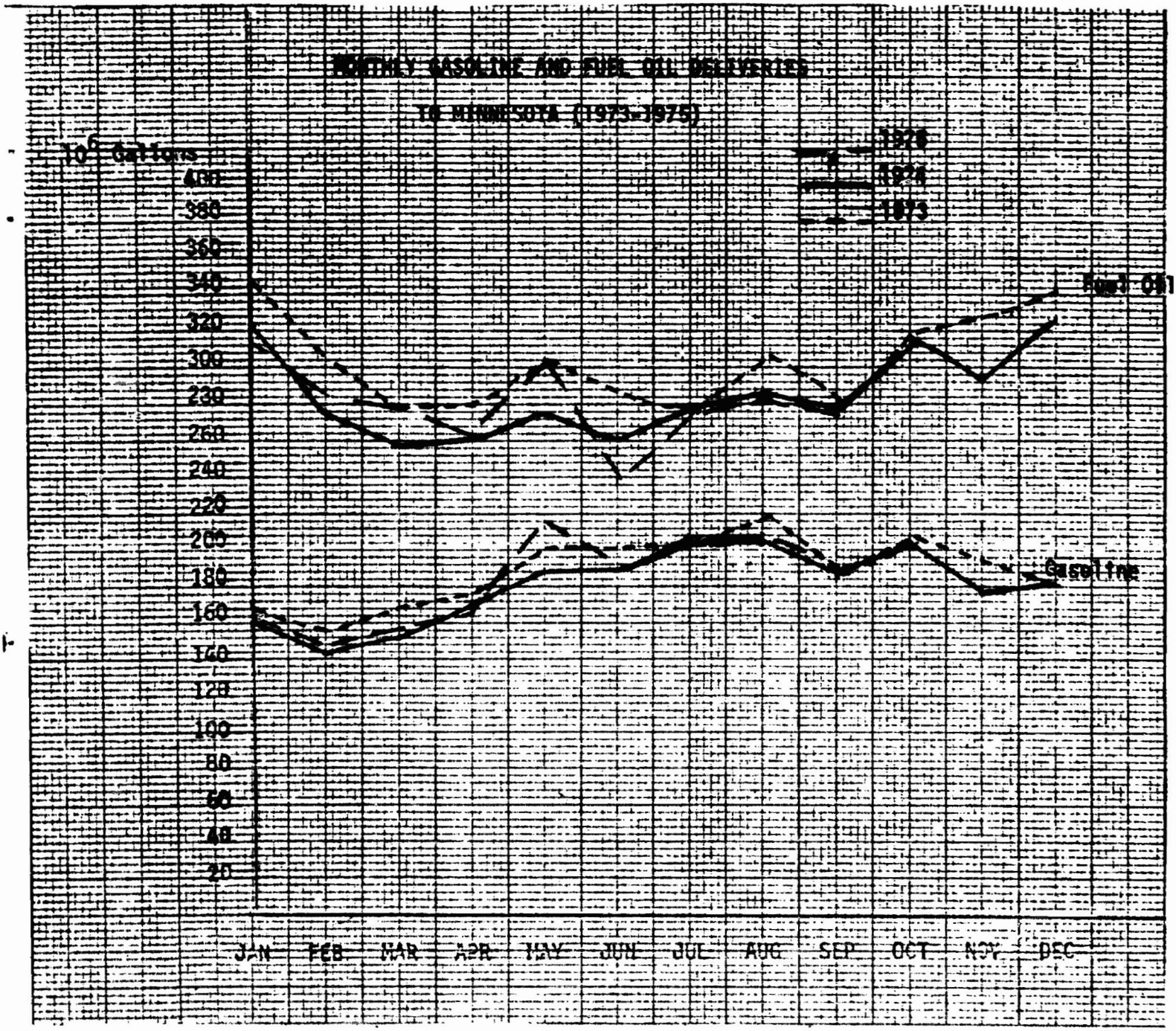


FIGURE 1.

Source: Minnesota Department of Revenue,
Petroleum Tax Division

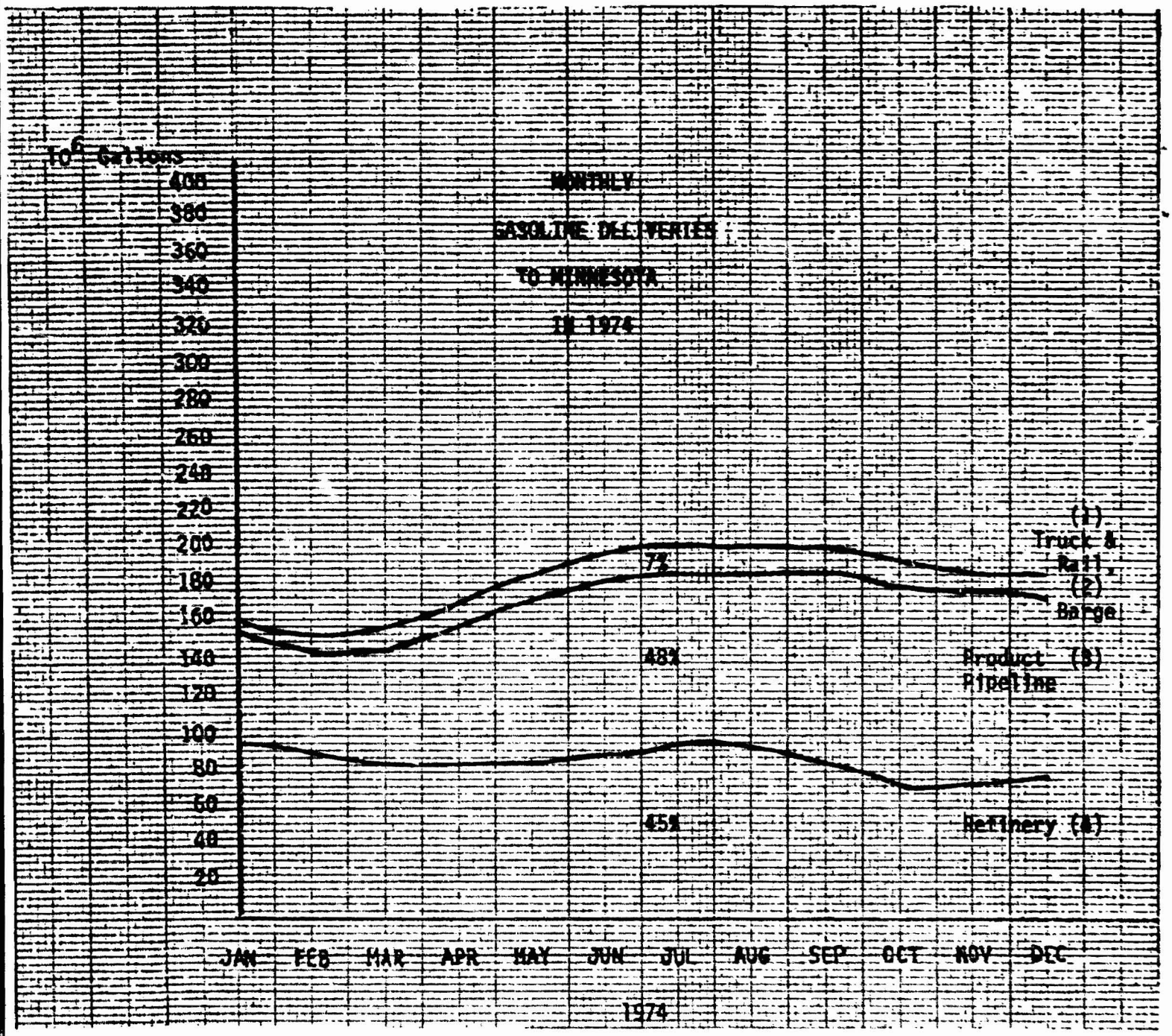


FIGURE 2.

1. Petroleum tax data
2. Corp of Engineers
3. Amoco based on FEO 1000; Williams Bors. based on 1974 petroleum tax data
4. FEO 1000

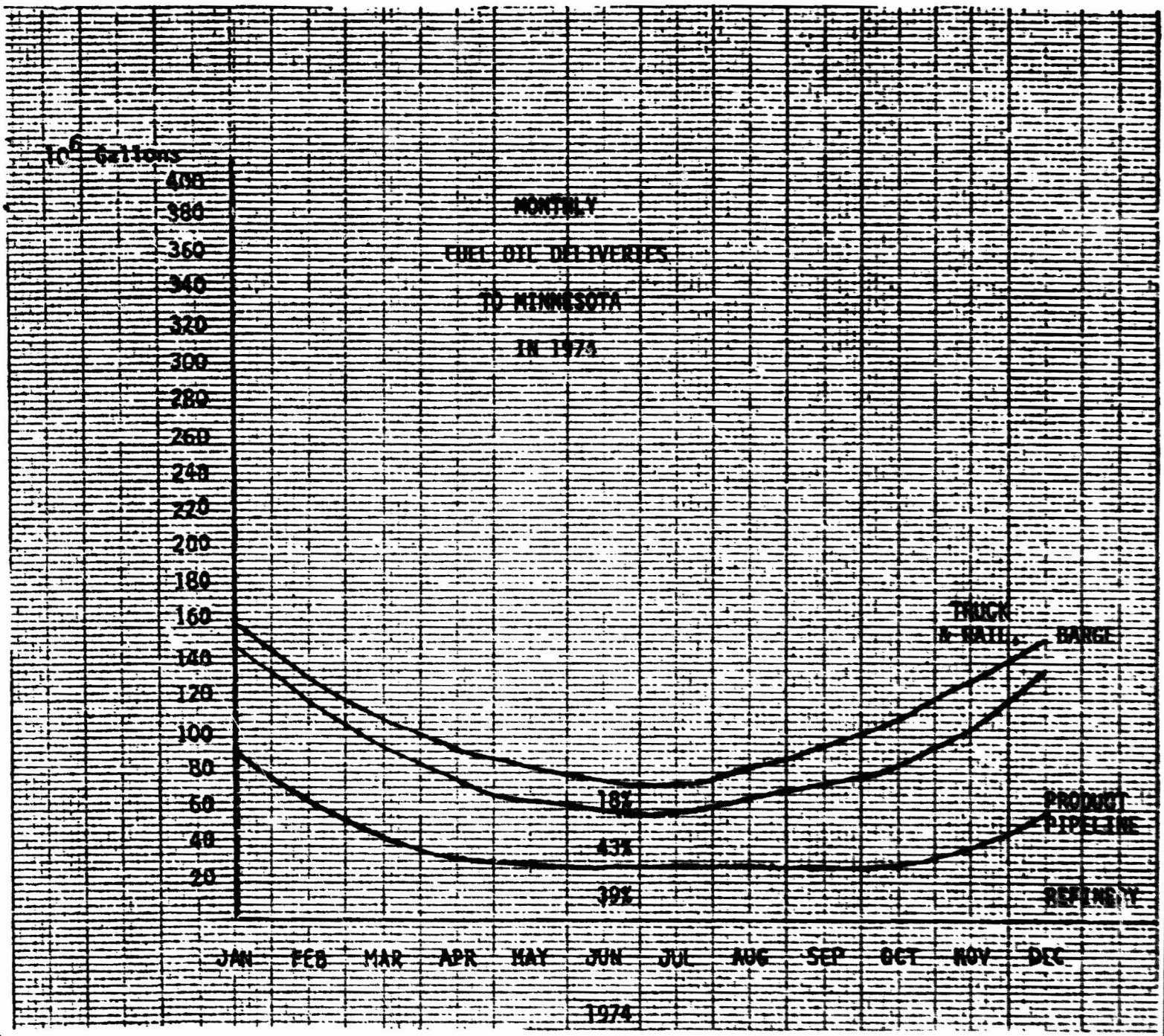

10^6 Gallons
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
MONTHLY
FUEL OIL DELIVERIES
TO MINNESOTA
IN 1973
TRUCK & RAIL
BARGE
PRODUCT PIPELINE
REFINERY
18%
43%
39%
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1974

FIGURE 3.

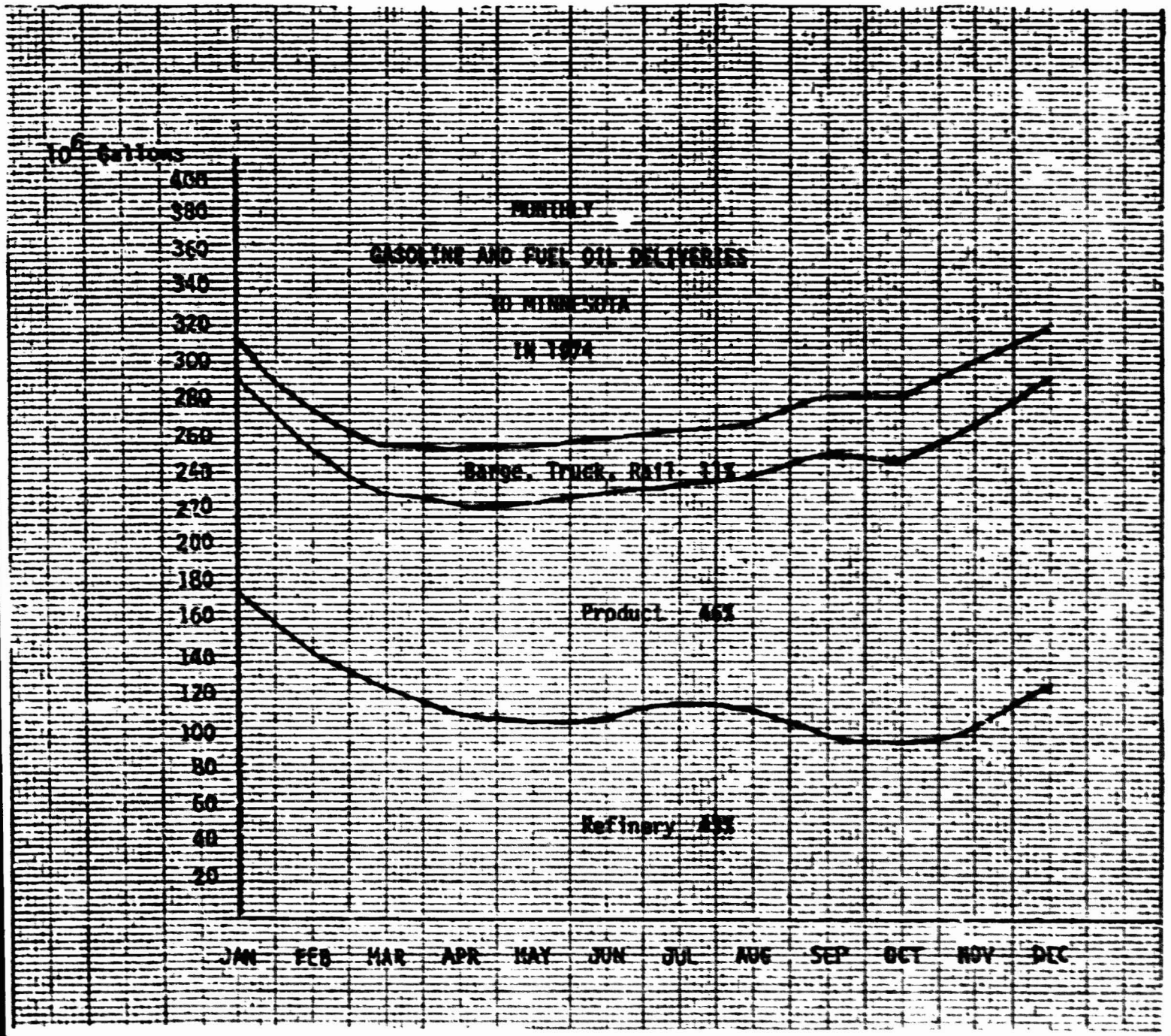

10^6 Gallons
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
MONTHLY
GASOLINE AND FUEL OIL DELIVERIES
TO MINNESOTA
IN 1974
Barge, Truck, Rail- 31%
Product 46%
Refinery 23%
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

FIGURE 4.

continued Canadian crude, is another short term means of supplementing supplies.

In order to gauge the effectiveness of any short term action, it is necessary to examine the seasonal impact of Canadian crude oil curtailments on refinery output, as well as seasonal capacities of various petroleum product transport modes in meeting expected short falls caused by these curtailments.

Figure 1 shows monthly deliveries of gasoline and fuel oil to Minnesota in 1973, 1974 and 1975. In 1974, gasoline accounted for 51.1% of all petroleum products consumed, distillate fuel oil was 26.8%, and residual fuel oil was 6.4%. The remaining 15.7% of petroleum products were LP gas (10.1%), aviation gasoline (4.4%) and kerosine (1.2%).

A three month moving average was applied to deliveries in order to smooth out monthly fluctuations in supplies. Gasoline deliveries (Fig.2) indicate an increase in consumption during the summer months, primarily due to recreational travel demand. Conversely, the demand for fuel oil (Fig.3) is greatest during the winter months for space heating and electric generation. The combined product flow in 1974 (Fig.4) indicates a declining trend in refinery output, largely due to the increased cost of Canadian crude oil. This was made up by petroleum products available through product pipelines.

Three scenarios were drawn to compare the possible effects

TABLE 2

Comparison of possible effects on Minnesota due to Canadian crude oil curtailment.

Year	Current CNEB CURTAILMENT SCHEDULE (BPD Export to U.S.)	WITHOUT PROPOSED FEA RULES BPD AVAILABLE TO AREA REFINERS (BPD)	WITH PROPOSED FEA RULES BPD AVAILABLE TO AREA REFINERS (BPD)
1976* (1st part)	510,000	87,900	162,800
1976* (2nd part)	385,000	63,200	162,800
1977	255,000	41,900	162,800
1978	166,000	27,300	114,100
1979	85,000	14,000	58,400
1980	55,000	9,000	37,800
1981	5,000	800	3,400

* Time of change will depend upon when the Sarnia-Montreal pipeline is opened.

Source: Federal Energy Agency

on Minnesota of Canadian crude oil curtailments (Table 2). The first two cases examine the short run effects to 1978, with and without FEA allocation rules for Canadian crude. The third case examines the effects to 1980 with FEA allocation rules (10 CFR Part 214), but without any substantial new supply source of crude oil. In each case gasoline and fuel oil requirements were increased 3.8% a year over 1974 requirements as projected in the Minnesota Energy Agency's 1976 Biennial Report.

The first scenario is based on the assumption that Minnesota will continue to receive the same percentage of Canadian crude as it received during the base period without the FEA allocation rules for Canadian crude. Area refineries will receive 87,900 BPD begining in January, 1976 and decline to 27,300 BPD in January, 1978. It is also assumed that, in 1978, the area refineries will receive as much domestic crude as in 1974. Furthermore, drastic cutback in refinery runs will cause refineries to service only preferred customers, such that all outputs maybe sold in Minnesota.

Petroleum product deliveries by barge, truck, and rail were kept at 1974 levels. Deliveries by product pipelines, the cheapest means of transporting petroleum products, were pushed to capacity. Given these assumptions, there will be a shortage of 467 million gallons of petroleum products in 1978, largely during the winter months (table 3). The shortfall amounts to 12% of projected requirements and a 22% shortfall during the months of January, February, and December. This consists primarily of fuel oil used for space heating.

TABLE 3.

CASE I: 1978 DELIVERIES * WITHOUT F.E.A. ALLOCATION RULES FOR CANADIAN CRUDE
(Million Gallons)

	REFINERY 1	PRODUCT 2 PIPELINE (Estimated Capacity)	BARGE 3 TRUCK & RAIL (1974 Deliveries)	TOTAL SUPPLIES	TOTAL MONTHLY END USE REQUIREMENTS (3.8%/yr Growth Rate over 1974)	DEFICIT
JAN	57.0	201.8	20.2	279.0	364.2	-85.2
FEB	51.5	182.3	22.6	256.4	319.0	-62.6
MAR	57.0	201.8	24.5	283.3	295.1	-11.8
APR	55.2	195.3	30.7	281.2	295.2	-14.0
MAY	57.0	201.8	29.7	288.5	295.9	- 7.4
JUN	55.2	195.3	30.3	280.8	301.3	-20.5
JLY	57.0	201.8	28.8	287.6	305.4	-17.8
AUG	57.0	201.8	30.4	289.2	311.4	-22.2
SEP	55.2	195.3	33.4	283.9	327.2	-43.3
OCT	57.0	201.8	36.2	295.0	327.6	-32.6
NOV	55.2	195.3	35.0	285.5	348.3	-62.8
DEC	57.0	201.8	22.7	281.5	368.6	-87.1
TOTALS:	671.3	2376.1	344.5	3391.9	3859.2	-467.3
Percent of 1974	74%	154%	100%	102 %	116%	

* Deliveries include only gasoline, distillate and residual fuel oil, all other petroleum products (LPG, jet fuel, kerosine, lube oil, ashalt) were omitted.

1. Expected refinery output without FEA allocation rules, and domestic crude oil at 1974 levels. Assumes 100 percent of refinery output goes to Minnesota customers.
2. Estimated maximum delivery capability to Minnesota, based on discussions with Williams Bros. and Amoco.
3. Deliveries by barge were based on 1974 data from the Corp of Engineers (petroleum product movement to Minnesota through lock and dam number 3 and 10); deliveries by truck and rail were based on 1974 Petroleum Tax data. The actual capacity of petroleum product deliveries by barge, truck and rail would be higher.

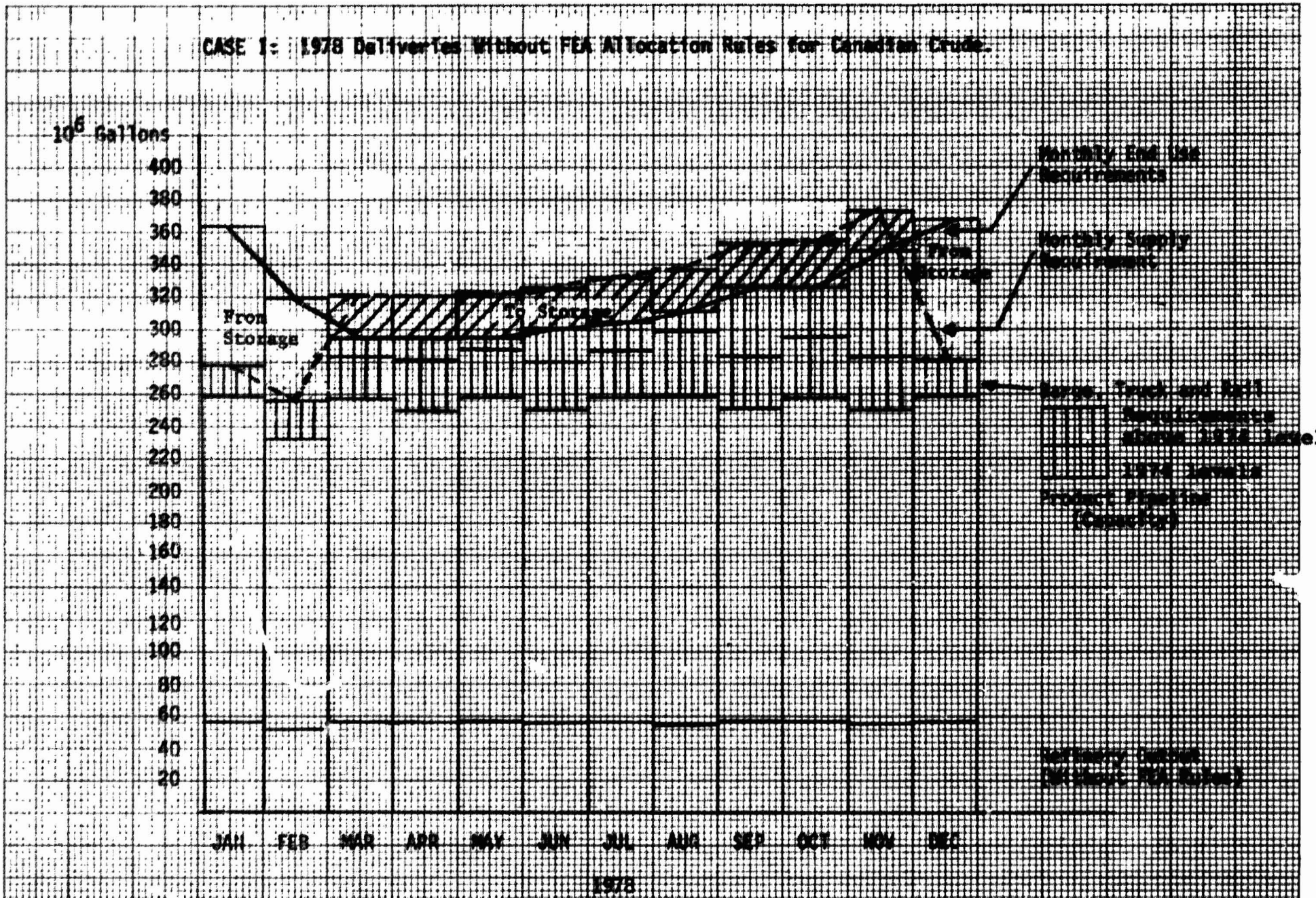

CASE 1: 1978 Deliveries Without FEA Allocation Rules for Canadian Crude.
10^6 Gallons
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
From Storage
To Storage
From Storage
Monthly End Use Requirements
Monthly Supply Requirement
Barge, Truck and Rail Requirements above 1977 levels
1978 levels
Product Pipeline Capacity
Refinery Capacity (Without FEA Rules)
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1978

FIGURE 5.

Running the product pipelines to capacity will depend on the capability of shippers to obtain additional refined product. The remaining shortfall of 467 million gallons will have to be made up by other transport modes. The least-cost mode of transportation, after the pipeline, is barge and ship*(Table 4).

Since the heaviest shortfalls are during the winter months, additional petroleum products could be barged and shipped to Minnesota for storage during the summer and fall.

It appears that adequate storage capacity would be available. In 1973, Koch, Ashland and Conoco had a combined storage capacity of 442 million gallons and reduced refinery output will provide a large part of this storage for shipped in petroleum products.

From Figure 5, the difference between monthly end use requirements and monthly supply between March and November represents the quantity of petroleum products going into storage. These products are drawn from storage during the months of January, February and December.

The second scenario is based on the assumption that FEA's rules for allocating Canadian crude oil would be adopted. In recognition of their critical position with respect to alternate crude supplies, Northern tier refineries are assigned first priority for declining Canadian crude supplies. This will allow refineries to continue servicing its entire market area, with Minnesota probably receiving 55% of output as in 1974.

If was also assumed in the second scenario that domestic crude oil deliveries, and delivery of petroleum products by

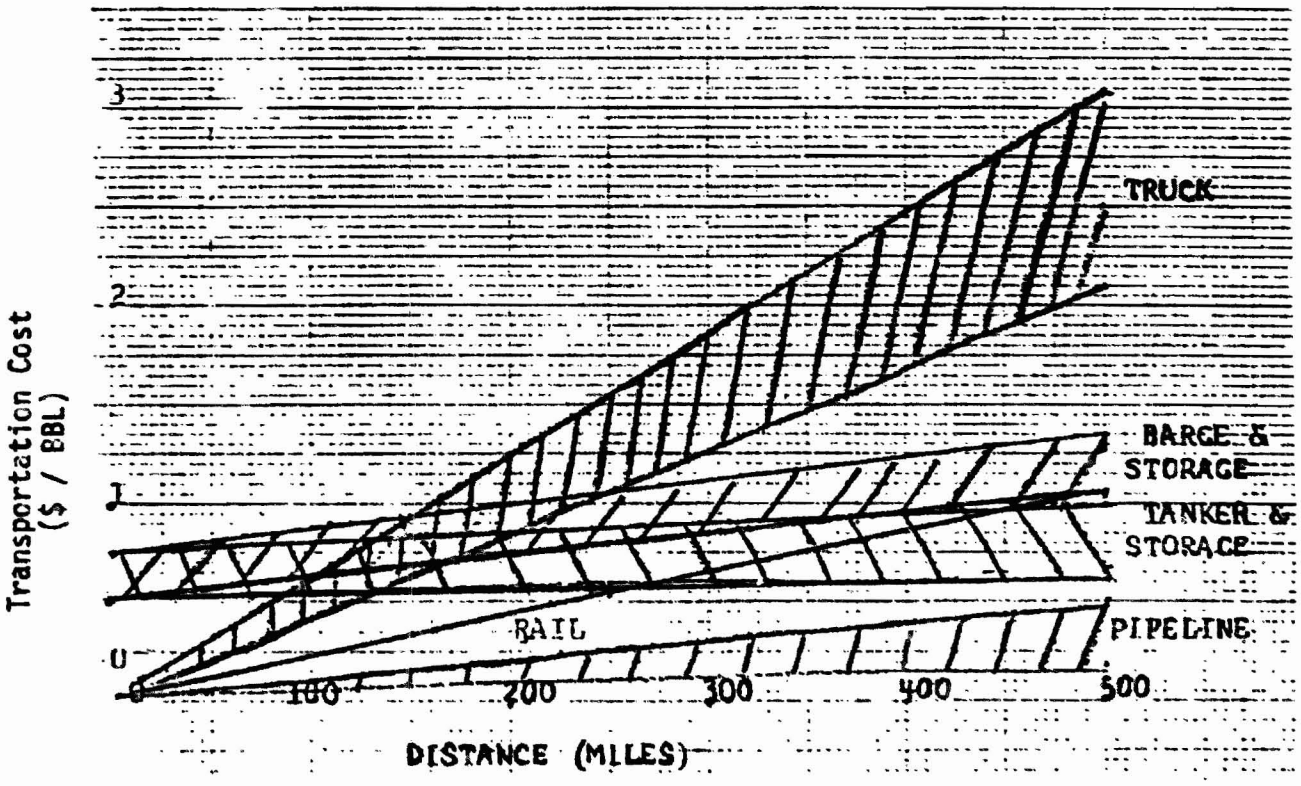
*petroleum products delivered by ship to Superior, Wisconsin are transported to Minnesota primarily by truck.

TABLE 4

ESTIMATED TRANSPORTATION COSTS

ALL FIGURES PER 100 BBL/MILE

Tanker	$0.0125	to	$0.0350
Pipeline	$0.0200	to	$0.1000
Barge	$0.0225	to	$0.1500
Rail	$0.1050	to	$0.5000
Truck	$0.4700	to	$0.6500



Source: M.W. Cardullo, "Pilot Study of Northern Tier Supply Curtailment", (FEA, January 20, 1976).

CASE II: 1978 DELIVERIES* WITH F.E.A. ALLOCATION

RULES FOR CANADIAN CRUDE
(million gallons)

	REFINERY[1]	PRODUCT PIPELINE[2]	TRUCK RAIL BARGE[3] (1974 deliveries)	TOTAL SUPPLIES	TOTAL MONTHLY END USE REQUIREMENTS (3.8%/yr growth rate over 1974)	DEFICIT OR SURPLUS (Supplies minus end use requirements)
Jan	85.4	201.8	20.2	307.4	364.2	-56.8
Feb	77.2	182.3	22.6	282.1	319.0	-36.9
Mar	85.4	201.8	24.5	311.7	295.1	+16.6
Apr	82.7	195.3	30.7	308.7	295.2	+13.5
May	85.4	201.8	29.7	316.9	295.9	+21.0
Jun	82.7	195.3	30.3	308.3	301.3	+ 7.0
Jly	85.4	201.8	28.8	316.0	305.4	+10.6
Aug	85.4	201.8	30.4	317.6	311.4	+ 6.2
Sep	82.7	195.3	33.4	311.4	327.2	-15.8
Oct	85.4	201.8	36.2	323.4	327.2	- 3.8
Nov	82.7	195.3	35.0	313.0	348.3	-35.3
Dec	85.4	201.8	22.7	309.9	368.6	-58.7
TOTAL	1005.7	2376.1	344.5	3726.4	3859.2	-132.4

*deliveries include only gasoline, distillate and residual fuel oil

1. expected refinery output with FEA allocation rules, and domestic crude oil at 1974 levels. Assumes 55 percent (same as 1974) of refinery output goes to Minnesota customers.
2. Estimated maximum delivery capability to Minnesota, based on discussions with Williams Brothers and Amoco.
3. deliveries by barge were based on 1974 data from the Corp of Engineers; deliveries by truck and rail were based on 1974 Petroleum Tax data.

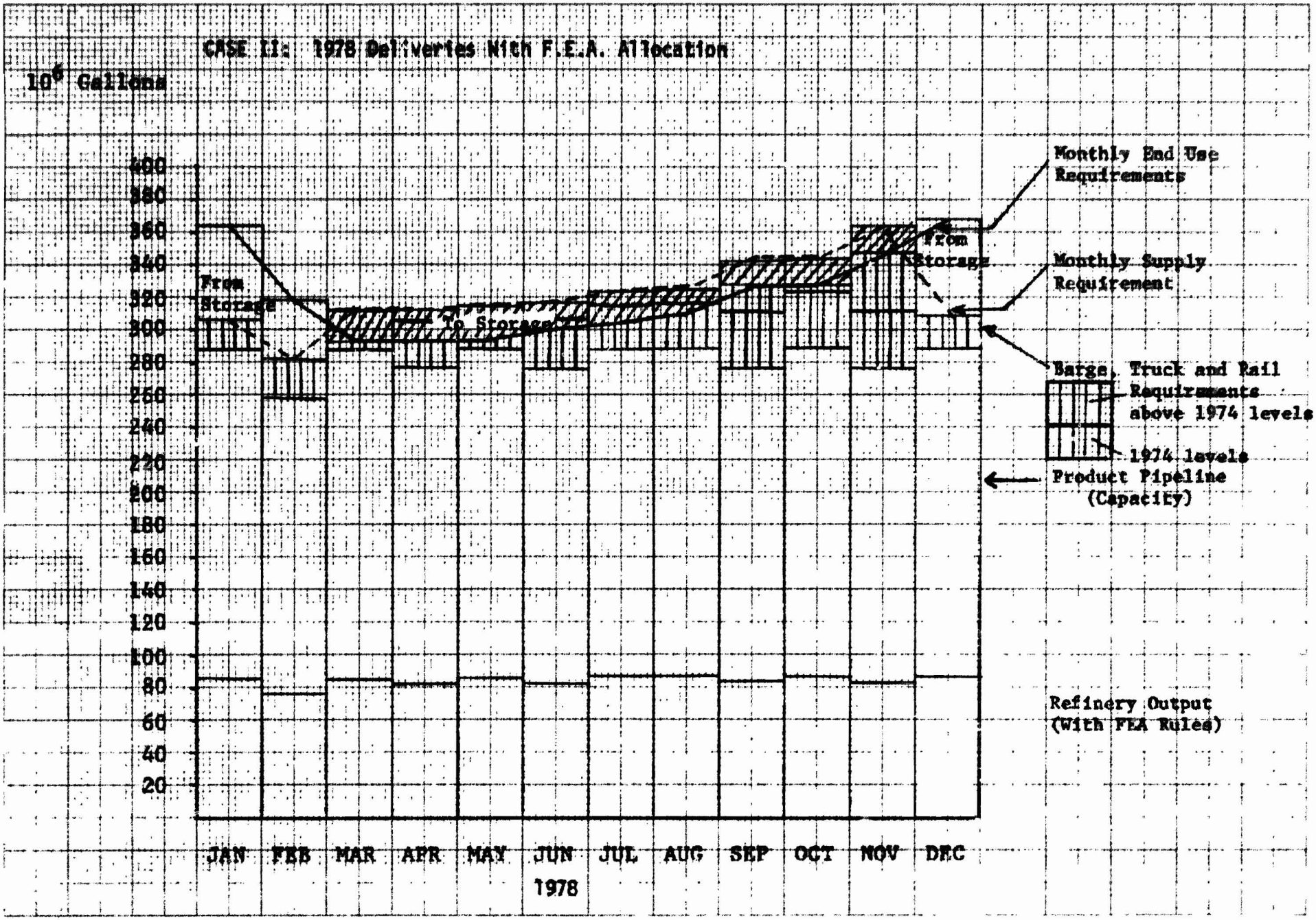

CASE II: 1978 Deliveries With F.E.A. Allocation
10^6 Gallons
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
From Storage
To Storage
From Storage
Monthly End Use Requirements
Monthly Supply Requirement
Barge, Truck and Rail Requirements above 1974 levels
1974 levels
Product Pipeline (Capacity)
Refinery Output (With FEA Rules)
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1978

FIGURE 6.

barge, truck, and rail will remain at 1974 levels. Pipelines may expand volumes up to present system capacities in order to fill product shortfalls in state.

Since larger supplies of Canadian crude translates to larger supplies of petroleum products to the state, a (net) shortfall of only 3.6% may be expected if petroleum product pipelines push deliveries to system capacities. This can be made up by increasing barge shipments between April and November by 16.6 million gallons per month or a total supply requirement from these modes 1½ times the 1974 deliveries. Large curtailments spread to area refiners as total Canadian exports decline to 10% of 1976 volumes.

These two scenarios describe the possible short-term effects of Canadian crude oil curtailments by 1978. While system capacities are available for pipeline and other modes to make up for the shortfall, it is still unclear whether these suppliers can procure substantial petroleum products from outstate sources, and the pattern of storage and distribution can be implemented. Dependence will shift from Canadian crude to domestic petroleum product supplies, creating a new web of relations with other state refineries and regulating agencies.

Case 3 extends scenario 2 through 1980 on the assumption that area refineries remain highly dependent on Canadian sources. Based on continuing Canadian curtailments, there would be 76,000 BPD less crude delivered to area refineries by 1980 compared to 1978. (see table 2) All refinery imports may be dedicated to Minnesota but still petroleum product pipelines will need to operate at capacity and other modes double their shipments (table 6) in order to fill total Minnesota demands. The large river shipments-storage-distribution strategy for

TABLE 6.

CASE III: 1980 DELIVERIES* WITH F.E.A. ALLOCATION RULES FOR CANADIAN CRUDE
(million gallons)

	REFINERY[1]	PRODUCT[2] PIPELINE (Estimated Capacity)	BARGE[3] TRUCK RAIL (1974 Deliveries)	TOTAL SUPPLIES	TOTAL MONTHLY END USE REQUIREMENTS 3.8%/yr Growth Rate Over 1974)	DEFICIT
JAN	68.9	201.8	20.2	290.9	392.4	- 101.5
FEB	62.2	182.3	22.6	267.1	343.7	- 76.6
MAR	68.9	201.8	24.5	295.2	318.0	- 22.8
APR	66.7	195.3	30.7	292.7	318.1	- 26.1
MAY	68.9	201.8	29.7	300.4	318.8	- 18.4
JUN	66.7	195.3	30.3	292.3	324.6	- 32.3
JLY	68.9	201.8	28.8	299.5	329.1	- 29.6
AUG	68.9	201.8	30.4	301.1	335.5	- 34.4
SEP	66.7	195.3	33.4	295.4	352.6	- 57.2
OCT	68.9	201.8	36.2	306.9	353.0	- 46.1
NOV	66.7	195.3	35.0	297.0	375.3	- 78.3
DEC	68.9	201.8	22.7	293.4	397.2	- 103.8
TOTALS:	811.3	2376.1	344.5	3531.9	4158.2	- 627.1
Percent of 1974	57%	154%	100%	106%	125%	

* Deliveries include only gasoline, distillate and residual fuel oil.

1. Expected refinery output with FEA allocation rules and domestic crude oil at 1974 levels. Assumes 100 percent of refinery output goes to Minnesota customers.
2. Estimated maximum delivery capability to Minnesota, based on discussions with Williams Bros. and Amoco.
3. Deliveries by barge were based on 1974 data from the Corp of Engineers; deliveries by truck and rail were based on 1974 Petroleum Tax data.

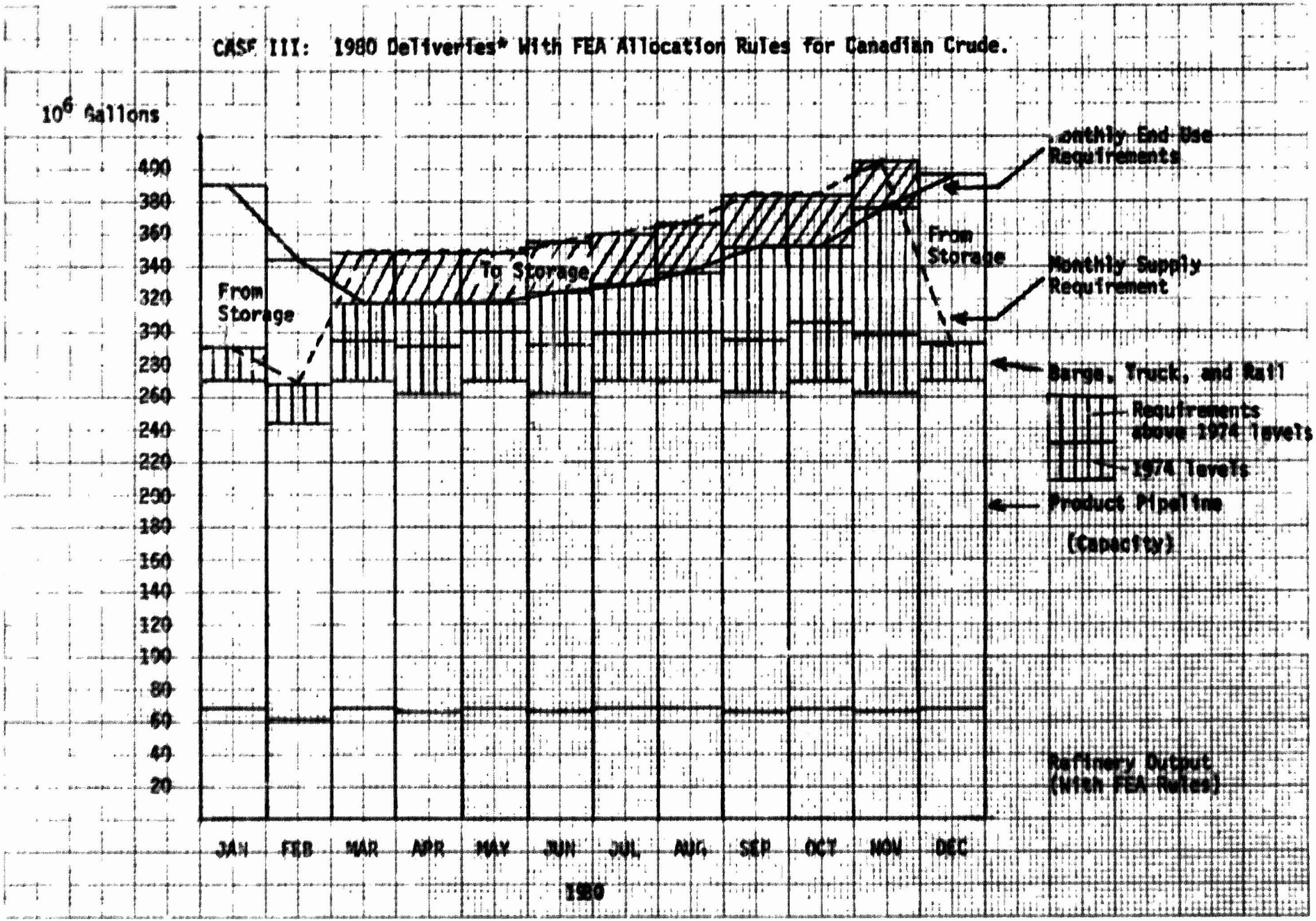

CASE III: 1980 Deliveries* With FEA Allocation Rules for Canadian Crude.
10^6 Gallons
490
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
From Storage
To Storage
From Storage
Monthly End Use Requirements
Monthly Supply Requirement
Barge, Truck, and Rail
Requirements above 1974 levels
1974 levels
Product Pipeline (Capacity)
Refinery Output (With FEA Rules)
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
1980

FIGURE. 7.

1978 under severe crude curtailments of scenario one needs to be implemented in 1980 because of severe limitations on crude supplies to refineries. If barges, rail and truck transport cannot expand beyond 1974 levels, or products were not available for shipment by these modes from southern sources, a shortfall of some 627 million gallons (15% of requirements) will appear in 1980. Thus, it is important for area refineries to be able to access Alaskan and other alternate sources of supply after 1978. FEA rules only provide time for area refineries to search and contract for alternate sources of crude.

Minnesota will be in the worst situation by 1980 without the FEA allocation rules. Present supply-storage-distribution systems can possibly fill only 1978 requirements so that a condition of surplus refining capacity, strained (out-state) product supply systems and large shortfalls will occur by 1980. With the pipelines operating at full capacity and other transport modes doubling their shipments, a demand-supply gap of some 354 million gallons (8% of requirements) will still exist. Of this unfilled requirement, Minnesota would be short some 135 million gallons of gasoline and 219 million gallons of fuel oil, assuming similar distribution of gas and fuel oil deliveries as in 1974. As in the worst case example for 1978, the shortage of fuel oil would occur largely during the winter months.

Impacts on the Local Economy

These three scenarios assume that the decline in product output from the Minnesota area refineries will be made up by refineries in other areas of the country in less vulnerable positions. Also, the second scenario assumes that additional petroleum products from out state refineries can be delivered by pipeline and barges. Since these are low cost transport modes, the product cost to the consumer should not change significantly. In the worst cases, scenarios for 1978 (Case I) and 1980 (Case 3), there would be dramatically lower area refinery runs, pipelines would be at capacity and remaining deficits would have to be delivered by transport modes other than pipeline. The freight cost of these modes are generally much higher (see table 4).

In addition, the lower availability of crude oil would probably cause a shut-down of all the area refineries except either Koch or Ashland. These impacts would result in higher petroleum product costs to the consumer, as well as local impacts from reduced employment and earnings and related business losses.*

Under case 1, the 467 million gallon shortfall in 1978 would have to be made up through barge, truck and rail. Doubling of barge traffic would supply 134 million gallons so that rail and truck should move 333 million gallons, or 63% over their 1974 deliveries. It would require some 120-150 unit trains to supply 333 million gallons.

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* These economic impacts are also discussed in "Environmental-Economic Impacts of Canadian Crude Oil Curtailment on Minnesota" by Wilbur R. Maki and Jawaid U. Elahi of the University of Minn.

At $3.92/ton or $0.014/gallon shipping charge by barge, and $11.80/ton or $0.043/gallon freight rate for rail, transport cost will reach $16.2 million, or 3.5¢/gallon on 467 million gallons. Since this cost is incurred in procuring only 11% of supplies, it is likely that either competitive forces or increases in non-transport cost will cause a pass through of this $16.2 million among all petroleum products sold in the state ($.56/gallon) under a different justification. In other words, this additional transport cost may not affect average prices in the state over the short term as retailers maintain market shares. Instead, it will be imbedded in the first price increase of procured products to be sold in Minnesota. Pipeline charges on additional products were not included because these represent replacement for crude supplies that were also piped in.

Similarly, immediate effects on average prices under Scenario 2 and its extension to 1980 (Scenario 3) may not be significant if additional transport cost were spread among all petroleum products sold in the state.

However, the closing of Conoco and Murphy without sufficient crude in 1980 have serious implications for Northeast Minnesota. Planned expansion of iron mining, pulp and paper, and other industries including electric utilities may be adversely affected by local shortages of fuel oil. Direct effects of a shut-down by Conoco will lay-off some 130 workers and jeopardize at least 4,000 future industrial job

openings in Northeast Minnesota. In addition, gasoline may have to be piped up from the Twin Cities or shipped in through the Great Lakes in order to sustain the recreation industry.

Impacts on state employment of an 85% reduction in refinery output and some 12% decline in output of manufacturing firms (equivalent to product shortfall) under Case 1 will result in some 74 thousand workers laid off in the state, or a 5.1% contribution to unemployment (Table 7)*. Only 36 thousand jobs are directly affected but ripple effects may affect another 38 thousand in related agriculture, trade and service sectors.

With FEA guidelines, refinery output in 1978 will be 61 percent of 1974 levels and there appears enough product delivery capacity to ship in replacement petroleum products. Hence, employment impacts will involve only two thousand workers in petroleum refining and its material suppliers in the state (See Table 7). However, continued Canadian curtailment through 1980 will reduce refinery output to only 20% of 1974 levels and impose heavy strains on the delivery-storage-distribution system for petroleum products procurred for out state. This will mean at least 3,800 jobs, and up to 48,000 jobs if only half the 627 million gallon shortfall were filled by product transport companies and the manufacturing sector suffers a 7.5% cutback in supplies (See Table 7).

Venegas, E.C., A Methodology for Impact Assessment of Energy Policies at State Level, St. Paul: Minnesota Energy Agency, January 28, 1976.

_____. MINTOM: Minnesota Tradeoff Model. St. Paul, Minnesota Energy Agency, April 1975.

Table 7. Employment Impacts of Canadian Crude Curtailments

Industry Group	Case I*	Case II*	Case III***	CaseIII****
	-Changes in Employment- thousand workers-			
LIVESTOCK	-2.13	-.00	-.01	-1.33
CROPS	-8.12	-.01	-.03	-5.10
OTHER AGRIC	-.21	-.00	-.00	-.13
IRON, FERRO	-.03	-.00	-.00	-.02
NON-FERROUS	-.00	0	0	-.00
OTHER, QUARRY	-.80	-.34	-.70	-.74
CONSTURCTION	-.42	-.06	-.11	-.31
FOOD & KINDRED	-5.98	-.00	-.01	-3.75
LUMBER, FURN	-2.23	-.01	-.01	-1.40
PULP & PAPER	-3.60	-.03	-.06	-2.30
PRINT & PUBL	-3.39	-.02	-.04	-2.14
CHEMICAL, ETC	-.54	-.04	-.09	-.89
PETROL. REFIN.	-.73	-.33	-.67	-.69
STONE, CLAY, GL	-1.22	-.01	-.03	-.77
PRIMARY METAL	-1.75	-.01	-.02	-1.11
FABRIC METAL	-6.10	-.03	-.07	-3.86
MACHINERY	-8.84	-.03	-.06	-5.56
ELECTRICAL	-3.28	-.01	-.02	-2.06
OTHER MFG	-12.04	-.04	-.08	-7.58
RAILROAD	-1.14	-.03	-.07	-.77
TRUCKING	-1.17	-.05	-.11	-.78
OTHER TRANS	-.83	-.26	-.53	-.70
COMMUNICATION	-.43	-.02	-.03	-.29
ELECTRIC UTIL	-.16	-.01	-.02	-.11
GAS UTILITIES	-.15	-.02	-.05	-.11
OTHER UTIL	-.03	-.00	-.01	-.02
WHOLESALE	-3.16	-.10	-.21	-2.10
RETAIL	-1.17	-.03	-.07	-.78
FINANCE(FIRE)	-.96	-.09	-.19	-.69
HOTELS, PERS	-.22	-.01	-.02	-.15
BUSINESS SERV	-1.93	-.14	-.28	-1.37
MEDICAL, EDUC	-.22	-.01	-.01	-.14
OTHER SERVICE	-.34	-.01	-.02	-.23
FED.GOVT.ENT	-.26	-.01	-.03	-.18
STATE-LOC. ENT	-.53	-.08	-.15	-.39
SUBTOTAL	-74.10	-1.86	-3.82	-48.57
PER CENT 1974	-5.1	-.1	-.3	-3.3

* Case 1 Includes a 12% decline in manufacturing output due to shortfall
** Case 2 Involving only a 39% decline in refinery output
*** Case 3 With replacement petroleum products
**** Case 3 163 million gallon shortfall in 1980 causing 7.5% cutback in manufacturing output.

Summary

FEA allocation rules for declining Canadian Crude oil among U.S. refineries present a sharp reduction in petroleum product supplies to Minnesota through 1978. Without these rules, present systems can hardly replace reduced products from refineries and still provide for continued growth of the economy through the last half of this decade. However, refineries should be able to tap alternate sources of crude in the 1980's as Canadian crude exports approach total curtailment. FEA rules merely provide time for finding alternate supplies for area refineries.

Large shipments and storage of petroleum products in the state during the summer months may be a partial solution, but it will involve doubling of transport and storage capacities at the same time that refineries are reduced to uneconomic levels of production. It appears that for sustained growth of the state's economy, and in order to maintain efficient use of all energy facilities, area refineries should be able to use alternate Alaskan or other crude supplies during the 1980's.

Pipeline and other modes may fill requirement gaps and provide for additional product demands due to economic growth. In addition, more efficient use of fuels through conservation measures should be implemented in the state in order to reduce future strains on petroleum product suppliers.