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WESTERN COAL TRANSPORTATION RATES FOR MINNESOTA USERS

by

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INTRODUCTION

No coal deposits are mined or known to be of commercial value in Minnesota. Most of the coal used in Minnesota is transported from Montana or other western states by rail and from southern Illinois and Western Kentucky by barges on the Mississippi River System. In addition, some coal from eastern sources is transported to Minnesota by lake vessel and landed at Duluth-Superior, and some coal is shipped from coal fields in the Midwest by rail directly to users. Minnesota is far enough away from its sources of coal so that the cost of transportation frequently exceeds the cost of the coal. In fact, in Minnesota, it is not unusual for the total cost of transportation and handling coal to amount to two or three times the cost of the coal at the mine. Because of Minnesota's increased reliance on coal for its energy supplies, the costs of transporting and handling coal are extremely and increasingly important to Minnesota citizens.

The objectives of this paper are to summarize the existing rates that determine the cost of transporting coal into Minnesota, to define the areas where there are no existing coal transportation rates and to provide a methodology for estimating the cost of transporting coal from the major producing areas to Minnesota users.

A subsequent study will determine the costs associated with transferring coal from one transportation mode to another. The results of both studies will provide a basis for estimating the coal transportation and handling costs for users of varying quantities of coal anywhere in Minnesota.

The next section of this paper will consist of a brief description of the Western coal supply areas and the Minnesota demand points. Railroad rates for transporting Western coal will then be examined. This will include developing regression models that generate estimates of unit and volume rates for potential coal movements. A general discussion of barge and truck rates for hauling coal will conclude the paper.

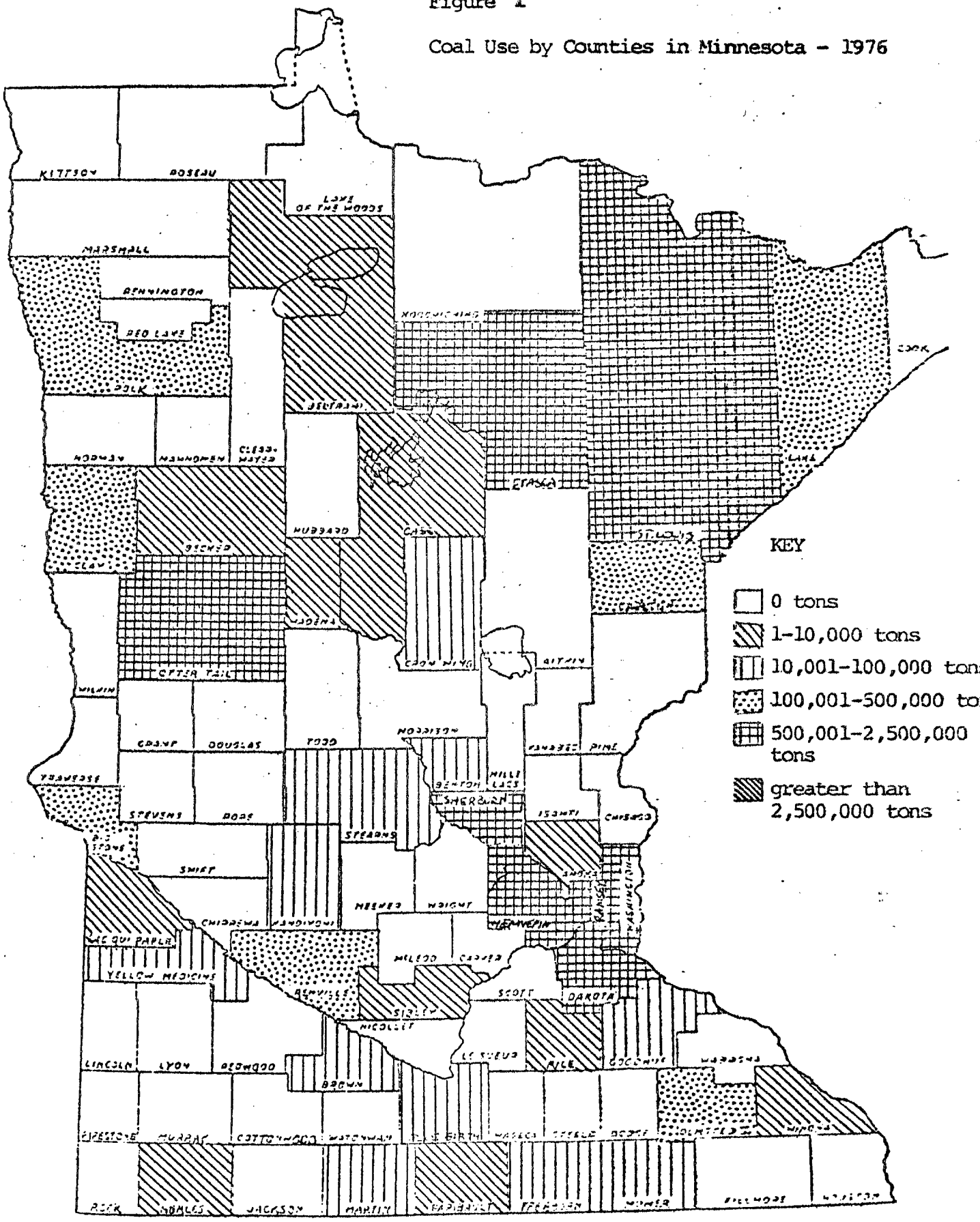
MINNESOTA COAL REQUIREMENTS AND SOURCES

Coal use in Minnesota in 1976 was approximately 13 million tons and is projected to increase to over 28 million tons by 1985 [20]. Further, the Minnesota Energy Agency projects the volume of western coal which will pass through Minnesota to Wisconsin, Illinois, and Michigan will increase from 7.5 million tons in 1976 to almost 16 million tons in 1985 [21]. Coal use by county in Minnesota is shown in Figures 1 and 2. In 1985, approximately 90 percent of projected coal use will occur in just several areas of the state--Becker, Cohasset, Floodwood, Fergus Falls, and the Twin Cities [21]. Most of the coal delivered to and through Minnesota is transported by rail. Figures 3, 4, and 5 give some indication of the current locations with either unit train, multiple car, or single car rates on coal delivered from Montana and Wyoming.

Western sources have increased their market share of Minnesota coal sales from about 60% in 1972 to more than 80% in the first half of 1976 [2]. Also, the general outlook for the future seems to indicate this same trend toward increased use of Western coal [21]. The western coal region includes eastern Montana, western North

Figure 1

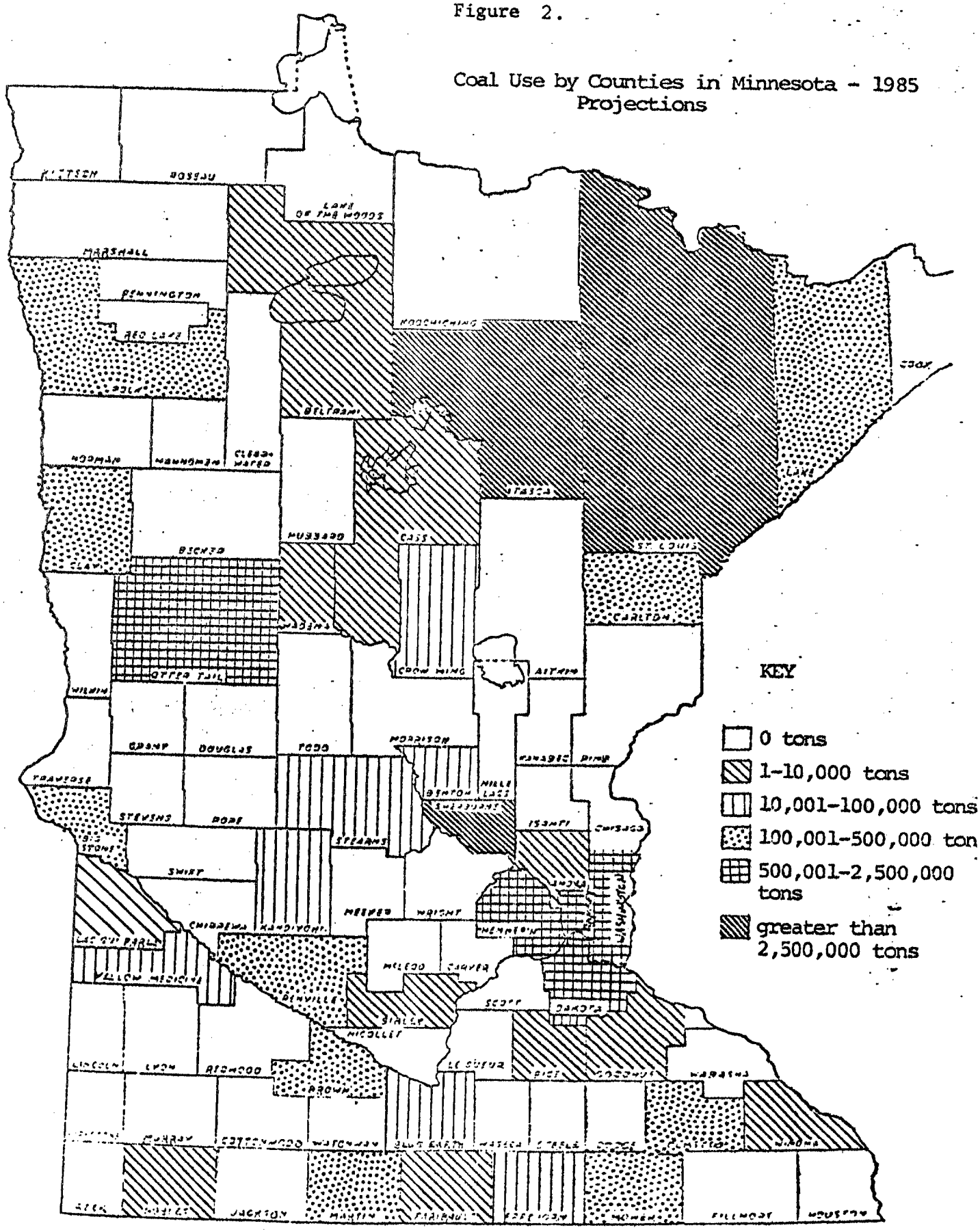
Coal Use by Counties in Minnesota - 1976



Source: Minnesota Energy Agency, Minnesota Coal Use and Projections: 1976-1985. (Draft)

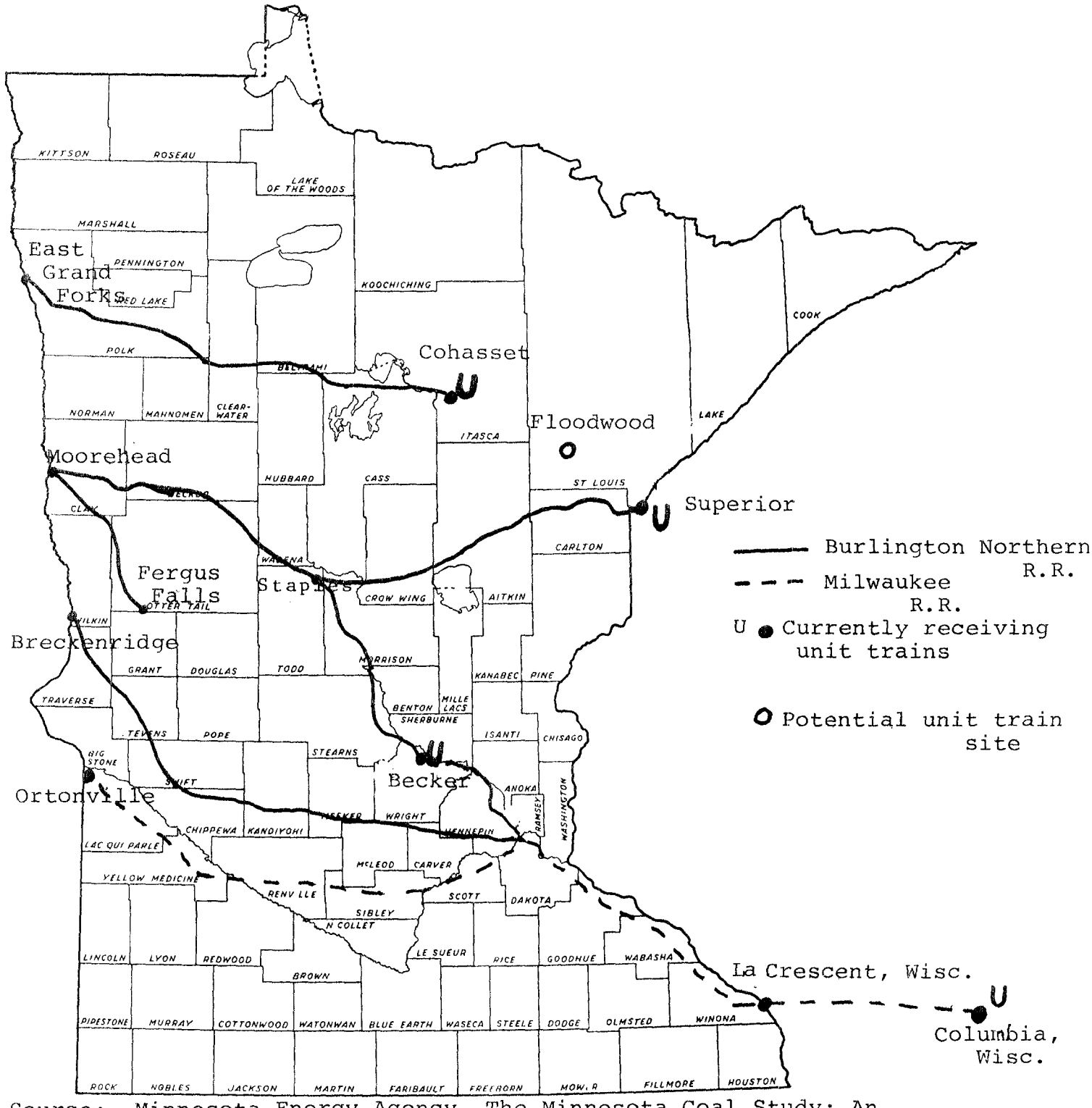
Figure 2.

Coal Use by Counties in Minnesota - 1985 Projections



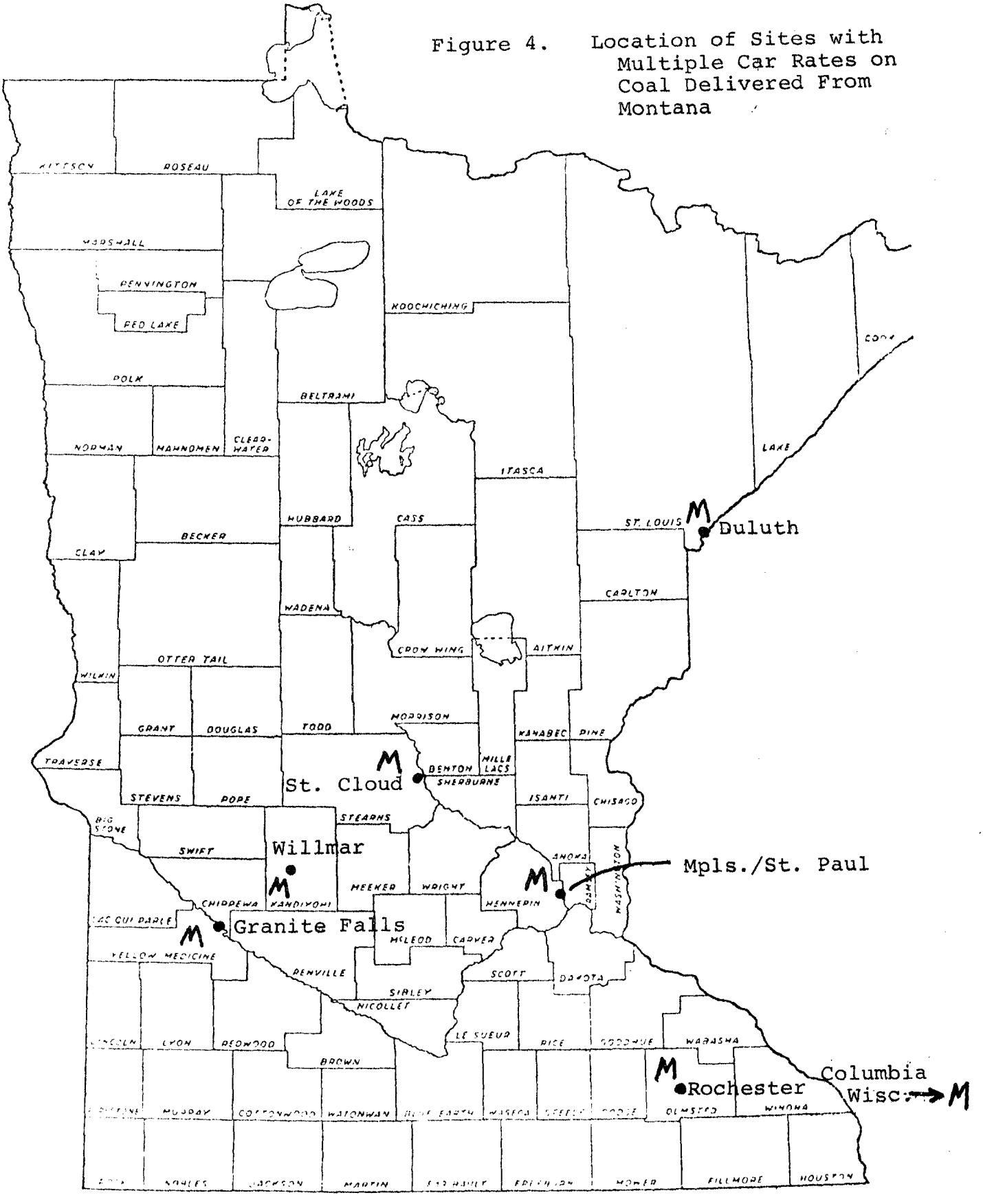
Source: Minnesota Energy Agency, Minnesota Coal Use and Projections: 1976-1985. (Draft)

Figure 3. Location of Sites Receiving Unit Train Shipments of Coal From Montana and Wyoming



Source: Minnesota Energy Agency, The Minnesota Coal Study: An Interim Report to the Legislature and Burlington Northern

Figure 4. Location of Sites with Multiple Car Rates on Coal Delivered From Montana



Source: BN Coal Tariff[9].

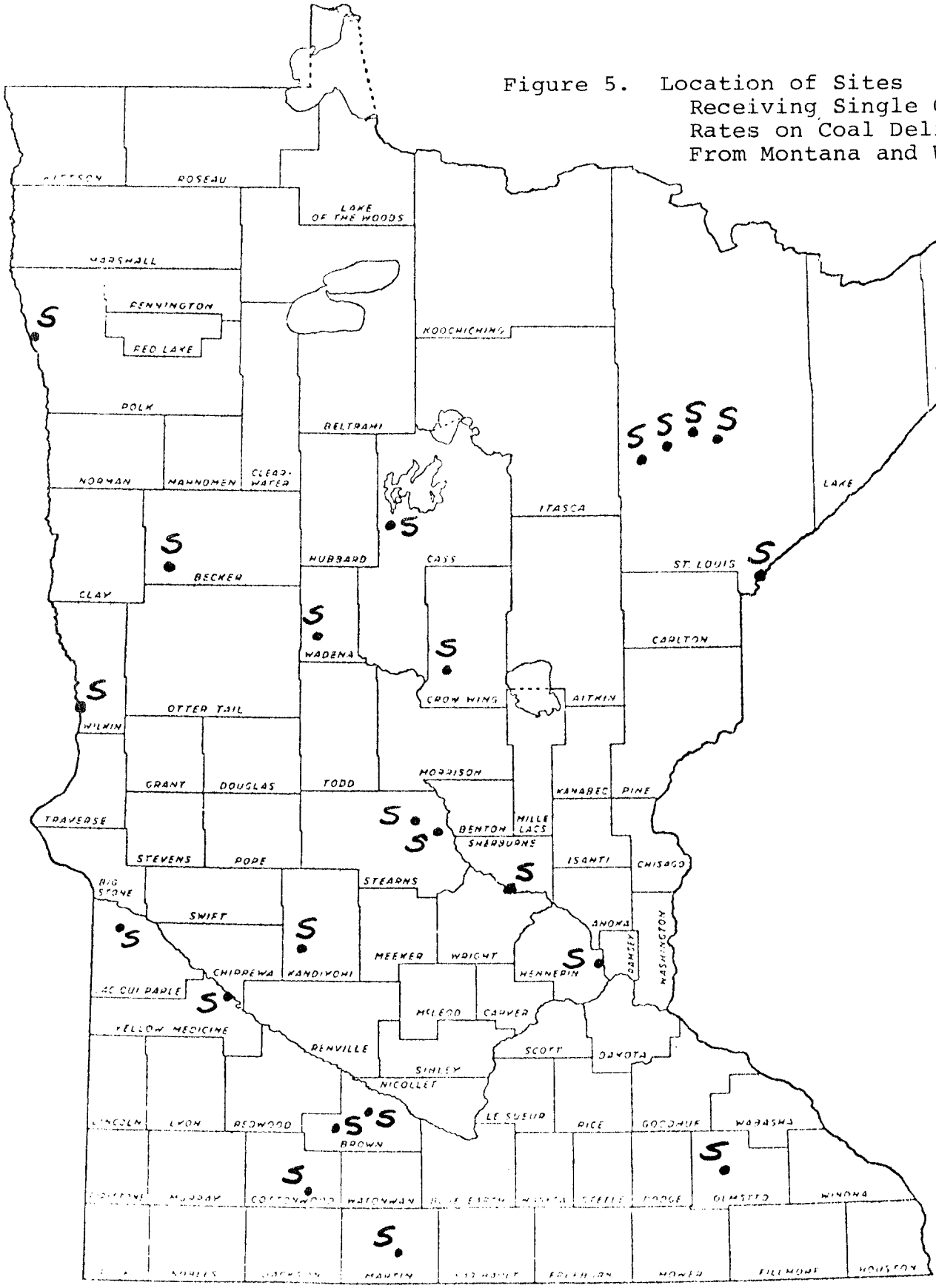


Figure 5. Location of Sites Receiving Single Car Rates on Coal Delivered From Montana and Wyoming

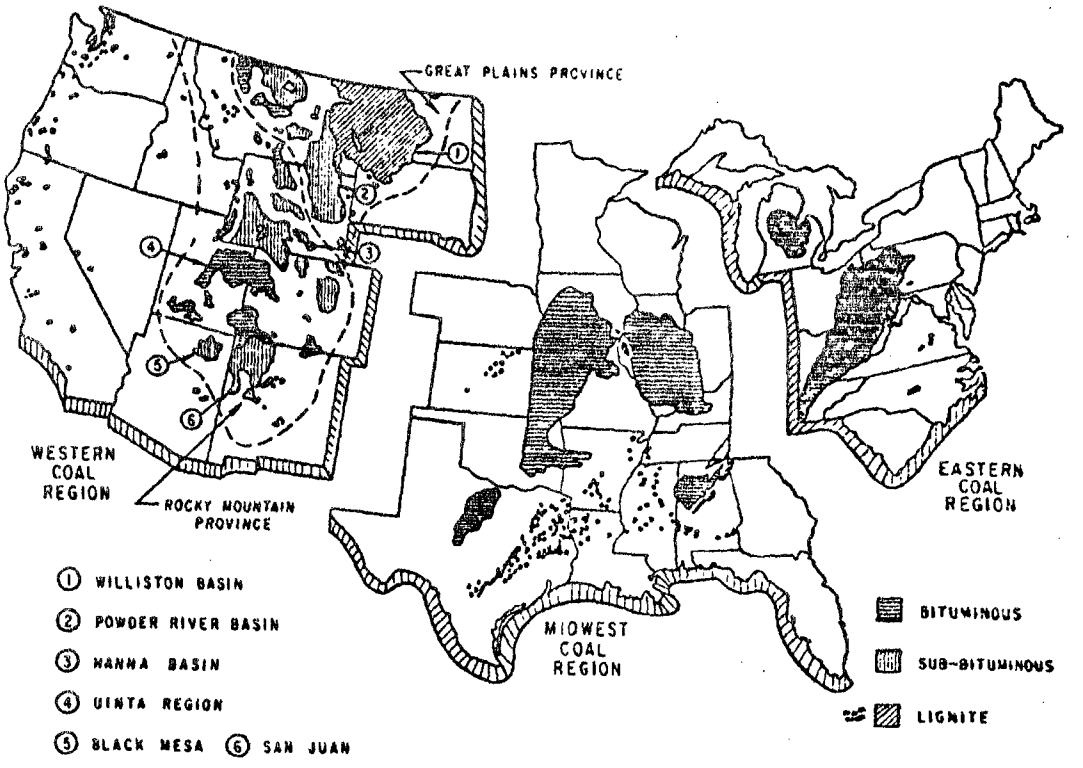
Source: BN Coal Tariff [8].

Dakota, northeastern Wyoming (see Fig. 6). However, because of transportation costs and energy content advantages, most of the coal that Minnesota has used recently comes from Montana. Also, several sugar beet processors and utilities in western Minnesota use North Dakota lignite as a fuel. Pass-through coal (coal enroute to demand centers outside of Minnesota but passing through Minnesota) moves on two major routes. Coal from Decker, Montana passes through Moorhead toward Superior on the Burlington Northern line where it is transferred to freighters that haul it on Lake Superior to Detroit Edison plants. Wyoming coal enroute for Columbia, Wisconsin passes through Minnesota on the Milwaukee Road between Ortonville and La Crescent, Wisconsin (see Figure 3). Other coal users in Wisconsin that receive coal from Montana and Wyoming are serviced by the southern Burlington Northern route that by-passes Minnesota. Tables 1 and 2 give some indication of various coal and lignite supply centers in the west that ship to Minnesota.

RAILROAD RATES FOR COAL

Railroads are required to publish their rates or tariffs so that unlike other modes, all rail rates in effect can be determined with certainty. Many factors including competition from other railroads or other transportation modes, the potential volume and the characteristics of the commodity ffect the rate that is actually filed with the Interstate Commerce Commission (ICC). It is important to recognize that the ICC can review rates and reject rates that are unreasonable or discrimatory, but does not set rates. Consequently,

Figure 6. Classification of Coal-Producing Regions



Source: Ashbury et.al., Survey of Electric Utility Demand for Western Coal.

Table 1. Western Coal Mines that Ship To or Through Minnesota

Source	MN Area Destination
Decker Mine (Montana) 1975 volume: 9,174,634 tons 1976 volume: 10,207,688 tons	6,000,000 tons to Havana, IL to barges for Commonwealth Edison plants. Detroit Edison will obtain approximately 7.4 million tons per year over the next 26 years via lake from Duluth.
Sarpy Creek (Absaloka) Mine (Montana) 1975 volume: 4,048,082 tons 1976 volume: 4,083,894 tons	NSP (High Bridge, King, Riverside plants) in MN; Interstate Power, Foxlake, MN; Dairyland Power Coop., Alma, WI; Wisconsin Power and Light, Columbia, WI.
Big Sky Mine (Montana) 1975 volume: 2,103,110 tons 1976 volume: 2,397,348 tons	1,560,000 tons to MP&L, Cohasset and Aurora, MN; Hibbard, Laskin, Boswell, and Virginia, MN.
Rosebud Mine (COLSTRIP, Montana) 1975 volume: 6,407,307 tons 1976 volume: 9,264,700 tons	Approximately 2,400,000 tons to NSP (Sherburne #1 and #2) in Becker, MN. (Expected to increase to 4.4 million tons by 1980.) 1,456,000 tons to NSP (King and Riverside plants) in St. Paul, MN; Minnesota Valley (Granite Falls), MN. 2,600,000 tons to Commonwealth Edison, Chicago, IL.
Big Horn #1 Mine (Wyoming) Projected 1974 volume: 997,274 tons	MN Sugar and other industries.

SOURCES: Environmental Protection Agency, Surface Coal Mining in the Northern Great Plains of the Western United States; Minnesota Energy Agency, Minnesota Coal Use and Projections: 1976-85 (Draft); Minnesota Energy Agency, The Minnesota Coal Study: An Interim Report to the Legislature, January 1978.

Table 2. Lignite Mines that Ship to Minnesota

Source	MN Area Destination
Gascoyne (Peerless) Mine (ND) 1975 volume: 1,979,253 tons 1976 volume: 2,482,123 tons	114,000 tons to Ottertail Power, Ortonville, MN.
Beulah Mine (ND) 1974 volume: 1,726,349 tons	750,000 tons to Ottertail Power, Hoot Lake (Fergus Falls), MN. 250,000 tons to numerous small utilities.
Velva Mine (ND) 1974 volume: 428,163 tons	70,000 tons to E. Grand Forks, MN (Sugar Beet Plant)
Noonan (Larson) Mine (ND) 1973 volume: 482,299 tons	Moorhead and Crookston, MN (Sugar Beet Plants)

SOURCES: Environmental Protection Agency, Surface Coal Mining in the Northern Great Plains of the Western United States; Minnesota Energy Agency, Minnesota Coal Use and Projections: 1976-85 (Draft); Minnesota Energy Agency, The Minnesota Coal Study: An Interim Report to the Legislature, January 1978.

the railroads have the freedom to set new rates within fairly wide limits as long as their out-of-pocket costs are recaptured. However, competition and the railroad's established rate structure generally provide practical upper limits to rate levels.

Unlike other modes, railroads cannot enter into long-term contracts with shippers. Consequently, although the railroad, as a common carrier, must take the coal tendered to it under existing tariffs, the shipper is free to use or not use the railroad if a competing carrier offers a lower rate or if volume is reduced. Because of the lack of long term contracts, railroad managements are sometimes hesitant to make the rate concessions and capital investments necessary to obtain and handle traffic that might be non-recurring. However, in the case of western coal, there are generally contracts between the mining company and electric generating utilities which assure that the tonnages will move for extended periods.

There are three general types of coal movements by rail into Minnesota, each with a different rate structure. These are for unit trains, for multiple car or trainload shipments, and for single car shipments. Rates for unit trains are typically the lowest followed by rates for trainloads and multiple car shipments. Single car rates are the highest. Unit trains are used for movements with sufficient volume to justify the dedication of one or more complete trains. A substantial investment by the consignor and consignee in loading and unloading equipment is also necessary. Rates are low because of the economics possible from the high volume and the efficiency in operations possible by the use of unit trains to capture these efficiencies. (The Appendix describes unit train operations.)

Trainload and multiple car shipments are used for movements between points where the volume is large enough to obtain operating and administrative economics but not large enough to justify a unit train operation.

Unit train rates are not subject to the general rate increases implemented by the rail industry. Rather an escalation formula based on railroad cost indices is applied. On Burlington Northern tariffs, this escalation is generally done annually on July 1. A few of the trainload rates are also subject to escalation but single car rates and most multiple car and trainload rates are subject to general increases.

Unit Train Rate Analysis

The existing unit train rates to points in Minnesota and Wisconsin from Montana mines are shown in Table 3a. These rates were obtained from tariffs published by the Burlington Northern Railroad [3-14] and were effective 1 July 1977. Table 3b shows unit train rates to locations in other states.

A regression model was developed from the rates in Table 3a to estimate the probable unit train rates to other points in Minnesota. Although frequently, institutional and competitive factors are important considerations in setting rates, the actual costs of the railroad are predominant in determining western coal unit train rates. Because of the limited number of observations, an extensive analysis was not possible. However, the most important factor effecting variable costs of operation is generally the length of the haul. A regression of the observed unit train rates on length of haul was performed. This proved unsatisfactory (R^2 = .06). A second regression used length of haul

Table 3a. Unit Train Coal Rates to Minnesota and Wisconsin Destinations (July 1977)

Origin	Destination	Rate ($/ton)	Miles	Rate/Ton Mile (¢)	Annual Minimum (tons)	# Cars
Colstrip	Becker	6.07	762	.80	2,800,000	105
Colstrip	Cohasset	5.82	773	.75	1,500,000	102
Colstrip	Cohasset	5.49	773	.71	1,750,000	102
Decker	Superior	6.55	1,025	.64	2,000,000	105
Colstrip	Columbia,WI	7.15	1,031	.69	1,900,000	105
Kuehn	Superior	10.30	824	1.29	none	100
Decker	Superior	12.13	1,025	1.18	none	100
Colstrip	Superior	9.98	808	1.24	none	100

Source: BN Coal Tariffs [3,7,9,10,11].

Table 3b. Unit Train Coal Rates to Points Other Than Minnesota and Wisconsin (July 1977)

Origin	Destination	Rate ($/ton)	Miles	Rate/Ton Mile (¢)	Annual Minimum (tons)	# Cars
Belle Ayr	Armarillo, TX	14.51	958	1.53	---	100
Belle Ayr	Metropolis, IL	13.78	1,296	1.06	---	100
Belle Ayr	Elmendorf, TX	24.61	1,640	1.50	---	97
Belle Ayr	Welsh, TX	20.43	1,445	1.41	---	97
Belle Ayr	Flint Creek, AR	16.00	1,032	1.55	---	97
Crodero	Elmendorf, TX	24.62	1,650	1.49	---	97
Belle Ayr	Metropolis, IL	9.68	1,296	.78	2,500,000	105
Belle Ayr	Metropolis, IL	9.63	1,296	.77	3,500,000	105

Source: BN Coal Tariffs [9, 12].

and minimum annual volume as independent variables. This equation was judged to be satisfactory for estimating unit train rates for moderate volumes over a single rail line to points in Minnesota and Wisconsin from Montana. The estimating equation is

Rate in cents per ton = 378.0 + .81 (length of haul in miles) - .00027 (Minimum Annual Volume in tons)

The economic interpretation of this equation is that the rate consists of an initial charge per ton of $3.78 plus a charge of $.81 per mile shipped less $.00027 for every ton of annual volume, i.e., the rate increases as length of haul increases and decreases as the annual volume increases.

This estimating equation does not distinguish between shipper- or carrier-owned cars. (Many large volume shippers furnish the coal cars because they are able to obtain better financing than the railroad.) In general rates will be higher than the estimates if the carrier furnishes the equipment and lower if the cars are furnished by the shipper.

The estimating equation also does not adjust for situations when a second railroad performs a short haul. All the observed rates were for a direct haul on one railroad or long hauls on two railroads. A short haul on a second railroad (which might be necessary for locations in southern Minnesota) would undoubtedly have a higher rate than the one given by this estimating equation.

Multiple Car Rate Analysis

Multiple car rates from Western mines to Minnesota, Wisconsin and Illinois destinations are found in Table 4a. The fifteen car rates to Minnesota are shown on Figure 7. These rates were obtained from published tariffs [9,14] and are the rates which were in effect in the fall of 1977.

These rates found in Tables 4a were combined with all the published multiple car rates from these mines to demand points in Wisconsin, Iowa, Illinois and a number of other states to form the data set for a regression analysis. These additional locations and rates are found in Table 4b. Separate analyses were performed on rates for direct hauls on a single railroad and for joint rates on two or more railroads. Length of shipment, shipment size (in tons or number of cars) and whether the cars were owned by the shipper or carrier were generally found to be the best explanatory variables.

Approximately 2/3 of the variation in rates for multiple car shipments on a single rail line can be explained by the length of the haul. This relationship is illustrated graphically by Figure 8. However, regression models with more variables can improve the fit substantially.

For shipments over a single rail line with carrier owned cars, the estimating equation is

Rate in cents per ton = 369.63 + 1.21 (length of shipment in miles) - .052 (shipment size in tons)

Table 4a. Western Coal Multiple Car Rate to Destinations in Minnesota and Other States (July 1977)

Origin	Destination	Rate ($/ton)	Miles	Rate/ Ton Mile (¢)	Annual Minimum (tons)	# Cars
Minnesota						
Colstrip	Minneapolis	7.61	784	.97	1,100,000	105
Colstrip	Duluth	11.11	808	1.38	none	75
Decker	Duluth	13.54	1,025	1.32	none	60
Colstrip	Granite Falls	11.64	666	1.75	none	14
Colstrip	Rochester	14.19	877	1.62	none	15
Kleenburn	Mankato	15.14	869	1.74	none	10
Kuehn	Twin Cities	13.52	829	1.63	none	15
Kuehn	St. Cloud	12.40	776	1.60	none	15
Kuehn	Willmar	12.12	749	1.62	none	15
Other States						
Kuehn	Sommer, IL	16.96	1,290	1.31	none	97
Colstrip	E.St.Louis, IL	15.68	1,430	1.10	none	97
Colstrip	Columbia, WI	12.60	1,031	1.22	none	50
Colstrip	Havana, IL	16.40	1,269	1.29	none	15
Colstrip	Byron,WI	16.90	1,009	1.67	none	15
Colstrip	Kaukarna,WI	18.12	1,116	1.62	none	15
Colstrip	Madison, WI	16.98	1,063	1.60	none	15
Colstrip	Rhinelander, WI	17.86	1,003	1.78	none	15
Colstrip	Stevens Pt., WI	16.90	984	1.72	none	15
Kleenburn	Byron, WI	19.82	1,153	1.72	none	15
Kleenburn	Rhinelander,WI	20.29	1,169	1.74	none	15
Kleenburn	Wisc.Rapids, WI	19.82	1,149	1.72	none	15

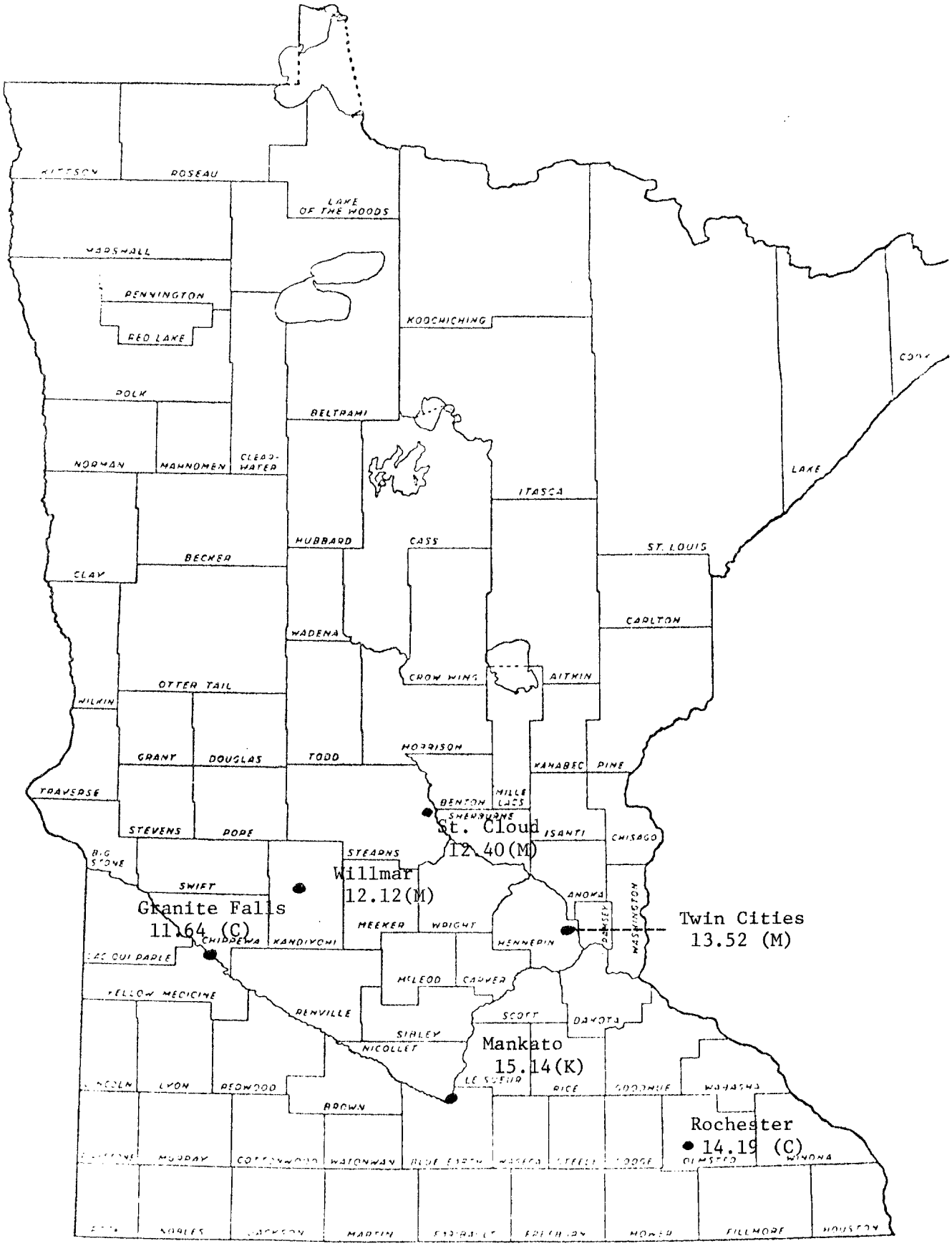
Source: BN Coal Tariffs [9,14].

Table 4b. Additional Western Coal Multiple Car Rates (July 1977)

Origin	Destination	Rate ($/ton)	Miles	Rate/Ton Miles (¢)	Annual Minimum (tons)	Number Cars
Decker	Havana, IL	12.73	1,174	1.13	2,200,000	102
Decker	Havana, IL	12.69	1,174	1.12	3,500,000	102
Kleenburn	Powerton, IL	12.73	1,131	1.17	2,200,000	102
Kleenburn	Powerton, IL	12.69	1,131	1.17	3,500,000	102
Belle Ayr	E.St.Louis,IL	12.93	1,140	1.14	---	97
Belle Ayr	Breed Switch,IN	20.14	1,340	1.50	---	97
Belle Ayr	Laude County,MO	12.52	969	1.29	---	102
Belle Ayr	Pueblo, CO	7.97	609	1.31	---	100
Colstrip	E.St.Louis,IL	16.31	1,430	1.14	---	97
Decker	Chicago, IL	16.07	1,238	1.30	---	97
Decker	E.St.Louis,IL	14.21	1,249	1.14	---	97
Decker	Havana, IL	16.29	1,174	1.39	---	97
Decker	Seneca, IL	13.75	1,218	1.13	---	97
Kuehn	E.Peoria,IL	17.64	1,284	1.37	---	97
Kuehn	E.St.Louis,IL	16.31	1,446	1.13	---	97
Belle Ayr	Burlington,IA	12.52	926	1.35	---	50
Belle Ayr	Denver, CO	7.74	494	1.57	---	50
Belle Ayr	Pueblo, CO	7.69	609	1.26	---	50
Belle Ayr	Peoria, IL	21.11	1,020	2.07	---	15
Kleenburn	Denver, CO	8.86	596	1.49	---	50
Belle Ayr	Bridgeport, IA	15.75	845	1.86	---	15
Belle Ayr	Burlington, IA	15.52	926	1.68	---	15
Kleenburn	Ames, IA	15.75	892	1.77	---	13
Kleenburn	Gary, IN	17.42	1,382	1.26	---	15
Sheridan	Peoria, IL	21.11	1,171	1.80	---	15

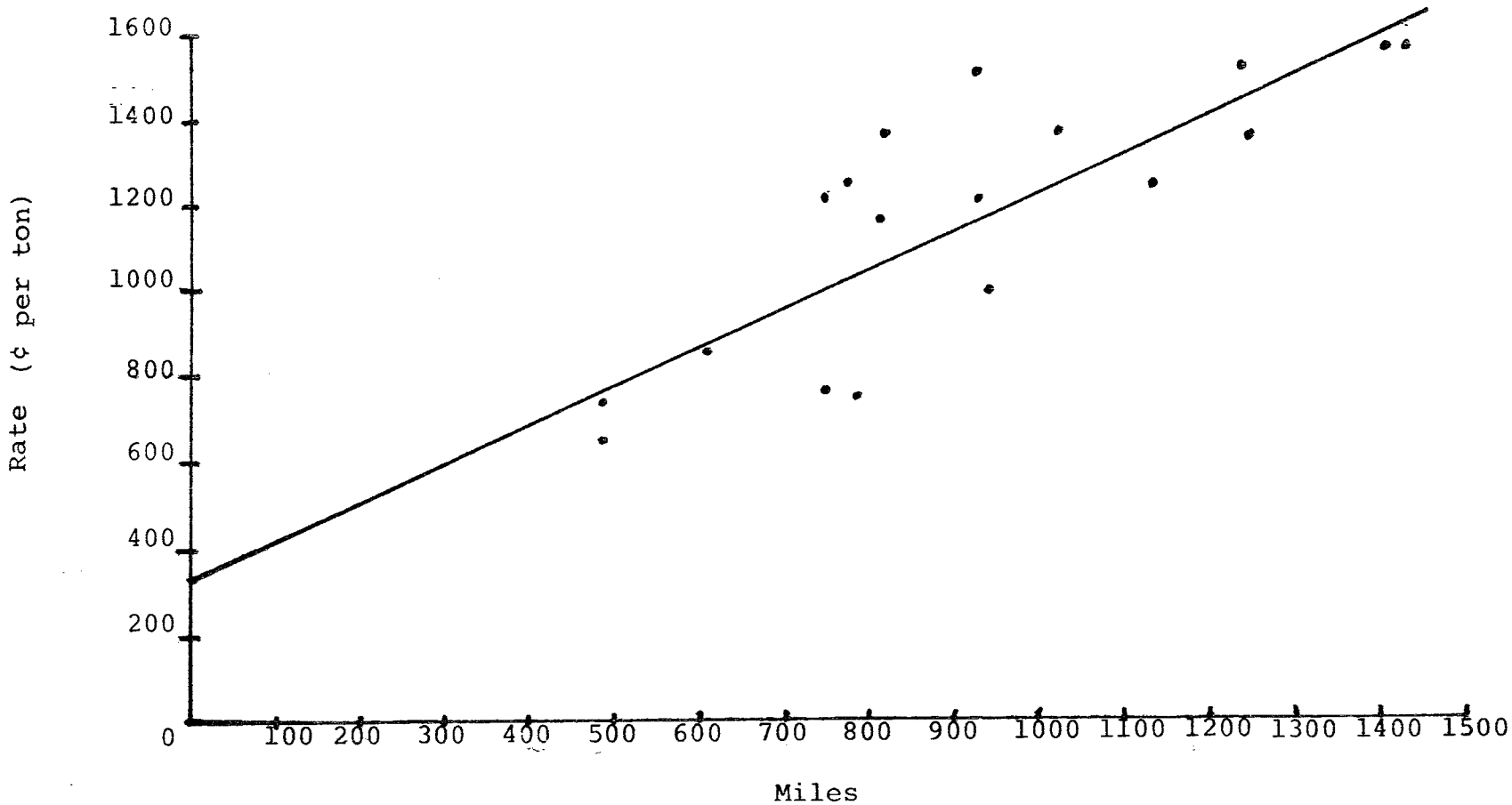
Source: BN Coal Tariffs [4,9,14].

Figure 7. FIFTEEN CAR RATES FOR SUB-BITUMINOUS COAL FROM COLSTRIP (C), KLEENBURN (K), OR KUEHN (M) TO POINTS IN MINNESOTA ($ per ton).



Source: BN Coal Tariff [9].

Figure 8. Single Line Multiple Car Rates from Montana and Wyoming Mines to Minnesota and Wisconsin Destinations



Source: Sub-Butuminous Coal Tariff (BN) [8].

If the cars are owned by the shippers the estimating equation is

Rate in cents per ton = 223.93 + 1.21 (length of shipment in miles) - .052 (shipment size in tons)

R^2 is .88. All the coefficients except the adjustment for car ownership are significant at the 5 percent level.

A separate analysis was performed for shipments over 2 or more lines. Statistically, length of haul explains less of the variance in rates than it does if the movement is over a single railroad. Minimum shipment size and car ownership were also used as explanatory variables. The estimating equation selected for shipments in carrier owned cars is

Rate in cents per ton = 624.08 + 1.15 (length of haul in miles) - .054 (minimum shipment size in tons)

For shipments in shipper owned cars the estimating equation is

Rate in cents per ton = 484.69 + 1.15 (length of haul in miles) - .058 (minimum shipment size in tons)

The adjusted R^2 was .76. All of the coefficients except the one for car ownership were significant at the 5% level.

Single Car Coal Rates

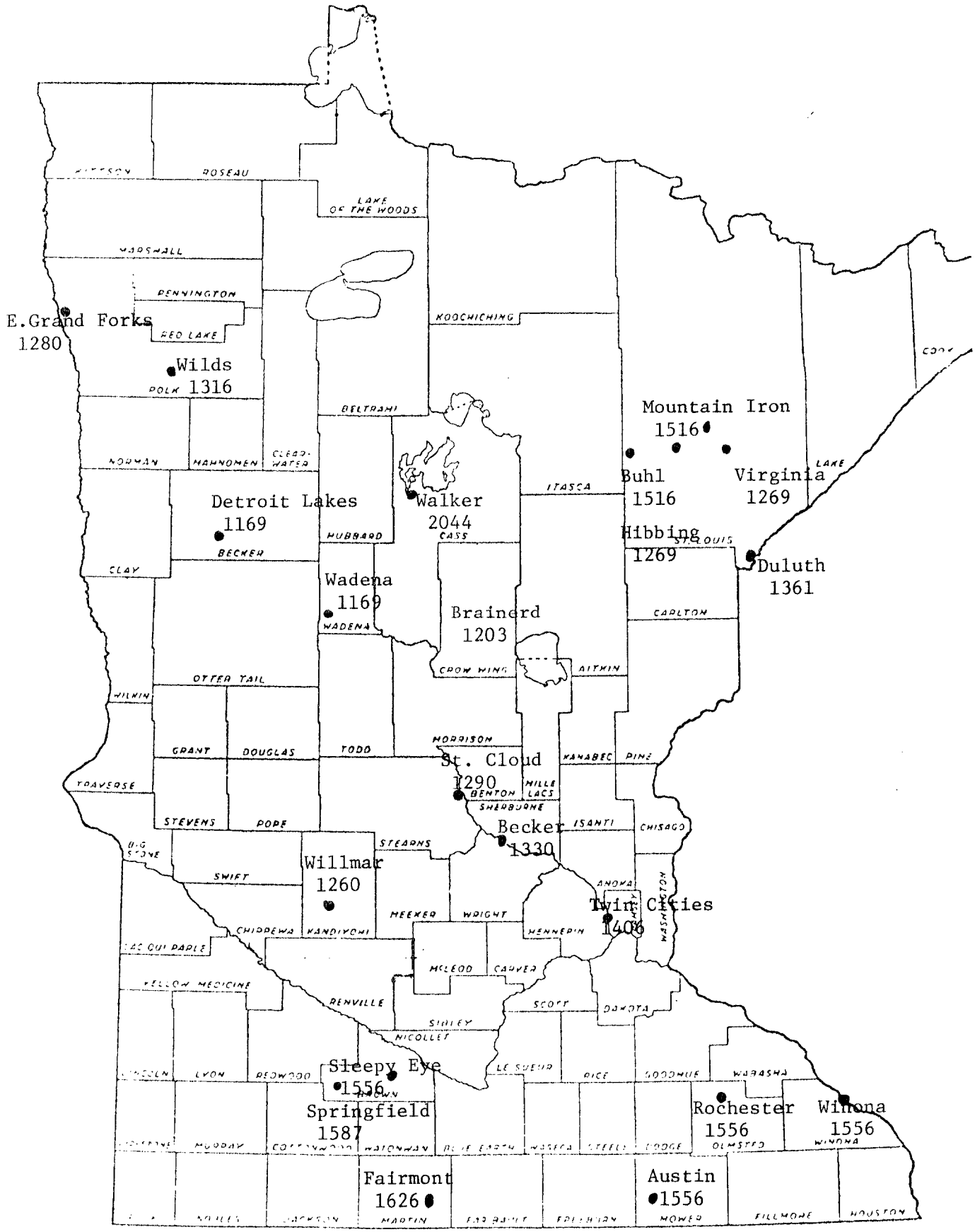
Single car coal rates from western mines to points in Minnesota are listed in Table 5 and exhibited in Figures 9 and 10. These rates were effective at the same time as the unit train and multiple car rates given in Tables 3a, 3b, 4a and 4b.

Table 5. Single Car Coal Rates to Minnesota

Origin	Destination	Rate ($/ton)	Miles	Rate/ Ton Mile (¢)
Colstrip,MT	E.Grand Forks	12.80	634	2.02
Colstrip	Wields	13.16	647	2.03
Colstrip	Detroit Lakes	11.69	604	1.94
Colstrip	Walker	20.44	712	2.87
Colstrip	Wadena	11.69	649	1.90
Colstrip	Brainerd	12.03	696	1.73
Colstrip	Hibbing	12.69	826	1.54
Colstrip	Buhl	15.16	836	1.81
Colstrip	Mountain Iron	15.16	842	1.80
Colstrip	Virginia	12.69	848	1.50
Colstrip	Duluth	13.61	808	1.68
Colstrip	St. Cloud	12.90	733	1.76
Colstrip	Becker	13.30	762	1.75
Colstrip	Wilmar	12.60	703	1.79
Colstrip	Twin Cities	14.06	784	1.79
Colstrip	Sleepy Eye	15.56	903	1.72
Colstrip	Springfield	15.87	916	1.73
Colstrip	Fairmont	16.26	937	1.74
Colstrip	Rochester	15.56	882	1.76
Colstrip	Austin	15.56	884	1.76
Colstrip	Winona	15.56	889	1.75
Kleenburn,WY	LaCrosse,WI	18.45	1,159	1.59
Kleenburn	Twin Cities	16.58	1,017	1.63
Thermupolis,WY	Twin Cities	19.33	1,047	1.85
Thermupolis	Collegeville	17.18	972	1.77
Kleenburn	Breckenridge	16.74	765	2.19
Wyodak,WY	Detroit Lakes	19.24	946	2.03
Wyodak	Walker	21.51	1,057	2.00
Kleenburn	Duluth/Superior	18.82	1,041	1.81
Thermupolis	Duluth/Superior	19.93	1,129	1.77

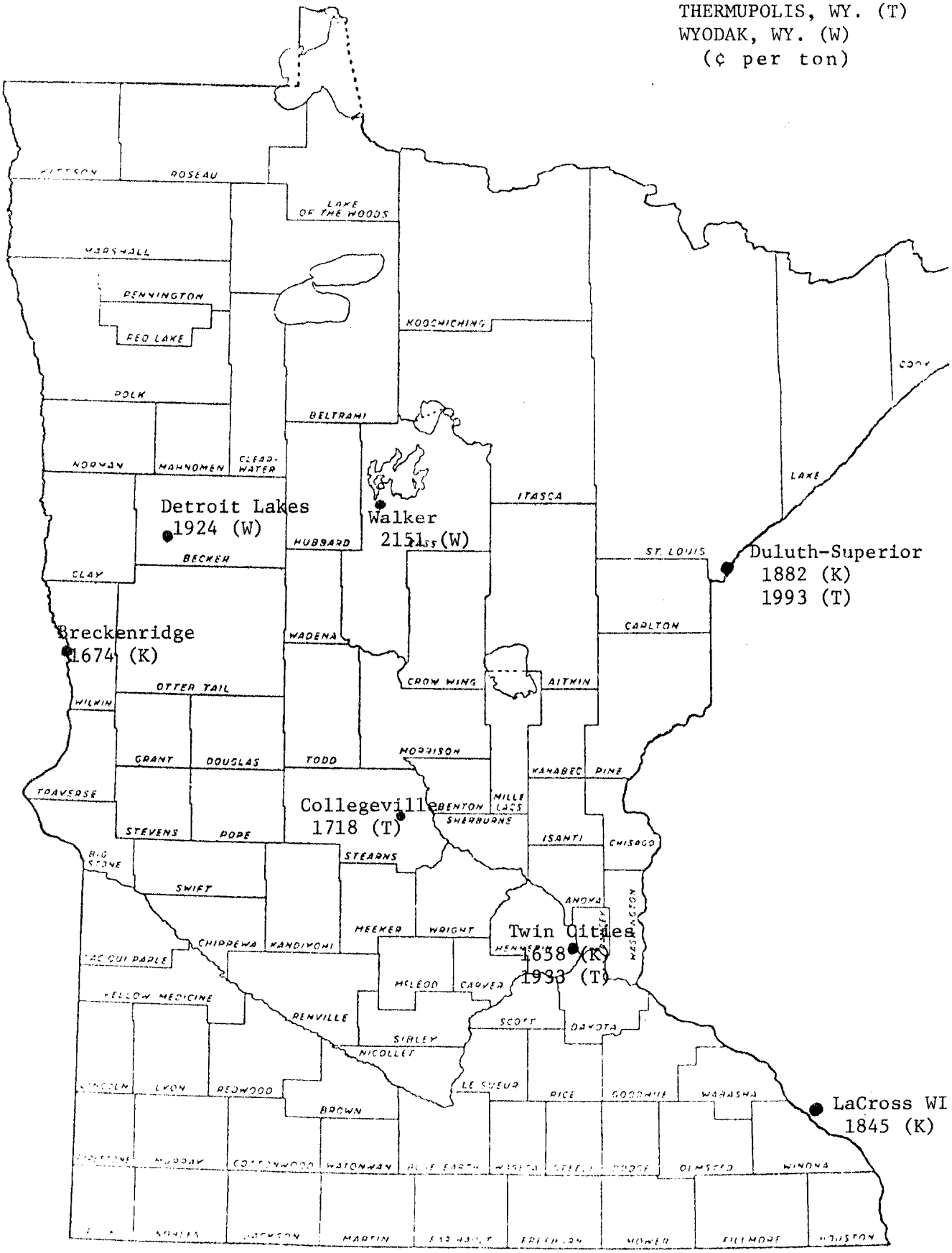
Source: BN Coal Tariff [8].

Figure 9. SINGLE CAR RATES FOR SUB-BITUMINOUS COAL FROM COLSTRIP TO POINTS IN MINNESOTA (¢ per ton).



Source: BN Coal Tariff & Chicago, Milwaukee, St. Paul and Pacific

Figure 10. SINGLE CAR RATES FOR SUB-BITUMINOUS COAL TO POINTS IN MINNESOTA FROM KLEENBURN WY. (K) THERMUPOLIS, WY. (T) WYODAK, WY. (W) (¢ per ton)



Source: BN Coal Tariff [8].

The substantial saving available to shippers who can utilize unit trains or multiple car rates is readily apparent. For instance, the difference between unit train and single car rates from Colstrip to Becker is $7.23 per ton. The difference between the single car rate and the 75 car rate to Duluth is $2.50 per ton and the difference between the single car rate and the 15 car rate to (Rochester) is $1.37 per ton.

It should be noted that there are existing single car rail rates from points in the midwest and east to points in southern Minnesota. There are also existing rates from Duluth-Superior to Minnesota points for coal received there by laker. A complete analysis of these rates was beyond the scope of this study.

Lignite Rail Rates

Table 2 contains the major North Dakota lignite mines which ship to Minnesota users. Tables 6, 7 and 8 show the existing rail tariff for lignite to points in Minnesota. Lignite has a different rate structure than bituminous coal because it is less stable and has different handling and shipping characteristics. In addition, lignite has fewer BTU's of heat energy per pound. Consequently most of the lignite used in Minnesota has been in the western part of the state near the North Dakota mines. The major movements of lignite to Minnesota are in the neighborhood of 200 to 600 miles as compared to movements in excess of 600 miles for sub-bituminous coal.

Table 6 contains both the single car rate and a rate for an annual volume of more than 40,000 tons, i.e., 400-600 cars per year.

Table 6. Rail Rates for Transporting Lignite.

Origin	Destination	Min. Annual Volume (tons)	Miles	Rate(¢/ton) (with minimum Annual Volume)	Rate/Ton-Mile(¢)	Rate(¢/ton) (w/o minimum Annual Volume)	Rate/Ton-Mile(¢)
Beulah, ND or Glenharold, ND or Republic, ND or Truax, ND	Bingham, MN	40,000	277	642	2.32	694	2.51
	E. Grand Forks, MN	40,000	352	646	1.84	710	2.02
	Moorhead, MN	40,000	274	589	2.15	642	2.34
	Wilds, MN	40,000	345	674	1.95	729	2.11
Larson, ND	Duluth, MN	---	570	---	---	844	1.48
Kincaid, ND or Larson, ND or Baukol Noonan, Inc. Siding, ND	Bingham, MN	40,000	321	625	1.95	675	2.10
	E. Grand Forks, MN	40,000	298	608	2.04	675	2.27
	Moorhead, MN	40,000	318	625	1.97	675	2.12
	Wilds, MN	40,000	389	625	1.61	675	1.74
Voltaire, ND	Bingham, MN	40,000	255	608	2.38	666	2.61
	E. Grand Forks, MN	40,000	229	568	2.48	632	2.76
	Moorhead, MN	40,000	253	608	2.40	666	2.63
	Wilds, MN	40,000	324	608	1.88	666	2.06

SOURCE: Lignite Tariff (3N)[5].

Table 7. Rail Rates for Transporting Lignite to Hoot Lake, MN.*

Origin	Destination	Minimum Annual Volume (tons)	Miles	Rate (¢/ton)	Rate/Ton-Mile(¢)
Beulah, ND	Hoot Lake, MN	$12,000 \leq M < 265,000$	330	655	1.98
or		$265,000 \leq M < 365,000$	330	616	1.87
Republic, ND		$365,000 \leq M < 465,000$	330	531	1.61
		$465,000 \leq M < 565,000$	330	417	1.26
		$M \geq 565,000$	330	394	1.19
Baukol Noonan, Inc.	Hoot Lake, MN	$12,000 \leq M < 265,000$	372	697	1.87
Siding, ND		$265,000 \leq M < 365,000$	372	657	1.77
or		$365,000 \leq M < 465,000$	372	576	1.55
Larson, ND		$465,000 \leq M < 565,000$	372	460	1.24
		$M \geq 565,000$	372	438	1.18

SOURCE: Lignite Tariff (BN) [5].

*Near Fergus Falls, MN

TABLE 8.

Representative Single Car Distance
Rail Rates for Lignite

Distance (miles)	Rate/Ton (¢) (single line)	Rate/Ton Mile (¢)	Rate/Ton (¢) Joint Line	Rate/Ton Mile (¢)
200	627	3.14	688	3.44
250	662	2.65	714	2.86
300	698	2.33	753	2.51
350	734	2.10	781	2.23
400	761	1.90	810	2.03
450	790	1.76	834	1.85
500	815	1.63	864	1.73
550	846	1.54	890	1.62
600	870	1.45	914	1.52
650	927	1.43	972	1.50
700	951	1.36	995	1.42

Source: Lignite Tariff (BN) [5].

Table 7 contains rates for larger annual volumes. The origin-destination pairs in Tables 6 and 7 are the only locations with specific rates. Table 8 is an excerpt from the mileage rates for lignite. Locations other than those listed in Tables 6 and 7 would pay a rate based on the mileage between their location and the mine. These rates are higher than the corresponding point to point rates. However, if a new location consumed substantial amounts of lignite, it would probably be able to negotiate with the railroad for the filing of a tariff with rates similar to those in Table 7.

BARGE RATES FOR COAL

Most bulk commodity movements by barge are not subject to rate regulation, so the actual charges for barge movements cannot be determined from published tariffs. Rates for barge movements of coal such as those to utilities are frequently established by a multi-year contract between the barge company and the utility. This arrangement allows the utility to determine its transportation costs in advance and allows the barge company to determine its future equipment needs more accurately. Such a contract will generally include escalator clauses which will adjust the rate if operating costs change.

One-time movements of coal move at the "spot" rate which is the rate in effect at the time the need to ship arises. This rate, or price quotation, is based on such things as the availability of barges and towboats, the possibility of a backhaul, whether the specific origin and destination is generally served by the barge company, and

the size of the shipment. The barge company's quotation or the spot rate may be affected by cometitive factors and the desire or lack of desire for a long term relationship with the shipper.

In some instances, shippers provide their own barge transportation through a captive barge line or provide the barges and contract just for towing services. In general, because of the competitive nature of the barge industry, the costs to these shippers probably approximate the rates that they would be able to negotiate on long term contracts.

Coal from both eastern sources such as Illinois and Kentucky and from western sources such as Montana and Wyoming are shipped on Minnesota waterways. Traditionally, utilities located in the Twin Cities or on the Mississippi River consumed coal from eastern sources that was received by barge. These utilities still receive substantial amounts of eastern coal but also use western coal because of its lower sulfur content. Most of the western coal transferred from rail to barge in the Twin Cities is consumed by NSP in the Twin Cities, and by Dairyland Power at Alma and Genoa, Wisconsin.

Table 9 provides estimates of rates for representative coal shipments for the 1977 barge season. It should be stressed that these are estimates derived from a combination of published materials and interviews with barge operators and shippers. Actual rates undoubtedly varied depending on the availability of equipment, backhauls, and other factors.

Table 10 contains actual rates that were charged for coal in 1974. These rates were obtained from a study performed for the U.S. Army Corps. of Engineers [16]. The movements were selected by

Table 9. Estimates of 1977 Barge Rates for Coal

Origin	Destination	Estimated Rate Per Ton ($)	Miles	Estimated Rate Per Ton Mile (¢)
St. Paul, MN	Alma, WI	1.25	100	1.25
E. St. Louis, Kellogg, Southwest Illinois	Keokuk, Davenport Muscatine	1.90-2.20	195-295[1/]	1.12-.64
E. St. Louis, Kellogg, Southwest Illinois	Lansing, IA	2.10	495[1/]	.43
E. St. Louis, Kellogg, Southwest Illinois	Twin Cities	2.50	661[1/]	.38
Louisville, KY	Keokuk, Davenport Muscatine	4.00	775-875	.52-.46
Louisville, KY	Twin Cities	5.00	1200	.42
Grand Rivers, KY	Twin Cities	3.50	908	.39
Huntington, WV Ashland, KY	Twin Cities	6.00	1500	.40
Pittsburg, PA	Twin Cities	9.00	1810	.50
Arkansas River, AR	Twin Cities	6.00	1500	.40

1/ Stated distance is from E. St. Louis. Kellogg is 40 miles greater.

Table 10. Barge Rates for Coal in 1974.

ORIGIN	DESTINATION	RATE PER TON ($)	MILES	RATE PER TON MILE (¢)	VOLUME 1/ OF SHIPMENT
St. Louis, MO	Cassville, WI	2.37	427	.55	213,304
St. Louis, MO	Alma, WI	2.55	572	.46	213,634
St. Louis, MO	St. Paul, MN	2.70	661	.41	195,162
Grand Rivers, KY	St. Paul, MN	3.16	908	.35	13,757
Uniontown, KY	St. Paul, MN	3.99	978	.41	12,984
Uniontown, KY	Mpls, MN	4.15	992	.42	58,940
Rochester, KY	Alma, WI	3.27	1,064	.31	64,534
Roseville, AR	Cassville, WI	5.01	1,210	.41	18,495
Ashland, KY	Mpls, MN	5.86	1,526	.38	4,250

Source: Charles Donley and Associates, Origin-Destination Rate Analysis of Commodity Movements Passing Through Lock No. 26; prepared for the St. Louis District U.S. Army Corps of Engineers.

1/ Volume of sampled shipment, not necessarily annual volume.

statistical sampling and should be an accurate representation of rates on coal movements passing through Lock and Dam 26 during 1974. When comparing Tables 9 and 10, remember that barge operating costs have increased some 28 percent from 1974 to 1977. It is apparent that rates have not risen as rapidly as costs during this period.

From Tables 9 and 10 one can see that the barge rates for short hauls are the highest and drop rapidly with distance, leveling off at about .4¢ or 4 mills per ton mile at distances greater than 500 miles. The lowest rate about 3.8 mills per ton mile is from E. St. Louis to the Twin Cities which is the origin-destination trip with the largest annual volume. With one exception, these are northbound rates which can be expected to be more favorable to shippers because northbound coal can be used as a backhaul with the primary movement being the southbound export grain out of the upper midwest.

The longest haul is from above Pittsburg. The rate appears high at 5 mills per ton mile. However, this is probably due to two factors. Pittsburg, like the Twin Cities, is near the head of navigation and generates more downbound traffic than it receives so that coal is not a backhaul. In addition, operating costs on the Mongehela River above Pittsburg are high. The higher rate probably reflects both a high demand for barges and the high operating costs above Pittsburg.

Terminal costs are not included in the estimated and actual rates in Tables 9 and 10. These costs can amount to a substantial portion of the total water related transportation costs if the water borne portion of the movement is short. For instance, the charge for transloading coal from rail to barge in the Twin Cities will run from 60¢ to over $1.00 per ton depending on annual volumes and other contract terms. The 1974 study for the Army Corps of Engineers listed transfer charges

of 28¢ to 57¢ at down river ports. Switching and fleeting costs are normally included in the line haul rate. However, these costs can be major components of the rates. For instance, towing charges from the Minnesota Upper Harbor to the St. Paul fleeting area are 25¢ to 50¢ per ton.

The costs of transferring from rail or truck to barge and fleeting and terminal costs tend to eliminate the economic advantages of cheap waterway transportation for relatively short hauls.

TRUCK RATES FOR COAL

Much of the Western and Eastern coal that arrives in Minnesota for small and medium-sized users must be delivered to its final destination by truck. This is frequently because of the inaccessability of the demand point to either rail or barge delivery. Even if the user is served by rail, the siding frequently services a warehouse area rather than the boiler area so that rail shipments are not convenient. For many other small users of coal it is simply less expensive to receive a truckload of coal from a distribution center than to receive the coal by rail and pay the single car rate.

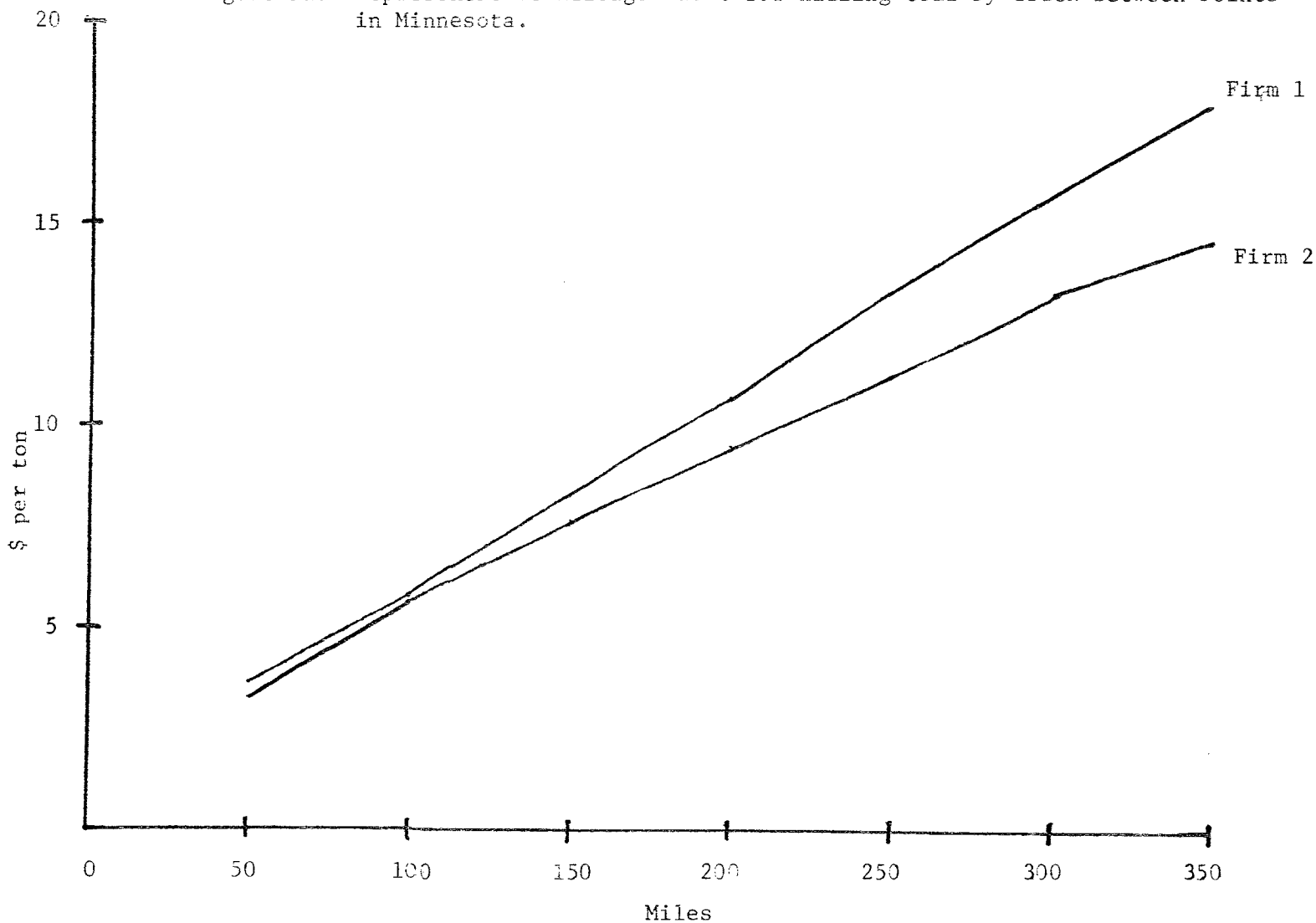
Trucking companies or carriers are essentially operating in all areas of Minnesota. However, unless a significant amount of business in hauling coal is or will be available, most of the larger carriers will not have a specific rate or tariff filed. Filing such a tariff with the Public Service Commission and Department of Transportation is required before any shipment of a commodity can be accepted.[1/]

[1/] Except in a "local cartage zone" (as designated by the Public Service Commission) such as in the Twin City area.

The larger carriers generally feel that the expense involved in drawing up and filing a tariff is not worth the profit from an occasional load of coal. However, many smaller carriers have a rate for coal even though no consistent business exists because they feel that even though the business is infrequent, it will in many instances furnish a "backhaul" that pays for the gas on the return trip. (A backhaul is a load of some commodity from the original destination point back to the origin of the first shipment.)

The different types of trucking rates are classed as either distance, point-to-point, or contract. Mileage or distance rates are rates that usually apply to a specific commodity, involve a minimum shipment weight, and list a specific charge per 100 pounds or 2000 pounds according to distance traveled. Many larger carriers who serve a large area throughout Minnesota have rates such as this type (see Figure 11). Point-to-point rates are similar except that the origin and destination of shipment is specified. Small carriers use this type of rate for backhauls (see Table 11). Also, contract rates are usually set up between specific origins and destinations. These contract rates usually specify the shipper and contractor and terms of the agreement such as yearly shipment size, loading and unloading specifications, etc. Large, consistent users of coal such as Northern States Power usually have rates such as these. D. E. Carter Co. of Cloquet, Minnesota is under contract with the following companies: Conweb Corp., Cloquet; Cutler-Magner, Duluth; Northwest Paper Co., Cloquet; Diamond National Corp., Cloquet; C. Reiss Coal Co., Shebaygan, Wisconsin; Great Lakes Coal and Dock Co., St. Paul;

Figure 11. Representative Mileage Rates for Hauling Coal by Truck Between Points in Minnesota.



Source: Minnesota Public Service Commission truck tariffs [1, 15].

TABLE 11. Point to Point Truck Rates for Hauling Coal

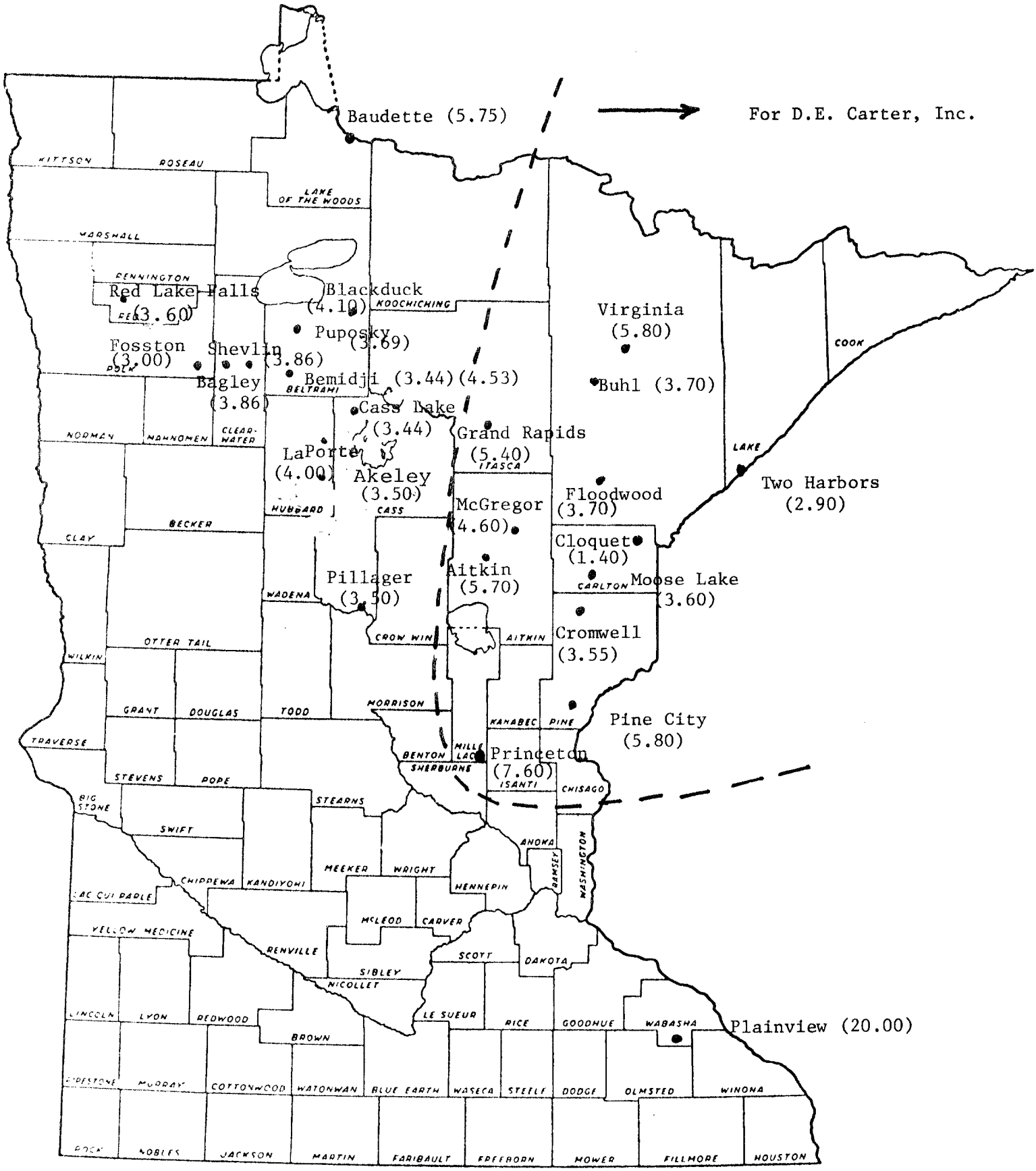
Carrier	From	To	Rate ($/ton)	Minimum Spmt. Weight (lbs.)
Scandia Express	Twin Cities	Elk River	1.85	42,000
Niskanen Transfer or C.D. Haugen, Inc.	Duluth	Ah Gawh Ching (Walker)	5.95	40,000
		Bagley	6.10	40,000
		Bemidji State College	5.53	40,000

Source: Agency Tariff 4-C, MN. P.S.C. No. 9 [1].

and Hallett Dock Co., Duluth. Carter operates in the Duluth/ Superior area which is a large coal distribution site. Figure 12 shows some of their rates as well as others throughout the state.

Many contract rates are not public knowledge since they apply to the local cartage zone of the Twin City area. Most of these rates are on an hourly basis since the distances involved are so short. These rates only apply when both the origin and destination points are in the designated local cartage zone. However, much of the coal that comes into the Twin Cities by train from the West and by barge from the South is dumped in local coal distribution yards and they delivered by truck to various points in the local cartage zone. Because of this, there is a large volume of truck-delivered coal, especially in the Twin Cities, for which rates are not publicly available.

FIGURE 12. Truck Rates from Duluth to Points in MN for a Group of Carriers ($ per ton).



Source: Agency Tariff 4-C. MN. P.S.C. No. 9 and Freight Tariff No. 7,

SUMMARY

Minnesota's future dependence on coal as one of its primary energy sources stresses the importance of examining the existing system for transporting coal from supply centers in the West and East to demand points in and beyond Minnesota. By analyzing these various modes of transportation and their corresponding rate structures, it is possible to examine efficiency implications of providing various Minnesota locations with coal transported by some specific means.

Most of the coal that Minnesota uses comes from Montana by rail. The eastern coal delivered to Minnesota arrives primarily by barge up the Mississippi River or tanker via Lake Superior. In addition, some lignite is transported by rail from North Dakota to sites in northwestern Minnesota. Burlington Northern handles most of the coal transported to and through Minnesota by rail. The rates they charge can be classified as either single car, multiple car, or unit train rates depending on factors such as loading and unloading time, minimum annual volume, and number of cars received in a shipment. There are definite cost advantages of unit train rates over single car rates (i.e. approximately one-half the cost). However, the capital costs involved in providing an unloading facility for unit trains are significantly larger. Barge rates for hauling coal depend on such factors as whether a north-bound or south-bound shipment is involved, the possibility of a back-haul, and distance. Because of the distances involved

it would probably be less expensive to ship Western coal by rail directly to Minnesota via a northern route through North Dakota and Minnesota than to ship by a rail/barge combination via a southern route with the coal being transferred to barge at St. Louis or Iowa terminals.

Once the coal arrives at Minnesota distribution sites, it is often necessary to transport it to its final destination by truck. This mode of transportation is more flexible than either barge or rail, but is also more costly.

A comparison of ton mile rates for transporting coal by the various modes is given in Table 12. There is a wide variation in the rates within each mode due to factors such as the annual volume between points, whether a backhaul is available and whether special equipment or services are required. Furthermore, the final decision on which mode or modes to use must include consideration of whether additional costs will be incurred for such things as transfers between modes, storage yards, and handling equipment.

TABLE 12

Range of Representative Rates for Transporting Coal by Various Modes of Transportation

Mode of Transportation	Rate/Ton-Mile (¢)
Railroad	0.64 - 2.99
Barge	0.39 - 1.25
Truck	1.57 -10.36

APPENDIX

THE UNIT TRAIN CONCEPT

Unit Trains

The most efficient method of moving bulk commodities such as coal, ores, and grains by rail is by unit train. The unit train in its purest sense is a dedicated set of locomotives and cars that remain together in a continuous cycle from origin to destination and back again. Such a unit train virtually only "slows down" for loading and unloading and stops only for fueling, crew changes and inspections. High speed loading and unloading facilities are required. Uncoupling and coupling of cars is unnecessary and "free time"[1/] for loading and unloading is four hours or less at both origin and destination for trains of 100 or more cars. Operations are scheduled so that the unit trains avoid terminals or pass directly through. Classification switching enroute is unnecessary because all cars have a common origin and destination.

Substantial cost savings are possible to the railroad and subsequently to the shipper because unit trains have very high equipment utilization rates compared to normal freight service. The rail cars are always fully loaded or on the way back for another load. Locomotive requirements are known and vary only with the terrain as trainload weights are the same on each trip. Paperwork and administrative costs are greatly reduced. For example, trainloads move on a single bill of lading instead of a bill of lading for each car or group of cars. Freight bills are collected from a single shipper rather than from up to 100 shippers on a general freight train. Labor and other costs of

[1/] Free time is the time allowed before demurrage changes are incurred.

switching, yard and terminal operations are avoided.

In order to take advantage of the unit train concept, a substantial investment is required by the shipping parties. In the case of coal, this includes a facility that can load 10,000 to 11,000 tons of coal in 4 hours, or at a rate of a 100 ton car every 3 minutes. Since existing unit train tariffs typically require only 4 hours notice from the railroad that a train will be arriving for loading, a ready storage area that will hold 10-11,000 tons of coal is also required. Typically, loading is accomplished by pulling the train under an overhead bin or tipple. The train crew brings the empty train under the tipple and spots the first car for loading. A pacesetter device in the lead locomotive is then activated by the engineer. A uniform train speed is maintained as the cars are top loaded as they are pulled under the tipple. Some facilities can load at the rate of 4000 tons per hour or one car every two minutes.

A substantial investment in equipment is also required at the receiving location in order to unload the 10,000 tons of coal in 4 hours. Facilities required include a loop or parallel track of sufficient length to hold the entire 100 car, 6000 ft. long unit train off the main railroad line without having to break the train or uncouple any cars as they are being unloaded. Also required is a rotary car dumper and related coal handling and conveying equipment that can handle the 10,000 tons of coal in 4 hours.

The rotary car dumper empties the cars by turning them 150 degrees so that the coal drops into a pit below where it is conveyed to a storage area. Rotary couplings on each car allow

this to occur without any cars being disconnected during unloading. The train road crew typically spots the first three cars when the train arrives at the rotary dump. After the first three cars, control of the trains' progress through the dumper is turned over to automated equipment and the entire train is pulled through the dumper house, one car-length at a time, each car being locked into position and turned upside down. Each car can be dumped in less than two minutes and the coal removed from the dumper pit by conveyer.

As might be expected capital costs of these specialized facilities are high. A rotary dumper alone costs $1.5 million. The minimum cost of a facility that can handle unit coal trains is probably $8 million with a $12 to $15 million cost being more likely if the flexibility of storing, handling and transloading various types of coal are to be included.

There are some additional costs along with the savings available from unit trains. Because of the constant utilization and heavy loads, railcars require heavier running gears and/or more maintenance than general service cars. Heavily loaded unit trains require good roadbeds and heavy rails but still probably require more track and roadbed maintenance than the more lightly loaded general freights trains.

All 500-mile and daily inspections and servicing of cars and locomotives are performed on completely coupled trains. Ideally the train is only uncoupled for monthly locomotive inspections and maintenance.

A 100 car unit train can carry an annual volume equal to 3,500,000 tons divided by the number of days required for a round trip. For example, if the round trip takes one week or 7 days one train set can carry 500,000 tons per year. If the round trip takes 10 days the annual volume per 100 car train set is 350,000 while a 100 car train set with a 3.5 day round trip can carry 1,000,000 tons per year.

Other High Volume Movements

Many coal users do not consume a sufficient volume of coal to justify a true unit or cycle train with its dedicated equipment and high capital requirements for loading and unloading equipment. However, many of the savings possible under the pure unit train concept can be obtained by "volume train" arrangements. For instance, train load shipments may be made directly from the origin mine to destination, bypassing all switching. Western mines virtually all have fast pull through loading facilities so that the uncoupling of cars is not necessary at the origin so origin free time is minimized.

Volume trains can consist of dedicated equipment if there is sufficient volume to make several successive trips between the origin and destination, or the equipment can be obtained each time for lower volume movements. The higher administrative and operating costs associated with the latter are reflected in higher tariffs for lower volume movements. However, some uncoupling and switching may be necessary at a destination

terminal without a loop track and rotary dumping equipment. In this case equipment utilization declines because of the increase in required "free time" typically from 4 hours to 24 hours but utilization is still much better than possible with single car movements. In addition, the paper work, switching, yard and terminal cost savings are retained.

It should be noted that the latter costs can frequently be reduced and equipment utilization improved by assigning a train to a series of volume movements between different origin and destinations.

Summary

A unit train does not have to consist of any fixed number of cars. The important consideration is the dedication of equipment to continuous movement between an origin and destination so that switching and classification can be avoided and equipment utilization can be maximized.

Similarly, a train does not have to be dedicated to year round use between only two points. Equipment can be dedicated and used as a volume train and obtain many of the cost savings through direct trainload movements between one or more mines and several destinations.

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