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RAIL TRANSPORTATION REQUIREMENTS FOR COAL MOVEMENT IN 1980

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FINAL REPORT

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16. Abstract
This rail-oriented coal transportation study is one of a series conducted by the Department of Transportation to identify and quantify transportation requirements for energy materials. Information provided by these studies will be used by government and industry to examine and shape present and future transportation policies and related resource allocation decisions.

The primary objectives of this study are to develop and present rail industry estimates of the amount of coal that will move by rail in 1980, the additional equipment and facilities required to handle the increased traffic, and the associated lead times involved. Other key report objectives are to describe present coal flows, associated operational policies and practices, and the interfaces with connecting or continuing modes of transportation. When possible 1974-1980 comparisons for these factors are made to illustrate the magnitude and direction of expected changes in levels of operations, distribution patterns, etc.

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PREFACE

This rail-oriented coal transportation study is one of a series of studies conducted by the Department of Transportation to identify and quantify transportation requirements for energy materials. Information provided by these studies will be used by government and industry to examine and shape present and future transportation policies and related resource allocation decisions.

This report documents key findings of Input Output Computer Services, Inc. (IOCS) under Contract DOT-TSC-1000 to the U.S. Department of Transportation, Office of Transportation Energy Policy and Transportation Systems Center.

In an undertaking that involved so many organizations and complex issues, the debts of the authors to others are quite extensive. Much help was derived from the published and nonpublished reports of others in the energy and transportation fields. We are indebted to the following organizations for providing valuable assistance in collecting and analyzing data and reviewing the report material. Without their help, this study could not have been successfully completed.

Association of American Railroads
Burlington Northern, Inc.
Illinois Central Gulf Railroad
National Coal Association
Norfolk and Western Railroad
Southern Freight Association
Traffic Executive Association - Eastern Railroad
Western Railroad Association

PREFACE (continued)

The officials within the rail industry and its associations not only provided valuable insight into complex issues but also freely gave their precious time and help in reviewing and analyzing various parts of the study. In this connection, we would like to thank Mr. Joe Feeney, Mr. Jim Walker, Mr. A. S. Lang, Mr. Gerald J. Robinson, Dr. Leland S. Case, Mr. A. F. Hohmann, Mr. D. Tolmie, Mr. J. Hertog, Mr. C. D. Leddon and Mr. Bates B. Bowers.

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Much inspiration and knowledge has come from Dr. David L. Anderson, Chief, Industry and Policy Analysis Branch, Transportation Systems Center and Technical Monitor for the project. He provided continuous advice and guidance to the project. Without the environment that he created, this project would not have been completed.

Finally, the authors wish to express their gratitude to the many others whose considerable effort helped to bring this project to a successful conclusion.

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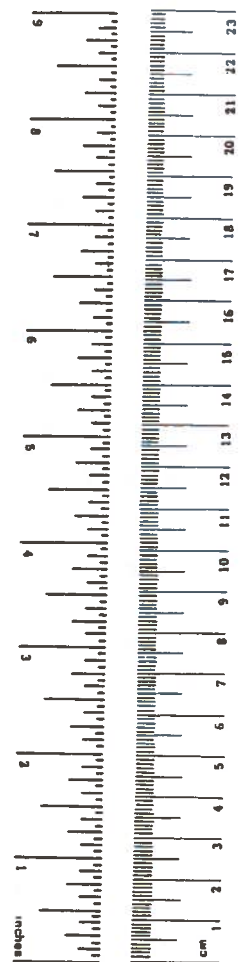
METRIC CONVERSION FACTORS

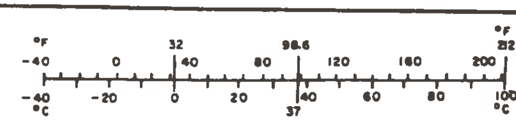
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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EXECUTIVE SUMMARY

Introduction

Under Project Independence[1], the U. S. government set a goal of self-sufficiency in energy by 1985. Due to its abundant supplies, higher oil prices and uncertainty associated with nuclear energy, a dramatic increase in the use of coal is expected.

This rail-oriented coal transportation study is one of a series of studies conducted by the U. S. Department of Transportation, Office of Transportation Energy Policy to identify and quantify transportation requirements for future energy materials movements. Information provided by these studies will be used by government and industry to examine and shape the present and future transportation policies and related resource allocation decisions.

Study Purpose and Objectives

The primary objectives of this study are to develop and present rail industry estimates of the amount of coal that will move by rail in 1980, and the additional equipment and facilities required to handle the increased traffic. Other key report objectives are to describe the present coal flows, associated operational policies and practices, and the interfaces with connecting or continuing modes of transportation. When possible, 1974-1980 comparisons for these factors are made to illustrate the magnitude and direction of the expected changes in levels of operations, distribution patterns, and equipment fleets among others.

1. Project Independence has been renamed National Energy Outlook, and the national goal under the newly named project is to reduce the national vulnerability to foreign energy supplies.

Further report objectives are to obtain and report rail industry comments as to the validity of certain transportation-related Project Independence assumptions[1], and the efficiencies that could result from the application of new technology or changes to regulatory legislation.

Study Approach

The study approach was to survey major coal carrying railroads through respective regional railroad associations to estimate 1980 rail coal traffic and equipment and plant requirements to handle this traffic.

Revenues earned from transporting coal are vital to the economic health of the rail industry. To protect and expand these revenues, rail carriers must compete against other rail carriers within the same or different districts, other modes of transportation, and other energy sources.

To maintain and improve the competitive position of coal against other energy materials, the rail carriers must also cooperate and work with the same competitors identified above. However, fierce competition still exists in this area as various "teams"[2] often contend for the same tonnage.

Recognizing the sensitive nature of the information requested and the need to maintain the confidentiality of data submitted, the study approach called for contacting major coal carriers through their affiliations in the Western, Southern, or Eastern Railroad Associations. The Western, Southern and Eastern

1. Used in the first Project Independence Report, Federal Energy Administration, November, 1974.
2. Teams of railroads and coal producers.

Railroad Associations have as members the railroads that operate in the respective districts. The railroads which operate over a wide geographic area generally belong to more than one regional association. The geographic boundaries for these districts are shown in Figure 1. When contacted, the regional associations agreed to distribute, collect, consolidate, and clarify member line responses to a contractor-prepared questionnaire. Further, regional co-ordinating committees were formed to facilitate in information exchange and the preparation of operational descriptions. In addition, the BN, L&N and N&W co-operated and worked with the contractor to prepare descriptions of coal operations, flows, etc.

In order to better understand the type, capacity, and cost of rail equipment, questionnaires were prepared and interviews were held with car and locomotive manufacturers. To gain insight into energy policies and related issues, the contractor met with the Fossil Energy Division, Federal Energy Administration and National Coal Association officials and major coal producers and consumers.

Study Findings

The findings of this report reflect the best judgment of the authors after extensive survey and interviews of officials within the railroad industry. However, it should be noted that the political, economic, social and technological factors bearing upon the long term U. S. energy outlook are subject to substantial change with the passage of time. Thus, future development will definitely provide additional insight into these findings.

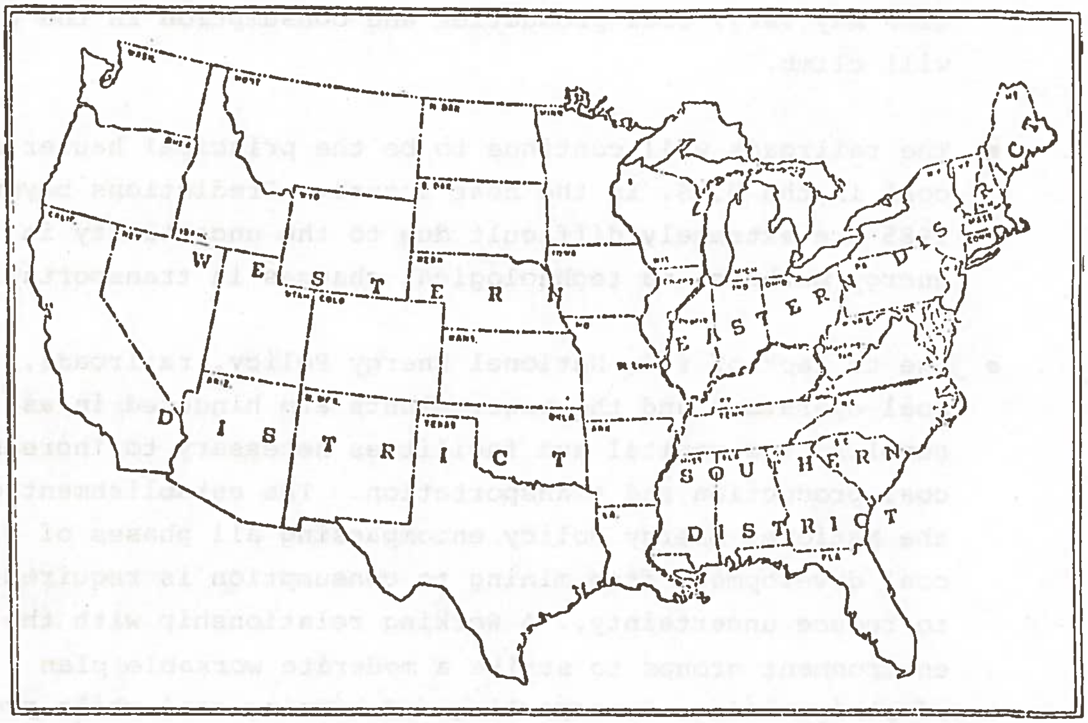


Figure S.1. ICC Defined U. S. Railroad Districts

- The nation's domestic coal resources are abundant. Due to political uncertainties in oil prices and supplies and lack of public acceptance of nuclear power plants, coal consumption is expected to grow steadily at least in the short term. Though forecasts for future coal consumption may vary, coal production and consumption in the U. S. will climb.

- The railroads will continue to be the principal hauler of coal in the U. S. in the near future. Predictions beyond 1985 are extremely difficult due to the uncertainty in energy markets and technological changes in transportation.

- Due to lack of firm National Energy Policy, railroads, coal operators and the power plants are hindered in assembling the capital and facilities necessary to increase coal production and transportation. The establishment of the National Energy Policy encompassing all phases of coal development from mining to consumption is required to reduce uncertainty. A working relationship with the environment groups to strike a moderate workable plan of strip mining, transporting and burning coal while providing maximum protection of the environment should be developed. The above groups will be helped by firmer assurances to burn coal for the next several years.

- The majority of railroads have adopted planning processes to project future coal and other traffic to identify capacity requirements to handle projected traffic. Anticipating the increased coal traffic railroads have developed plans for increasing their coal carrying capacity. These plans include improving and/or adding to their fixed plant, increasing car and locomotive fleets and providing more efficient and reliable service.

- The participating railroads project to originate some 724 million tons of coal in 1980 as compared to over 371 million tons in 1974. To get ready for this increase in coal traffic volumes, in the next five years railroads are considering the investment of over $1.5 billion for improving tracks, signalling and facilities used for coal movements. During the same time period, the railroads identified requirements for approximately 103,000 100-ton equivalent cars and 1,900 3000-hp equivalent locomotives in coal service. The acquisition of this added fleet is estimated to cost railroads some $3.6 billion. In addition railroads in Western and Southern Districts estimate 22,000 100-ton equivalent cars in shippers' coal car fleet in 1980. The existing equipment maintenance facilities will be expanded and few new facilities will be built.

- The most dramatic increase in rail coal traffic is expected to be in the Western District. The participating roads in the Western District expect to increase their originating coal traffic by 323 percent, from 66 million tons in 1974 to about 279 million tons in 1980. Their investment requirements call for 29,000 new 100-ton equivalent cars, 1,500 3000-hp locomotives and over a billion dollars in the fixed plant used for coal movement.

- The railroads in the Southern District expect to increase their originating coal traffic by about 43 percent by 1980. Their requirements to accommodate this increase include 19,000 100-ton equivalent cars, 200 3000-hp equivalent locomotives and over $241 million in improving the fixed plant used for coal movements.

- The railroads in the Northeast face additional uncertainties with restructure of over one half of the rail systems in that area. This situation is affecting adversely not only the bankrupt roads but also solvent roads in the east. The participating roads project 48 percent increase in coal originating traffic from 195 million tons in 1974 to 288 million tons in 1980. By 1980, they will require some 54,000 100-ton equivalent cars and 200 3000-hp equivalent locomotives and some $182 million in fixed plant used for coal movement.

- Although coal is the principal commodity handled by the railroads, it only accounted for 17 percent of ton miles in 1975. As such, coal traffic does not constitute a dominant portion of the total rail traffic. The anticipated coal traffic increases, even though affecting individual railroads unevenly, would not place unmanageable strain on rail capacity.

- The anticipated increase in coal traffic promises to be a large financial help to a number of railroads. Assuming a reasonable rate structure, revenues from this traffic will provide necessary economic justifications for investment to improve line capacity, operating conditions and car supply. These developments should result in a better railroad physical plant thus making movements of other commodities more efficient.

- Uncertainties in government policies in regards to energy, environment, other competing modes of transportation may impair the railroads ability to raise capital to finance the above mentioned requirements.

Rail And Coal Industry

Historically, the rail and coal industries are heavily interdependent. Railroads haul more coal than any other mode of transportation and coal is the largest single commodity moving by rail.

The nation's railroads haul a major share of coal produced. In 1974, the nation produced 601 million tons of coal; of this total, railroads originated over 387 million tons and generated approximately $1.8 billion in revenue.

Rail Coal Traffic Planning Process

The planning processes need to develop future coal traffic forecasts and related capacity varies from railroad to railroad. The level of sophistication also differs from strictly manual process to sophisticated computer simulation techniques. During the interviews conducted under the study, railroad officials discussed this process in detail. In general these processes follow the pattern described below.

Coal traffic forecasts are performed by railroad coal traffic and marketing personnel. The effort usually involves an extensive survey of major coal consumers, brokers and transloader facility operators. The information gathered includes coal demand and type and points of consumption and production. Some railroads put more emphasis on information obtained from coal producers rather than that from consumers. In this case a review is conducted with the cooperation of mining companies whose facilities are served by railroads. Present and planned production estimates are developed for each mine on the basis of proven resources, proposals for future deliveries, existing production contracts and estimated long term production based on the geology of the mines. From all these information gathering processes, the railroads find out about how much coal will be mined in their territory, when and where it will be mined and where it will be shipped. Consideration is given to coal consumption in mine mouth plants as well as competition from other modes of transportation in arriving at coal flows.

After coal flows are identified, a determination as to what rail routes this coal will be transported on is made. Routes are determined on the basis of shipper's choices and the cost economics of the move.

These coal traffic forecasts are then converted into trains to be handled based on current and projected operating policies reflecting horsepower per ton and train size taking into account seasonability and the effect of winter and summer operations on train size.

Using the projected trains a simulation is carried out by operating personnel at the level who are responsible for operating the system, followed by analysis and identification of constraints. In this simulation consideration is also given to other commodity traffic.

After identifying coal routes and constraints, a plan for incremental expansion and improvement of the fixed plant is developed. This planning process is complex and uses computer simulations and other techniques. The railroad is segregated into main line segments with each segment being established after consideration of several factors including physical terrain, track condition, traffic characteristics, density of traffic, and others. The computer simulated increased train movements based on expected increases in coal and other traffic. Computer outputs enable the planning personnel to optimize the programming of new rail, reballasting, siding extensions, improved signalling, and double track. At this time alternative solutions are advanced and discussed. Simulated runs are made with proposed changes and outputs are examined until acceptable operations criteria are achieved. Railroads by the above process prepare one year, three year, and five year programs for plant improvement. A ten year program is also developed but is normally prepared at macro level. Long lead time required to open mines and plants help this process smooth out any unforeseen changes in the forecasts.

From the forecasts and coal movements information developed above, an equipment analysis is performed to arrive at cars and locomotive requirements. The equipment maintenance facilities are also examined as to their capability to maintain increased equipment fleet.

Estimated Coal Traffic Volumes, 1980

The participating railroads (Table 1) originated over 370 million tons and including interline received traffic carried over 520 million tons of coal in 1974. The total coal revenue for these roads in 1974 amounted to some $1.5 billion. With respect to U. S. totals these roads accounted for some 88.7 percent of the total coal carried and 84.2 percent of the revenues earned in 1974.

The participating railroads were asked to project 1980 coal movements on the basis of origin and destination states and the type of movement involved. Table 2 presents the consolidated figures by type of traffic. A summary of the originated coal traffic is provided below.

PARTICIPATING RAILROADS

RAILROAD	Participated Through		
	WRA	SRA	ERA
Atchison, Topeka & Santa Fe Railroad	X		
Burlington Northern, Inc.	X		
Baltimore and Ohio Railroad			X
Bessemer and Lake Erie Railroad			X
Denver and Rio Grande Western Railroad	X		
Elgin, Joliet and Eastern Railroad	X		
Chesapeake and Ohio Railroad			X
Chicago and North Western Railroad	X		
Chicago Rock Island and Pacific Railroad	X		
Chicago, Milwaukee, St. Paul and Pacific Railroad	X		
Clinchfield Railroad		X	
Illinois, Central Gulf Railroad		X	
Louisville and Nashville Railroad		X	
Pittsburg and Lake Erie Railroad			X
Penn Central Railroad			X
Norfolk and Western Railroad			X
Moussouri Pacific Railroad	X		
Southern Railroad		X	
Southern Pacific Railroad	X		
Union Pacific Railroad	X		
Western Maryland Railroad			X

Table S.1. Participating Railroads

Year/District	Originating & Terminating On Line (000 tons)	Originating & Delivered to Connection (000 tons)	Received from Connection & Term. on Line (000 tons)	Received from Connection & Del. to Conn. (000 tons)	Total Carried (000 tons)
1980 Projections (1)					
Western	123,200	156,186	76,495	19,668	375,549
Southern	106,184	51,191	25,525	10,876	193,776
Eastern	184,614	103,665	67,178	38,066	393,523
Totals	413,998	311,042	169,198	68,610	962,848
1974 Totals (2)					
Western	38,340	27,460		35,216 (3)	101,016
Southern	59,877	50,163		21,863	131,903
Eastern	112,522	82,105		93,009	287,636
Totals	210,739	159,728		150,088	520,555
Tonnage Increase	203,259	151,314		87,720	442,293
% Increase	96.5	94.7		36.9	85.0

Notes:
1. Figures for participating railroads as consolidated and reported by regional Rail Associations.
2. Source, Coal Traffic Annual, 1975, Participating Railroads Only.
3. Includes received interchange traffic terminated on line or delivered to connection.

Table S.2. Projected Increase in Coal Traffic, Participating Railroads, 1974 - 1980

ORIGINATED COAL TRAFFIC

District	1974 Million Tons	1974 Percent Of Total	1980 Million Tons	1980 Percent Of Total	Percent Increase
Eastern	195	52.6	288	39.8	48
Western	66	17.8	279	38.5	323
Southern	110	29.6	157	21.7	43
Total	371	100.0	724	100.0	95

Railroads surveyed indicated a projected coal originations of over 724 million tons in 1980, some 95 percent increase over 371 million tons in 1974. In 1974, over 52 percent of coal was originated by eastern roads as compared to about 30 percent by southern and 18 percent by western railroads. However, in 1980, the percentage share of total rail coal transportation will shift substantially among these districts. Due to increased coal production in the west, the railroads in the Western District will originate almost as much coal as roads in the Eastern District. In addition to originated coal the railroads also carry coal received from other rail carriers. The total coal traffic including that received from other lines is given below. As can be noted, the trend in total coal traffic is much similar to that for originated coal traffic.

TOTAL COAL COAL TRAFFIC

District	1974 Million Tons	1974 Percent Of Total	1980 Million Tons	1980 Percent Of Total	Percent Increase
Eastern	288	55.3	394	40.9	37
Western	101	19.4	376	39.0	272
Southern	132	25.3	194	20.1	47
Total	521	100.0	964	100.0	85

The most dynamic growth in rail coal traffic is in the Western District. This is due to vast reserves of low sulphur coal and expected dramatic increase in coal production in the Western States. Great Plain Region-States of Montana, Wyoming, and North Dakota - will contribute about 50 percent of the coal mined in the Western States in 1980. Low sulphur coal from this region is expected to be marketed more than 1,000 miles away in the midwestern and south central states. Essentially, the increased use of Western coal is attributable to large producers and consumers being able to enter into long term, high volume contracts for coal that meets low sulphur EPA Regulations.

The participating railroads in the Southern District project originations of over 157 million tons of coal in 1980 as compared to about 110 million tons in 1974. This is an increase of about 47 million tons or some 43 percent over 1974 originated coal. Of the total rail originated coal in the district in 1980, approximately 72 million or 46 percent is expected to be mined in the state of Kentucky. Coal originated on southern lines in the Appalachian and Eastern Interior Fields will flow generally south and southeast. The mines located in the midwestern fields of Illinois, Indiana and Western Kentucky have historically been competitative with each other to the Illinois, Indiana, Iowa, Minnesota, Missouri, and Wisconsin coal receiving markets. This will continue to be true for the future however, the midwestern coal will have to compete with the low sulphur western coal which has already found a market in these states.

The surveyed railroads in the Eastern District will originate an estimated 288 million tons of coal in 1980, an increase of 48 percent over the 195 million tons in 1974. About 77 percent of this coal will be produced in the states of West

Virginia, Pennsylvania, and Kentucky. It is expected to be transported to thirty-six states. However, some 268 million tons or about 93 percent of the originated coal will terminate in only nine states. These are Ohio, Virginia, West Virginia, Pennsylvania, Michigan, Maryland, Indiana, New York and North Carolina. The overseas export coal, one of the major coal movements in the east, is expected to increase steadily over the next few years.

To check the reasonableness of rail coal traffic projections an independent survey of the responsible state agencies in the coal producing states was performed. Table 3 presents survey results of coal production in 1980 by states along with expected rail share of total state markets. A quick examination of the table reveals a variance between projected coal production as reported by the states and rail originations reported by railroads.

The reported variance partly can be explained by market share of other modes of transportation especially in appalachia and eastern interior states. However, in the west most of the coal in the near future is expected to move by rail. The variance may be also indicative of time lag and/or difference in methods and assumptions involved in coal production estimating processes of states and railroads. Better coordination between transportation companies and responsible state agencies in coal producing states in projecting the future coal production may help reduce this variance. Another reason for the variance is possible duplication in reporting coal traffic by origin and destination. As an example, several carriers in Wyoming say the UP, BN and C&NW may be attempting to develop a future unit train movement to a utility and report the same tonnage individually. Some attempts were made by regional railroad associations to avoid such

State	Rail (1) Originated Tonnage (000's)	State (2) Production (000's)	Rail % of State Production	State	Rail Originated Tonnage (000's)	State Production (000's)	Rail % of State Production
Alabama	13,000	25,000	52.0	New Mexico	918	34,000	2.7
Alaska	--	700	--	North Dakota	3,250	28,700	11.3
Arizona	236	12,000	2.0	Ohio	25,265	63,000	40.1
Arkansas	--	750	--	Oklahoma	525	18,000	2.9
Colorado	20,200	30,000	67.3	Pennsylvania	57,554	(3)	--
Illinois	66,568	73,500	90.6	Tennessee	7,500	9,000	83.3
Indiana	17,925	35,000	51.2	Texas	8,101	25,000	32.4
Iowa	198	900	22.0	Utah	14,248	10,500	135.7
Kentucky	119,816	184,400	65.0	Virginia	54,674	(3)	--
Kansas	--	2,000	--	W. Virginia	116,926	137,500	85.0
Maryland	1,997	2,700	74.0	Wyoming	134,960	96,000	140.6
Missouri	93	5,500	1.7	Others (4)	9,460	--	--
Montana	51,250	42,820	119.7	Total	715,204	836,970	

Notes:
1. Source: IOCS survey of major coal carrying railroads
2. Source: IOCS survey of coal producing states
3. Data not reported by state
4. Others include data for which railroads did not report originating state

Table S.3. Estimated 1980 Coal Production and Rail Originations, U.S.

duplications, however, they were limited by confidentiality of data involved and amount of work needed to analyze each individual move.

Railroads interviewed indicated that their marketing analysis allowed for a portion of coal production to be used in mine mouth utility and gasification plants. This partly explains lower coal rail originations compared to total state productions for some states (e.g. North Dakota).

Coal production is not expected in the states of Idaho and Wisconsin. Data analysis revealed that often coal is shipped to a point and unloaded. Then later on, for any number of reasons, it is reloaded and shipped from that point to some other point.

Estimated Coal Cars In Coal Service, 1980

Usually open top hopper cars are used to ship coal. Whenever high volume permits rotary dumping mechanism to unload the cars, the railroads and shippers tend to use less versatile but inexpensive gondola cars. The participating railroads owned and operated some 88 percent of U. S. open top hopper car fleet in 1974.

Cars required to transport estimated coal traffic volumes were also reported by the participating railroads. The consolidated car requirements are presented in Table 4.

The surveyed railroads and shippers they serve plan to have some 266,000 100-ton equivalent cars in coal service in 1980. Of this total it is estimated that approximately 244,000 100-ton equivalent cars will be supplied by railroads and the rest - 22,000 - will be supplied by shippers. Please note that railroads in the Eastern District did not provide estimates on shippers cars. Railroads and car manufacturers indicated that increasing amounts of coal will probably move in shipper owned cars. This provides shippers not only cost economies in transporting the coal but also assures him availability of cars and flexibility of their use.

The surveyed railroads had about 181,000 100-ton equivalent cars in coal service in 1974. In addition these railroads have ordered and estimated requirements for some 103,000 100-ton equivalent cars through 1980 at an estimated cost of $2.9 billion. During the same period about 40,000 100-ton equivalent cars are expected to retire.

The trend is toward larger cars. Smaller and older cars are continuously being replaced by larger, mostly 100-ton

District	1980 Equipment Projections (1)				1980 Projected Requirements	
	Railroad		Shipper			
	Cars	100-ton Equiv.	Cars	100-ton Equiv.	Cars	100-ton Equiv.
Western	43,499	41,272	19,388	18,644	62,837	59,916
Southern	59,484	50,570	3,613	3,613	63,097	54,183
Eastern	173,674	151,990	(1)	(1)	173,674	151,990
Totals	276,607	243,832	23,001	22,257	299,608	266,089

Note: (1)Not available

Table S.4. Estimated Cars in Coal Service: Participating Railroads, 1980 capacity cars. Respondents also reported that wheel track dynamics and track structure limitations will limit car capacity to one hundred tons.

Car Utilization

Gross measurement of coal car utilization in terms of loads per car per year indicate about 28 percent improvement from 21 loads per car per year for 1974 - to 27 loads per car per year in 1980. Improved loading and unloading practices, increased reliance on unit trains, mechanized yard, computer systems, increased train size and improved cooperation among carriers all bear on the improved car utilization. The car utilization measured in terms of ton-miles per car per year is expected to show further gain as coal movements being developed for the next five years will be predominantly long haul in nature in contrast with the numerous short to medium haul coal movements at the present time. This is particularly true in West as more Western coal finds its market in distant states.

Estimated Locomotives in Coal Service, 1980

Depending upon the type of service and movement horsepower of locomotives used in coal service vary from 1,500 to 3,600 hp. However locomotives with more than 2,000 hp are used most frequently. Locomotives, except for dedicated unit train service, usually are not assigned to hauling any single commodity. Therefore estimated locomotive requirements were provided by the participating railroads. In 1974 the surveyed railroads had about 2,100 3,000-hp equivalent locomotives in coal service. In addition these roads have ordered or estimated requirements for 1,900 3,000-hp equivalent locomotives through 1980 to haul increased coal traffic. The acquisition will cost railroad industry approximately $665 million. During the same period 100 2,000-hp equivalent locomotives will be retired bringing the fleet to 3,900 3,000-hp equivalent locomotives in 1980.

Estimated Physical Plant Improvements, 1980

The continued ability of the rail industry to serve an expanding coal market rests upon the existance of a total national rail network. This ability is continuously being argumented by physical plant improvement programs initiated by railroads in anticipation of the future coal market. The investments required to support 1980 level of coal traffic were reported by participating railroads and are presented in Table 5.

The surveyed railroads have plans to invest over $1.5 billion in improving their physical plant[1]. The railroads in the Western District alone plan to invest over $1 billion, upgrading the capacity of light density lines in the areas of new coal production. Increases in coal traffic in Southern and Eastern Districts predominantly come from areas already under production and hence the railroads in these areas will require relatively less investment in the physical plant. Due to rehabilitation of railroads in the Northeast planned by Conrail, it was difficult to isolate investment due to coal movements from total investments.

Estimated Equipment Maintenance Facilities, 1980

Maintenance facilities for cars and locomotives generally are not dedicated to a given type of equipment or commodity.

1. Does not include Conrail funding potential. The impact on eastern roads due to this will be substantial.

Category	Southern District		Western District		Eastern District(5)		Total	
	Miles	1975 Dollars (000's)	Miles	1975 Dollars (000's)	Miles	1975 Dollars (000's)	Miles	1975 Dollars (000's)
Rail Relay	1,415	63,373	3,513	312,085	1,185	83,743	6,113	459,201
Signalling	648	29,000	1,449	88,834	52	1,766	2,149	119,600
Ballasting	3,155	5,164	9,868	25,602	7,255	8,865	20,278	39,631
New Lines (2)	93	81,200	469	283,958	34	36,800	596	400,958
Supplemental Lines (3)	88	45,000	52	183,520	13	5,600	153	234,120
Yard Facilities	30	612	76	49,142	15	25,800	121	75,554
Plow and Sledding	50	2,500	-	-	-	-	50	2,500
Communication	300	500	-	-	-	-	300	500
Other	-	14,000	520	192,191	36	19,600	556	225,791
Total	5,779	241,789	15,887	1,135,332	8,590	182,174	30,256	1,559,295

Notes:
1. Includes totals for surveyed railroads in each district.
2. Includes mine spurs and industrial plant spurs.
3. Includes double track, sidings, etc.
4. As some railroads did not consistently report both miles and dollars for each category, average cost per mile cannot be developed from above totals.
5. Due to rehabilitation of railroads in the Northeast planned by Conrail, it was difficult to isolate the investment due to coal movements from the total investment.

Table S.5. Projected Physical Plant Improvements, All Districts

This makes it difficult to estimate the added investment requirements necessary for these facilities due to the increased coal traffic.

The majority of the survey respondents indicated that the existing facilities will have to be expanded to accommodate increased cars and locomotive fleets. Some railroads did isolate and report investment requirements as a result of the anticipated coal traffic increase. These investment requirements are summarized below. The investment potential of Northeastern railroads has improved due to formation of Conrail and its impact will be substantial.

	Maintenance Facilities For:			
District	Cars (000s)	Locomotives (000s)	Cars and Locomotives (000s)	Total (000s)
Western	$19,907	$22,000	$59,755	$101,662
Southern	30	700	--	730
Eastern	--	--	--	--
Total	$19,937	$22,700	$59,755	$102,392

The reported increase in car fleet in coal service for Eastern railroads is not substantial, especially when compared with the total car fleet. The roads indicated that a nominal increase in service facilities will be required due to increase in coal traffic. The additional services will be generally provided through expanding the existing facilities. The railroads did not report any dollar investment for this purpose.

Technological Changes

Survey respondents found it difficult to forecast the innovations and developments which would have substantial impact on coal movements. However, during the survey and interviews conducted under the study, the trends in certain aspects of coal movements seem fairly definite. Emphasis seems to be more on adaptation of existing technologies than on new developments. Some of the survey comments are summarized below.

Coal Cars

Hopper and gondola cars will continue to be used in coal service. The trend in shipper-owned coal cars will be towards gondola cars. Because of the wheel track dynamics and road bed structural considerations, 100 net tons will be the maximum capacity for cars in the foreseeable future. Use of aluminum cars due to its lighter tare weight and hence increase in net payload may also increase.

For unloading services on coal cars, continued use of rotary-dump and some increase in the use of guide discharge bottom dump is forecasted. One major car producer estimates that 85 percent of new cars will have rotary dumpers while 15 percent will use bottom dump methods. The design of present rapid discharge systems make the tare wieght of the car too high and hence render it less suitable for long haul moves. Development of lightweight rapid discharge mechanisms is expected to continue. Future hopper cars will use rapid discharge systems utilizing air and mechanically operated remote controlled devices.

Adoption of improved distribution methods and automated data processing systems has enabled railroads to increase car utilization. The unit train cars may travel approximately as much as ten times as far in one year as cars previously did. This will have adverse effects on car life. The increased utilization will have little effect on car body and it should extend body calendar life to a point that running gear life will be the critical parameter. It will create the need for more parts such as wheels, side frames, bolsters, and center plates. This has required changes in car design and maintenance practices. Though the methods and frequency vary from railroad to railroad, preventive maintenance on unit train cars is routinely performed.

Locomotives

Unit horsepower for locomotives in coal service vary from 1,800-hp to 3,600-hp. However, 2,000 - 3,000-hp locomotives are most commonly used with the trend towards 3,000-hp. Coal trains normally require high tractive effort more than horsepower. No great increase in unit horsepower, but an increase in adhesion, is expected in the foreseeable future for locomotive technology. Individual wheel slip control realization of a 20 to 30 percent increase in adhesion would result in a large increase in capacity of the present fleet and reduction of total fleet requirements for locomotives.

Signalling

Railroads will continue to improve signalling systems by adopting centralized control systems for high-density rail corridors. This will have an effect of increasing rail carrying capacity substantially. A computerized train dispatching for high-density corridors will be adopted. Bypass tracks and CTC will be added to single track to improve carrying capacity of light-density lines.

Loading/Unloading Facilities

Adoption of fast loading and unloading facilities by coal producers and consumers would lead to significant increases in rail carrying capacity. According to one western railroad, it is the single most important advance that can contribute the most to rail carrying capacity in their region. Railroad officials also indicated that their customers have begun to realize the importance of fast loading and unloading facilities, and more such facilities will be built in the near future.

Effect on Other Commodities

Although coal is the principal commodity handled by the railroads, it only accounted for some 17 percent of ton-miles in 1975. As such, coal traffic does not constitute a dominant portion of the total traffic. The anticipated coal traffic increases, even though affecting individual railroads unevenly, would not place unmanageable strain on rail capacity.

During the survey and interviews conducted under the study, generally it was found that the majority of the railroads are planning for projected total traffic, including anticipated increases in other commodities, on their system. All of them indicated that they would be able to absorb the anticipated coal traffic without any adverse effect on movement of other commodities. A discussion on railroads planning processes for line capacity is provided in subsequent chapters. The anticipated increase in coal traffic promises to be a large financial help to a number of railroads. Assuming reasonable rate structure, revenues from this traffic will provide economic justification for necessary investments to improve line capacity, operating conditions, and car supply. These developments should result in a better railroad physical plant. Thus the increased coal traffic should help rather than hinder the movements of other commodities.

High volume bulk commodities like coal serve as a solid base on which most successful railroads build. Some railroads indicated that if this base is lost to other modes of transportation, the railroads will be left with other commodity traffic and a charter to serve all shippers without the benefit of economy of scale. This will have a debilitating effect on their financial and operating health.

Regulatory changes/Transportation policies

Reportedly, some $3.3 billion or 22.6 percent of rail revenue, was required in 1973 for railroads to own, maintain, and pay taxes on their private right of way. By contrast in the same year class I intercity motor carriers required some 4.4 percent of their revenue dollars for their use of public highways; and barge line operators pay no charges for using public waterways developed at a cost of some $5.5 billion.

Given the above, most respondents focused on the need to correct the imbalance that exists between the regulatory treatment of railroads as compared to other modes of transportation. Generally, two basic approaches for even handed government treatment of various modes were suggested. The first was to recover from users a fair and proportionate share of costs associated with building, maintaining, and improving highways and waterways. The second was to have the Federal Government assume a corresponding portion of rail industry costs for providing and maintaining tracks and other fixed facilities.

Railroad Revitalization and Regulatory Act of 1976 has called for significant regulatory changes to improve the operations and structure and restore the financial stability of the railway system of the United States. Under this law major responsibility has been placed on the Department of Transportation by congress to study past and present policies and methods of providing Federal Aid for construction, improvement, operation, and maintenance of rail transportation facilities and services. The DOT will also examine past and present policies on Federal Aid to various modes of transportation and weather they have disadvantaged the rail carriers and the extent of such disadvantage. The department will conduct studies to determine policies to establish and maintain an open and competetive market in which rail transportation can compete on equal terms with other modes of transportation.

From a purely rate regulatory point of view, proposals that would enable railroads to compete on an equal footing called for freedom for railroads to enter requirements contracts on a percentage as well as a tonnage basis, to enter long-term contracts, and to adjust rates within reasonable limits without prior ICC approval.

Another proposal for correcting the perceived imbalance between modes called for the introduction of a pricing system that would allow railroads' freight rates to adjust to changes in the level of shipper demands. A flexible price approach could reportedly smooth demand, improve the quality of service provided, and generate funds to expand the national car fleet. Other proposals included simplification of Tariff Circular 20 which prescribes formats for publishing rates. Required formats and procedures impede the application of computer technology.

The respondents also indicated that the establishment of National Energy Policy encompassing all phases of coal development from mining to transporting to end user is required to eliminate the uncertainties. The majority also advocated a working relationship with the environmental groups in an attempt to strike a moderate workable plan of strip mining and transporting coal while providing maximum protection of our environment.

Respondents also emphasized the need for amendments to labor agreements to allow a greater distance between crew change points on unit train, terminal runthrough with unit trains, and fewer men per crew where applicable.

1. NATIONAL SUMMARY

1.1 Introduction

Under Project Independence[1], the U. S. government set a goal of self-sufficiency in energy by 1985. Due to its abundant supplies, higher oil prices and uncertainty associated with nuclear energy, a dramatic increase in the use of coal is expected.

This rail-oriented coal transportation study is one of a series of studies conducted by the U. S. Department of Transportation, Office of Transportation Energy Policy to identify and quantify transportation requirements for future energy materials movements. Information provided by these studies will be used by government and industry to examine and shape the present and future transportation policies and related resource allocation decisions.

1.1.1 Study Purpose and Objectives

The primary objectives of this study are to develop and present rail industry estimates of the amount of coal that will move by rail in 1980, and the additional equipment and facilities required to handle the increased traffic. Other key report objectives are to describe the present coal flows, associated operational policies and practices, and the interfaces with connecting or continuing modes of transportation. When possible, 1974 - 1980 comparisons for these factors are made to illustrate the magnitude and direction of the expected changes in levels of operations, distribution patterns, and equipment fleets among others.

1. Project Independence has been renamed National Energy Outlook.

Further report objectives are to obtain and report rail industry comments as to the validity of certain transportation-related Project Independence assumptions[1], and the efficiencies that could result from the application of new technology or changes to regulatory legislation.

1.1.2 Study Approach

The study approach was to survey major coal carrying railroads through respective regional railroad associations to estimate 1980 rail coal traffic and equipment and plant requirements to handle this traffic.

Revenues earned from transporting coal are vital to the economic health of the rail industry. To protect and expand these revenues, rail carriers must compete against other rail carriers within the same or different districts, other modes of transportation, and other energy sources.

To maintain and improve the competitive position of coal against other energy materials, the rail carriers must also cooperate and work with the same competitors identified above. However, fierce competition still exists in this area as various "teams"[2] often contend for the same tonnage.

Recognizing the sensitive nature of the information requested and the need to maintain the confidentiality of data submitted, the study approach called for contacting major coal carriers through their affiliations in the Western, Southern, or Eastern Railroad Associations. The Western, Southern and Eastern Railroad Associations have as members the railroads that operate in the respective districts. The railroads which operate over a wide geographic area generally belong to more than one regional association. The geographic boundaries for these district

1. Used in the first Project Independence Report, Federal Energy Administration, November, 1974.
2. Teams of railroads and coal producers.

are shown in Figure 1.2. When contacted, the regional associations agreed to distribute, collect, consolidate, and clarify member line responses to a contractor-prepared questionnaire. Further, regional coordinating committees were formed to facilitate in information exchange and the preparation of operational descriptions. In addition, the BN, L&N and N&W cooperated and worked with the contractor to prepare descriptions of coal operations, flows, etc.

In order to better understand the type, capacity, and cost of rail equipment, questionnaires were prepared and interviews were held with car and locomotive manufacturers. To gain insight into energy policies and related issues, the contractor met with the Fossil Energy Division, Federal Energy Administration and National Coal Association officials and major coal producers and consumers.

1.2 Importance Of Coal As An Energy Source

To sustain unprecedented prosperity, the U. S., with some six percent of the world's population, used about one third of all global energy produced in 1972. The natural gas shortages and 1973 oil embargo indicated an over-reliance on these energy sources, and a growing dependency on foreign sources for oil.

In 1973, more than 90% of the energy used in the U. S. came from the direct combustion of fossil fuels. When compared to proven domestic reserves for oil and gas, coal reserves are virtually unlimited. Consequently, with respect to other fossil fuels, most forecasters expect the relative percentage of coal used to increase substantially over the next two decades.

The long-term importance of coal as an energy source cannot be determined with any great degree of confidence at this time due to political, economic, and social uncertainties associated with the use, development, and cost of other non-fossil sources of energy.

Coal represents the largest, most accessible reserve of energy available within the continental United States. Identified and hypothetical reserves of coal in the U. S. amount to some 3,224 billion tons. Table 1.1 below shows a breakdown of total U. S. coal resources. Of these total resources, approximately 150 billion tons of recoverable coal exists in formations of comparable thickness and depth to those being mined by present technology. Maximum projected production through 1985 will require less than 10% of this 150 billion tons. Please see Table 1.2. Further exploration and mapping of the nation's coal reserves should substantially add to the reserves mineable by present technology.

Under Project Independence, a comparison of proven reserves of various fossil fuels was made. At current levels (1972) of consumption, it showed that coal reserves would last about 800 years, well beyond the availabilities of other fossil fuels. (See Table 1.3 for comparison.) By contrast, oil and gas reserves are considerably more limited, about ten years of domestic supply.

During the 19th century, coal provided almost all the energy consumed by the nation. However, with the availability of cheaper oil and gas, coal became a secondary source of energy. Also, the implementation of clean air standards during the 1970's has created uncertainties about coal consumption and has resulted in large coal users converting to oil. By 1972, coal accounted for only 17% of the energy consumed by the nation. See Figure 1.1. Under Project Independence, a projection of domestic energy production was made. The results, given in Table 1.4, indicate coal's increased share of total U. S. energy production.

The "energy crisis" has started a flood of in-depth analysis of energy needs for the remainder of the century. Though the forecasts may vary in specific consumption figures, one central theme emerges--that coal production in the U. S. will and must climb by many millions of tons.

	Billion Tons
Mapped and explored (identified) (0-3,000 ft. overburden)	1,581
Unmapped and unexplored (indicated and probable)	
0-3,000 ft. depth	1,306
3,000-6,000 ft. depth	337
Total	3,224

Source: Keystone Coal Industry Manual, 1974

Table 1.1 The Breakdown of U. S. Coal Resources

	Billion Tons
Total remaining coal resources (1) (Identified and hypothetical, overburden 0-6,000 ft.)	3,224
Recoverable coal (1) (2)	150
Requirements maximum production 1985 (1)	15

Notes: 1. USGS.
2. Identified recoverable, 1975 technology, 0-1,000 ft. overburden, 28" thick.

Table 1.2 U. S. Coal Resource Base

Source	Fuel Units	Quadrillion BTU's	Years Left at 1972 Consumption Levels
Coal			
High-sulphur (more than 1%)	273 billion tons	6,908	
Low-sulphur (less than 1%)	160 billion tons	3,838	
Total	433 billion tons	10,746	823
Oil			
Lower 48 (crude)	30 billion barrels	176	
Natural gas	6 billion barrels	37	
Alaska	10 billion barrels	59	
Total	46 billion barrels	272	8
Gas	218 TCF	225	
Lower 48	32 TCF	32	
Total	250 TCF	257	11
Shale	20-170 billion barrels	116-986	3-28
Tar Sands	29 billion barrels	168	28

Table 1.3 Proven Resources

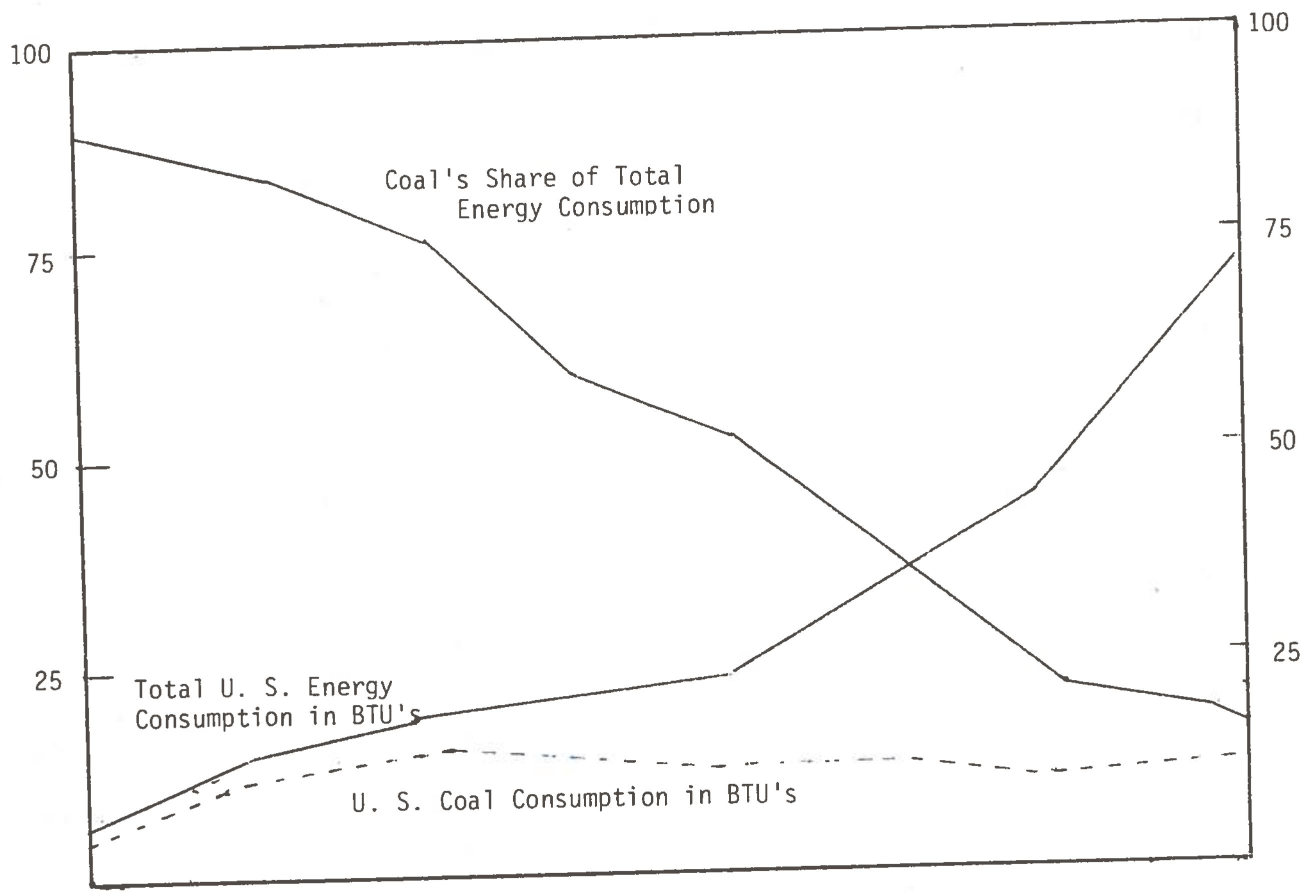


Figure 1.1 Coal's Declining Share of Total United States Energy Consumption

	1972		1985	
	Quadrillion BTU's	%	Quadrillion BTU's	%
Oil	22.4	36.9	31.3	32.5
Gas	22.1	36.5	24.6	25.5
Coal	12.5	20.7	22.9	23.8
Nuclear	0.6	1.0	12.5	12.9
Other	2.9	4.9	5.1	5.3
Total	60.6	100.0	96.4	100.0

Table 1.4 Composition of U. S. Domestic Energy Production, 1985

Table 1.5 tabulates these forecasts for demand of coal made by various organizations.

1.3 Interdependency of Rail and Coal

Historically, the rail and coal industries are heavily interdependent. Railroads haul more coal than any other mode of transportation and coal is the largest single commodity moving on rail.

Due to its bulk, transportation charges are a major cost element in the total cost of coal to consumers. Table 1.6 gives a historic perspective of this relationship. In 1931, rail rates amounted to 59% of the delivered price of coal, but by 1973 they declined to 31% of the FOB destination value. Though the ratio is decreasing. the cost of transporting coal still is an important element in the economics of coal consumption.

The nation's railroads haul a major share of coal produced. In 1974, the nation produced 601 million tons of coal; of this total, railroads originated over 387 million tons and generated approximately $1.8 billion in revenue. As shown below, the railroads originated about 66.2% of the coal produced over the period 1965-1974.

Year	Production of Bituminous Coal & Lignite	Rail Tons Originated Coal & Lignite	Percent of Coal Moved by Rail
1965	512.0	352.6	68.9
1966	533.8	367.5	68.8
1967	552.6	376.7	68.2
1968	545.2	371.7	68.2
1969	560.5	376.3	67.1
1970	602.9	398.8	66.1
1971	552.2	355.0	64.3
1972	595.0	371.1	62.4
1973	591.0	376.0	63.6
1974	601.0	387.7	64.5

Source	Forecast in Millions of Tons			
	1975	1977	1980	1985
1	733	-	856	1075
2	754	-	1134	1708
3	670	-	830	920
4	713	-	845	1001
5	615	-	850	1000
6	-	927	1376	2063
7	-	755	895	1100
8	-	-	-	1260
9	636	-	740	980

Sources:

1. Understanding the Energy Dilemma--Center of Strategic and International Studies for the Atomic Energy Commission
2. Batelle Memorial Institute
3. U. S. Bureau of Mines--L. Westerstorm
4. U. S. Energy Outlook, An Initial Appraisal--1971-1985--National Petroleum Council
5. U. S. Energy: A Summary Review--Department of Interior
6. Project Independence Report: Accelerated Scenario
7. Project Independence Report: Business-As-Usual Scenario
8. U. S. Energy Prospects: An Engineering Viewpoint
9. U. S. Energy Through Year 2000--Department of Interior

Table 1.5 Comparison of Coal Use Forecasts

Year	U.S. Coal Production (Million Tons)	Average Price/Ton FOB Coal Mine	Average Rail Rates Per Ton	Total Price/Ton	% Rail to Mine Value	% of Destination Value	
						Coal	Rail Rates
1931	382.1	$ 1.54	$ 2.22	$ 3.76	144.1	41.0	59.0
1941	514.1	2.19	2.22	4.41	101.4	49.7	50.3
1951	533.7	4.92	3.16	8.08	64.2	60.9	39.1
1961	402.9	4.58	3.40	7.98	74.2	57.4	42.6
1965	512.0	4.44	3.13	7.57	70.5	58.7	41.3
1966	533.8	4.54	3.01	7.55	66.3	60.1	39.9
1967	552.6	4.62	3.00	7.62	64.9	60.6	39.4
1968	545.2	4.67	3.01	7.68	64.5	60.8	39.2
1969	560.5	4.99	3.10	8.09	62.1	61.7	38.3
1970	602.9	6.26	3.41	9.67	54.5	64.7	35.3
1971	552.2	7.07	3.70	10.77	52.3	65.5	34.4
1972	595.0	7.53	3.67	11.20	48.7	67.2	32.8
1973	591.0	8.42	3.79	12.21	45.0	69.0	31.0

Table 1.6 Comparison of FOB Mine Realization and Railroad Rates on Coal--U. S.

As stated, coal transportation is of vital importance to rail carriers. For many years, coal ranked first among all commodities in rail traffic. A significant measure of the importance of coal transportation to railroads is the percentage of total revenue derived from this source. Data for the period 1964-1973 is presented in Table 1.7.

Another measurement of the interrelation of the industries is that in 1973, class I railroads originated 376 million tons of coal, nearly 64% of the total U. S. production, and they received over $1.4 billion in revenue. Other 1973 figures are that coal amounted to nearly 25% of the total tonnage and 10% of the revenue of the railroads, and that rail rates formed 31% of the total delivered cost of coal and 45% of the mine value of coal.

1.4 Survey Responses and Findings

1.4.1 Overview

Railroads are assigned to one of three districts by the ICC on the basis of primary area of operations. The geographic boundaries for these districts are given in Figure 1.2.

The Western, Southern, and Eastern Railroad Associations are formed and supported by the railroads that operate in the respective districts. Railroads that operate over a wide geographic area generally belong to more than one regional association. Table 1.8 identifies major coal carriers and denotes those that participated in the project through their respective association.

Rail carriers participated in the project by completing contractor-furnished questionnaires and by assessing the validity of certain key Project Independence transportation assumptions. In addition, the BN, L&N, and N&W cooperated and worked with the contractor to prepare descriptions of coal operations, flows, etc. These descriptions are presented in Sections 2 through 4 and are considered fairly representative of other railroads operating in their districts.

Year	Bituminous Revenue Freight (2) (000 tons)	Bituminous Freight Revenue (3) ($000,000)	Total Revenue Freight (2) (000 tons)	Total Freight Revenue (3) ($000,000)	% Bituminous Revenue Freight	% Bituminous Freight Revenue
1964	344,970	$ 1,072	1,354,612	$ 8,907	25.5 %	12.0 %
1965	352,597	1,102	1,387,423	9,276	25.4	11.9
1966	367,505	1,105	1,448,900	9,719	25.4	11.4
1967	376,703	1,130	1,407,628	9,530	26.8	11.9
1968	371,653	1,117	1,431,346	10,210	26.0	10.9
1969	376,336	1,171	1,473,457	10,836	25.5	10.8
1970	398,830	1,362	1,484,161	11,366	26.9	12.0
1971	354,954	1,315	1,390,960	12,247	25.5	10.7
1972	371,135	1,362	1,732,349	13,012	25.6	10.5
1973	376,078	1,426	1,532,164	14,335	24.6	10.0

Notes: 1. Includes carload and LOL traffic.
2. Originated, excluding duplications.
3. Total freight traffic, including duplications.

Source: Interstate Commerce Commission and Association of American Railraods Coal Facts, 1973-4

Table 1.7 Bituminous Coal Traffic, a Major Source of Railroad Freight and Revenue

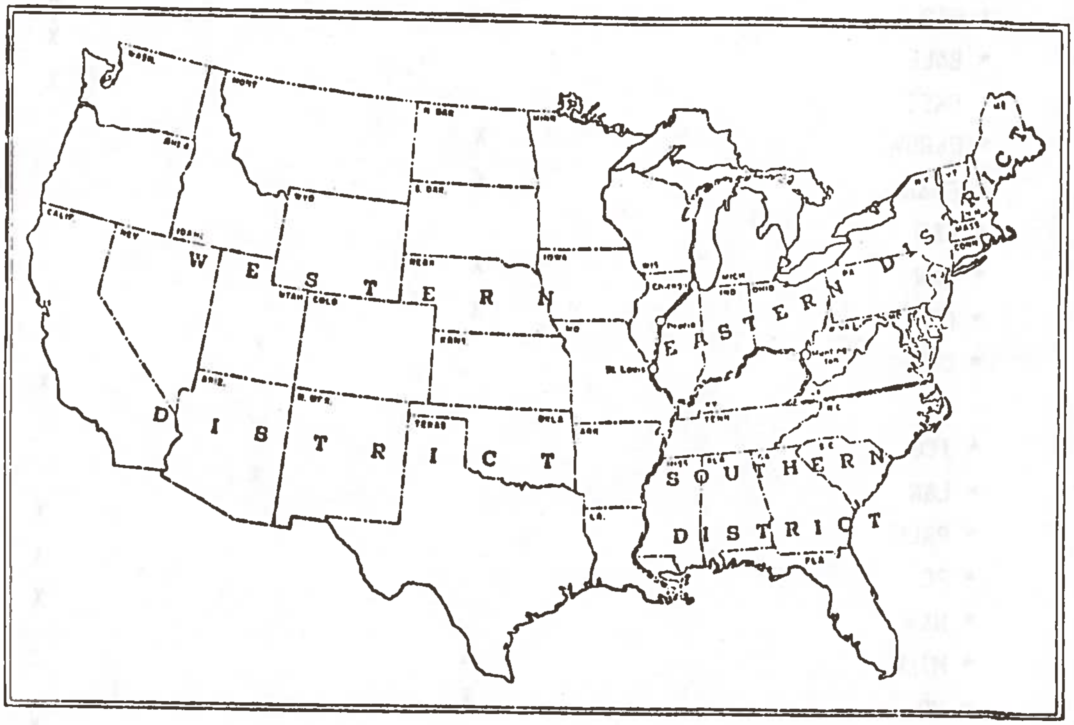


Figure 1.2 ICC Defined U. S. Railroad Districts

Railroad	Regional Association		
	WRA	SRA	ERA
* ATSF	X		
* BN	X		
* B&O			X
* B&LE			X
C&EI			X
* D&RGW	X		
* EJ&E	X		
* C&O			X
* CNW	X		
* CRIP	X		
* CRR		X	
EL			X
* ICG		X	
* L&N		X	
* P&LE			X
* PC			X
* N&W			X
* MILW	X		
* MP	X		
RDG			X
SCL		X	
SLSF	X		
* SOU		X	
* SP	X		
* UP	X		
WM			X

*--participated in study

Table 1.8 Major Coal Carriers

Tables 1.9 and 1.10 that follow present a profile of 1974 rail bituminous coal operations. Consolidated totals are presented in terms of volume of traffic handled, revenues received, and cars furnished by participating railroads within districts. With respect to U. S. totals, the participating railroads accounted for some 88.7 percent of the total coal carried and 84.2 percent of revenues earned in 1974.

In the sections that follow, 1974 profile information is used to help focus changes in expected 1980 levels of operation, distribution patterns, and associated investment requirements.

1.4.2 Estimated Coal Traffic Volumes, 1980

The participating railroads were asked to project 1980 coal movements on the basis of origin and destination states and the type of movement involved. Consolidated traffic projections for these parameters are given in Tables 1.11 and 1.12. When possible, 1974 - 1980 comparisons are made to illustrate the magnitude and direction of expected changes, if any. A summary of the originated coal traffic is provided below.

ORIGINATED COAL TRAFFIC

	1974		1980		
District	Million Tons	Percent Of Total	Million Tons	Percent Of Total	Percent Increase
Eastern	195	52.6	288	39.8	48
Western	66	17.8	279	38.5	323
Southern	110	29.6	157	21.7	43
Total	371	100.0	724	100.0	95

Railroads surveyed indicated a projected coal originations of over 724 million tons in 1980, some 95 percent increase over 371 million tons in 1974. In 1974, over 52 percent of coal was originated by eastern roads as compared to about 30 percent by southern and 18

	000's of Tons				$000's	% Total U. S.	
	Originated and		Total	Total	Revenue	Tons	Rev.
	Terminated on Line	Delivered to Conn.	Originated	Carried	Received		
Western District (1)	38,340	27,460	65,800	101,016	$ 319,663	17.1	17.5
Southern District (2)	59,877	50,163	110,040	131,903	331,863	22.6	18.2
Eastern District (3)	112,522	82,105	194,627	287,636	887,292	49.0	48.5
Totals	210,739	159,728	370,467	520,555	1,538,818	88.7	84.2

Source: Coal Traffic Annual, 1975

Notes:
1. Includes totals for ATSF, BN, C&NW, MILW, D&RG, EJ&E, MP, RI, SP, and UP.
2. Includes totals for CRR, ICG, SCL, and SOU.
3. Includes totals for B&LE, B&O, C&O, P&LE, PC, N&W, and WM.

Table 1.9 Bituminous Coal Handled by Participating Railroads - 1974

District	Cars	Capacity (000 net tons)	100-ton Equiv. Cars	% of Total U. S. Cars	% of Reported 100-ton Equiv.
Western (1)	49,690	3,882	38,820	14.5	16.7
Southern (1)	61,608	4,758	47,580	17.9	20.7
Eastern (1)	185,832	14,492	144,920	54.1	62.6
Sub Total	297,130	23,132	231,320	86.5	100.0
U. S. Totals	343,392	(2)	(2)	100.0	

Notes: 1. Includes totals for participating railroads only.

2. Data not available.

Table 1.10 Profile of Hopper Car Fleet: Participating Railroads, 1974

Year/District	Originating & Terminating On Line (000 tons)	Originating & Delivered to Connection (000 tons)	Received from Connection & Term. on Line (000 tons)	Received from Connection & Del. to Conn. (000 tons)	Total Carried (000 tons)
1980 Projections (1)					
Western	123,200	156,186	76,495	19,668	375,549
Southern	106,184	51,191	25,525	10,876	193,776
Eastern	184,614	103,665	67,178	38,066	393,523
Totals	413,998	311,042	169,198	68,610	962,848
1974 Totals (2)					
Western	38,340	27,460	35,216 (3)		101,016
Southern	59,877	50,163	21,863		131,903
Eastern	112,522	82,105	93,009		287,636
Totals	210,739	159,728	150,088		520,555
Tonnage Increase	203,259	151,314	87,720		442,293
% Increase	96.5	94.7	36.9		85.0

Notes: 1. Figures for participating railroads as consolidated and reported by regional Rail Associations.
2. Source, Coal Traffic Annual, 1975, Participating Railroads Only.
3. Includes received interchange traffic terminated on line or delivered to connection.

Table 1.11 Projected Increase in Coal Traffic, Participating Railroads, 1974 - 1980

State	Rail (1) Originated Tonnage (000's)	State (2) Production (000's)	Rail % of State Production	State	Rail Originated Tonnage (000's)	State Production (000's)	Rail % of State Production
Alabama	13,000	25,000	52.0	New Mexico	918	34,000	2.7
Alaska	--	700	--	North Dakota	3,250	28,700	11.3
Arizona	236	12,000	2.0	Ohio	25,265	63,000	40.1
Arkansas	--	750	--	Oklahoma	525	18,000	2.9
Colorado	20,200	30,000	67.3	Pennsylvania	57,554	(3)	--
Illinois	66,568	73,500	90.6	Tennessee	7,500	9,000	83.3
Indiana	17,925	35,000	51.2	Texas	8,101	25,000	32.4
Iowa	198	900	22.0	Utah	14,248	10,500	135.7
Kentucky	119,816	184,400	65.0	Virginia	54,674	(3)	--
Kansas	--	2,000	--	W. Virginia	116,926	137,500	85.0
Maryland	1,997	2,700	74.0	Wyoming	134,960	96,000	140.6
Missouri	93	5,500	1.7	Others (4)	9,460	--	--
Montana	51,250	42,820	119.7	Total	715,204	836,970	

Notes:
1. Source: IOCS survey of major coal carrying railroads
2. Source: IOCS survey of coal producing states
3. Data not reported by state
4. Others include data for which railroads did not report originating state

Table 1.12. Estimated 1980 Coal Production and Rail Originations, U.S.

percent by western railroads. However, in 1980, the percentage share of total rail coal transportation will shift substantially among these districts. Due to increased coal production in the west, the railroads in the Western District will originate almost as much coal as roads in the Eastern District. In addition to originated coal the railroads also carry coal received from other rail carriers. The total coal traffic including that received from other lines is given below. As can be noted, the trend in total coal traffic is much similar to that for originated coal traffic.

TOTAL COAL TRAFFIC

	1974		1980		
District	Million Tons	Percent Of Total	Million Tons	Percent Of Total	Percent Increase
Eastern	288	55.3	394	40.9	37
Western	101	19.4	376	39.0	272
Southern	132	25.3	194	20.1	47
Total	521	100.0	964	100.0	85

The most dynamic growth in rail coal traffic is in the Western District. This is due to vast reserves of low sulphur coal and expected dramatic increase in coal production in the Western States. Great Plain Region-States of Montana, Wyoming, and North Dakota - will contribute about 50 percent of the coal mined in the Western States in 1980. Low sulphur coal from this region is expected to be marketed more than 1,000 miles away in the midwestern and south central states. Essentially, the increased use of Western coal is attributable to large producers and consumers being able to enter into long term, high volume contracts for coal that meets low sulphur EPA Regulations.

The participating railroads in the Southern District project originations of over 157 million tons of coal in 1980 as compared to about 110 million tons in 1974. This is an increase of about 47 million tons or some 43 percent over 1974 originated coal. Of the total rail originated coal in the district in 1980, approximately 72 million or 46 percent is expected to be mined in the state of Kentucky. Coal originated on southern lines in the Appalachian and Eastern Interior Fields will flow generally south and southeast. The mines located in the midwestern fields of Illinois, Indiana and Western Kentucky have historically been competitative with each other to the Illinois, Indiana, Iowa, Minnesota, Missouri, and Wisconsin coal receiving markets. This will continue to be true for the future however, the midwestern coal will have to compete with the low sulphur western coal which has already found a market in these states.

The surveyed railroads in the Eastern District will originate an estimated 288 million tons of coal in 1980, an increase of 48 percent over the 195 million tons in 1974. About 77 percent of this coal will be produced in the states of West Virginia, Pennsylvania, and Kentucky. It is expected to be transported to thirty-six states. However, some 268 million tons or about 93 percent of the originated coal will terminate in only nine states. These are Ohio, Virginia, West Virginia, Pennsylvania, Michigan, Maryland, Indiana, New York and North Carolina. The overseas export coal, one of the major coal movements in the east, is expected to increase steadily over the next few years.

To check the reasonableness of submitted projections, an independent survey of major coal-producing states was performed. The response to questionnaires received from the states serviced by railroads that participated in the survey are presented in table 1.12 together with the expected share of total state markets.

The FEA Coal Office projected in April, 1975 that some 130 new coal mines with an estimated total capacity of some 293 million tons will open during the period 1975 - 1982. Tables 1.13 and 1.14 allocate this tonnage by state and by year.

State	Surface		Deep		Total	
	Tons (1)	No. of Mines	Tons (1)	No. of Mines	Tons (1)	No. of Mines
Alabama	-	-	13,250	7	13,250	-
Arizona	8,000	1	-	-	8,000	1
Colorado	2,600	1	-	-	2,600	1
Illinois	5,100	2	19,100	7	24,200	9
Indiana	3,000	1	-	-	3,000	1
Kentucky	3,900	2	13,645	11	17,545	13
Montana	32,000	3	-	-	32,000	3
North Dakota	5,600	1	-	-	5,600	1
Ohio	-	-	9,400	4	9,400	4
Pennsylvania	1,340	3	27,950	32	29,290	35
Tennessee	1,350	1	-	-	1,350	1
Texas	14,190	4	-	-	14,190	4
Utah	-	-	8,300	4	8,300	4
Virginia	-	-	3,300	3	3,300	3
Washington	-	-	2,000	2	2,000	2
West Virginia	6,201	5	29,190	25	35,391	30
Wyoming	82,000	10	1,500	1	83,500	11
Total	165,281	34	127,635	96	292,916	130

Source: FEA Coal Office

Note: 1. In thousands.

Table 1.13 New Coal Mine Capacity by State

Year	Surface Tons(1)	Surface No. of Mines	Deep Tons(1)	Deep No. of Mines	Total Tons(1)	Total No. of Mines
1975	12,460	4	4,850	4	17,310	8
1976	18,016	7	20,316	24	38,332	31
1977	3,405	3	19,544	19	22,949	22
1978	13,200	5	39,475	23	52,675	28
1979	14,900	3	18,480	10	33,380	13
1980	88,300	11	16,450	10	104,750	21
1981	-	-	4,700	3	4,700	3
1982	15,000	1	3,820	3	18,820	4
Total	165,281	34	127,635	96	292,916	130

Source: FEA Coal Office

Note: 1. In thousands.

Table 1.14 New Mine Capacity by Year

As shown, 34 surface mines are expected to account for some 165 million tons or 56 percent of total new capacity, and deep mines will account for some 128 million tons or 44 percent of the new capacity.

The national projections for mine expansion and closures for the period are not available. However, more detailed information for selected states is presented in Sections 2 through 4.

1.4.3 Estimated Equipment in Coal Service, 1980

Cars and locomotives, required to transport estimated coal traffic volumes were also reported by participating railroads. Consolidated equipment requirements for these categories and selected 1974 - 1980 comparisons are presented in Tables 1.15 and 1.16.

The surveyed railroads and shippers they serve plan to have some 266,000 100-ton equivalent cars in coal service in 1980. Of this total it is estimated that approximately 244,000 100-ton equivalent cars will be supplied by railroads and the rest - 22,000 - will be supplied by shippers. Please note that railroads in the Eastern District did not provide estimates on shippers cars. Railroads and car manufacturers indicated that increasing amounts of coal will probably move in shipper owned cars. This provides shippers not only cost economies in transporting the coal but also assures him availability of cars and flexibility of their use.

The trend is toward larger cars. Smaller and older cars are continuously being replaced by larger, mostly 100-ton capacity cars. Respondents also reported that wheel track dynamics and track structure limitations will limit car capacity to one hundred tons.

Gross measurements of car and locomotive utilization were calculated to determine the direction and magnitude of expected change, 1974 - 1980. These measurements are summarized in Table 1.17 and indicate

District	1980 Equipment Projections (1)				1980 Projected Requirements	
	Railroad		Shipper			
	Cars	100-ton Equiv.	Cars	100-ton Equiv.	Cars	100-ton Equiv.
Western	43,449	41,272	19,388	18,644	62,837	59,916
Southern	59,484	50,570	3,613	3,613	63,097	53,183
Eastern	173,674	151,990	(2)	(2)	173,674	151,990
Totals	276,607	243,832	23,001	22,257	299,608	266,089

Note: 1. See Sections 2.3, 3.2, and 4.2 for details on existing fleet, retirements, on order, planned, etc. as reported by regional Associations.

2. Not available

Table 1.15 Estimated Cars in Coal Service: Participating Railroads, 1980

District (1)	Originated Coal	Locomotive Fleet 3000hp Equivalent	Tons/Locomotive Per Year
Western	266,881 (2)	1,890	141,207
Southern	157,375	801	196,473
Eastern	288,279	1,126	256,020
U S Total	712,535	3,817	186,586

Notes:
1. Figures for participating railroads as consolidated and reported by regional railroad associations.
2. One western railroad did not report any locomotives in coal serivce hence coal traffic originated by this railroad was not included in these calculations.

Table 1.16 Projected Coal Originations and Gross Locomotive Utilization Measurements, 1980

Year/District	Originated Coal (000 tons)	Car Fleet 100-ton Equivalent	Ton/Car Per Year	Loads/Car Per Year	Days/Load
1980 Projections (1)					
Western	266,881 (2)	59,916	4,454	45	8
Southern	157,375	53,183	2,959	29	13
Eastern	288,279	151,990	1,897	19	19
Totals	712,535	265,089	2,688	27	14
1974 Totals (3)					
Western	65,799	14,203	4,631	47	8
Southern	110,440	40,317	2,739	27	14
Eastern	194,627	126,372	1,540	15	24
Totals	370,866	180,892	2,050	21	17

Notes:
1. Figures for participating railroads as consolidated and reported by regional Railroad Associations.
2. One major western railroad did not report any figures for car fleet and hence their originated coal tonnage was not considered for these calculations.
3. As reported in Coal Traffic Annual, 1975
4. Data not available.

Table 1.17 Projected Coal Originations and Gross Car Utilization Measurements: Participating Railroads, 1980 about 28 percent improvement from 21 loads per car per year for 1974 to 27 loads per car per year in 1980. Improved loading and unloading practices, increased reliance on unit trains, mechanized yard, computer systems, increased train size and improved cooperation among carriers all bear on the improved car utilization. The car utilization measured in terms of ton-miles per car per year is expected to show further gain as coal movements being developed for the next five years will be predominantly long haul in nature in contrast with the numerous short to medium haul coal movements at the present time. This is particularly true in West as more Western coal finds its market in distant states.

1.4.4 Estimated Additional Maintenance Facilities, 1980

Maintenance facilities for cars and locomotives generally are not dedicated to a given type of equipment or commodity. This makes it difficult to estimate the added investment requirements necessary for these facilities due to the increased coal traffic.

The majority of the survey respondents indicated that the existing facilities will have to be expanded to accommodate increased cars and locomotive fleets. Some railroads did isolate and report investment requirements as a result of the anticipated coal traffic increase. These investment requirements are summarized below. Details on the number of railroads responding, etc. are provided in regional sections.

	Maintenance Facilities For:			
District	Cars ($000s)	Locomotives ($000s)	Cars and Locomotives ($000s)	Total ($000s)
Western	19,907	22,000	59,755	101,662
Southern	30	700	--	730
Eastern	--	--	--	--
Total	19,937	22,700	59,755	102,392

The reported increase in car fleet in coal service for Eastern railroads is not substantial, especially when compared with the total car fleet. The roads indicated that a nominal increase in service facilities will be required due to increase in coal service. The additional services will be generally provided through expansion of the existing facilities. The investment requirements for this expansion were not reported.

1.4.5 Estimated Requirements for Physical Plant Improvements, 1980

The investments required to support anticipated 1980 level of operations were reported by participating railroads. Consolidated totals of these estimates are presented in summary form in Table 1.18, and in more detail in the regional sections.

Generally, physical plant and equipment are not dedicated to a single commodity. Therefore, planned capital expenditures should not be equated to or viewed as "the direct cost of moving increased coal traffic."

The surveyed railroads have plans to invest over $1.5 billion in improving their physical plant[1]. The railroads in the Western District alone plan to invest over $1 billion, upgrading the capacity of light density lines in the areas of new coal production. Increases in coal traffic in Southern and Eastern Districts predominantly come from areas already under production and hence the railroads in these areas will require relatively less investment in the physical plant. Due to rehabilitation of railroads in the Northeast planned by Conrail, it was difficult to isolate investment due to coal movements from total investments.

1. Does not include Conrail funding potential. The impact on eastern roads due to this will be substantial.

Category	Southern District		Western District		Eastern District[5]		Total	
	Miles	1975 Dollars (000's)	Miles	1975 Dollars (000's)	Miles	1975 Dollars (000's)	Miles	1975 Dollars (000's)
Rail Relay	1,415	63,373	3,513	312,085	1,185	83,743	6,113	459,201
Signalling	648	29,000	1,449	88,834	52	1,766	2,149	119,600
Ballasting	3,155	5,164	9,868	25,602	7,255	8,865	20,278	39,631
New Lines (2)	93	81,200	469	283,958	34	36,800	596	400,958
Supplemental Lines (3)	88	45,000	52	183,520	13	5,600	153	234,120
Yard Facilities	30	612	76	49,142	15	25,800	121	75,554
Plow and Sledding	50	2,500	-	-	-	-	50	2,500
Communication	300	500	-	-	-	-	300	500
Other	-	14,000	520	192,191	36	19,600	556	225,791
Total	5,779	241,789	15,887	1,135,332	8,590	182,174	30,256	1,559,295

Notes:
1. Includes totals for surveyed railroads in each district.
2. Includes mine spurs and industrial plant spurs.
3. Includes double track, sidings, etc.
4. As some railroads did not consistently report both miles and dollars for each category, average cost per mile cannot be developed from the above totals.
5. Due to rehabilitation of railroads in the Northeast planned by Conrail, it was difficult to isolate the investment due to coal movements from the total investment.

Table 1.18 Projected Physical Plant Improvements, All Districts.

A three-step procedure was generally used by most railroads to estimate investment requirements. Although the degree of sophistication varies, all approaches taken involved either manual or computer simulation of the various output states that can result given the number of dynamic variables involved.

Railroads first identified all major coal corridors and branch lines. Then they determined the gross ton-miles for coal and other commodities moving over these rail routes. Finally, through an iterative process, they estimated the physical plant improvement requirements to accommodate the anticipated traffic. A basic rail network to transport coal from a majority of coal-producing areas to consuming areas does exist and investments generally reflect improvements such as sidings, double tracking, and signalling required to handle the increased traffic more efficiently. A discussion of track improvement planning processes for two major coal-carrying railroads is given in subsequent chapters.

1.4.6 Technological Changes

After World War II, confronted by increased competition from other modes of transportation and changing distribution patterns, railroads adopted numerous technological advances to improve productivity and customer service and facilitate the growth of intermodal transportation. For example:

- From steam to diesel power.
- From hand-operated signalling and switching to electronic traffic control.
- From flat switching operations to automated hump classification systems at strategic locations
- From maintenance of way by gangs of men to completely mechanized procedures.

- From hand computers to the tape random-access memory systems and electronic computers.
- From single car yard-to-yard oriented multi-car unit trains, to run through trains for eliminating or reducing terminal delays.

Some of these changes have contributed significantly in making coal movements efficient. This is evidenced by the fact that rail coal rates have been going down as a percentage of delivered price of coal. (Table 1.6.)

Survey respondents found it difficult to forecast the innovations and developments which would have substantial impact on coal movements. However, during the survey and interviews conducted under the study, the trends in certain aspects of coal movements seem fairly definite. Emphasis seems to be more on adaptation of existing technologies than on new developments. Some of the survey comments are summarized below.

Loading/Unloading Facilities

Adoption of fast loading and unloading facilities by coal producers and consumers would lead to significant increases in rail carrying capacity. According to one western railroad, it is the single most important advance that can contribute the most to rail carrying capacity in their region.

An effect of suboptimal unloading facilities is described in Section 2.3.4.3. Railroad officials also indicated that their customers have begun to realize the importance of fast loading and unloading facilities, and more such facilities will be built in the near future.

Coal Cars

Hopper and gondola cars will continue to be used in coal service. The trend in shipper-owned coal cars will be towards gondola cars. Because of the wheel track dynamics and road bed structural considerations, 100 net tons will be the maximum capacity for cars in the foreseeable future. Use of aluminum cars due to its lighter tare weight and hence increase in net payload may also increase.

For unloading services on coal cars, continued use of rotary-dump and some increase in the use of guide discharge bottom dump is forecasted. One major car producer estimates that 85 percent of new cars will have rotary dumpers while 15 percent will use bottom dump methods. The design of present rapid discharge systems make the tare weight of the car too high and hence render it less suitable for long haul moves. Development of lightweight rapid discharge mechanisms is expected to continue. Future hopper cars will use rapid discharge systems utilizing air and mechanically operated remote controlled devices.

Adoption of improved distribution methods and automated data processing systems has enabled railroads to increase car utilization. The unit train cars may travel approximately as much as ten times as far in one year as cars previously did. This will have adverse effects on car life. The increased utilization will have little effect on car body and it should extend body calendar life to a point that running gear life will be the critical parameter. It will create the need for more parts such as wheels, side frames, bolsters, and center plates. This has required changes in car design and maintenance practices. Though the methods and frequency vary from railroad to railroad, preventive maintenance on unit train cars is routinely performed.

Locomotives

Unit horsepower for locomotives in coal service vary from 1,800 hp to 3,600 hp. However, 2,000 - 3,000 hp locomotives are most commonly used with the trend towards 3,000 hp. Coal trains normally require high tractive effort more than horsepower. No great increase in horsepower, but an increase in adhesion, is expected in the foreseeable future for locomotive technology. Individual wheel slip control realization of a 20 to 30 percent increase in adhesion would result in a large increase in capacity of the present fleet and reduction of the total fleet requirements for locomotives.

Signalling

Railroads will continue to improve signalling systems by adopting centralized control systems for high-density rail corridors. This will have an effect of increasing rail carrying capacity substantially. A discussion of traffic systems and related rail capacity is provided in subsequent chapters. A computerized train dispatching system for high-density corridors will be adopted.

1.4.7 Project Independence Assumptions

During 1974, the Federal Energy Administration conducted the Project Independence study to evaluate the nation's energy problems and provide a framework for developing a national energy policy. This study also evaluated the nation's transportation networks and their ability to carry energy materials. The study naturally involved some generalization and several assumptions related to transportation.

The scope of our study included evaluation of rail coal transportation assumptions. We reviewed the Project Independence report and related supporting documents to list all major assumptions related to rail coal transportation. We circulated a list of these assumptions to all major coal-carrying railroads and sought their comments. The text that follows provides details on the railroads' responses.

1. All new coal movements will be in 100-car unit trains.

   It is true that the majority of new coal will move in unit trains in the Southern and Western Railroad Districts. However, the size of the trains may differ. Each train is an integrated logistics system to optimize equipment utilization. Its size will be governed by factors such as railroad operating philosophy, total demand at a given point, distance between supply and demand points, and terrain and population pattern along the train route. The 100-car train, however, was considered a good generalization by Western railroads. In the Southern District, 70 to 80-car trains will be more common. It is estimated that 87% and 65% of the coal will be moving in unit trains in the Western and Southern rail districts, respectively.

2. The unit trains will move short-line miles from supply to demand centers.

   Everything being equal, trains move by short-line miles from supply to demand centers. However, in real life, there are departures from this norm for various reasons. Besides the originating carrier's desire to have a greater revenue share, there are other practical considerations such as terrain, service points, population centers, etc. for a carrier to use other than the short-line mile route. Greater new track construction costs at the origin and destination or track rehabilitation over a lesser used route may make the mileage route uncompetitive.

3. Loading and unloading times do not vary excessively among links.

   This assumption is true when high-volume loading facilities ship to receivers with rapid unloading facilities. The majority of the new facilities will be equipped with such modern loading and unloading devices. However, existing electric generating plants switching to coal from gas/oil use and some older utility plants using coal do not have modern unloading devices and hence their unloading time will vary considerably from the new plants. Also, many times, due to the terrain at the mine and space requirements at the user's end, it is not possible to use modern loading and unloading methods.

   Some railroads and mines use scheduled loading which allows more time for loading or unloading because turn-around time for the train is calculated by "whole days" rather than by hours. Also, the majority of the electric generating facilities work only five days a week and tariffs allow for free time allowance provisions which exclude weekends and holidays.

4. Increased coal movements on supply and demand links will not hinder existing nor divert future non-coal movements.

   Railroads will be able to integrate new coal movements with existing and potential "other" freight movements. The majority of the railroads agreed with this viewpoint and added that added coal movements will allow them to be financially stronger. This will allow them to improve roadway and structures and increase overall "capacity". This development should allow railroads to move other commodities in a better fashion.

5. Rail trackage is of approximately uniform quality for new road bed requirements.

   Significant new track construction may be of the same approximate quality in terms of rail weight, fastenings, and tie spacings; however, necessary grading and bridging can vary significantly with terrain requirements. Other factors which go into consideration are traffic density and climatic conditions.

6. Contingencies in transit are uniform across all links.

   Contingency time for crew change, train servicing, and inspection may be roughly the same from one carrier to another. However, the total time allocated to transit contingencies varies considerably from one move to another. For example, contingency time would be considerably higher if a movement operates through a congested area. Weather, distance between origin and destination, type of loading and unloading facilities, etc. also play an important role in estimating contingency times.

7. Coal is generally of homogeneous quality and grade.

   Coal quality varies from region to region as well as within a region. Western coal producing districts, as a whole, contain the entire range of coal quality and grade from lignite to anthracite. Individual producing districts commonly mine two or three grades and subgrades.

8. Engine crew and car cycle times are all the U. S. average adopted for all links.

   Each coal movement is designed to obtain optimum utilization of equipment, labor, and capital. Cycle time is a function of loading and unloading facilities, distance between origin and destination, road beds, population centers, and terrain, and varies considerably from one movement to another. Also, it would be misleading to apply existing averages to future hypothetical situations where economies of efficient unit trains can be brought to bear. A variable cycle time as a function of type of movement, distance, and loading and unloading facilities would be more appropriate.

9. Doubling the coal movement will require a doubling of facilities and rolling stock requirements.

   Not true. Additional coal moving through present terminals and facilities may not cause any increase in those facilities, let alone doubling them. If it can be assumed doubling the demand for coal will create situations where unit train economies of scale can be justified, it will not be necessary to double the capacity of railroad physical plant or car fleet. Other factors such as utilization of the present plant and facilities and productivity along with volume should be considered in projecting the future requirements.

10. Line haul costs make up over eighty percent of total operating costs of unit trains.

    True. By placing railroad operating costs into two categories--line haul and terminal expenses--it is clear that the majority of expense would fall under line-haul costs. Unit train operating objectives--avoidance of intermediate yarding and minimization of time at loading and unloading sites--also support the above contention. In the absence of empirical data, "80%" could reasonably be used to demonstrate line haul cost allocation. However, some railroads estimated that for shorter hauls, the capital costs may approach 50%.

11. Unit trains are defined as greater than 6000 net tons per train-load.

    Unit trains are not defined by number of cars or net tonnage, but by method of operation. A majority of Western railroads plan to operate 100 100-ton cars in unit trains. A major railroad is even planning to operate 200-car trains by 1980. 10,000 tons per train-load may be a more appropriate tonnage for Western railroads. The train sizes in the Southern Rail District will vary from 5,000 to 11,000 tons.

12. Actual per ton rates charged by railroads in 1969 for unit train coal movements are used as the "cost" to the shipper of shipping coal.

The 1969 rates are obviously outdated. Current rates for actual unit train coal movements reflect individual circumstances and would be invalidly used as generalizations about the future rate levels in an environment where unit train coal movement is much more extensive than is presently the case. True shipping costs to shipper or receiver should also take into account costs related to loading and unloading facilities and manpower and car ownership, if any.

13. Rates depend primarily on length of haul, average train-load, and annual tons moved on a particular link.

Everything else being equal, rates will depend primarily on the above mentioned variables. However, they are modified by other factors including equipment type and ownership, loading and unloading methods, inter- and intra-modal competition and regulatory guidelines.

14. Total non-haul activity time (loading, unloading, and contingencies) for unit train operation is estimated to be forty-eight hours for all links between demand and supply centers.

If a 48-hour contingency for both loading and unloading is necessary, the railroad operation will not, in all probability, be accomplished by "unit trains". With modern loading and unloading facilities, a better estimate would be four hours each for loading and unloading.

Factors considered in determining both rates and non-haul activities are listed below:

- Location of coal mine to the railroad
- Loading time interval
- Loading method
    - A. Flood loading with railroad performing pull-through service
    - B. Gravity roll loading

C. Use of car puller or mine-operated switcher

- . Grades of route from origin to destination
- . Traffic density on the particular route
- . Location of receiver with respect to the railroad
- . Unloading time intervals
- . Unloading method
  - A. Automatic unloading with railroad performing pull-through service
  - B. Plant switcher or car puller positioning car for rotary dumping
  - C. Older, more conventional methods
- . Round trip cycle time of equipment
- . Annual volume of coal to be moved
- . Train labor characteristics of the operation
- . Single line haul or combination of two or more railroads
- . Need for making improvements in the particular line segment. Savings resulting from a favorable combination of the above (and other) items may or may not accrue to all three parties involved (mine, railroad, shipper)
- . Equipment, shipper or carrier owned
- . Length of haul

15. Average speed in mph on regional coal roads included switching, terminal, crew changing, etc. The estimated regional speeds are:

Eastern	18
Southern	21
Northwestern	22
Central Western	26
Southwestern	22

As overall averages, these are satisfactory estimates for study purposes.

16. In calculating crew requirements, total block time for each trip was calculated. The average train speed for these calculations is 20 mph.

This is a reasonable assumption. If possible, the assumption should reflect special labor agreements.

17. An average unit train crew has four members and works 1900 hours per year.

1900 hours per man is reasonable as an average; however, the range could be fairly wide assuming work hours on duty modified by vacation, holiday time off, etc. Two railroads reported a fifth position of reserve engineer or foreman in the train crew.

18. The horsepower requirements for moving a 10,000-ton gross weight train at an average block speed of 20 mph is about 15,000 hp.

Horsepower requirements depend also on railroad and operation conditions, grade restraints, traffic flows, etc. The average assumed is a good generalized figure for study purposes.

19. Average weekly utilization rate on a locomotive is 72 hours.

72 hours per week may or may not be reasonable for general-service locomotives; however, it is too low for unit train dedicated motive power. The utilization should be in the area of 85% to 95% availability. Based on seven days a week and 90% availability, average weekly utilization rate for locomotives will be about 151 hours. One railroad puts this average at about 120 hours.

20. One hundred open hopper cars are needed per unit train.

A fairly good assumption for future coal movements. As indicated earlier, the train size depends on many other factors. BN considers a 105-car train to be an optimum size for their unit trains. Assumptions 1, 11, and 20 need to be consistent and more definitive with regard to the term "unit train".

21. Coal is of homogeneous quality within a given region.

Not true. See assumption 7.

22. Coal will flow so as to minimize transportation costs while satisfying supply, demand, and capacity constraints.

Everything else being equal, this assumption is true. However, availability and quality (sulphur content) remain overriding factors for coal demand. Preference for low-sulphur Montana coal over Illinois by utility plants in the Chicago area is an example of this phenomenon. Coal demand is also a function of "through boiler" economics and some of the major costs are:

Price of coal, FOB mine

Price of transportation and handling

Sulphur dioxide and fly ash removal sludge and ash disposal

Also, some regions produce more coal than can be consumed in the normal destination market: therefore, some coal is bound to flow from some regions to destinations which are not the market in order to satisfy supply and demand.

1.4.8 Effect on Other Commodities

Although coal is the principal commodity handled by the railroads, it only accounted for some 17 percent of ton-miles in 1975. As such, coal traffic does not constitute a dominant portion of the total traffic. The anticipated coal traffic increases, even though affecting individual railroads unevenly, would not place manageable strain on rail capacity.

During the survey and interviews conducted under the study, generally it was found that the majority of the railroads are planning for projected total traffic, including anticipated increases in other commodities, on their systems. All of them indicated that they would be able to absorb the anticipated coal traffic without any adverse effect on movement of other commodities. A discussion on railroads planning processes for line capacity is provided in subsequent chapters. The anticipated increase in coal traffic promises to be a large financial help to a number of railroads. Assuming reasonable rate structure, revenues from this traffic will provide economic justification for necessary investments to improve line capacity, operating conditions, and car supply. These developments should result in a better railroad physical plant. Thus the increased coal traffic should help rather than hinder the movements of other commodities.

High volume bulk commodities like coal serve as a solid base on which most successful railroads build. Some railroads indicated that if this base is lost to other modes of transportation, the railroads will be left with other commodity traffic and a charter to serve all shippers without the benefit of economy of scale. This will have debilitating effect on their financial and operating health.

1.4.9 Regulatory changes/Transportation Policies

Reportedly, some $3.3 billion or 22.6 percent of rail revenue, was required in 1973 for railroads to own, maintain, and pay taxes on their private right of way. By contrast in the same year class I intercity motor carriers required some 4.4 percent of their revenue dollars for their use of public highways; and barge line operators pay no charges for using public waterways developed at a cost of some $5.5 billion.

Given the above, most respondents focused on the need to correct the imbalance that exists between the regulatory treatment of railroads as compared to other modes of transportation. Generally, two basic approaches for even handed government treatment of various modes were suggested. The first was to recover from users a fair and proportionate share of costs associated with building, maintaining, and improving highways and waterway. The second was to have the Federal Government assume a corresponding portion of rail industry costs for providing and maintaining tracks and other fixed facilities.

Railroad Revitalization and Regulatory Act of 1976 has called for significant regulatory changes to improve the operations and structure and restore the financial stability of the railway system of the United States. Under this law major responsibility has been placed on the Department of Transportation by congress to study past and present policies and methods of providing Federal Aid for construction, improvement, operation, and maintenance of rail transportation facilities and services. The DOT will also examine past and present policies on Federal Aid to various modes of transportation and weather they have disadvantaged the rail carriers and the extent of such disadvantage. The department will conduct studies to determine policies to establish and maintain an open and competetive market in which rail transportation can compete on equal terms with other modes of transportation.

From a purely rate regulatory point of view, proposals that would enable railroads to compete on an equal footing called for freedom for railroads to enter requirements contracts on a percentage as well as a tonnage basis, to enter long-term contracts, and to adjust rates within reasonable limits without prior ICC approval.

Another proposal for correcting the perceived imbalance between modes called for the introduction of a pricing system that would allow railroads' freight rates to adjust to changes in the level of shipper demands. A flexible price approach could reportedly smooth demand, improve the quality of service provided, and generate funds to expand the national car fleet. Other proposals included simplification of Tariff Circular 20 which prescribes formats for publishing rates. Required formats and procedures impede the application of computer technology.

The respondents also indicated that the establishment of National Energy Policy encompassing all phases of coal development from mining to transporting to end user is required to eliminate the uncertainties. The majority also advocated a working relationship with the environmental groups in an attempt to strike a moderate workable plan of strip minimg and transporting coal while providing maximum protection of our environment.

Respondents also emphasized the need for amendments to labor agreements to allow a greater distance between crew change points on unit train, terminal runthrough with unit trains, and fewer men per crew where applicable.

2. WESTERN RAILROAD DISTRICT/ASSOCIATION

2.1 Overview

Railroads are assigned to the Western District by the ICC on the basis of primary area of operations. Geographically the Western District comprises the section on the Canadian boundary between Washington and the westerly shore of Lake Michigan to Chicago, west of a line from Chicago through Peoria to St. Louis and the Mississippi River to the Gulf of Mexico.

This area is shown in Figure 1.2. The Western Railroad Association (WRA) is a voluntary association of railroads that operate in the Western District. Railroads that operate over a wide geographic area generally belong to more than one regional association. The list that follows identified major coal carrying WRA member line roads. The list also denotes railroads that participated in the study by completing questionnaires and assessing the validity of certain key Project Independence transportation assumptions. In addition, the Burlington Northern, Inc. cooperated and worked with the contractor to prepare descriptions of coal operations, flows, etc. These descriptions are considered similar to operations on other railroads operating within the district. The descriptive material is presented in Section 2.3.

WRA Major Coal Carriers

*Atchison, Topeka & Santa Fe Railroad
*Burlington Northern, Inc.
*Chicago North Western Railroad
*Chicago, Milwaukee, St. Paul & Pacific Railroad
*Chicago, Rock Island & Pacific Railroad
*Denver & Rio Grande Western Railroad
**Elgin, Joliet & Eastern Railroad
*Missouri Pacific Railroad
St. Louis - San Francisco Railroad
*Southern Pacific Transportation Co.
*Union Pacific

*Denotes study participants.

**Primarily an Eastern railroad, but participated in the study through WRA.

Tables 2.1 and 2.2 that follow present a profile of 1974 Western District bituminous coal operations. The material is organized and presented in terms of volume of traffic handled, revenues received, and cars furnished by the ten participating railroads. With respect to U. S. totals, the ten participating railroads accounted for some 17.1 per cent of total coal carried and 17.5 per cent of revenues earned.

In the sections that follow 1974 profile information is used to help focus changes in expected 1980 levels of operations, distribution patterns, and associated investment requirements.

Railroad	Originated and Term. On Line	Originated and Del. To Connect.	Total Originated	Total[1] Carried	($000's) Revenue Received	% Western RR Tons	% Western RR Rev.	% Total US Tons	% Total US Rev.
	(In thousands of tons)								
Atchison, Topeka & Santa Fe	1,315	228	1,542	4,247	13,287	4	4	0.7	0.7
Burlington Northern	17,281	12,173	29,453	31,512	140,992	28	42	5.4	7.7
Chicago & Northwestern	1,089	2,352	3,441	13,709	30,820	12	9	2.3	1.7
Chicago, Milwaukee, St. Paul & Pacific	2,018	1,131	3,149	5,535	12,004	5	3.5	0.9	0.7
Chicago, Rock Island & Pacific	215	619	833	1,834	5,194	1.6	1.5	0.3	0.3
Denver & Rio Grande	6,054	3,149	9,203	11,162	26,980	10	8	1.9	1.5
Elgin & Joliet & Eastern	1	0	1	9,969	12,955	9	3.8	1.7	0.7
Missouri Pacific	7,782	738	8,520	10,020	19,708	9	5.8	3.4	1.0
Southern Pacific	1	1	2	476	3,136	0.4	0.9	0.08	0.2
Union Pacific	2,585	7,070	9,655	12,552	54,588	11	16	2.1	3.0
TOTAL	38,340	27,460	65,800	101,016	319,663	90	94	17.1	17.5
Other Western Railroads	2,325	2,768	5,094	10,841	18,820	10	6	1.8	1.0
Total Western Railroads	40,665	30,228	70,893	111,857	338,483	100	100	19	18.5
Total U S	216,382	171,322	387,704	587,783	1,826,029	-	-	100	100
% Western of Total	18.8	17.6	18.3	19.0	18.6	-	-	19	18.5

Source: Coal Traffic Annual, 1974

Note: 1. Includes coal received from other lines and terminated on line and delivered to connecting lines.

Table 2.1. Bituminous Coal Handled by Selected Western Railroads - 1974.

Railroad	Cars (1)	Capacity (000 Tons)	100 Ton Equiv. Cars	% of Western District Cars	% of Total U. S. Cars
Atchison Topeka & Santa Fe	5,182	419	4,190	7.3	1.5
Burlington Northern	18,819	1,427	14,270	26.6	5.4
Chicago & N. Western	4,018	297	2,970	5.6	1.2
Denver, Rio Grande & West	2,564	217	2,170	3.6	0.7
Elgin, Joliet & Eastern	-	-	-	-	-
Milwaukee	2,460	156	1,560	3.5	0.7
Missouri Pacific	6,270	549	5,490	8.9	1.8
Rock Island	2,123	161	1,610	3.0	0.6
Union Pacific	8,289	656	6,560	11.7	2.4
TOTAL	49,690	3,882	38,820	70.2	14.3
Total Western District	70,752	-	-	100.0	20.6
Total All Districts	343,392	-	-	-	100.0

Source: Coal Traffic Annual - 1975

Note: 1. Car totals include new, rebuilt, and leased cars.

Table 2.2. Profile of Open Hopper Car Fleet, Western District, 1974.

2.2 Survey Responses and Findings

2.2.1 Estimated Coal Traffic Volumes, 1980

Participating railroads were asked to project 1980 Western District coal movements on the basis or origin and destination states and the type of movement involved. Consolidated traffic projections for these parameters are presented in Tables 2.3 and 2.4. As the majority of western coal, some 88%, will move in unit trains in 1980, the railroads' projected traffic included only unit train movements. When possible 1974-1980 comparisons are made to illustrate the magnitude and direction of expected changes, if any. The participating railroads expect to originate some 279 million tons of coal in 1980 as compared to about 66 million tons in 1974. This is an increase of 213 million tons or 324% over the 1974 originated tonnage. The Great Plain region states of Montana, Wyoming, and North Dakota will contribute about 50% of the coal mined in the western states in 1980. The reported smaller long distance movements can be assumed to be for metallurgical coal. These movements exist today and are expected to continue through 1980.

To provide a visual picture, 1980 coal movements are mapped in Figure 2.1. It shows that the coal produced in the Great Plain region will flow generally east, south and southeast and will find its market as far away as Texas, Louisiana and Indiana.

To check the reasonableness of submitted projections an independent survey of major coal producing states was performed. The responses to questionnaires received from the seventeen states serviced by Western District railroads that participated in the survey are presented in Table 2.5, together with expected rail share of total State markets.

Destinations	Origins CA	CO	ID	IL	IN	IA	MT	NM	ND	OK	TX	UT	WI	WY	Other	Total
AR														14,250		14,250
CA		958						200				2,551		28		3,737
CO		4,268								200				7,304		11,772
ID		6	97											919		1,022
IL		335		14,330			10,700							15,017		40,382
IN		54		1,500	3,225									3,267		8,046
IA		53	1	1,100		105								10,046		11,305
KS		4												7,354		7,358
KY														4		4
LA														10,120		10,120
MN							14,400		700					804		15,904
MO				12,000			3,000			100				17,829		32,929
MT		139					550							7		696
NE		178												9,853		10,031
NV												650				650
OH														56		56
OK														12,600		12,600
OR	1		3									47		1,453		1,504
SD									2,500							2,500
TN											1					1
TX							9,400			225	8,100			10,500		28,225
UT		1,200										1,000		105		2,305
WA		5												25		30
WI				12,000	600		12,700						275	8,344		24,919
WY														4,576		4,576
Other		13,000					500		50			10,000			9,460	33,010
Total	1	20,200	101	31,930	3,825	105	51,250	200	3,250	525	8,101	14,248	275	134,960	9,460	278,431

Note: In addition to the above, 953,000 tons of coal will be transported to Mexico from the States of Arizona and New Mexico

Table 2.3. 1980 Unit Train Coal Organizations and Destinations, Western District (Thousands of Tons.)

Year	Originating & Terminating On Line	Originating & Delivered To Connection	Received From Connection & Term. On Line	Received From Connection & Del. To Conn.	Total Traffic
	Thousands of Tons				
1980 (1)	123,200	156,184	76,495	19,668	375,549
1974 (2)	38,340	27,460	35,216 (3)		101,016
Tonnage Increase	84,860	128,724	60,947 (3)		274,533
% Increase	221	469	173 (3)		272

NOTES: 1.) Source IOCS questionnaire, unit train movement only.
2.) Source Coal Traffic Annual 1975
3.) Includes received interchange traffic terminated on line or delivered to connection.

Table 2.4 Projected Increase in Unit Train Coal Traffic, Selected Western District Railroads, 1974-1980

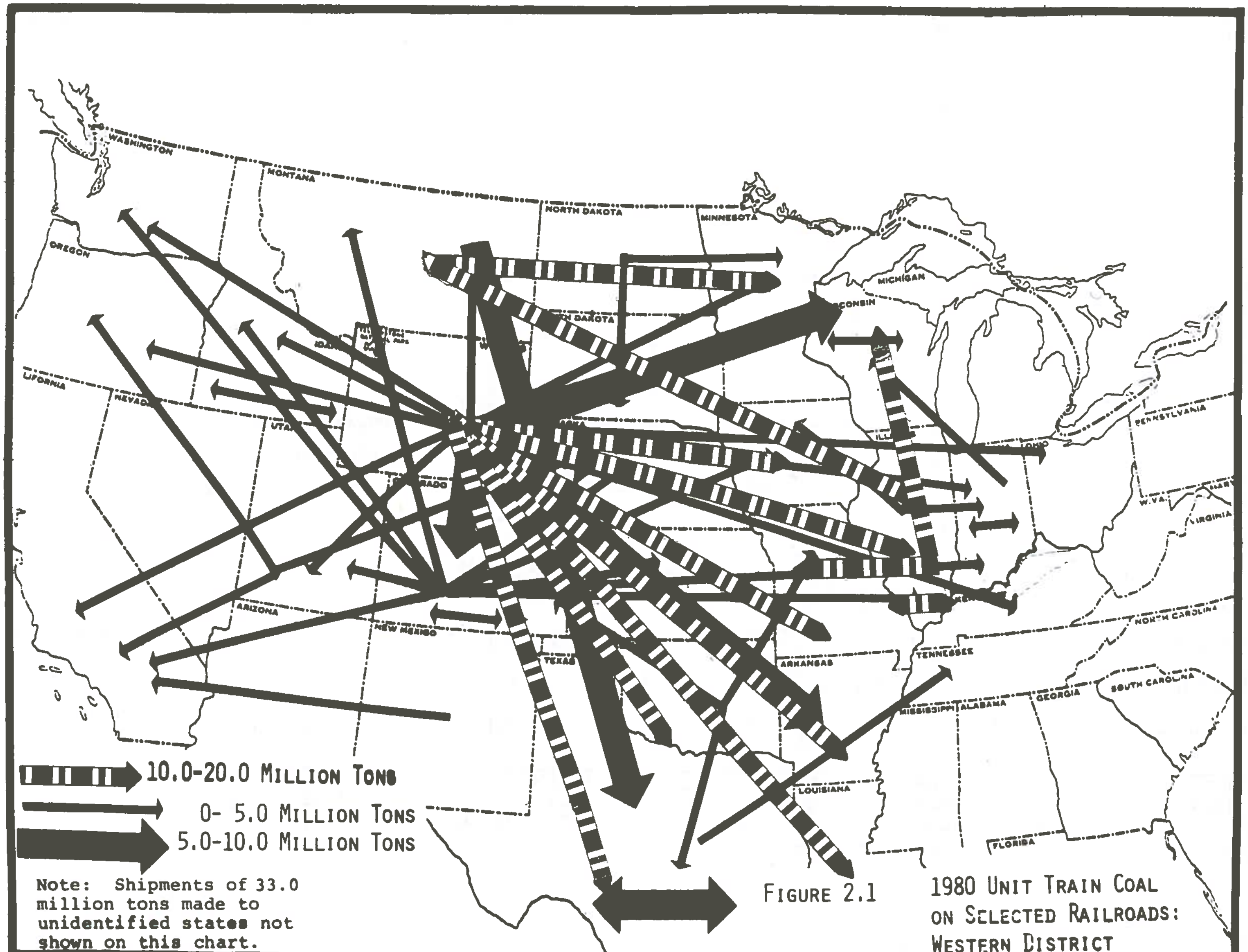


FIGURE 2.1 1980 UNIT TRAIN COAL ON SELECTED RAILROADS: WESTERN DISTRICT

Thousands of Tons

State	Total Rail[1] Originated Coal (A)	Total[2] State Production (B)	Rail Percent to Total Production (A/B)	State Percent to Total Production
Arizona	236	12,000	2.0	2.89
Arkansas	-	750	-	0.18
Colorado	20,200	30,000	67.3	7.23
Illinois[4]	31,930	73,500	43.4	17.73
Indiana[4]	3,825	35,000	10.9	8.44
Iowa	105	900	11.7	0.21
Idaho	101	-	-	-
Kansas	-	2,000	-	0.48
Missouri	-	5,500	-	1.33
Montana	51,250	42,820	124.4	10.34
New Mexico	918	34,000	2.7	8.19
North Dakota	3,250	28,700	11.3	6.92
Oklahoma	525	18,000	2.9	4.34
Texas	8,101	25,000	32.4	6.03
Wisconsin	275	-	-	-
Wyoming	134,960	96,000	140.6	23.16
Utah	14,248	10,500	135.7	2.53
Others[3]	9,460	-	-	-
TOTAL	279,384	414,670	67.4	100.00

Notes:
(1) Rail originated coal as reported by WRA
(2) State production as reported by states and other sources
(3) "Others" includes data where a railroad(s) did not report state of origin
(4) Coal from Illinois and Indiana will also be originated by Eastern and Southern railroads.

Table 2.5 1980 Rail Coal Traffic Projections--Western Railroad Association

Due to a lack of water resources in the area, the majority of western coal is expected to move by rail in 1980. A quick examination of Table 2.5 reveals a variance between coal productions reported by states and rail originations reported by railroads serving those states. This reported variance may be indicative of time lag and/or difference in methods and assumptions involved in coal production estimating processes of states and railroads. Another reason for the variance is a possible duplication in reporting coal traffic by origin and destination. As an example, several carriers in Wyoming, say the UP, BN and C&NW may be attempting to develop a future unit train movement to a utility and report the same tonnage individually. Some attempts were made by WRA to avoid such duplications, however, it was limited by confidentiality of data involved and amount of work needed to analyze each individual move.

Railroads interviewed indicated that their marketing analysis allowed for a portion of coal production to be used in mine mouth utility and gasification plants. This partly explains lower coal rail originations compared to total state productions for some states (e.g. North Dakota).

Coal production is not expected in the states of Idaho and Wisconsin. Data analysis revealed that often coal is shipped to a point and unloaded. Then, later on, for any number of reasons, it is reloaded and shipped from that point to some other point. It was also further revealed that these are some existing moves and reportedly will continue.

States west of the Mississippi River have half the coal reserves in the USA. As most of the nation's low-sulpher coal is in the West, this region holds particular interest with regard to future coal production and movement. Most coal from this region is used for electric power generation.

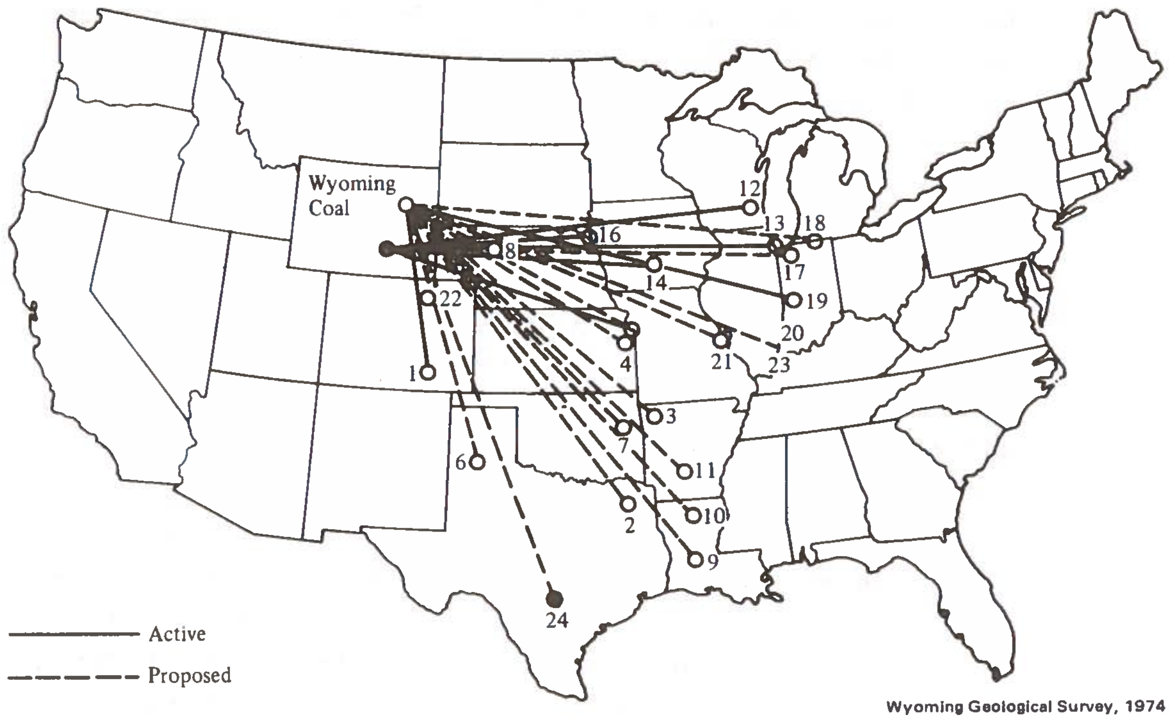
Low-Sulphur coal from Wyoming and Montana has and continues to find new markets in the midwestern and south central states. Essentially, the increased use of Western coal is attributable to large producers and consumers being able to enter into long term, high volume contracts for coal that meets low-sulphur EPA regulations. Generally, overall coal requirements are sufficiently high to justify investment requirements of mine operators and utility companies. Further, annual volumes are usually sufficient to justify economical unit train operations. The states of Wyoming and Montana expect to market their coal more than 1000 miles away. Figure 2.2 depicts destinations of Wyoming coal under signed contracts for present and future coal deliveries by unit train. A map in Figure 2.3 shows the predicted coal consumption by power plants for the year 1980 and possible markets for Western coal. The numerals within the state borders indicate, in millions of tons, the amount of Montana coal which would be needed to meet the predicted requirements. The distances indicated by concentric circles are from a point east of Billings, Montana. Montana coal is already being shipped to electric generating plants in the Chicago area. A description of this coal movement is provided in Section 2.3.3.4.

2.2.2 Estimated Equipment in Coal Service, 1980

Cars, locomotives, and cabooses required to transport estimated coal traffic volumes were also reported by participating railroads. Consolidated equipment requirements for these categories are presented in Tables 2.6 and 2.7. The equipment requirements are presented in the context of unit train operations as single and multi-car shipments will account for only thirteen percent of the total tonnage in 1980. Further, equipment used in single and multi-car shipments are not dedicated to a particular commodity and are used on an as-required basis.

Except for unit train operations and special purpose cars such as those used to transport automobiles, piggyback trailers, and

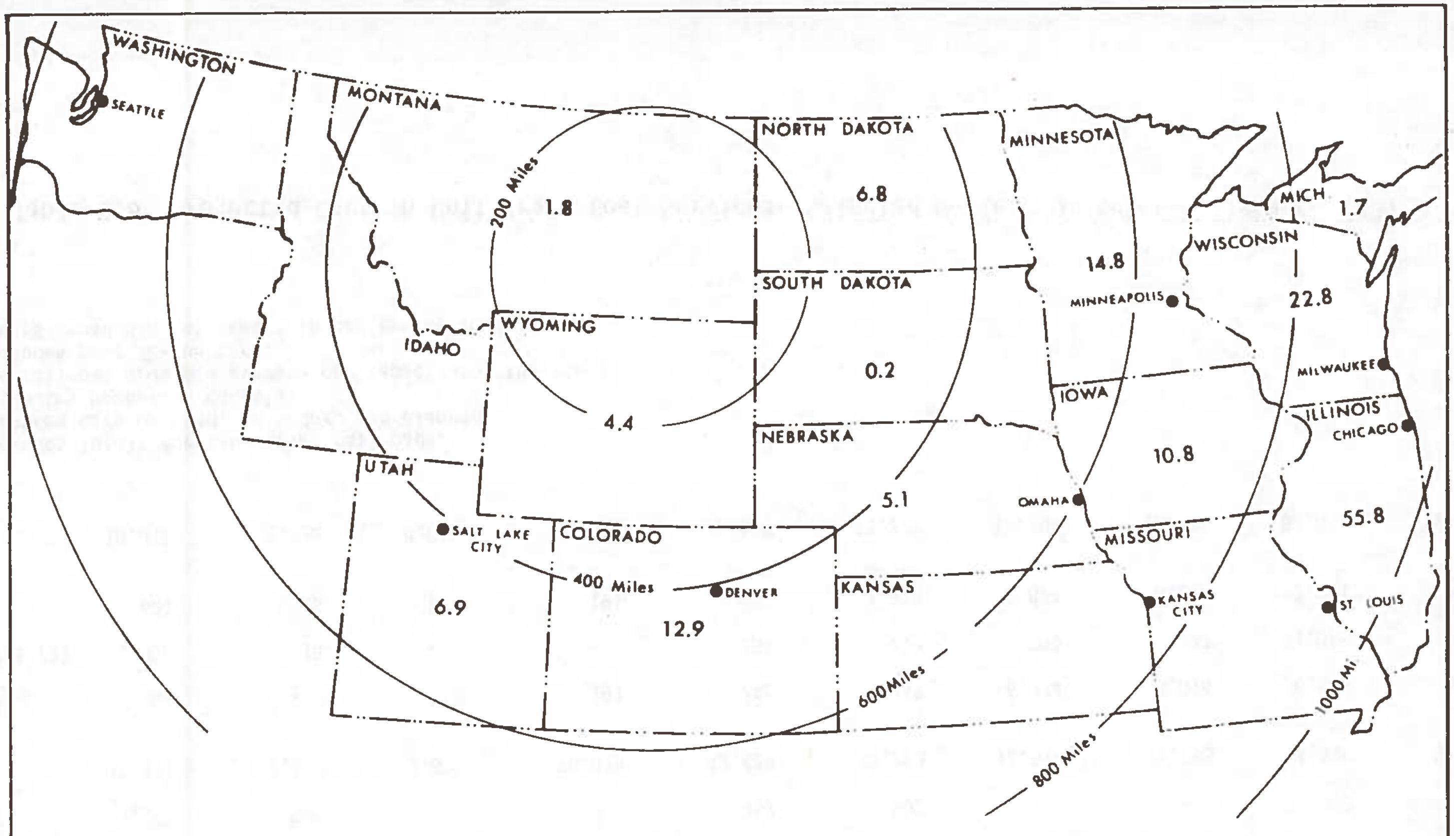
Coal Unit-Train Destinations



Explanation

1. Amax Coal Co.
2. Amax Coal Co., begins 1976
3. Amax Coal Co., begins ?
4. Amax Coal Co., begins 1977
5. Amax Coal Co., begins 1976
6. Atlantic Richfield, begins 1975
7. Atlantic Richfield, begins 1976
8. Atlantic Richfield, begins 1976
9. Kerr-McGee Corp., begins 1977
10. Kerr-McGee Corp., begins 1978
11. Kerr-McGee Corp., begins 1977
12. Arch Mineral Corp.
13. Arch Mineral Corp.
14. Arch Mineral Corp.
15. Arch Mineral Corp.
16. Energy Development Co.
17. Medicine Bow Coal Co., begins 197_
18. Carter Oil Co., begins 1976
19. Amax Coal Co.
20. ? Amax Coal Co., begins ?
21. ? Amax Coal Co., begins ?
22. Amax Coal Co.
23. ? Carter Oil Co., begins ?
24. Sun Oil Co., begins 1976

Figure 2.2



Coal Required for Power Generation in 1980

Millions of Tons of Montana Coal Equivalent

Conventional Conversion Based on FPC Regional Advisory Reports, 1969

Figure 2.3

Type	Capacity	Existing Fleet 1974 (1)	Retirements Through 1980	Now On Order	Additional Planned Through 1980	1980 Equipment Projections (6) Railroad		1980 Equipment Projections (6) Shipper (2)		1980 Projected Requirements	
						Cars	100-ton Equiv.	Cars	100-ton Equiv.	Cars	100-ton Equiv.
H (3)	100	8,705	1,072	3,005	18,869	29,501	29,501	6,014	6,014	35,515	35,515
	88.9 (4)	2,350	500	800	7,150	9,800	8,712	6,500	5,779	16,300	14,431
	70 (5)	2,804	650	-	-	2,154	1,508	-	-	2,154	1,508
	55	1,552	585	-	-	967	532	-	-	967	532
Sub Total		15,411	2,813	3,805	26,019	42,422	40,253	12,514	11,793	54,936	52,046
G (3)	100	301	-	250	191	742	742	6,074	6,074	6,816	6,816
	97.1 (4)	300	15	-	-	285	277	800	777	1,085	1,054
Sub Total		601	15	250	191	1,027	1,019	6,874	6,851	7,901	7,870
Grand Total		16,012	2,828	4,055	26,210	43,449	41,272	19,388	18,644	62,837	59,916

Notes:
1. Includes Totals for ten survey railroads.
2. Includes cars on hand, on order, and planned.
3. H denotes hopper, G gondola.
4. One railroad provided average car capacity of the fleet.
5. Includes some 72-ton cars.
6. One railroad did not report in car projections.

Table 2.6 Projected Cars in Unit Train Coal Service: Selected Western District Railroads, 1980

Horsepower	Existing(1) Fleet	Retirements Through 1980	Presently on Order	Additional Planned Through 1980	Total Required
3,000	431	7	118	1,348	1,890

Notes:
1. Includes total for ten survey railroads.
2. In addition to above, several railroads reported that they use available locomotives from a pool.

Table 2.7 Projected Locomotives in Unit Train Coal Service: Selected Western District Railroads, 1980 containers, equipment requirements are expressed in the number of units that normally will be used in coal service throughout the year. As such, reported figures may vary in accordance with periods of peak demand and overall level of total demand.

The trend is toward larger cars. Responders also reported that wheel track dynamics and track and structure limitations will limit car capacity to one hundres tons. The surveyed railroads and shippers they serve will have some 49,916 100-ton equivalent cars in coal service in 1980. Of this total, 41,272 100-ton equivalent cars will be supplied by the participating railroads and and the rest, 18,644 will be supplied by the shippers they serve. The railroad officials interviewed indicated that a substantial amount of future coal will move in shipper owned cars. This provides the shipper not only cost-economies in transporting the coal, but it also assures him on availability of these cars and flexibility of their use.

The participating railroads had 14,206 100-ton equivalent cars in unit train coal service in 1974. This fleet is expected to grow to 41,272 cars - a three fold increase. Smaller and older cars are continuously being replaced by larger, mostly 100-ton capacity cars.

An analysis of car and locomotive surveys was performed on the projected fleets. This is summarized in Tables 2.8 and 2.9. At first glance it seems questionable that loads per car per year would decrease. However, a decrease in the number of loads per year 1980 versus 1974 can result from the fact that most of the unit train movements being developed for the next five-year period are predominantly long haul in nature in contrast with the numerous short to medium haul trains now in operation. For example, a major coal carrying railroad reported that their coal unit train average haul is expected to increase from about 600 miles in 1974 to about 800 miles in 1980.

Year	Originated Coal (000's of tons)	Car Fleet 100-ton Equivalent	Tons/Car Per Year	Loads/Car Per Year	Days/Load
1980	266,881 (1)	59,916 (2)	4,454	45	8.11
1974	65,799 (3)	14,206 (1)	4,631	47	7.77

Notes:

1. Consolidated originated coal projections furnished by Western Railroad Association for nine survey railroads.
2. One railroad did not report any cars in coal service and hence their coal traffic projections were not included in the above calculations.
3. 1974 coal traffic volumes - source: Coal Traffic Annual, 1975

Table 2.8 Projected Coal Originations and Gross Measurements of Coal Car Utilizations: Selected Western District Railroads, 1980

Year	Originated Coal (000's of Tons)	Locomotive Fleet 3000 hp Equivalent	Tons Per Locomotive Per Year
1980	266,881(1)	1,890	141,207

Notes: 1. Consolidated originated coal projections furnished by Western Railroad Association from mine survey railroads. One railroad did not report any locomotives in coal service and hence this coal traffic was not included in the above calculations.

Table 2.9 Projected Coal Originations and Gross Measurements of Locomotive Utilization: Selected Western District Railroads, 1980

2.2.3 Estimated Equipment Maintenance Facilities, 1980

Railroads seldom have maintenance facilities totally dedicated to service cars and locomotives in coal service. Usually their shops handle all cars and locomotives, regardless of the commodities they handle. Also, the capacity of existing facilities is dependent on varied factors such as number of shifts worked, labor force, tools and machinery, etc. These factors, combined with location of facilities and logistics involved, make it almost impossible to estimate the added investment necessary for these facilities due to the increased coal traffic.

Four out of ten railroads responded to the question of added facilities required to maintain increased car and locomotive fleets in coal service. One railroad did not separate car and locomotive maintenance facility investment. These railroads together will handle 62.3% of the total coal handled by surveyed railraods in 1980.

Responses to our survey are summarized below:

Number of Railroads Reporting	Maintenance Facilities for	Investment Required
2	Locomotives	$ 22,000,000
3	Cars and Cabooses	19,907,000
1	Cars, Cabooses, & Locomotives	59,755,000
TOTAL		$ 101,662,000

2.2.4 Estimated Physical Plant Improvements, 1980

Participating railraods also reported estimates of capital improvements to the tracks, signalling, and related facilities used for their high-volume coal movements. As tracks, signalling, yard facilities, etc. are not dedicated to one given commodity, several railroads found it difficult to identify coal-related investment. However, an attempt was made to identify and isolate the coal-related physical plant improvements planned in the next five years. Our survey results are presented in Table 2.9A. As some railroads did not consistently report both

Category	Planned/Under Construction(1)		Total Required		Cost per Mile Range	
	Miles	1975 Dollars (000's)	Miles	1975 Dollars (000's)	Minimum	Maximum
Rail Relay	2,413	161,239	3,513	312,085	4,604	82,480
Signalling	922	59,345	1,449	88,834	31,723	71,313
Ballasting	8,857	12,983	9,868	25,602	1,300	9,000
New Lines(2)	284	187,965	469	283,958	344,828	2,697,000
Supplemental Lines(3)	17	147,964	52	183,520	178,486	321,667
Yard Facilities	76	44,642	76	49,142	868	868
Other	520	125,547	520	192,191	-	-
TOTAL	5,089	739,685	15,887	1,135,332	-	-

Notes:
1. Includes totals for survey railroads in the Western District.
2. Includes mine spurs and industrial plant spurs.
3. Indludes double track, sidings, etc.
4. As some railroads did not consistently report both miles and dollars for each category, average cost/mile cannot be computed from the above totals.
5. Minimum and maximum cost/mile data was furnished by the WRA.

Table 2.9A Projected Physical Plant Improvements: Selected Western District Railroads miles and dollars for each category, average cost per mile could not be calculated from reported data. However, from individual responses, the WRA furnished maximum and minimum costs per mile for each category. As can be noted, participating coal carriers are planning to invest over $1 billion to handle the anticipated coal volumes more efficiently. Other category includes grade crossing enhancements, bridges, crew quarters, and other miscellaneous items.

2.3 Description of Coal Operations: Burlington Northern

2.3.1 Overview

The Burlington Northern is the principal coal carrier in the Western District. In 1974, it carried over 31 million tons of coal, some 31% of the total coal carried by Western railroads. BN coal revenue amounted to about $141 million, some 11.1% of the total freight revenue. BN and its subsidiaries operate more than 25,000 miles of line in 19 western and midwestern states and two Canadian provinces. A BN system map is given in Appendix A.

2.3.2 Coal Flows

BN projects that it will handle over 142 million tons of coal in unit train service in 1980. This is an increase of 111 million tons, or 390% over 1974 tonnage. This is also about 45% of the total increase in coal movements projected by surveyed railroads in the Western District.

To project coal traffic volumes, BN initiated a thorough analysis to isolate and identify coal production which could move over the BN line. This included all mines in the Fort Union formations in Montana and Wyoming. Figure 2.4 on the following page denotes existing mines, mines under construction or scheduled for construction, and mines identified for future development. This review was conducted with the cooperation of the mining companies whose facilities are served by BN. Present and planned production estimates were developed for each mine on the basis of proven resources, proposals for future deliveries, ecexuted contracts for future deliveries, existing production contracts, and estimated long-term production based on the geology of the mines. From this initial analysis, BN officials know with the greatest possible accuracy how much coal will be mined in their territory, when and where it will be mined, where it will be shipped, and what routes it will take.

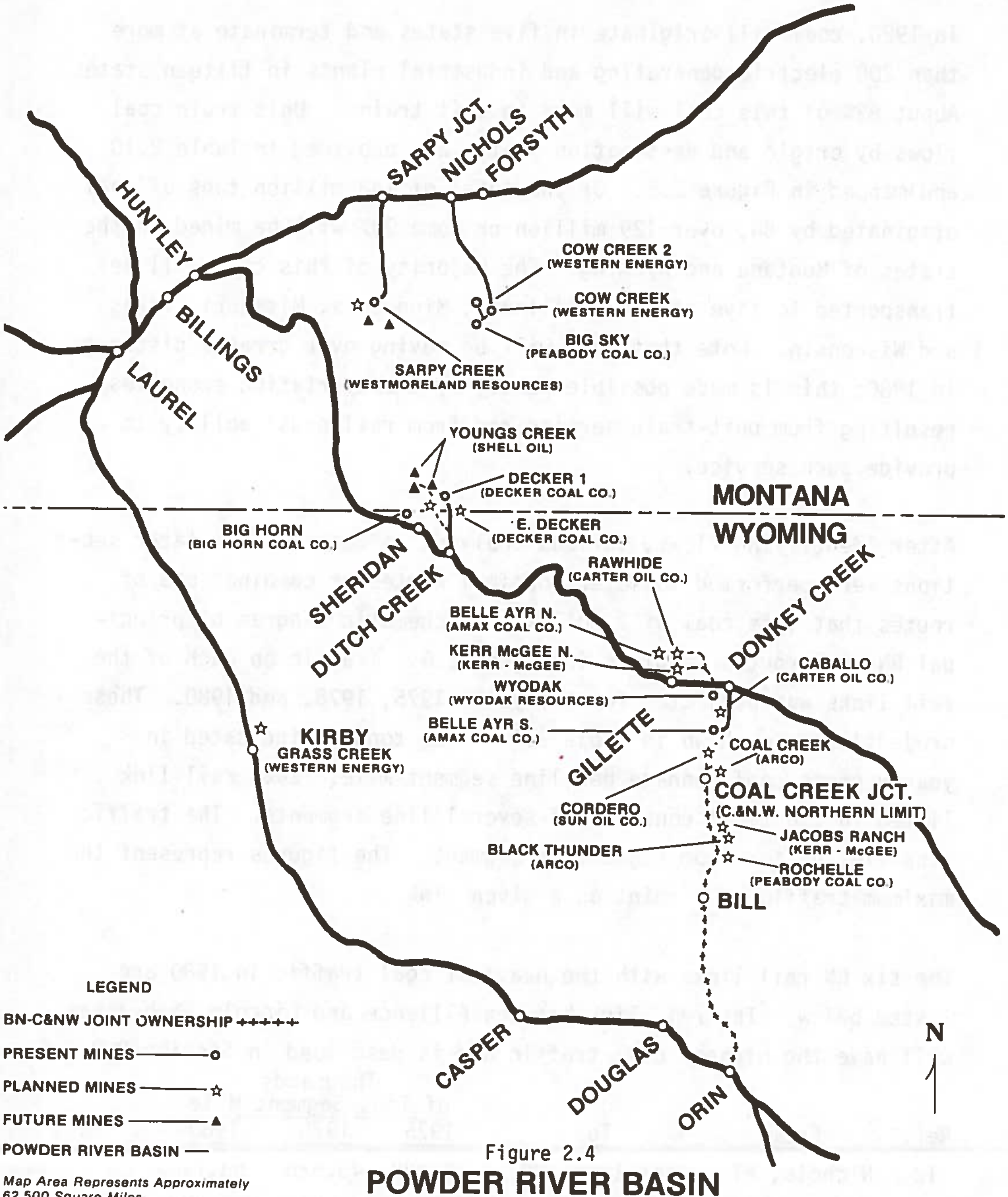


Figure 2.4

POWDER RIVER BASIN WESTERN COAL FIELDS

SHOWING RAIL LINES IN AREA

NOVEMBER 1975

In 1980, coal will originate in five states and terminate at more than 200 electric generating and industrial plants in fifteen states. About 89% of this coal will move in unit trains. Unit train coal flows by origin and destination states are provided in Table 2.10 and mapped in Figure 2.5. Of the total of 142 million tons of coal originated by BN, over 129 million or some 90% will be mined in the states of Montana and Wyoming. The majority of this coal will be transported to five states - Illinois, Minnesota, Missouri, Texas, and Wisconsin. Note that coal will be moving over greater distances in 1980; this is made possible partly by transportation economies resulting from unit-train service and from railroads' ability to provide such service.

After identifying flows, various analyses as described in later sections were performed to select optimal routes or combinations of routes that this coal will follow. A schematic diagram of principal BN coal routes is given in Figure 2.6. Traffic on each of the rail links was projected for the years 1975, 1978, and 1980. These projections are shown in Table 2.11. The tonnage indicated in yearly gross coal tonnage per line segment mile. Each rail link listed in the table consists of several line segments. The traffic densities differ from segment to segment. The figures represent the maximum traffic at a point on a given link.

The six BN rail links with the heaviest coal traffic in 1980 are listed below. The rail link between Alliance and Lincoln, Nebraska, will have the highest coal traffic and is described in Section 2.3.3.6.

			Thousands of Tons/Segment Mile		
Ref.	From	To	1975	1978	1980
12	Nichols, MT	Casselton, ND	23,992	43,520	53,748
20	Alliance, NE	Lincoln, NE	18,437	84,017	128,797
21	Lincoln, NE	Kansas City, MO	-0-	21,780	53,539
22	Lincoln, NE	Burlington, IA	18,437	58,059	68,954
30	Wendover, WY	Denver, CO	-0-	-0-	53,293

Gross Coal Tonnage Per Line Segment Mile.

Dest'n State \ Origin State	Illinois	Montana	North Dakota	Utah	Wyoming	Total
Arkansas					9.25	9.25
Colorado					5.90	5.90
Illinois	1.25	10.70		6.00	6.00	23.95
Iowa					2.40	2.40
Kansas					6.50	6.50
Louisiana					3.37	3.37
Minnesota		14.40	0.70		0.80	15.90
Missouri	2.40	3.00			13.80	19.20
Nebraska					5.40	5.40
Oklahoma					9.60	9.60
Oregon					1.20	1.20
Texas		9.40			10.50	19.90
Wisconsin	2.00	12.70			1.30	16.00
Wyoming					3.00	3.00
Montana		0.55				0.55
Total	5.65	50.75	0.70	6.00	79.02	142.12

Table 2.10 Unit Train Coal Flows - 1980, Burlington Northern, Inc.
(Millions of Tons)

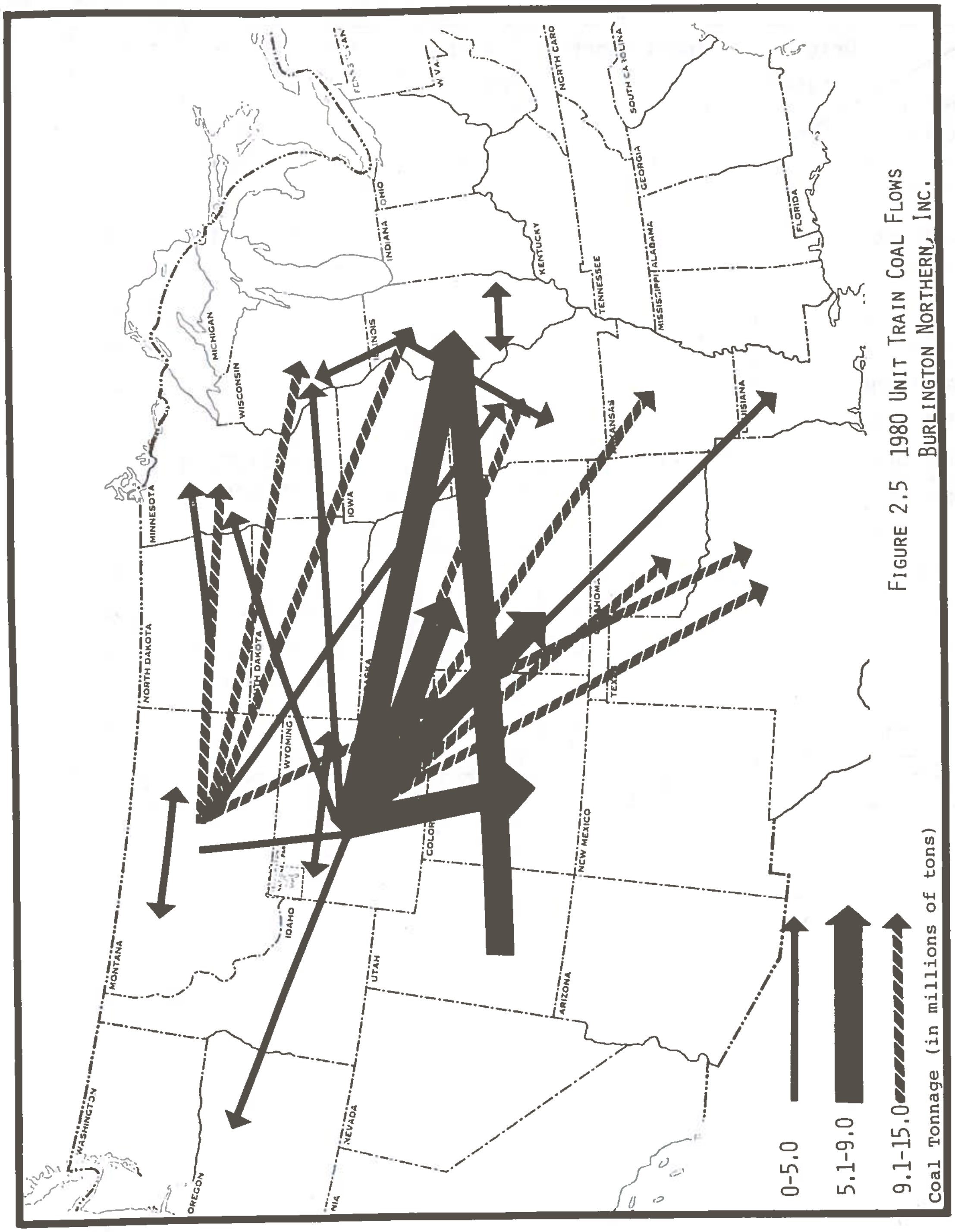


FIGURE 2.5 1980 UNIT TRAIN COAL FLOWS
BURLINGTON NORTHERN, INC.

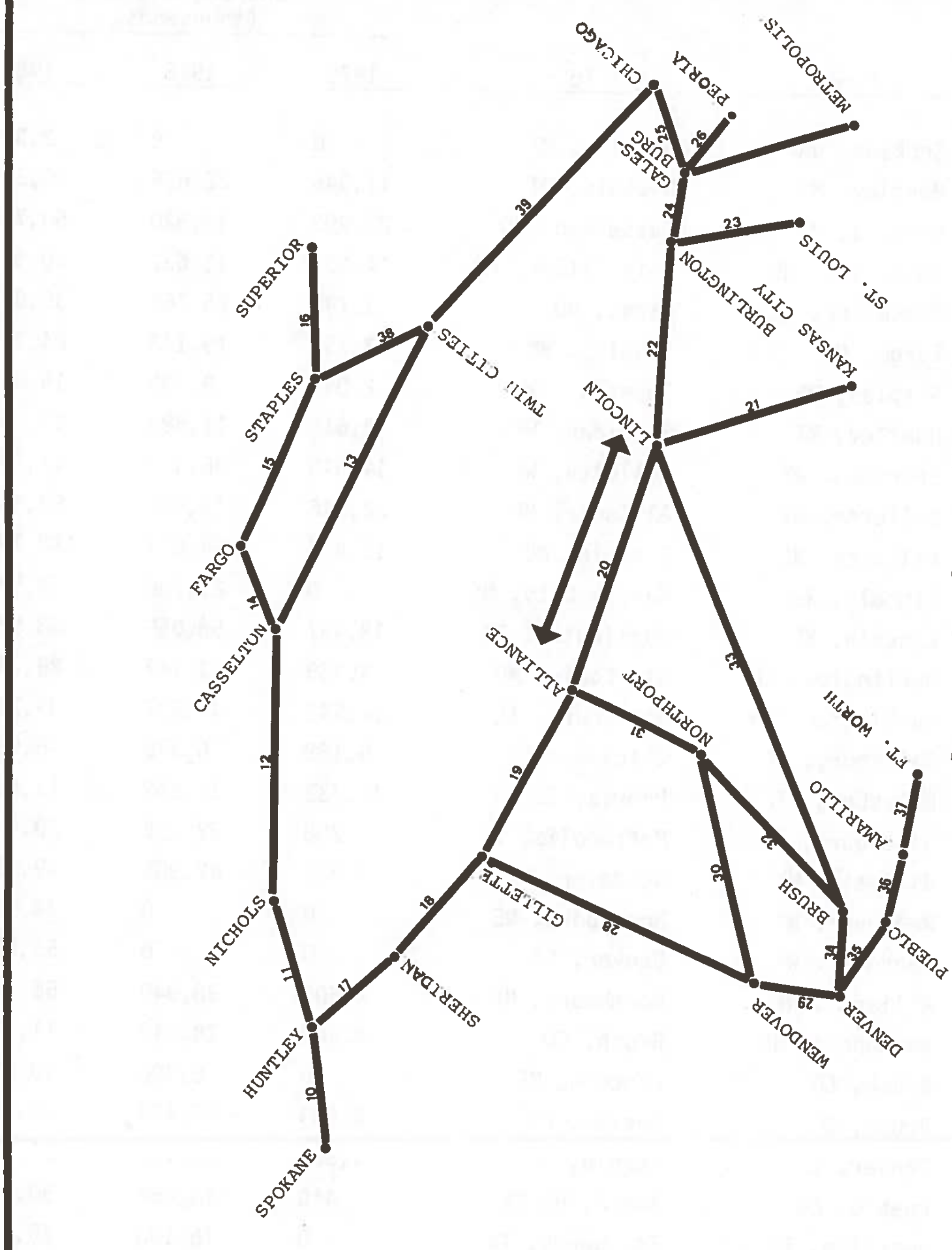


FIGURE 2.6 PRINCIPAL COAL ROUTES - BN

Reference	From	To	Tons/Segment Mile (thousands) 1975	1978	1980
10	Spokane, WA	Huntley, MT	0	0	2,317
11	Huntley, MT	Nichols, MT	11,345	22,666	30,316
12	Nichols, MT	Casselton, ND	23,992	43,520	53,748
13	Casselton, ND	Twin Cities, MN	14,035	15,622	16,522
14	Casselton, ND	Fargo, ND	9,792	25,767	35,095
15	Fargo, ND	Staples, MN	3,757	19,143	24,993
16	Staples, MN	Superior, WI	2,041	9,799	15,649
17	Huntley, MT	Sheridan, WY	2,615	11,583	18,850
18	Sheridan, WY	Gillette, WY	14,648	36,407	47,245
19	Gillette, WY	Alliance, NE	22,946	112,957	87,503
20	Alliance, NE	Lincoln, NE	18,437	84,017	128,797
21	Lincoln, NE	Kansas City, MO	0	21,780	53,539
22	Lincoln, NE	Burlington, IA	18,437	58,059	68,954
23	Burlington, IA	St. Louis, MO	3,339	13,147	29,740
24	Burlington, IA	Galesburg, IL	14,648	44,687	39,215
25	Galesburg, IL	Chicago, IL	6,138	6,876	6,930
26	Galesburg, IL	Peoria, IL	11,732	15,552	11,664
27	Galesburg, IL	Metropolis, IL	288	22,259	20,621
28	Gillette, WY	Wendover, WY	8,928	62,905	49,192
29	Wendover, WY	Northport, NE	0	0	34,909
30	Wendover, WY	Denver, CO	0	0	53,293
31	Alliance, NE	Northport, NE	4,509	28,940	56,360
32	Northport, NE	Brush, CO	4,509	28,940	11,999
33	Brush, CO	Lincoln, NE	0	6,300	10,800
34	Brush, CO	Denver, CO	4,509	29,439	10,800
35	Denver, CO	Pueblo, CO	4,509	23,139	34,909
36	Pueblo, CO	Amarillo, TX	410	18,862	30,236
37	Amarillo, TX	Ft. Worth, TX	0	16,180	26,651
38	Staples, MN	Twin City, MN	1,334	7,267	7,267
39	Twin City, MN	Chicago, IL	33	980	980

Table 2.11 Coal Traffic Projections

2.3.3 Route Volume and Capacity

2.3.3.1 Overview

This section illustrates the complex planning processes a major coal-carrying railroad follows to increase its line capacity. Rail carrying capacity between two points is a very complex subject. Elements that are considered in calculating rail capacity include tracks, track conditions, signal systems, train operating techniques, terminal congestion, population patterns along the route, terrain, cars, motive power, shops, and servicing facilities. There are several measures of capacity in the rail industry. For main lines, rail capacity is frequently expressed in trains per day or gross ton-miles per mile of track.

Generally, railroads continually examine and match their projected traffic or given line with link capacity. If they find that a link will not handle projected traffic (e.g. a unit train), then they would build up the link capacity by changing one or more elements that govern line capacity. Sometimes as an alternative to building up capacity they direct the traffic over an alternate route.

2.3.3.2 BN's Planning Process for Future Line Capacity Requirements

After forecasting volumes and identifying the routes (Section 2.3.2), BN develops a plan for incremental expansion and improvement of their fixed plant. This planning process is complex and uses computer simulations and other techniques. The whole BN system is segregated into main line segments with each segment being established after consideration of several factors including physical terrain, track condition, traffic characteristics, density of traffic, and others. The computer simulates increased train movements based on both expected increases in coal tonnage and the routes which this new production will follow. The simulation also considers other commodity flows. Computer outputs enable the planning personnel to optimize the arrangement for ballast and siding, improved signalling, new rail, and double track. This process allows step-by-step commitment to meet new capacity requirements and prevents premature investments in a given area.

The result of this complex planning process is a five-year track investment program. This is summarized below:

Year		Investment in Roadway (Millions of Dollars)
1976		$ 61.4
1977		101.2
1978		134.2
1979		87.9
1980		63.4
	TOTAL	$ 448.1

By the above track improvement program, BN in the next five years plans to install 1790 miles of rail relay, 358 miles of new track and siding, and 1402 miles of new CTC signalling.

2.3.3.3 Line Capacity Analysis

The background information on line capacity and track and signalling configurations provided in this subsection will help to more effectively understand the line capacity for the specific rail route discussed in Section 2.3.3.4.

Other things being equal, line capacity is heavily dependent on the type of track and signalling systems. There are various types of track configurations--they include single track, single track with sidings, alternating single and double tracks, and double tracks.

Sidings on single track permit bypassing of trains travelling in the same or opposite direction. Sizes (lengths) of trains bypassing each other are determined by the length of these sidings. The closer the sidings, the easier it is to arrange train "meets" and hence trains can be operated more frequently.

Signalling systems determine how closely the trains can be run on a given track. Signalling systems vary from timetable and train order at the lower end to centralized traffic control systems at the high end. "Timetable and train order" uses the train order signals at stations manned by telegraph operators. *"Meets" between trains are established by the dispatcher based on train progress reports he receives from the telegraph operators or from train crews via telephone or radio.

A centralized traffic control (CTC) system permits the dispatcher to establish meeting points by signal indication. A control panel in the dispatcher's office operates remotely all of the siding switches and signals, replacing the telegraph operators' office. The time lag in effecting a meet is reduced.

A discussion of train operating techniques based on signal systems and track configurations is provided in Appendix B.

Estimates of line capacity for various track configurations and signal systems are shown in Table 2.12. The estimates are based on the following assumptions:

- Train speed limits are fifty miles per hour
- Tracks are on average rolling terrain
- No priorities among trains are permitted
- No overtaking among trains going in the same direction is permitted

*Two trains encountering each other from opposite directions or from the same direction with different speeds.

Statement of Estimated BN Track Capacity for Coal Traffic

Type of track	TRACK CONFIGURATION: 2½ mile sidings 11 miles apart	TRACK CONFIGURATION: 2½ mile sidings 7 miles apart	TRACK CONFIGURATION: 5 mile sidings 7 miles apart	TRACK CONFIGURATION: 10 miles double 30 miles single track with 2½ mile sidings	TRACK CONFIGURATION: 10 miles double & 10 miles single	SIGNAL SYSTEM: Timetable & train order	SIGNAL SYSTEM: CTC	Average Coal Trains per day
Single track	x					x		10-15
	x						x	20-25
		x					x	30-35
			x				x	40-45
Alternating Single/double Track				x			x	50-55
					x		x	60-70
Double track							x	75-125

Table 2.12. Estimated Line Capacities Based on Conditions and Assumptions Shown in Paragraphs 2.3 through 2.3.3.4 for Routes Handling Coal Trains Only.

- o Six hours per day reserved only for maintenance of way and other contingencies is allowed
- o Allowable delay for trains is fifty minutes per hundred miles.

CTC allows a dispatcher to run the trains closer and thus it is possible to run more trains in a given time period. Note that the train traffic on a single track with 2-1/2 mile sidings every 11 miles can be doubled by installing CTC. By keeping the signalling system (CTC) the same and by increasing the length of sidings from 2-1/2 miles to 5 miles every seven miles, the capacity can be increased from 30-35 trains per day to 40-45 trains per day. With the increased length of sidings longer trains can be run and also a train when side tracked can keep moving at a slow speed while the other train passes by. This allows the train to pick up the speed faster and in less time.

2.3.3.4 Specific Route Volume and Capacity

The majority of coal produced in the Powder River Basin will flow to Midwestern and Southeastern markets over a BN line segment between Alliance, Nebraska and Lincoln, Nebraska. As indicated in Table 2.11, this segment will experience more growth in coal traffic than any other segment on the BN system. This growth of coal traffic is summarized below:

Thousands of Annual Gross Tons/Line Segment Mile				Trains/Day*			
1975	1980	Increase		1975	1980	Increase	
		Number	%			Number	%
18,437	128,797	110,360	599	5	35	30	600

* Based on 10,000 net tons per train

Coal Traffic Growth: Alliance, NE - Lincoln, NE; Burlington Northern, Ir

Presently a 365-mile line segment between Alliance and Lincoln is a single track with over one-mile long sidings approximately every ten to fifteen miles. Figure 2.7 illustrates a small section of this segment.

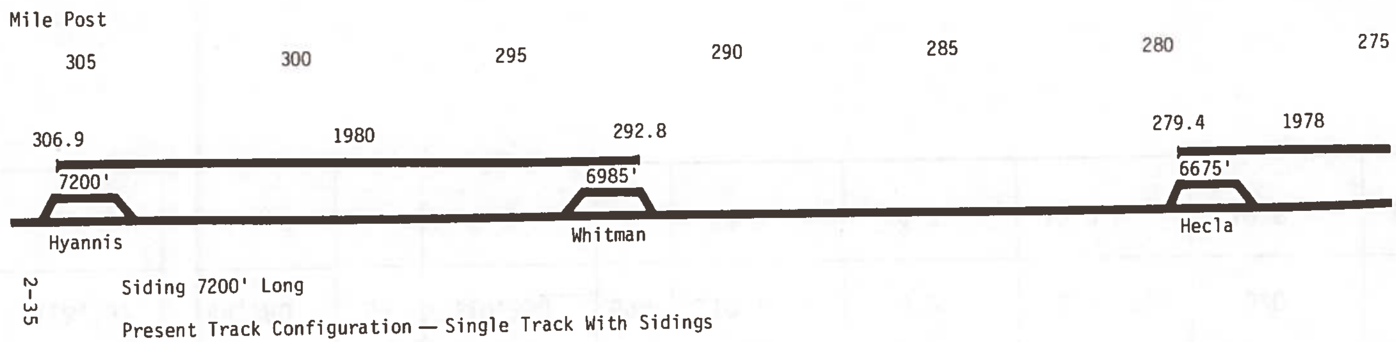
The section from Alliance to Ravenna, Nebraska is equipped with modified CTC. This CTC system has power switches centrally controlled at one end of the siding and a spring switch at the other. This allows the train to go into the siding from one end and go out at the other end. However, this does not permit the train to enter from the other end of the siding. The train can move into and out of the siding in one direction only. The rest of the segment--from Ravenna to Lincoln--has automated block signalling and uses train order techniques.

Estimated line capacity of the segment is approximately 15 to 20 trains per day. The computer simulation process previously described was applied to generate a track improvement program sufficient to accomodate the growth in coal and other traffic. The result was a program summarized in Table 2.13.

By 1977, BN plans to invest $28.7 million in main and yard tracks, rail relays, and signalling systems over this segment. This will enable BN to increase its annual coal traffic over the segment by 366%. In terms of train traffic, this is an increase of eighteen trains per day.

When the improvement program is fully implemented, the tracks between Alliance and Grand Island will be alternating ten-mile single and ten-mile double tracks. The section between Grand Island and Lincoln will be double-tracked.

The present CTC system between Alliance and Ravenna will be upgraded to allow bi-directional movements over the sidings. A new CTC system will be installed between Ravenna and Lincoln.



Note:
1. Line segment between Alliance, Nebrasks to Lincoln, Nebrasks is a single track with about one mile long sidings every ten miles. From Alliance to Ravenna it's equipped with CTC while the remainder, from Ravenna to Lincoln has Automatic Block Signalling.
2. By 1980, this segment will be alternating ten mile single and ten mile double tracks with CTC.
3. Between 1977 and 1980 Centralized Traffic Control will be upgraded / installed on the segment.

Figure 2.7 Illustration of a Link Build-up Between Alliance, Nebraska and Lincoln, Nebraska.

Year	Coal Traffic Thousands tons/mile	Increase over Previous Projection		Increase over 1975 Traffic		Track Improvements				
		Thousands tons/mile	%	Thousands tons/mile	%	Main Track (millions)	Yard Tracks (millions)	New Rail Relay (millions)	Signals (millions)	Total (millions)
1975	18,437	-	-	-	-	-	-	-	-	-
1976						2.7	0.0	2.2	2.6	7.5
1977						15.8	0.0	1.5	3.9	21.2
1978	84,017	65,580	356	65,580	356	30.0	3.0	2.2	4.0	39.2
1979						20.2	1.1	2.8	0.0	24.1
1980	128,797	44,780	53	110,360	599	10.1	0.2	2.2	0.0	12.5
Total						78.8	4.3	10.9	10.5	104.5

Table 2.13 Projected Coal Traffic and Planned Capital Expenditures, Alliance, NE to Lincoln, NE

With the above line improvements, the line capacity is estimated to increase to 70 trains per day (see Table 2.13). 1980 coal traffic is expected to be 35 trains per day. This will leave sufficient line capacity for other commodity traffic.

2.3.4 Coal Movement Description

One of the most dramatic marketing developments in coal traffic is the growth of unit trains and the bright prospect of an increasing demand for this efficient rail service. The unit train has been defined in various ways. Basically, it is a specialized train of coupled cars designed for automated loading and unloading and moving between origin and destination on a predetermined schedule over a fixed route carrying certain minimum amounts of a single commodity.

The unit train concept is of great importance to the Western railroads. One survey of Western railroads has shown that the majority--about 87%--of Western coal will move in unit trains. Table 2.14 summarized the results of our survey on the percentage of coal moving in unit trains in 1980.

With the unit train service has come the idea of "Total Delivery System". In this system, combined efforts of the utility plant, mine company, and railroad are brought together to provide a lowered delivered price of coal. Consumers and producers have come to realize that loading and unloading facilities play a crucial role in an efficient coal movement. This, of course, also affects the railroad's capacity to deliver coal and effectively use the equipment. This was clearly demonstrated to us during our field trip to two power plants in Minnesota. One power plant has a modern rotary dumper with loop track, while the other one, in a metropolitan area, has traditional unloading devices due to space restrictions. In the first case, the train unloads in about four hours

Railroad	% of Total Coal in Unit Train
1	100
2	100
3	70
4	97
5	90
6	80
7	89
8	100
9	25
10	75
Weighted Average	87

Table 2.14 Percentage of Total Coal Moving in Unit Trains--1980: Selected Railroads in the Western District

without stopping, while in the latter case the train had to be broken and car cuts of 13 to 18 cars had to be delivered to the utility plant. Unloading time for the latter is about 36 hours.

The sections that follow describe representative coal movements in the Western Railroad District. They include:

- o Optimal unit train movement with modern loading and unloading facilities.
- o Suboptimal unit train movement to an older electric generating plant with traditional unloading facilities.
- o Unit train movement with rail interchange and rail-to-water transfer.
- o Multi-care movement.

2.3.4.1 Unit Train Movement--Ideal

The ideal unit train operation allows rail carriers to increase equipment utilization, reduce labor costs and improve customer service. This reduces the overall costs of transporting coal and makes it possible for railroads to offer a reduction in coal rates. It is expected that the future coal unit train operation will be designed to suit the near ideal situation. One such train operation is described in Section 5.2.4.2. Characteristics of an ideal unit train are described below.

Rate(s) and Volume(s) Governing Train: Tariff provides one or more volume rates applicable to the movement of one or more minimum volume tonnages during a specified time period--generally twelve consecutive months.

Integrity of Train: Complete train, including locomotives, cars, caboose, but not always the radio-controlled units if used, remain coupled during the entire trip cycle.

Radio-controlled Units in Train: Train may be uncoupled during each trip only for adding or removing radio-controlled units due to grade constraints on part of route.

Inspection and Maintenance of Train: All 500-mile and daily inspections and servicing of cars and locomotives are performed on completely coupled train. Train may be uncoupled for monthly locomotive inspection and emergency car and locomotive maintenance.

Number and Size of Trains: The number and size of cars, locomotives, and trains is governed by the annual tonnage to be shipped, the length and topography of the route, and the physical characteristics of the railroad(s), the origin shipping facility, and the destination receiving facility.

Loading, Unloading, and the Interchange of Train: Loading and unloading is performed within four hours at each facility. Interchanging of the train between railroads is performed on a complete train run-through basis.

The idealized unit train operation is depicted in Figure 2.9.

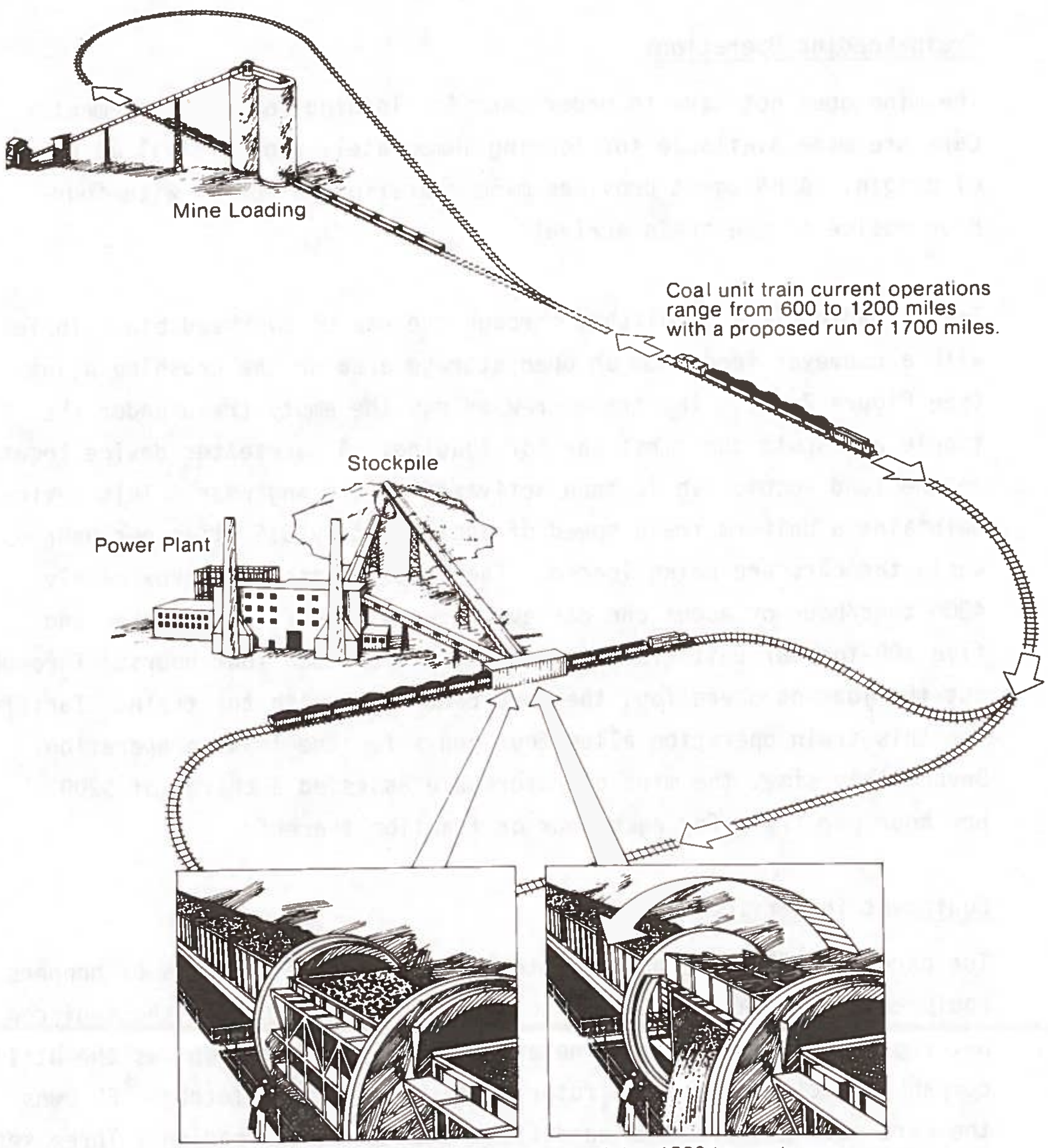
2.3.4.2 Unit Train Movement--Optimal

A near ideal BN unit train operation is supplying Montana coal to an electric generating facility in Becker, Minnesota. Efficient loading and unloading facilities permit faster turn-around and better equipment utilization. This coal movement is described briefly in the following paragraphs.

Operation of Mine

Coal originates at a strip mine in Colstrip, Montana. Drag lines are used to take the overburden off and then coal is removed by large shovels. Trucks are used to bring the coal to an open storage near the railroad. The truck haul varies from one-half to one and one-half miles. A fleet of six 100-ton trucks is used to transport coal over private roads.

Coal Unit Train Transportation System



As train arrives at unloading area, the car locked in the dumping cradle . . .

. . . rotates 180° to empty contents. Rotary coupler allows cars to remain coupled as a unit.

Figure 2.8

Front end loaders push coal onto a conveyor through a hole near the stockpile. The conveyor brings coal to a crushing plant, where crushed coal is fed to a tipple hopper for loading the rail cars or brought back to the storage area by conveyors.

Train Loading Operations

The mine does not have to order cars for loading for each movement. Cars are made available for loading immediately upon arrival at point of origin. A BN agent provides mine operation personnel with four-hour notice of the train arrival.

Train loading is accomplished through the use of overhead bin (tipple) with a conveyor feed from an open storage area or the crushing plant (see Figure 2.9). The train crew brings the empty train under the tipple and spots the first car for loading. A pacesetter device located in the lead locomotive is then activated by the engineer. This device maintains a uniform train speed of approximately 0.5 miles per hour while the cars are being loaded. The loading rate is approximately 4000 tons/hour or about one car every two minutes. One hundred and five 100-ton car unit train is loaded in less than four hours. Throughout the loading operation, the road crew stays with the train. Tariffs for this train operation allow four hours for the loading operation. Beyond this time, the mine operators are assessed a charge of $200 per hour per train for each hour or fraction thereof.

Equipment in Service

The cars are 100-ton capacity, steel, solid bottom gondolas or hoppers equipped with rotary couplings to permit rotary dumping without disconnecting. The primary factor determining the cars' design was the utility company's decision to use a rotary dumping unloading method. BN owns the cars and maintains and conditions them prior to loading. Three sets of 105 cars will be employed when the plant becomes fully operational.

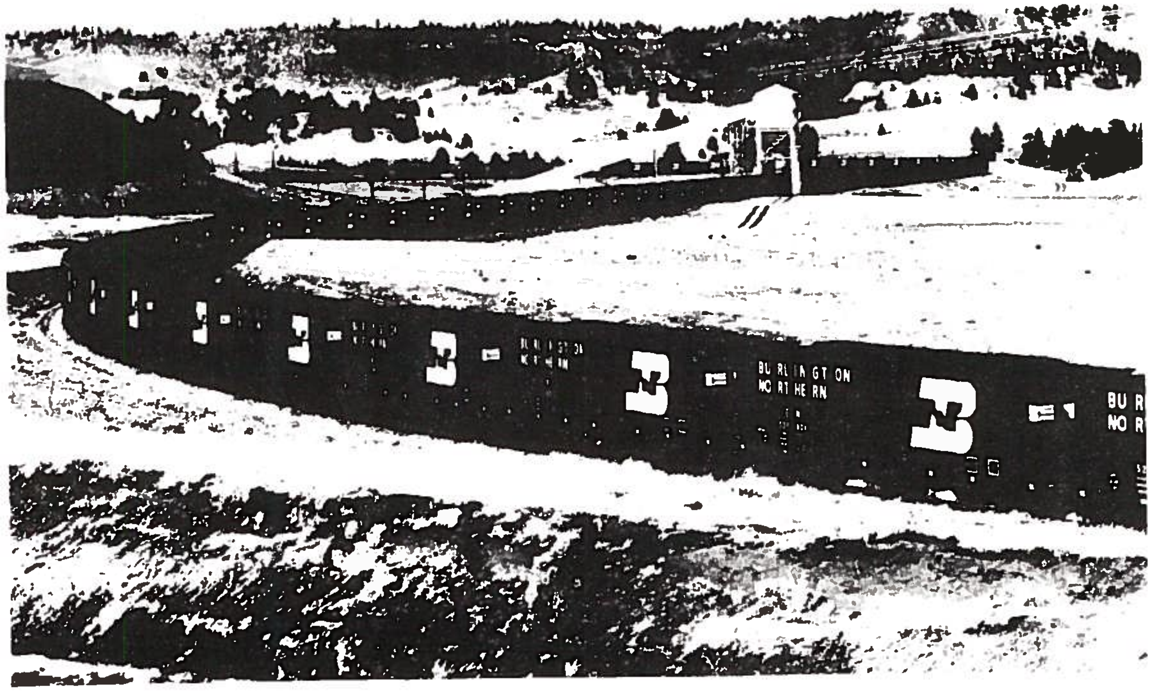


Figure 2.9 Unit Train Loading Operation, Burlington Northern, Inc.

Train Operation

The train moves along the BN routes from origin to destination. The movement and associated operational events are shown in Figure 2.11.

The motive power for the train over the majority of the route consists of four 3000-horsepower locomotives. When the train leaves the mine, there are five locomotives pulling it. The fifth locomotive is needed to pull the train over Fryberg. At Mandan, the fifth locomotive is taken off and a 500-mile inspection is performed. This inspection is required by ICC regulations. At this point, locomotives are serviced and a new crew takes over the train.

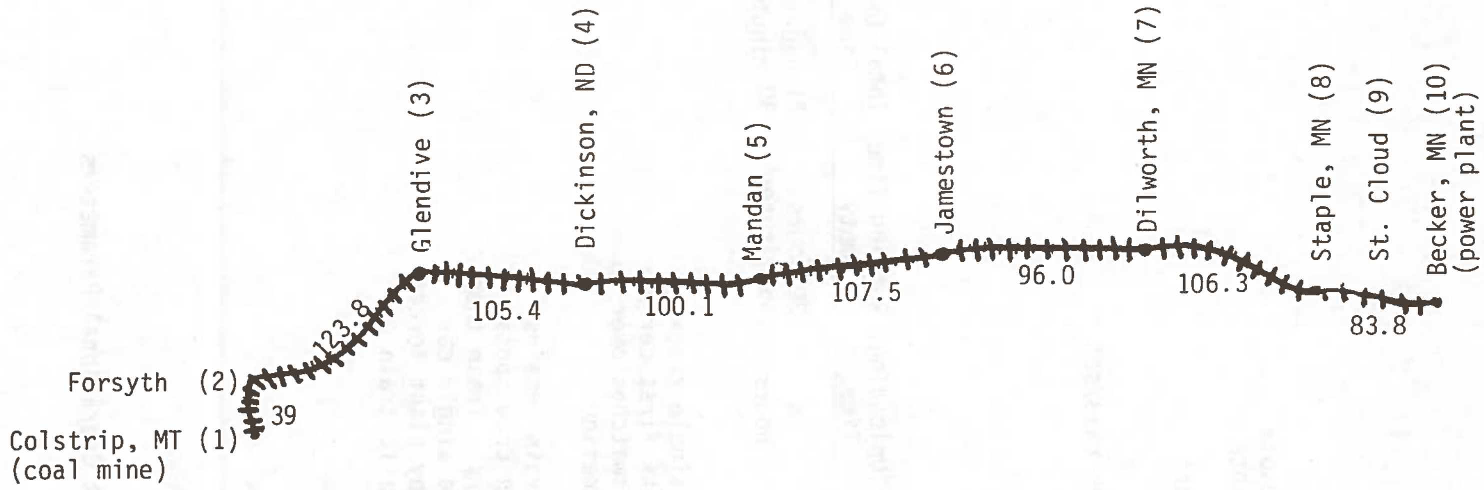
After several crew changes the train arrives at the plant. The train unloading is accomplished by rotary dumper and described in subsequent paragraphs.

At Staples, MN another 500-mile inspection is performed on the empty train during its return trip and the crew is changed. At Mandan, the empty train is inspected again for damaged cars. The damaged cars are taken off or repaired at this time.

Spare cars are stored at Glendive. If the train needs more cars, they are picked up from Glendive on its return empty trip. The 1524-mile round trip, including crew changes, inspection, and loading and unloading, is completed in about 84 hours. Pertinent operational parameters are provided in Table 2.15.

Train Unloading

The train arrives at a utility plant on a loop track and pulls up to the rotary dumper house. The road crew spots the first three cars and then the train indexer is turned on. The indexer pulls the entire train through the dumper house, one car-length at a time. After it advances the train, the car in the dumper area is



	1	2	3	4	5	6	7	8	9	10
E Train Loading	x									
V Service Power					x					
E Locomotive Removal					x					
N 500-mile Inspection					x					
T Crew change		x	x	x	x	x	x	x	x	
REFERENCE LOCATION:	1	2	3	4	5	6	7	8	9	10
E Crew change		x	x	x	x	x	x	x		
V 500-mile inspection								x		
E A locomotive added			x							
N Complete train check					x					
T Train unloading										x
	1	2	3	4	5	6	7	8	9	10

Figure 2.10 Unit Train Movement — Optimal: Burlington Northern, Inc.

Origin:	Forsyth, Minnesota
Destination:	Becker, Minnesota
Routing:	BN, Direct
Frequency:	Two per week/set
Cars in Service:	3 sets 105 hundred-ton cars/set
Car Ownership:	BN
Tons/train:	10,500 tons
Round trip Distance:	1524 miles
Schedule:	

Loading Time	Running Time Loads	Unloading Time	Running Time Empty	Total Cycle Time
4 hours	32 hours 30 minutes	4 hours	30 hours 45 minutes	71 hours 30 minutes

Loading:	Loop loading, single track. Train crew spots first car for loading, then switches over to Pacesetter operation.
Unloading:	Loop Track. Train remains coupled. Train crew spots first three cars. Train then moves through a single car rotary dumper by plant forces using an automatic train positioner.
Tariff Authority:	BN 231

Table 2.15 Pertinent Operational Parameters

locked into position and turned upside down over a hopper (see Figure 2.12). The coal is then carried by a system of conveyor belts out from the basement of the dumper to the stockpiles. As the cars are equipped with special rotary couplers, it is not necessary to uncouple the cars for unloading.

Coal-removal capacity of the belt is about 3500 tons/hour. When the entire train has been dumped, a process that takes four hours, the train begins the return trip to Staples, Minnesota.

2.3.4.3 Unit Train Movement--Suboptimal

The train operation described in this subsection is suboptimal in that the train is broken into smaller lots in a yard and then brought to plant for unloading.

The Montana coal is brought to an electric generating facility in Minneapolis by BN unit train service. Operations at mine and train loading and movement are very similar to the optimal case described above. There are 67-70 cars in this unit train service. Cars are 100-ton capacity steel drop-bottom hoppers or gondolas. The principal difference between this unit train operation and the one previously described is train handling at destination. The plant is old and due to its location has severe space restrictions. It is not equipped with modern unloading facilities and represents a suboptimal unloading operation.

The space restriction prohibits a loop track or full train length tracks on both sides of the unloading point (dumper house). The track layout at the plant is shown in Figure 2.13. Four tracks in front of the dumper house hold about sixteen to twenty cars each. Two tracks leading into the dumper house hold four cars each over the hoppers installed under the tracks.

The unit train, after travelling about 824 miles, arrives at the BN Grove Yard in Minneapolis. The road crew spots the train on the

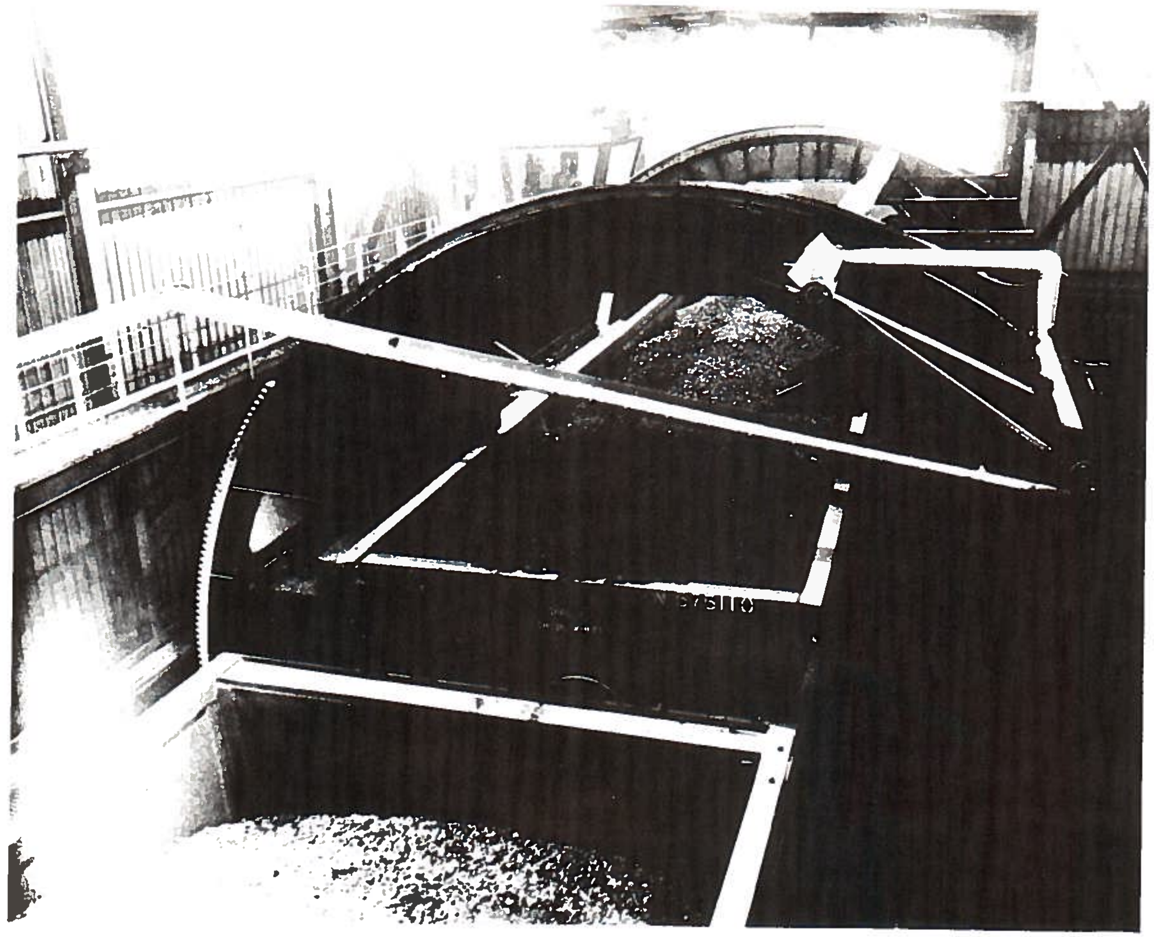
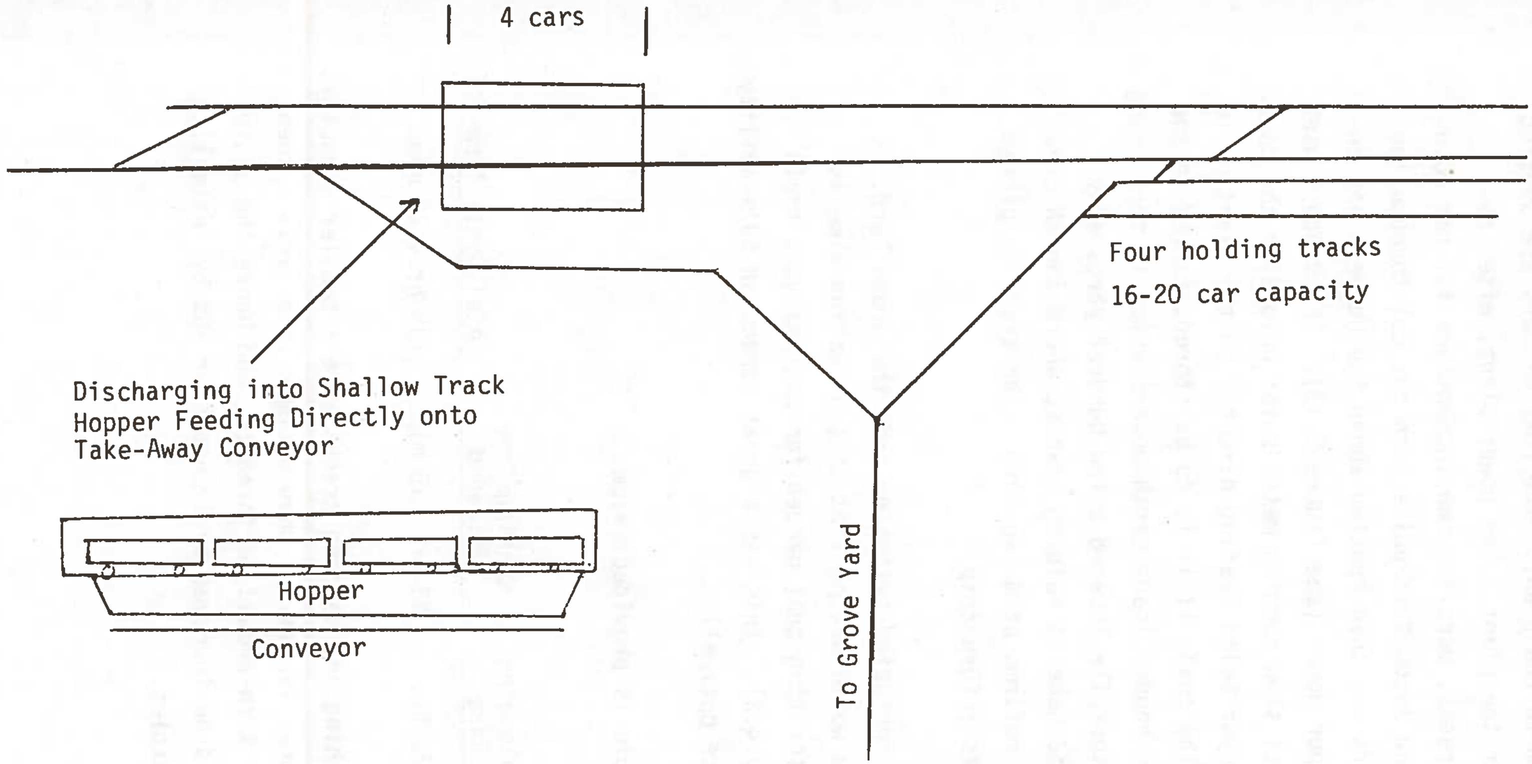


Figure 2.11 Rotary Car Dump Allows Fast Unloading of Unit Trains.



Notes: 1. Two tracks in dumper house can hold four cars each.
2. Cars are dumped into eight hoppers that feed to conveyors leading to plant or storage area.

Figure 2.12 Track Configuration at the Utility Plant Unit Train Operation--Suboptimal yard track, and a switch crew breaks the train in cuts of 14-18 cars and shuttles them to the plant. The cuts of cars are spotted on holding tracks near the plant. The power plant, after receiving cars on its tracks, uses its own locomotives for car movement when desired. The locomotive pulls each car cut through the dumper house. The cars are then spotted above the hoppers and unloaded by opening hopper doors (see Figure 2.13). The process uses conventional mechanical slow dumping methods for unloading the cars. The hoppers feed conveyor belts leading directly to the plant or to an elevated hopper. The coal, if it is to be stored, is fed to the elevated hopper. This hopper loads earth movers which in turn bring the coal to an open stockpile located a few hundred yards away. Empty cars are switched back to holding tracks, where the BN crew picks up the cars and reforms at Grove Yard. The train is picked up by road crew for its return trip.

Total unloading time, including switching from the Grove Yard, is about 36 hours. It is worth noting that this unloading time is about nine times greater than that needed for optimal unit train unloading (Section 2.3.4.2). This has a great impact on BN's ability to operate this service optimally.

The total train schedule is provided below:

Loading Time	Running Time Loaded	Unloading Time	Running Time Unloaded	Total Cycle Time
4 hr.	35 hr.	36 hr.	33 hr., 15 min.	108 hr., 15 min.

Because the yard switching and holding tracks have a smaller capacity, the train size (70) cars) is smaller than optimal (105 cars). Theoretically, the train's turn-around performance, and hence the equipment utilization, could be improved by 32 hours or 30% by installing modern unloading facilities.

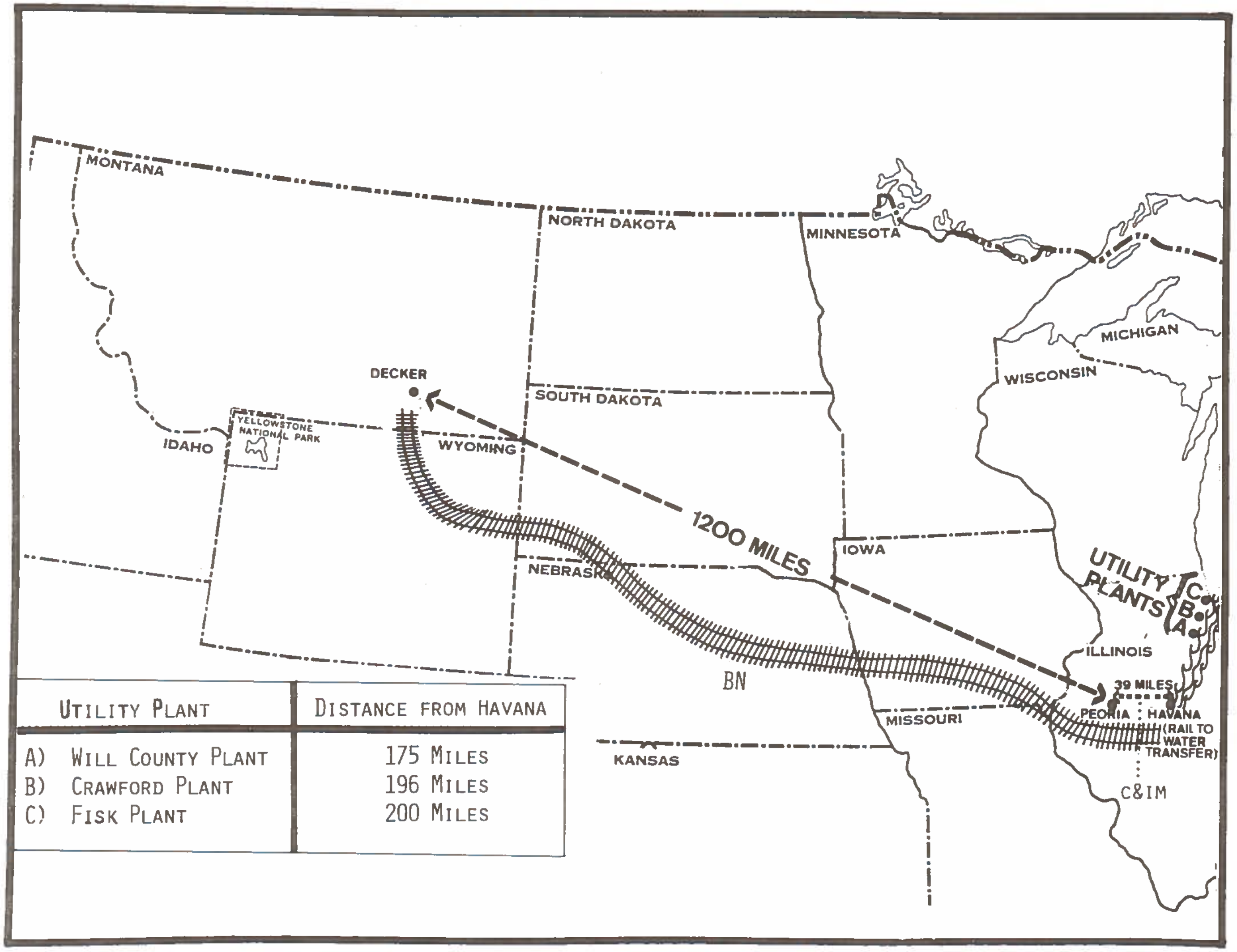
2.3.4.4 Unit Train Movement--Rail Interchange and Rail-to-Water Transfer

A complex rail-barge movement involving Burlington Northern and Chicago & Illinois Midland railroads and the Valley Line (barge) Company is bringing Decker, Montana coal to Commonwealth Edison Company's three electric generating facilities in the Chicago area (see Figure 2.14). Annually, about five million tons of coal are brought to Havana, Ill. by rail, transferred to barges and towed to three utility plants located on the Illinois River.

At Decker, Montana, large 75-100 ton trucks carry the coal over private roads from a strip mine to a crusher. The distance between the mine and the crushing plant is approximately one mile. After the crushing operation, coal is brought to siloes for storage by conveyor. A road crew spots the first car on a unit train under a tipple hopper. After the loading operation commences, the train moves at about one-half mile per hour by utilizing a pacesetter until all cars are loaded. Figure 2.15 illustrates this loading operation. The train loading operation is generally completed in two hours; however, the tariff allows four hours for this operation.

The train generally has one hundred 100-ton hopper or gondola cars. In addition to five locomotives in front of the train, a pusher service of two 3000-horsepower locomotives is used to bring the train from the mine to a main line. Similar pusher service is used to provide additional motive power to push the train over Crawford Hill in Nebraska. After Lincoln, only four locomotives are required to pull the train to Peoria, Illinois.

At Peoria, the train is interchanged with the Chicago & Illinois Midland Railroad (C&IM). BN locomotives and caboose are removed and the C&IM locomotives added for the train's 39-mile journey to the Havana docks. At this point, an interchange inspection is performed. No per diem charges are assessed against C&IM. The time required to change motive power and caboose and to perform the interchange inspection delays the train as much as two hours.



Utility Plant	Distance from Havana
A) Will County Plant	175 Miles
B) Crawford Plant	196 Miles
C) Fisk Plant	200 Miles

Figure 2.13 Rail-Water Coal Movement, Burlington Northern, Inc.

Figure 2.14 Train loading Operation.

After the train is unloaded, it is brought back to Peoria by C&IM. Under the labor contracts, westbound car movement in Peoria can be handled only by the Peoria and Pekin Union Railway (P&PU). Thus, on the return empty trip, C&IM has to interchange the train with P&PU and it in turn returns the train to BN. This interchange involves considerable delay, sometimes as long as six hours.

Depending on volume, BN employs about 12-16 sets of equipment in this service. An approximate schedule for this unit is provided in the chart below:

Loading Time	4 Hours
Running Time, Loaded	59 Hours, 20 Minutes
Unloading Time	24 Hours
Running Time, Unloaded	63 Hours, 15 Minutes
Total Cycle Time	150 Hours, 35 Minutes

The C&IM road crew brings the loaded unit train to Havana and spots it on a yard track. A switch crew breaks the train into two 50-car cuts and brings them to unloading facilities.

At the dockside, a single car rotary dumper unloads the cars. Cars are pulled up to the rotary dumper by a hydraulically operated mechanism called a "barney mule". Rotary dumper design does not permit unloading without uncoupling each individual car from the unit train. The train can be unloaded in approximately twenty-four hours.

Coal can either be dumped to open storage or conveyed directly to the barge on dockside. The open storage method is used to stack about fifteen trainloads or 150,000 tons of coal.

Valley Line Company utilizes two hundred 1200-ton barges to move this coal from Havana to three Edison plants. Barges can be loaded directly from the rotary dumper or from the stockpile. Loading from the stockpile involves a rotary wheel traveling along the pile. It reclaims the coal from the pile and dumps it on a conveyor. The conveyor carries the coal to a hopper feeding the barge. After the loading is completed, a tow is formed with fifteen barges. A tow boat pushed the barges to the three plants located on the Illinois River. Approximate distances to these plants from the Havana docks are given below.

Plant	Distance In Miles
Will County	175
Crawford	196
Fisk	200

The docks at each of the plants are owned by the utility company. Barges are unloaded by a crane traveling along the tracks along the dockside. The crane is a gantry type, and is equipped with a clamshell bucket. The crane dumps coal into a hopper which either feeds the conveyor leading to the stockpile or the plant directly. River freezing during the winter does not permit smooth scheduling of barge movements. However, mild winters in the last two or three years have prevented any major problems.

3. SOUTHERN RAILROAD DISTRICT/ASSOCIATION

3.1 Overview

Railroads are assigned to the Southern District by the ICC on the basis of primary area of operations. Geographically the Southern District comprises the section east of the Mississippi River and south of the Ohio River to a point near Kenova, West Virginia, and a line thence following the eastern boundary of Kentucky and the southern boundary of Virginia to the Atlantic. This area was shown in Figure 1.2.

The Southern Freight Association (SFA) is a voluntary association of railroads that operate in the Southern District. Railroads that operate over a wide geographic area generally belong to more than one regional association. The list that follows identifies major coal-carrying SFA member line roads. The list also denotes railroads that participated in the study by completing questionnaires and assessing the validity of certain key Project Independence transportation assumptions. In addition, the Louisville and Nashville Railroad Company cooperated and worked with the contractor to prepare descriptions of coal operations, flows, etc. These descriptions are considered similar to the operations on other railroads operating within the district. The descriptive material is presented in Section 3.2. The SFA major coal carriers:

*Clinchfield Railroad
*Illinois Central Gulf Railroad
*Louisville and Nashville Railroad
Seaboard Coast Line Railroad
*Southern Railroad

*Denotes study participant.

Tables 3.1 and 3.2 that follow present a profile of 1974 Southern District bituminous coal operations. The material is organized and

	(In thousands of tons)								
	Originated and				($000's)	% Eastern RR		% Total US	
Railroad	Term. On Line	Del. To Connect.	Total Originated	Total Carried [1]	Revenue Received	Tons	Rev.	Tons	Rev.
Clinchfield	4,541	3,370	7,911	14,963	26,236	10.0	7.2	2.6	1.4
ICG	13,465	11,855	25,320	27,841	64,170	18.5	17.6	4.7	3.5
L & N	19,572	31,601	51,173	52,796	145,592	34.8	40.0	9.0	8.0
SOU	22,299	3,337	25,636	36,803	95,865	24.5	26.3	6.3	5.3
sub total	59,877	50,163	110,040	131,903	331,863	87.8	91.1	22.6	18.2
Other Southern Railroads	11	74	85	18,377	32,581	12.2	8.9	3.1	1.8
Total Southern District	59,888	50,237	110,125	150,280	364,444	100.0	100.0	25.7	20.0
Total All Districts	216,382	171,322	387,704	587,783	1,826,029	--	--	100.0	100.0
% Southern to Total	27.7	29.3	28.4	25.6	20.0				

Source: Coal Traffic Manual, 1975

Note: 1. Includes coal received from other lines and terminated on line and delivered to connecting lines.

Table 3.1. Bituminous Coal Handled by Selected Southern Railroads - 1974.

Railroad	Cars (1)	Capacity (000 Tons)	100 Ton Equiv. Cars	% of Southern District Cars	% of Total U. S. Cars
Clinchfield	4,251	316	3,160	5.84	1.24
ICG	11,972	981	9,810	16.45	3.49
L & N	32,527	2,350	23,500	44.70	9.47
SOU	12,858	1,111	11,110	17.67	3.75
Other Southern Railroads	11,163	(2)	(2)	15.34	3.24
Total Southern District	72,771	--	--	100.00	21.19
Total All Districts	343,392	26,613	266,130		

Source: Coal Traffic Annual, 1975

Notes: 1. Car totals include new, rebuilt, leased, and returned cars.

2. Data not available.

Table 3.2 Profile of Hopper Car Fleet: Southern District, 1974 and presented in terms of volume of traffic handled, revenues received, and cars furnished by the four participating railroads, total Southern District railroads, and all U. S. railroads. With respect to U. S. totals, the four participating railroads accounted for some 22.6% of the total coal carried and 18.2% of the total revenues earned.

In the sections that follow, 1974 profile information is used to help focus changes in expected 1980 levels of operations, distribution patterns, and associated investment requirements.

3.2 Survey Responses and Findings

3.2.1 Estimated Coal Traffic Volumes, 1980

Participating railroads were asked to project Southern District coal movements on the basis of origin and destination states and the type of movements involved. Consolidated traffic projections for these parameters are presented in Tables 3.3 and 3.4. When possible, 1974-1980 comparisons are made to illustrate the magnitude and direction of expected changes, if any.

The participating railroads project to originate over 157 million tons of coal in 1980 as compared to about 110 million tons in 1974. This is an increase of about 47 million tons or some 43% over 1974 originated coal traffic. Of the total rail originated coal in the Southern Railroad District in 1980, approximately 72 million or 46% is expected to be mined in the State of Kentucky.

To provide a visual picture, coal movements are mapped in Figure 3.1. It shows that the coal produced in the Applachian and Eastern Interior Field will flow generally south and southeast and coal distribution patterns will remain very similar to those in 1974. The mines located in the midwestern fields of Illinois, Indiana and western Kentucky have historically been competitive with each other to the Illinois,

Destinations	Origins AL	IL	IN	KY	TN	VA	Total
AL	12,100			900	500		13,500
GA	900		1,700	600	2,400		5,600
IN		2,500	5,400			429	8,329
KY			300		800		1,100
NY						330	330
NC				324	1,100	9,230	10,654
OH						1,182	1,182
PA						680	680
SC				129	400	809	1,338
TN			300	178	1,000	3,284	4,762
VA				400		11,172	11,572
Other (1)		27,230		69,800	1,300		98,330
Total	13,000	29,730	7,700	72,331	7,500	27,116	157,377

Note: 1. Other includes the data for which destination states were not identified or grouped together.

Table 3.3. 1980 Rail Coal Originations and Destinations: Southern District (Thousands of Tons).

<table>
<tr><th>Year</th><th>Originating & Terminating On Line(4)</th><th>Originating & Delivered To Connection(4)</th><th>Received from Connection & Term. On Line(4)</th><th>Received from Connection & Del. to Conn.(4)</th><th>Total Traffic(1)</th></tr>
<tr><td>1980 (2)</td><td>106,184</td><td>51,191</td><td>25,525</td><td>10,876</td><td>193,776</td></tr>
<tr><td>1974 (3)</td><td>59,877</td><td>50,163</td><td colspan="2">21,863</td><td>131,903</td></tr>
<tr><td>Tonnage Increase</td><td>46,307</td><td>1,028</td><td colspan="2">14,538</td><td>61,873</td></tr>
<tr><td>% Increase</td><td>77.3</td><td>2.1</td><td colspan="2">66.5</td><td>46.9</td></tr>
</table>

Notes:
1. Includes coal traffic for Clinchfield, ICG, L & N, and Southern Railroads.
2. Source: IOCS survey of selected railroads in the Southern District.
3. Source: Coal Traffic Annual, 1975.
4. Thousands of Tons

Table 3.4 A Comparison of 1974 and 1980 Coal Rail Traffic for Selected Railroads in the Southern District.

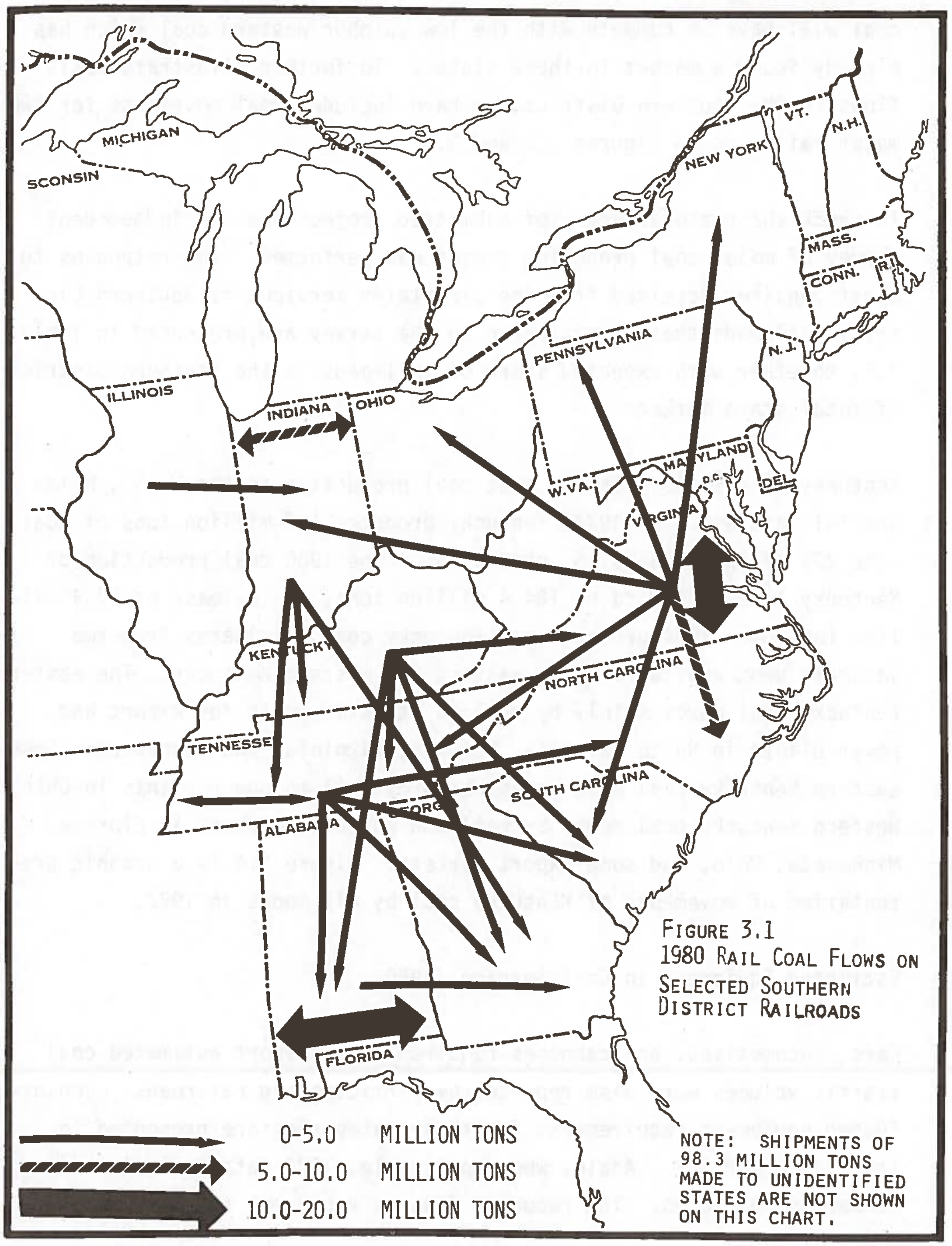


FIGURE 3.1
1980 RAIL COAL FLOWS ON SELECTED SOUTHERN DISTRICT RAILROADS

Indiana, Iowa, Minnesota, Missouri and Wisconsin coal receiving markets. This will continue to be true for the future, however, the midwestern coal will have to compete with the low sulphur western coal which has already found a market in these states. To further illustrate coal flows in the Southern District, we have included coal movements for two major railroads in Figures 3.2 and 3.3.

To check the reasonableness of submitted projections, an independent survey of major coal producing states was performed. The responses to questionnaires received from the six states serviced by Southern District railroads that participated in the survey are presented in Table 3.5, together with expected share of railroads in the Southern District of total state markets.

Kentucky, the state with the most coal production in the U. S., holds special interest. In 1974, Kentucky produced 137 million tons of coal, some 23% of the total U. S. production. The 1980 coal production of Kentucky is expected to be 184.4 million tons, an increase of 47.4 million tons over 1974 production. Kentucky coal originates from two separate geographical areas - eastern and western Kentucky. The eastern Kentucky coal moves mainly by rail to Atlantic ports for export and power plants in North Carolina, Georgia, Virginia, and Tennessee. Some eastern Kentucky coal also moves north by rail to power plants in Ohio. Western Kentucky coal moves by rail and water to markets in Florida, Minnesota, Ohio, and some export markets. Figure 3.4 is a graphic presentation of movements of Kentucky coal by all modes in 1972.

3.2.2 Estimated Equipment in Coal Service, 1980

Cars, locomotives, and cabooses required to transport estimated coal traffic volumes were also reported by participating railroads. Consolidated equipment requirements for these categories are presented in Tables 3.6 and 3.7. Again, when applicable, 1974 data is included for comparison purposes. The reported figures represent the cars that

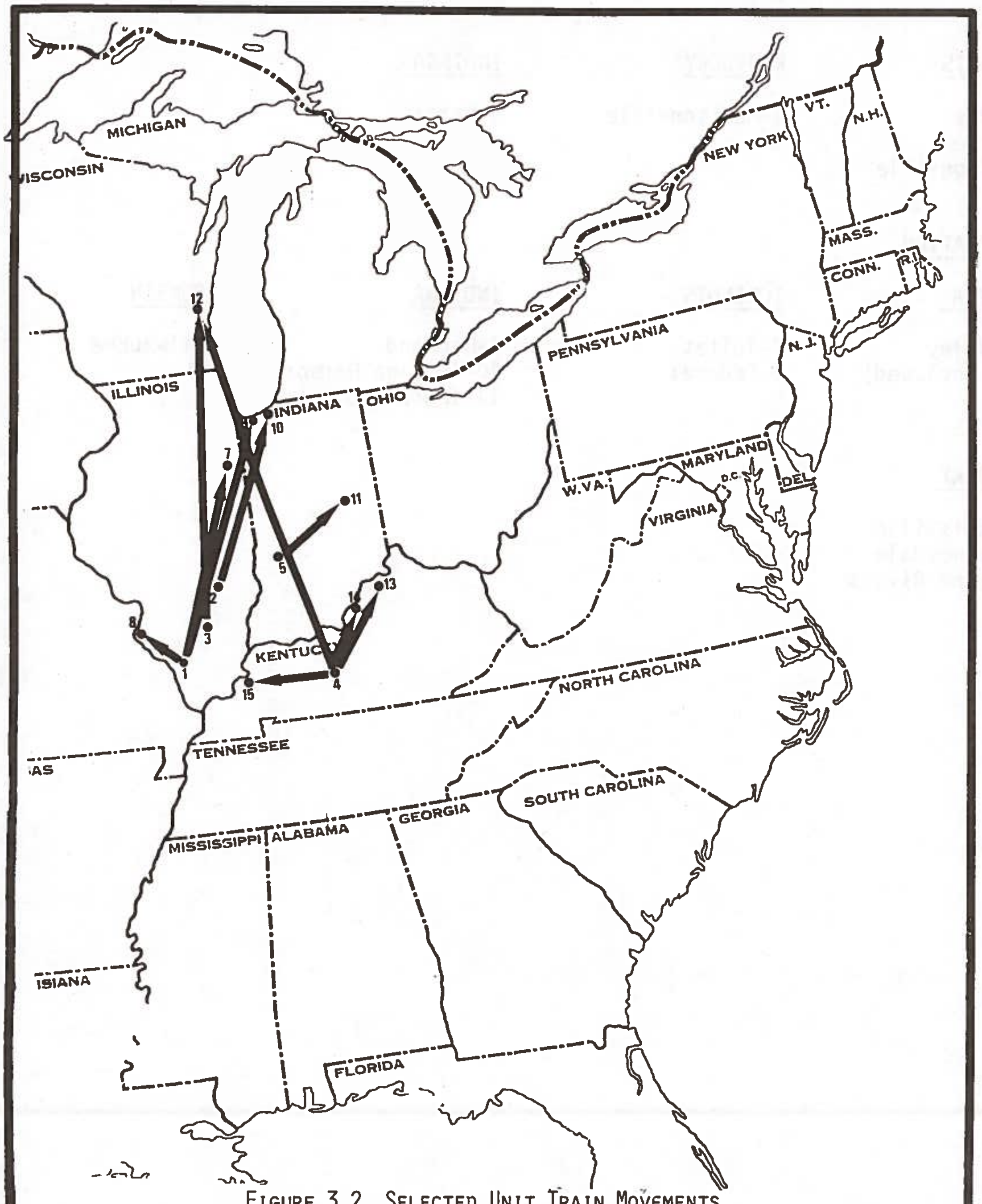


Figure 3.2 Selected Unit Train Movements
Illinois Central Railroad

ORIGIN

ILLINOIS	KENTUCKY	INDIANA
1-Percy 2-Jesse 3-Waltonville	4-Madisonville	5-Latta

DESTINATION

GEORGIA	ILLINOIS	INDIANA	WISCONSIN
6-Wansley (not included)	7-Joliet 8-Federal	9-Hammond 10-Indiana Harbor 11-Indianapolis	12-Milwaukee

KENTUCKY

13-Louisville
14-Kosmosdale
15-Grand Rivers

Key to Figure 3.2

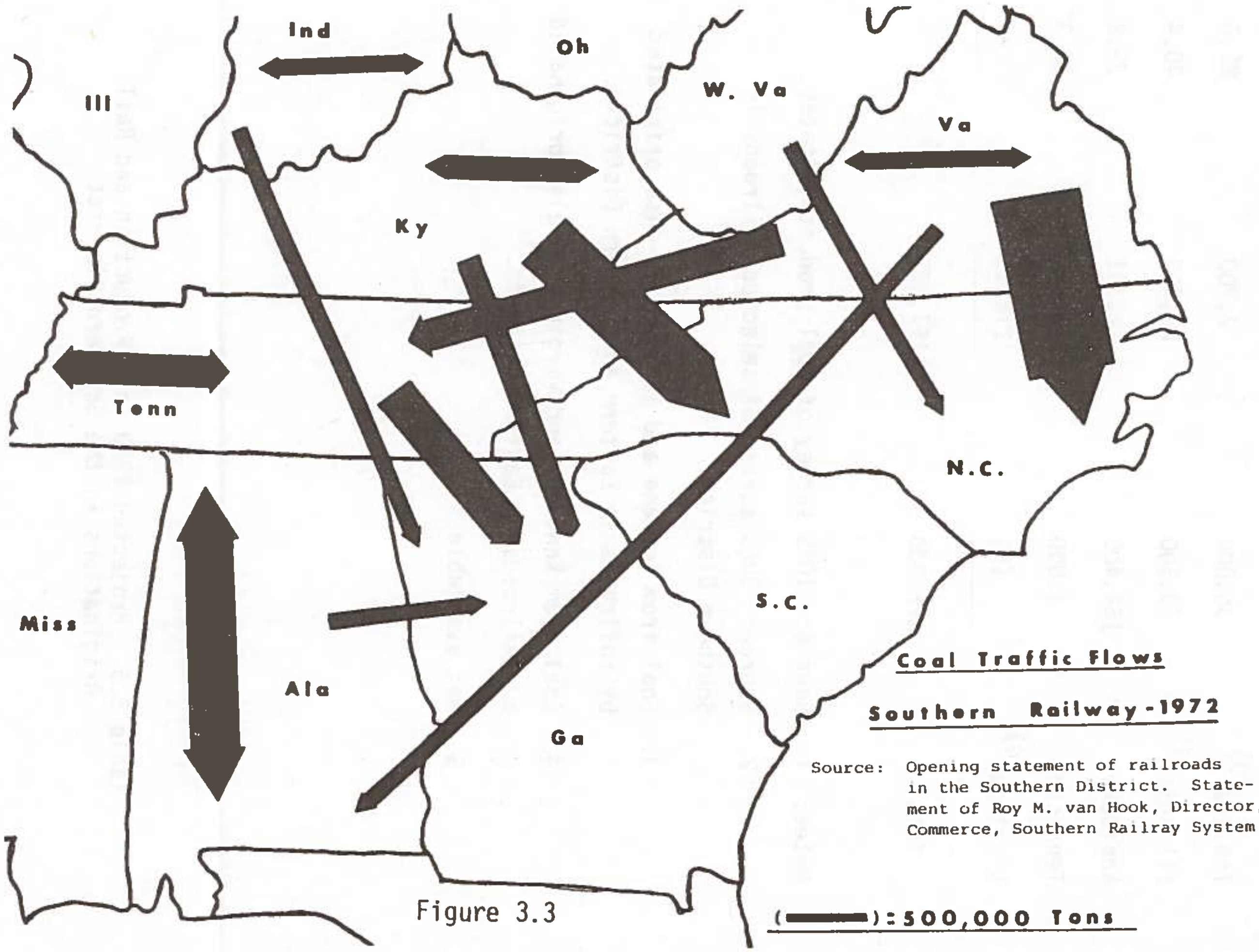

Ill
Ind
Oh
W. Va
Va
Ky
Tenn
N.C.
Miss
S.C.
Ala
Ga
Coal Traffic Flows
Southern Railway-1972
Source: Opening statement of railroads in the Southern District. Statement of Roy M. van Hook, Director, Commerce, Southern Railray System
( ):500,000 Tons

Figure 3.3

State	Thousands of Tons: Production(1)	Thousands of Tons: Rail Originations(2)	Rail Percent Of Total Production
Alabama	25,000	13,000	52.0
Indiana(3)	35,000	7,700	22.0
Illinois(3)	73,500	29,730	40.4
Kentucky	184,400	72,331	39.2
Tennessee	9,000	7,500	83.3
Virginia(4)	(5)	27,116	--
Total	326,900	157,377	

Notes:

1. Source: IOCS survey of coal producing states.
2. Source: IOCS survey of selected railroads in Southern District.
3. Coal from Indiana and Illinois is also originated by railroads in Eastern and Western Districts.
4. Coal from Kentucky and Virginia is also originated by railroads in Eastern District.
5. Not available.

Table 3.5. Projected 1980 Coal Production and Rail Originations in the Southern District

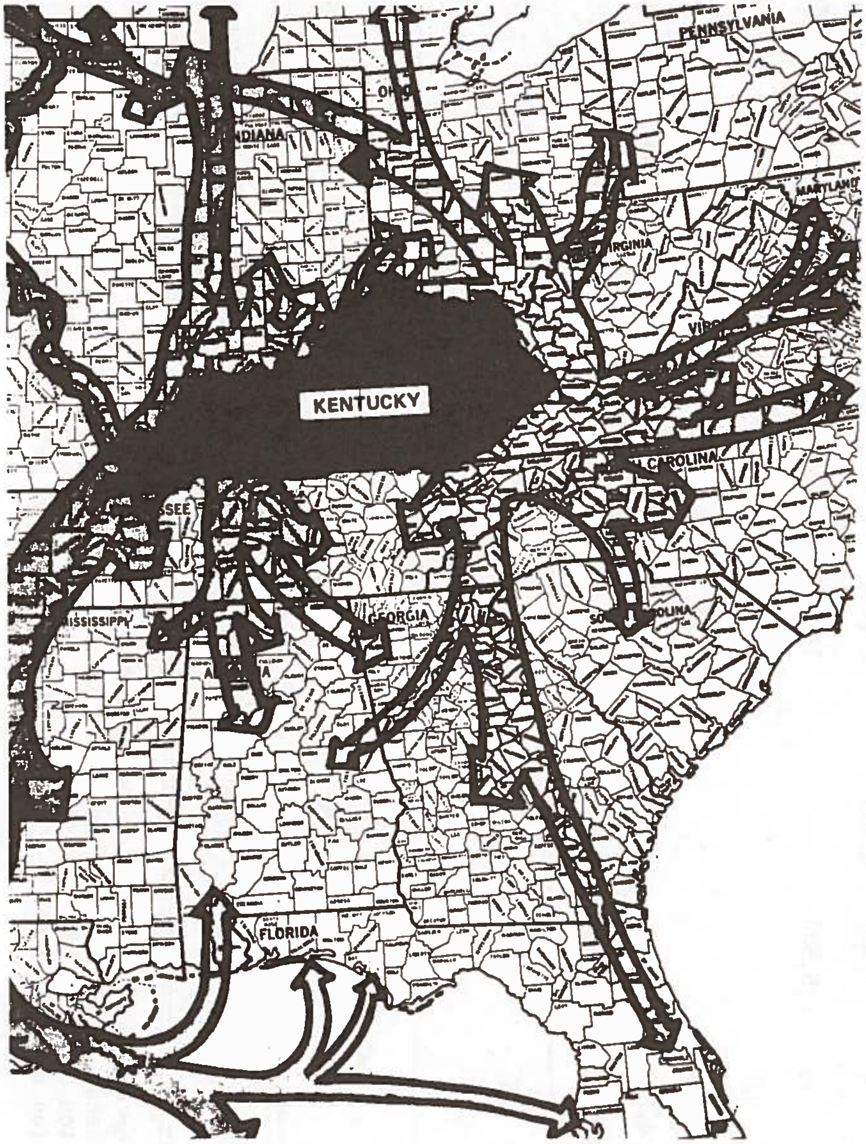


Figure 3.4
Movements of Kentucky Coal by all modes in 1972

Source: U.S. Army Engineering Division, Ohio River Division, Cincinnati, Ohio in <u>Kentucky's Coal Transportation</u>, State of Kentucky.

Type	Capacity	Existing Fleet 1974 (1)	Retirements Through 1980	Now On Order	Additional Planned Through 1980	1980 Equipment Projections: Railroad Cars	Railroad 100-ton Equiv.	Shipper (3) Cars	Shipper (3) 100-ton Equiv.	1980 Projected Requirements Cars	100-ton Equiv.
Hopper	100	8,920	24	7,700	6,400	22,996	22.996	3,017	3,017	26,013	26,013
Hopper	80(3)	13,464	15	5,500	-	18,949	15,159	-	-	18,949	15,159
Hopper	70(4)	15,481	925	-	-	14,556	10,189	-	-	14,556	10,189
Hopper	60	9,834	9,336	-	-	498	299	-	-	498	299
Hopper	50	5,930	4,814	-	-	1,116	558	-	-	1,116	558
Subtotal		53,629	15,114	13,200	6,400	58,115	49,201	3,017	3,017	61,132	52,218
Gondola (2)	100	743	5	-	-	738	738	596	596	1,334	1,334
Subtotal		743	5	-	-	738	738	596	596	1,334	1.334
Others		181	-	150	300	631	631	-	-	631	631
Subtotal		181	-	150	300	631	631	-	-	631	631
Grand Total		54,553	15,119	13,350	6,700	59,484	50,570	3,613	3,613	63,097	54,183

Notes:
1. Includes totals for Clinchfield, ICG, L&N, and Southern.
2. Includes cars on hand, on order, and planned.
3. Includes some 77 ton capacity cars.
4. Includes some 83 ton capacity cars.

Table 3.6. Projected Cars in Coal Service: Selected Southern District Railroads, 1980.

Horsepower	Existing[1] Fleet	Retirements through 1980	Presently on order	Additional Planned through 1980	Total Required
2,370[2]	70	-	-	-	70
3,000	620	40	34	132	746
TOTAL	690	40	34	132	816

Notes:
1. Includes total for Clinchfield, ICG, L&N and Southern
2. One of the railroads provided avergae horsepower for their locomotive fleet
3. In addition to the above, there are four-axle, smaller locomotives used for car gathering service near mines.
4. One railroad reported that about ten locomotives will be required by shippers on their lines.

Table 3.7 Projected locomotives in coal service: selected Southern District railroads, 1980 normally will be used in coal service throughout the year. As such, reported figures may vary according to the overall demand.

The trend is toward larger cars. Respondants also reported that wheel track dynamics and structure limitations will limit capacity to one hundred tons. The four railroads and shippers they serve will have some 54,183 100-ton equivalent cars in coal service in 1980. Of this total, 50,570 100-ton equivalent cars will be supplied by the participating railroads and the rest - some 3613 - will be supplied by shippers. The participating railroads' present fleet of 40,317 100-ton equivalent cars in coal service is expected to grow by 10,434 100-ton equivalent cars or some 26% by 1980.

An analysis of car and locomotive utilization was performed on reported present and projected car fleets. This is summarized in Tables 3.8 and 3.9. Loads per car per year for the years 1974 and 1980 are 27 and 29. This is the proximity to more efficient coal movements in the future resulting into improved car utilization. Though estimates on the distances over which coal will be transported were not available, the majority of rail officials interviewed indicated that future coal hauls will be longer. Hence, car utilization measured in terms of ton-miles per car will show further gains.

3.2.3 Estimated Additional Maintenance Facilities, 1980.

Three out of the four survey railroads indicated that no new facilities to maintain added equipment will be required. One major railroad reported that they will have $700,000 and $30,000 additional investments in locomotive and car maintenance facilities to handle the increased locomotive and car fleet in coal service. All of them indicated that the existing facilities will increase service and repair equipment to accommodate increased demand for car and locomotive maintenance.

Year	Originated Coal (000's of tons)	Car Fleet 100-Ton Equivalent	Tons/Car Per Year	Loads/ car Per year	Days/Load
1974	110,440 (1)	40,317 (2)	2,739	27	14
1980	157,375 (2)	53,183 (2)	2,959	29	13

Notes:
1. Includes Clinchfield, ICG, L&N and Southern originated coal as reported in Coal Traffic Annual, 1975
2. Consolidated totals projections furnished by Southern Freight Association for Clinchfield, ICG, L&N, and Southern originated coal.

Table 3.8 Projected Coal Originations and Gross Measurements of Coal Car Utilizations: Selected Southern District Railroads, 1974 and 1980

Year	Originated Coal (ooo's of tons)	Locomotive Fleet 3000 hp Equivalent	Tons/Locomotive Per Year	% Increase
1974	110,040[(1)]	675[(2)]	163,022	
1980	157,375[(2)]	801	196,473	20.5

Notes:
1. Includes Clinchfield, ICG, L&N, and Southern originated coal as reported in Coal Traffic Annual
2. Consolidated totals and projections furnished by Southern Freight Association for Clinchfield, ICG, L&N and Southern originated coal

Table 3.9 Projected Coal Originations and Gross Measurements of Locomotive Utilization Selected Southern District Railroads, 1974 and 1980.

3.2.4 Estimated Physical Plant Improvements,1980

Participating railroads also reported estimates of capital improvements to the tracks, signalling, and related facilities used in their high-volume coal movements. As tracks, signalling, yard facilities, etc. are not dedicated to one given commodity, several railroads found it difficult to identify coal-related investment. However, an attempt was made to identify and isolate the coal-related physical plant improvements planned in the next five years. Our survey results are presented in Table 3.10.

Participating railroads in the Southern District are planning to invest some $241 million to handle anticipated increased coal traffic. Note the wide spread between maximum and minimum cost per mile for each category. This is mainly due to geological and geographical considerations, population patterns along the routes, and land purchase values, if any.

3.3 Description of Coal Operations - Louisville & Nashville Railroad.

3.3.1 Overview.

The Louisville & Nashville Railroad (L&N) is a principal coal carrier in the Southern District. The Family Lines (F/L) system, of which L&N is a part, operates a network of more than 16,000 miles in thirteen states. The Family Lines railroads include the Seaboard Coast Line, the Louisville & Nashville, the Clinchfield, and the Georgia and West Point Route railroads. The Family Line System map is given in Appendix C.

Coal is the Family Line System's largest single revenue producer. In terms of overall tonnage, coal is also the top commodity handled. Each day they move about 235,000 tons of coal. In 1974, the 88 million tons of coal wheeled by F/L trains produced revenues of $214.7 million.

Category	Planned/Under Construction(1) Miles	(000's) 1975 Dollars	Total Required Miles	(000's) 1975 Dollars	Average Cost/Mile	Cost/Mile Range Min.	Max.
Rail Relay	305	$ 12,572	1,415	$ 63,373	$ 44,787	$ 42,000	$ 110,000
Signalling	360	24,800	648	29,000	44,753	6,667	76,667
Ballasting	2,905	4,304	3,155	5,604	1,776	1,481	5,200
New Lines (2)	18	10,700	93	81,200	873,118	250,000	1,000,000
Supplemental Lines (3)	70	36,000	88	45,000	511,364	333,334	523,000
Yard Facilities	-	-	30	612	204,000	204,000	204,000
Other (4)	-	-	-	14,000	N/A	N/A	N/A
Plow & Sledding (5)	-	-	50	2,500	50,000	50,000	50,000
Communications	300	500	300	500	1,667	1,667	1,667
Total	3,958	88,876	5,779	241,789			

Notes:
1. Includes totals for Clinchfield, ICG, L & N, and Southern Railroads.
2. Includes mine spurs and industrial plant spurs.
3. Includes double track, sidings, etc.
4. Upgrading of two yards.
5. Replacing ballast under existing tracks.

Table 3.10 Projected Track Improvement Requirements

Selected Southern District Railroads

In 1974, the L&N originated over 51 million tons of coal, some 46% of the total coal originated by southern railroads. Its coal revenue amounted to over $145 million, some 23.9% of the total freight revenue.

3.3.2 Coal Flows

Within F/L railroads, L&N and Clinchfield are the top coal originators. They serve mines in eastern and western Kentucky, southern Indiana, southern Illinois, eastern Tennessee, southern Tennessee, southwestern Virginia, and northern Alabama. Along with other Family Line railroads, they move this coal to large steel, chemical, manufacturing, and utility plants in the Midwest, Northeast, and South. From Kentucky alone they originated over 35 million tons for transport to 35 states and several foreign countries. Export coal via F/L moves to the port cities of Mobile and Norfolk. Inland water ports like Chicago and Louisville are also served by the L&N. Figure 3.5 on the following page shows the general location of the coal producing areas and power generating plants and ocean and inland ports which handle rail-to-water coal movements.

L&N projects handling over 75 million tons of coal in 1980. This is an increase of over 25 million tons or 47% over 1974 tonnage. This is also about 57% of the total increase projected by surveyed railroads in the Southern District.

Today, L&N serves 207 active mine operations. Of this total 189 are in eastern and western Kentucky and Tennessee. Another three are in Indiana, and fifteen more are in Alabama. Some thirty new mine operations on L&N are currently in various stages of development. When they are in operation, they will contribute significantly to total originated coal tonnages.

Coal traffic forecasts are performed by L&N's coal traffic and marketing personnel. Ninety percent of the effort is involved in an

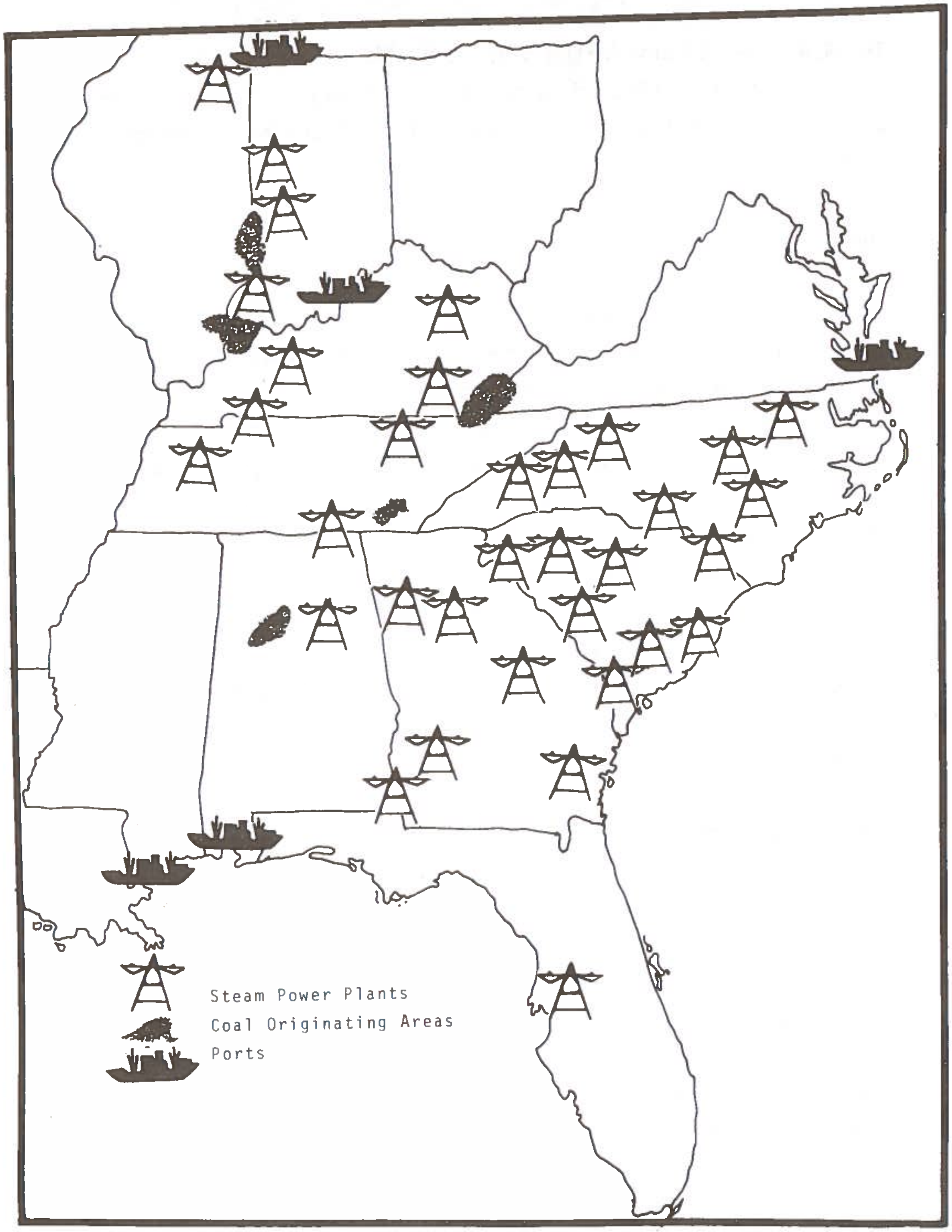


Figure 3.5 Map of F/L Territory Showing General Locale of Coal Producing Areas and Power Generating Plants and Ports Which Handle Rail-To-Water Coal Movements.

extensive survey of major coal consumers, brokers, and trans-loader facility operators. The information gathered includes coal demand and type and points of consumption and production. The coal producers in the area also contribute substantially to this process; however, heavy reliance is placed on the consumer. Routes are determined on the basis of shipper's choice, and the economics of the move. If the move is inter-line, shipper's choice plays the more important role. For on-line moves, cost economics determine the coal route. Computer systems are used to collate and analyze the data gathered during the survey. Past experiences indicate that the process has resulted in an accurate forecast for shorter time frames (e.g. one year), relatively accurate information for intermediate time frames (2-3 years), and reliable information for operations planning for a five-year time frame. Long lead times to open mines and plants help this process smooth out any unforeseen changes in the forecasts.

The 1980 coal flows on the L&N railroad are presented in Table 3.11. L&N coal will originate in five states (Kentucky, Tennessee, Alabama, Illinois, and Indiana), and terminate in 13 states (Michigan, Ohio, Kentucky, Indiana, Illinois, Georgia, Alabama, Tennessee, North Carolina, South Carolina, Florida, Mississippi, and Virginia). Table 3.12 shows L&N's present unit-train operations under long-term contracts. These unit train movements are shown in Figure 3.6. Note that coal flow patterns in 1980 are similar to the present ones.

A thorough analysis of coal flows is performed to determine the routes over which the coal will be transported. A schematic diagram of L&N's major coal corridors is provided in Figure 3.7. Table 3.13 presents coal traffic and line capacity for each coal corridor in the years 1975, 1978 and 1980. The coal traffic is expressed in terms of million gross tons per segment mile and trains per day while the capacity is expressed in million gross tons per segment mile. The lines with the heaviest coal traffic in 1980 are listed below.

Origin State	Destination State				Total
	Alabama	Indiana	Group I[1]	Group II[2]	
Alabama	7.5				7.5
Illinois		2.3			2.3
Indiana		4.0			4.0
W. Kentucky			10.3		10.3
E. Kentucky				44.8	44.8
Tennessee				1.2	1.2
TOTAL	7.5	6.3	10.3	46.0	70.1

Notes:
1. Group I includes the states of Kentucky, Tennessee, Alabama, Georgia and Illinois.
2. Group II includes the states of Ohio, Indiana, Illinois, Michigan, Kentucky, Tennessee, Virginia, North Carolina, South Carolina, Georgia, and Florida.
3. Figures for coal originated in Kentucky and Tennessee and terminating in each individual states in Group I and Group II are not available.

Table 3.11. 1980 Coal Flows, Louisville & Nashville Railroad (Millions of Tons).

MINE RAIL LOCATION	LOADING FREQUENCY (trains/wk)	CARS PER TRAIN	SETS	CAR SIZE (tons)	OWNERSHIP	DESTINATION	ROUTE	ROUND TRIP MILES
Alamo, KY	1	72	1	70-80	L&N	North Wateree, SC	L&N-Atlanta-SCL	1238
Amru, KY	2	70[1]	1	100	GGPX	Stilesboro, GA JacMac, GA Harllee, GA	L&N L&N L&N-Atl-Ga RR	662 664 1046
Amru, KY	7	70	1	100	L&N	JacMac, GA Harllee, GA	L&N L&N-Atl-Ga RR	734 1046
Benham, KY	2	60	2	100	L&N	South Chicago, IL	L&N	1148
Brookside, KY Hilo, KY Little Creek, KY	1	72	4	80	L&N	Terrell, NC	L&N-St. Paul-CRR-Bostic-SCL	790
Lynch, KY[2]	10	90	6	100	L&N, PC	Corbin, KY	L&N	190
Corbin, KY[3]	10	80	12	100	L&N, PC	Gary, IN	L&N-Cincy-PC-Hartsdale-EJE	918
Creech, KY	1	70	1	100	L&N	Pinopolis Jct., SC	L&N-Atl-SCL	1460
Creech, KY	1	70	1	100	L&N	Harllee, GA	L&N-Atl-Ga RR	1106
Karen, KY	1	70	1	100	L&N	JacMac, GA	L&N	734
Levi, KY	3	70	1	100	L&N	Harllee, GA	L&N-Atl-Ga RR	1068
Red Bird, KY	4	70	2	100	L&N	Augusta, SC Irmo, SC N. Wateree, SC	L&N-Atl-Ga RR-SCL L&N-Atl-SCL L&N-Atl-SCL	1140 1146 1128
Viall, KY	3	70[1]	1	100	GGPX	Stilesboro, GA Harllee, GA	L&N L&N-Atl-Ga RR	608 1036

1. Georgia Power Co. has a fleet of 660 100-ton automated rapid discharge hoppers market GGPX assigned to unit trains on the L&N Railroad.
2. Raw coal trains shipped to coal washer at Corbin, Kentucky.
3. Clean coal moved from coal washer in conjunction with above movement.

Table 3.12 (Page 1 of 3) Present Unit Train Operations Under Long Term Contracts, L&N Railroad.

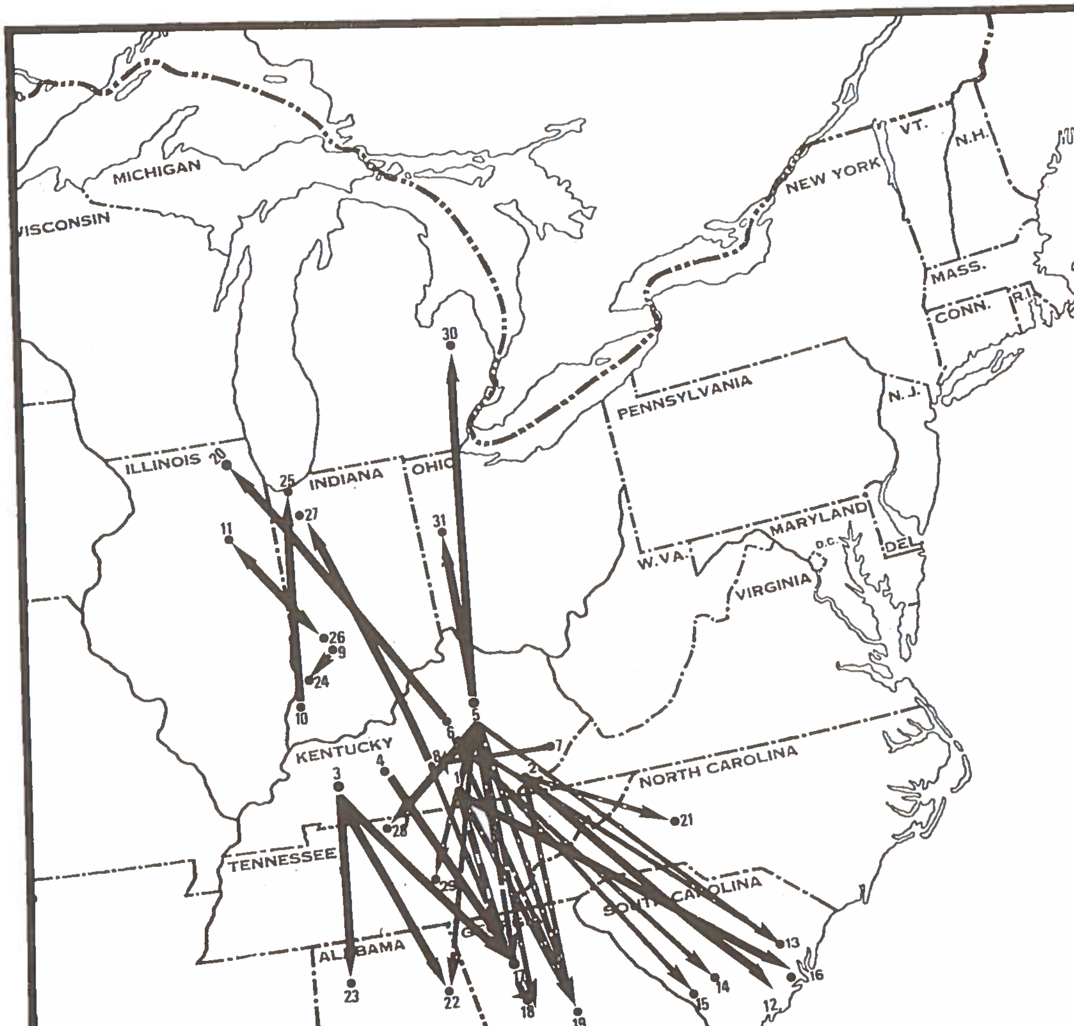
MINE RAIL LOCATION	LOADING FREQUENCY (trains/wk)	CARS PER TRAIN	SETS	CAR SIZE (tons)	OWNERSHIP	DESTINATION	ROUTE	ROUND TRIP MILES
Viall, KY	1	70	1	100	L&N	Pinopolis Jct., SC	L&N-Atl-SCL	1382
Whipple, KY	2	60	1	100	L&N	N. Wateree, SC	L&N-Atl-Ga-Aug-SCL	1244
Andy, KY	2	60	2	100	L&N	Pennyroyal, SC	L&N-St.Paul-CRR-Bostic-SCL	1614
Arnold, KY	2	70	1	100	L&N	JacMac, GA Harllee, GA	L&N L&N-Atl-Ga RR	1016 1398
Arnold, KY	1	60	1	100	L&N	Dayton, OH	L&N-Cincy-PC	666
Fariston, KY	1	70	1	100	L&N	JacMac, GA	L&N	596
Haddix, KY	7	70	7	100	L&N	Bridgeport, AL	L&N	1026
Haddix, KY	3	80	2	70-80	L&N	Harriman, TN	L&N-Harriman-SOU	572
Haddix, KY	2	70	1	100	L&N	Gallatin, TN	L&N	926
Southfork #3, KY	2	98	2	100	DEEX	Trenton, MI	L&N-Cincy-PC	984
Wahoo, KY	2	70	2	100	L&N	Harllee, GA	L&N-Atl-Ga RR	1270
Alston, KY	5	70[1]	1	100	GGPX	Stilesboro, GA	L&N	803
Cayuga, IN	5	100	1	100	PSIX	Cayuga, IN	L&N	62
Cimarron, KY	5	70[1]	1	100	GGPX	Stilesboro, GA	L&N	724
Colonial, KY	2	70	1	50	L&N	Bridgeport, AL	L&N	488
Dotiki, KY	5	60	2	80	L&N	Florence, AL	L&N	516

Table 3.12 (Page 2 of 3) Present Unit Train Operations Under Long Term Contracts, L&N Railroad.

MINE RAIL LOCATION	LOADING FREQUENCY (trains/wk)	CARS PER TRAIN	SETS	CAR SIZE (tons)	OWNERSHIP	DESTINATION	ROUTE	ROUND TRIP MILES
Nortonville, KY	4	50	2	100	L&N	Bridgeport, AL	L&N	440
Chinook, IN	5	50	2	100	AEPX	Breed, IN	L&N	76
Providence, KY	5	60	2	80	L&N	Florence, AL	L&N	500
Enos, TN[4]	2	100	2	100	NORX	Baileytown, IN	AW&A-Sou-Princeton-L&N-Chicago-CSS&SB	586

4. This train originates on the Southern Railway and moves over L&N for termination off L&N on CSS&SB.

Table 3.12 (Page 3 of 3) Present Unit Train Operations Under Long Term Contracts, L&N Railroad.



ORIGIN	DESTINATION	
1-Pineville, KY	12-N. Wateree, SC	23-Florence, AL
2-Harlan, KY	13-Pennyroyal, SC	24-Breed, IN
3-Madisonville, KY	14-Irmo, SC	25-Baileytown, IN
4-Centertown, KY	15-Augusta, SC	26-Clinton, IN
5-Hazard, KY	16-Pinopolis Jct., SC	27-Gary, IN
6-Manchester, KY	17-Stilesboro, GA	28-Gallatin, TN
7-Lynch, KY	18-Jac Mac, GA	29-Harriman, TN
8-Corbin, KY	19-Harllee, GA	30-Trenton, MI
9-Terre Haute, IN	20-S. Chicago, IL	31-Dayton, OH
10-Oakland City, IN	21-Terrell, NC	32-Corbin, KY
11-Danville, IL	22-Bridgeport, AL	

FIGURE 3.6 UNIT TRAIN MOVEMENTS
LOUISVILLE & NASHVILLE RAILROAD

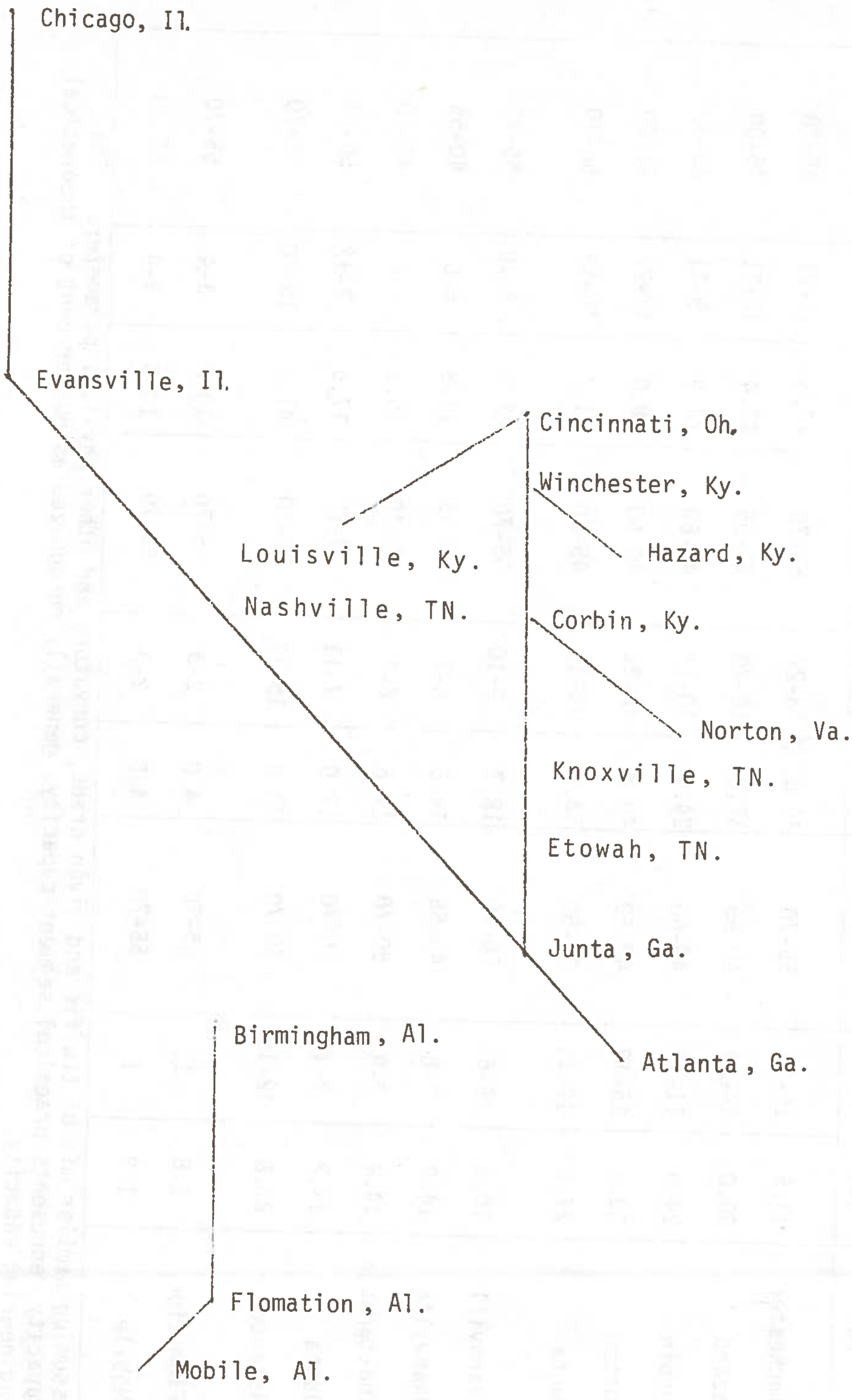


Figure 3.7 Major Coal Corridors Louisville & Nashville Railroad.

FROM	TO	1975 ACTUAL MOVEMENTS		CAPACITY(1)	1978 PROJECTED MOVEMENTS		CAPACITY(1)	1980 PROJECTED MOVEMENTS		CAPACITY(1)
		COAL MGT/M (2)	COAL TRAINS PER DAY	MGT/M	COAL MGT/M	COAL TRAINS PER DAY	MGT/M	COAL MGT/M	COAL TRAINS PER DAY	MGT/M
Cincinnati	Winchester	33.5	15-19	55-70	40.0	18-22	55-70	47.5	17-21	55-70
Winchester	Hazard	30.0	14-19	40-55	37.2	16-20	40-55	47.4	17-21	45-60
Winchester	Corbin	24.9	11-14	45-60	24.9	10-12	45-60	24.9	9-11	45-60
Corbin	Norton	33.7	15-19	40-50	40.2	18-22	40-50	48.0	17-22	45-60
Corbin	Junta	27.8	12-15	35-50	33.7	15-19	45-60	41.7	15-19	50-70
Chicago	Evansville	10.9	5-6	50-70	18.7	9-10	55-70	22.0	8-10	55-70
Evansville	Nashville	14.9	7-8	40-55	14.6	6-7	40-55	14.3	5-6	40-55
Nashville	Chattanooga	14.9	7-8	50-70	14.6	6-7	50-70	14.3	5-6	40-70
Chattanooga	Junta	15.2	7-10	50-70	17.0	7-11	50-70	17.5	7-12	50-70
Junta	Atlanta	27.8	12-15	50-70	33.8	15-17	50-70	41.9	15-20	55-70
Birmingham	Flomation	1.8	1	55-70	4.8	2-3	55-70	10.0	3-4	55-70
Flomation	Mobile	1.8	1	55-70	4.8	2-3	55-70	10.0	3-4	55-70

Notes: 1. Assuming similar mix of traffic and given grade, curvature and other physical parameters. The capacity represents practical segment capacity, generally recognized as 60 per cent of theoretical engineering capacity.

2. Million Gross tons per year.

Table 3.13. Coal Traffic Projection on Major Coal Corridors Louisville & Nashville Railroad.

From	To
Cincinnati, Ohio	Winchester, Kentucky
Winchester, Kentucky	Hazard, Kentucky
Corbin, Kentucky	Norton, Virginia
Corbin, Kentucky	Junta, Georgia
Junta, Georgia	Atlanta, Georgia

The most significant of the above links is the link between Corbin, Kentucky to Junta, Georgia. The difference between the projected 1980 traffic and present estimated line capacity is greatest for this link and hence is identified as a critical link. This link is described in Section 3.3.3.2.

3.3.3 Route Volume and Capacity

3.3.3.1 L&N's Planning Process for Future Line Capacity Requirements

L&N uses a complex iterative process to plan for future line capacity requirements. The process requires detailed traffic forecasts on all line segments in the L&N system. As indicated previously, the forecasts are completed by marketing and sales personnel. The forecasts are converted to trains to be handled based on current and projected operating policies.

L&N employs several computer programs and simulation models in planning future track improvements. Two of these models are (1) a modified train performance calculator and (2) a single track capacity analyzer.

The train performance calculator simulates train movement given some fixed parameters. It enables L&N to simulate each train operation in various ways to determine train schedules, delays, speeds over various segments, fuel consumptions, train lengths, etc. This is a valuable tool in finalizing the train schedules and costs operations.

The track analyzer allows operating personnel to simulate projected trains over existing tracks and signalling systems and then identify constraints, if any. This simulation normally is carried out by L&N personnel who are responsible for operating the railroads. All L&N line segments with operating characteristics, such as curvatures, grades, speed restrictions, and signalling systems, are stored on the computer files. The track analyzer allows operating personnel to dispatch trains. The computer simulates the train movements and arranges train meets. The computer identifies locations for train meets, calculates train delays and speeds over various sections, and outputs other operational parameters. The operating personnel then examine the output for allowable delays and train schedules. The purpose of the simulation is to identify the constraints in the fixed plant and predict when they will occur. At this time alternative solutions are advanced and discussed. Simulated runs are made with proposed changes and outputs are examined until acceptable operations criteria are achieved.

The process is repeated for each segment to develop a total track and signal improvment program. A cost-benefit analysis follows this process before a final implementation plan is developed, although consideration is given to projected revenue, expenses, and cash flow before finalizing any plan.

The Centralized Traffic Control system is implemented on all L&N main lines except the one discussed in Section 3.3.3.2. Signalling systems are not limiting factors in deciding L&N's line capacity and hence 90% of the evaluation process described is geared to siding, track, and yard improvements.

3.3.3.2 Specific Route Volume and Capacity

One of L&N's major coal routes lies between Corbin, Kentucky and Atlanta, Georgia. Over this segment moves coal from Appalachian coal fields in southeastern Kentucky and Virginia, a significant portion of the coal from eastern Kentucky coal fields and some coal from mines along the main line between Corbin, Kentucky and Knoxville, Tennessee. (See Figure 3.6.)

This route traverses the mid-portion of the Appalachian Mountains and has problems typical of mountainous territory: steep grades, large amounts of cut and fill and many areas of severe curvature.

A portion of this route, the segment between Etowah and Junta, is of particular interest because of its relatively high traffic densities and the absence of an advanced signalling system. This segment is about 90 miles in length and is characterized by gently rolling hills. The track grades average 0.6%, rarely exceeding 0.7%. The track slowly undulates up and down at about a 0.6% grade; the "wave length" of the undulations is about six miles. Curved track is extensive, but not predominant. Curvature represents about 40% of the track miles in the segment. Curves average 2^{o} and do not exceed 5^{o} but once in the segment.

The segment is single track with four passing tracks in the 60-90 car capacity range. The mean train length across the segment, however, is about 90 cars, with most revenue freight trains having lengths in excess of any passing track capacity. The segment has automated block signalling, further limiting its capacity.

This configuration was sufficient in the past, since most traffic consisted of shorter coal trains. Recently, however, new route possibilities have opened up with other railroads in the Family Lines group and thus the other traffic along with coal traffic over this segment has increased greatly.

The capacity of the segment when most traffic was coal was higher than the present capacity with mixed traffic. With the present traffic mix, practical capacity is estimated to be 35 to 50 MGT/M. Presently, the

MGT/M, including merchandise traffic, is 35.6 with approximately 16-20 trains per day. The segment capacity is sufficient to handle present volumes of traffic; however, traffic is expected to grow to 43.7 MGT/M or 17-22 trains per day by 1978 and 52.8 MGT/M or 20-25 trains per day in 1980 (see Table 3.14).

It is anticipated that within the next three years, two existing passing tracks will be lengthened to have capacities in excess of 190 cars. This, in addition to allowing longer trains on the segment, will also permit the trains running time on passing tracks. These extensions are expected to cost approximately $850,000 total. In addition, there are plans to improve the signalling system by installing CTC. This is expected to cost about $2.6 million and is planned to take place between 1977 and 1979. Further, rail improvements will continue on this segment. It is presently laid in 132-pound rail installed new. This rail will be replaced as it wears out. Rail replacements are carried out under the maintenance of ways program.

When the improvement program is completed, practical track capacity is expected to be between 50 and 70 MGT/M or some 40% increase over present capacity. However, traffic is projected to increase some 48% over the same time period. It is expected that utilization of the link by 1980 will again approach the practical limits of this segment. At that time, consideration will be given to double tracking the segment or using other techniques to increase its capacity or reduce traffic volume.

3.3.4 Coal Movement Description

3.3.4.1 Unit Train Movement

On the Family Lines, thirty unit train operations are scheduled, totalling up to nearly 100 separate train movements every week. Fast loading tipples at mine sites and fast dumping facilities at receiving points contribute greatly to the success of these operations.

Item	1975	1980	Change Number	Change Percent
Track Configuration	Single Track with four passing tracks of 60-90 car capacity.	Single Track with two 60-90 and two 190 car capacity passing tracks		
Signaling	Automatic Block Signaling	Centralized Traffic Control		
Coal Traffic				
MGT/M	21.8	41.7	19.9	71.6
Trains/day	12-15	15-19	3-4	26.7
Other Traffic				
MGT/M	7.8	11.1	2.2	42.3
Trains/day	4-5	5-6	1	25
Total Traffic				
MGT/M	35.6	52.8	17.2	48.3
Trains/day	16-20	20-25	4-5	25
Track Capacity				
MGT/M	35-50	50-70	15	22.4

Track Improvement	Dollars	Period
Side Tracks	$ 850,000	1975-78
Signaling	2,600,000	1977-79
Rail Replacement	as needed	

Table 3.14 Link Volume, Capacity, and Improvement, Etowah, Tennessee to Junta, Georgia: Louisville and Nashville Railroad

During 1974, these unit trains moved nearly half the total volume of coal originated, utilizing just 13% of the Family Line's available hoppers. Most of the cars used in unit trains are 100-tonners. Greatly improved car utilization afforded by unit trains has made it possible to transfer badly needed hoppers elsewhere and, in some cases, provided needed equipment for new unit train services. Table 3.12 contains parameters for some coal unit train operations on the L&N.

The average L&N unit train has 60 - 70 100-ton cars and four 3000-hp locomotives, and runs at a posted speed of 35 miles per hour. The majority of the trains operate in the high terrain of Appalachia, and hence are shorter compared to those operating in the Western Region (Section 2.3.3.3). L&N southbound trains carry about 7,000 tons of coal as compared to 10,000 in the Western Region.

An L&N unit train operation is bringing coal from the Cimarron Coal Company mines in western Kentucky to Plant Bowen of the Georgia Power Co. near Cartersville, Georgia.

Origin: Cimarron, KY

Destination: Stilesboro, GA

Routing: L&N. L&N uses SCL tracks near the plant

Frequency: five trains per week

Cars in service: Two 70-car sets plus ten extra 100-ton automated rapid discharge hopper cars.

Car ownership: Georgia Power Co.

Tons/Train: 6500

Round Trip Distance: 740 miles

Schedule:

Loading Time	Running Time Loads	Unloading Time	Running Time Empties	Total Cycle Time
2 hours	20½ hours	30 min.	25 hours	48 hours

Loading: Loop loading, single track

Unloading: Loop track over trestle, train moves 6 miles per hour, fast modernized bottom dump

Tariff Authority: ICC S988

Table 3.15 Pertinent Operational Parameters, Unit Train Coal Operation: Louisville & Nashville Railroad

Operation At Mine

Coal is recovered from surface mines. The land in the area is plain with rolling hills. The coal seam is approximately 56 inches thick. Coal is carried out of the pit by 50-ton trucks and driven over private roads to a raw coal stockpile two to three miles away. The coal is washed and dumped to a clean coal stockpile from where it is loaded into rail cars.

Train Loading Operations

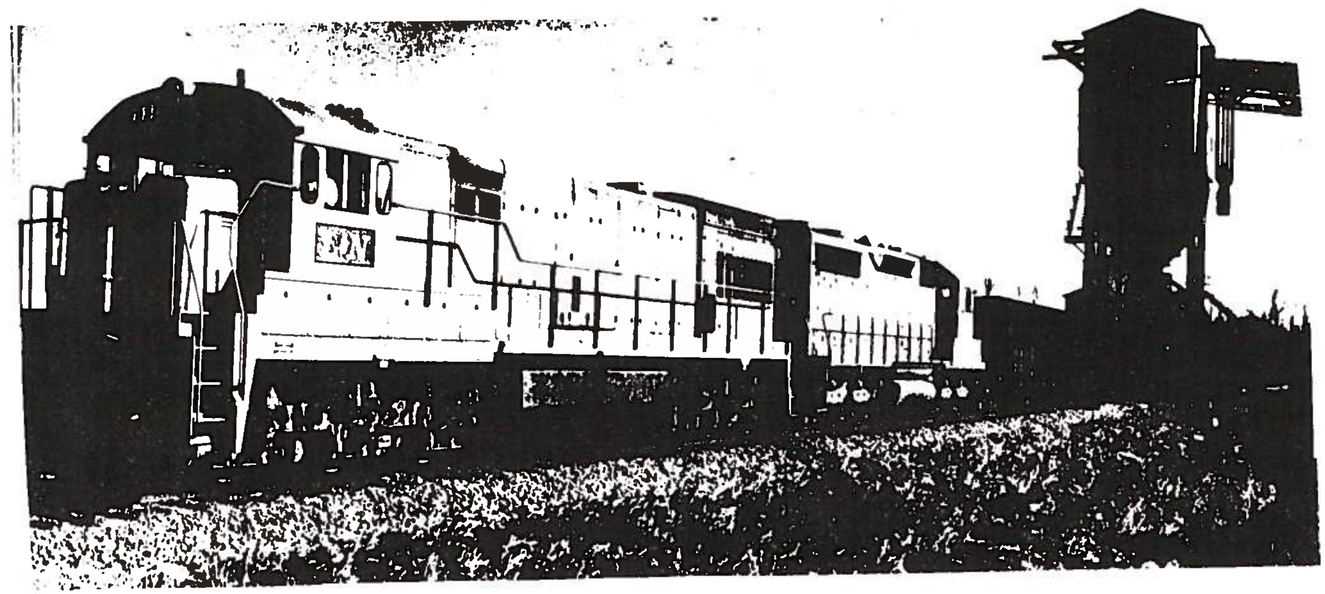
A mine run crew brings an empty train to the mine and brings it back to the Atkinson yard after it is loaded. At Cimarron's loading facility near Madisonville, Kentucky, the coal from continuously operating overhead conveyors pours right into the passing train, with each car taking one minute and forty seconds to fill. (See Figures 3.8 and 3.9.) Scales on the conveyor weigh the coal as it moves from nearby stockpiles to the over-track loading tipple. Moving around a loop track the entire train is loaded in less than two hours. Throughout the loading operation, the crew stays with the train.

Equipment in Service

One hundred and fifty roller-bearing 100-ton hopper cars are assigned to this unit train service. These cars are built by the Ostner Freight Car Co., Covington, Kentucky, and are leased by the Georgia Power Co. from General American Transportation Corporation. Five bottom side discharge gates, special slope sheets and electropneumatic dumping mechanisms give the cars their fast unloading capabilities. L&N assigns four 3000 horsepower six-axle diesels for each train.

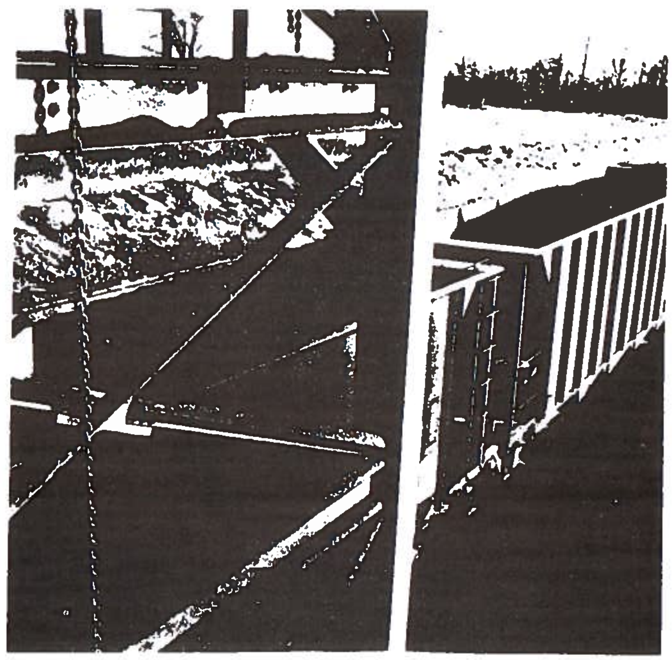
Train Operation

Presently, two 70-car trains are transporting coal six days a week from Cimarron to Plant Bowen. The trains run straight through from



Extra 1537 eases train of 70 empty hoppers beneath fast-loading facilities near Madisonville, Ky. Never stopping, cars are filled with coal, then roll south to Georgia.

Figure 3.8



Overhead conveyor at Cimmaron weighs coal, then funnels it into each hopper car of Plant Bowen train in less than two minutes.

Figure 3.9

mines to receiver and back as a unit with the same motive power. The stops they make are brief and are only for crew changes and servicing. Each train makes three 740-mile round trips per week, taking approximately 48 hours to complete the mine-to-powerplant-to-mine cycle. The trains, called A & B, are scheduled as shown in the chart below.

Day	Location of Train A	Location of Train B
Monday	Mine-Loading	Plant-Unloading
Tuesday	Plant-Unloading	Mine-Loading
Wednesday	Mine-Loading	Plant-Unloading
Thursday	Plant-Unloading	Mine-Loading
Friday	Mine-Loading	Plant-Unloading
Saturday	Plant-Unloading	Mine-Loading

A lead track from Cimarron joins the Atkinson-to-Nashville main line just to the West. After a train is loaded, it leaves for Nashville. A map of the unit train route and its itinerary is provided in Figure 3.10. At Nashville, the train stops at Koyne Avenue yards for inspection and crew change. Note (Figure 3.10) that its routing by-passes Radnor Yard to save valuable time. At Chattanooga, the train routing by-passes busy Wauhatchi Yard. The train stops briefly to change crews. Georgia Power's Plant Bowen is located about seven miles southwest of Cartersville on the Etowah River. To reach the plant, the train operates over the Seaboard Coast Line tracks, another Family Line railroad.

Train Unloading Operation

Once at Plant Bowen, the train moves around a loop track and onto a 1000-foot trestle. Moving at about six miles an hour, the train dumps its entire contents - approximately 7,000 tons - in thirty minutes (Figure 3.11).

As the train rolls onto a trestle, a small "shoe" mounted on the side of each car rubs against a wayside third rail energized with electricity.

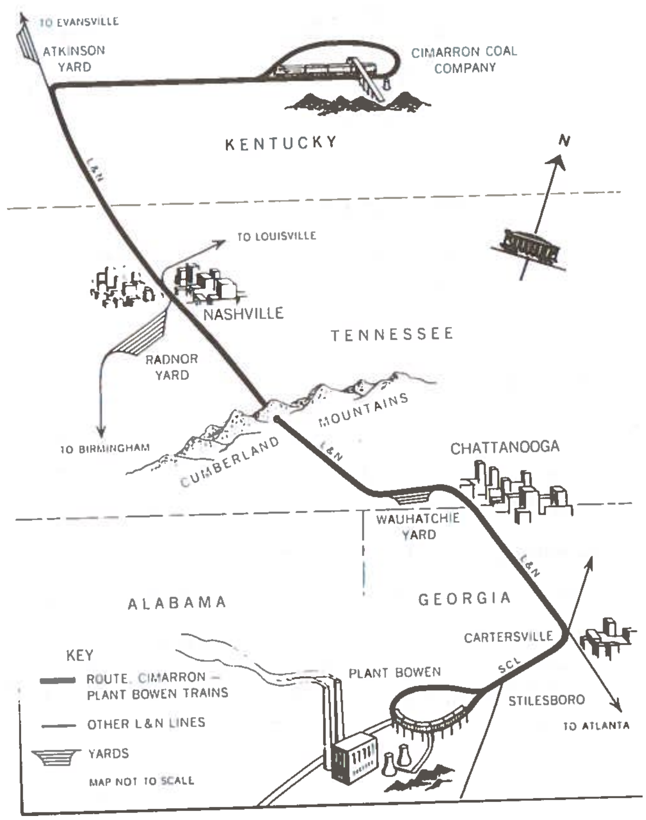


Figure 3.10 Unit Train Coal Route.

L & N diesels wheel unit coal train around loop track at Plant Bowen onto 1,000-foot-long discharge trestle.

Figure 3.11

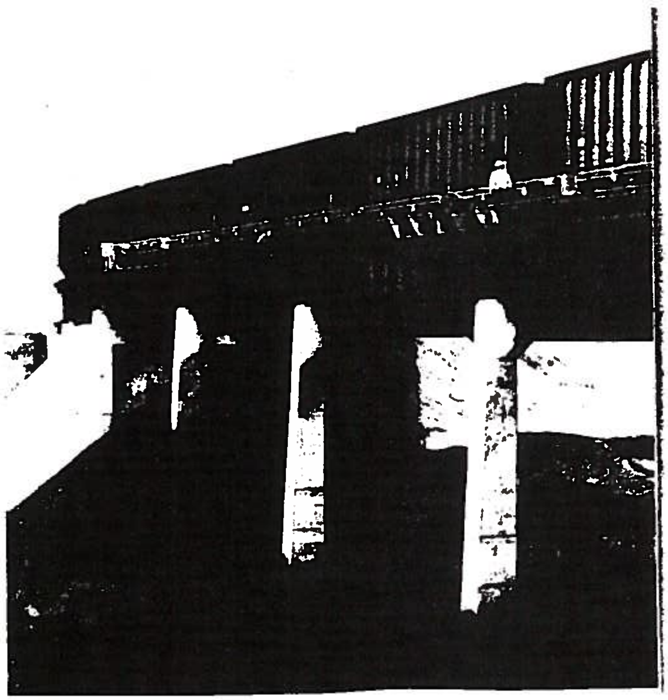
Contact between the shoe and the rail activates the car unloading mechanism and coal dumps out through the bottom of the car onto conveyors below the trestle. (See Figure 3.12.) These conveyors then feed the coal either to storage areas or directly to the plant's boilers.

After the unloading operation is complete, the train is on its way to Cartersville and from there to Wauhatchie Yard. At the yard, the four locomotives are inspected, fueled, and fully serviced. Each car in the train is also inspected. The train heads back to the mine in Kentucky with a new crew, and with one intermittent stop at Nashville for a crew change. For pertinent operational parameters please refer to Table 3.14.

3.3.4.2 Multi-Car Movement

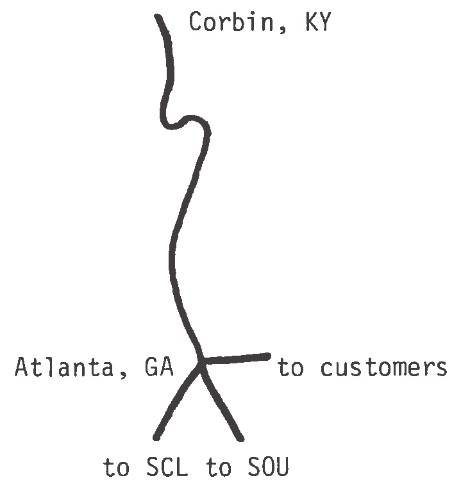
On the L&N, about fifty-five percent of the total coal tonnage moves under single and multiple car rates. These coal movements usually originate from several small mines in the Appalachia region and move to a large single consumer, or several smaller consumers. These small mines normally are not equipped with high speed loading facilities and use various types of equipment, ranging from front end loaders to conventional tipples, to load rail cars. Coal is recovered from deep or strip mines and generally brought to the rail heads by trucks. Mine crews on local trains gather the cars from each mine lead. While picking up loaded cars, empty cars are dropped for reloading. Cars are then brought to a yard and are consisted on a regular freight train or a solid coal train. Sometimes L&N runs a special coal train — called an extra train — to meet the demand. In the following paragraphs, a typical multi-car movement is described.

Coal from various mines is collected and brought to the Corbin yard. At Corbin, coal cars going south are blocked and moved to Atlanta on a solid coal train. At Atlanta, the cars are interchanged with other railroads. Some cars are also delivered to customers in the Atlanta region. A schematic of this movement is shown in Figure 3.13.



As cars roll across trestle, third rail along trestle engages assemblies on car sides, opening car-discharge doors for quick dumping of coal onto conveyors below.

Figure 3-12



Notes:

1. Coal from several mines is collected and brought to Corbin, KY.
2. A solid coal train going south to Atlanta is formed at Corbin.
3. At Atlanta cars are interchanged with Southern and Southern Coast Line Railroads.
4. Some cars are delivered directly to customers in the Atlanta region by L&N.

Figure 3.13 Multi-Car Movement.

Several mines in eastern Kentucky, especially near Roaring, Kentucky, ship coal to Mitchell, Georgia under multi-car rates. Minimum shipment calls for 2,500 tons and is made in unassigned open top hoppers of 50 to 80 ton capacity. The route these cars follow involves two Family Line railroads - L&N and SCL - and is shown in Figure 3.14.

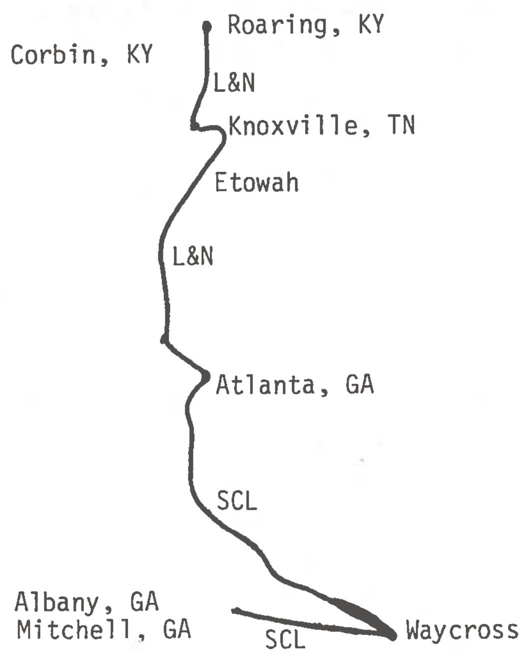
Coal is recovered from strip mines and is brought to rail lead by heavy duty, high volume trucks moving on private roads. Cars are picked up by a mine run crew and brought to the Corbin, Kentucky yard. Here they are classified into a Mitchell, Georgia block. A complete car inspection is also performed at this time.

An extra train of loaded coal hoppers is called at Corbin for a run to Atlanta via Etowah, Tennessee. The train usually consists of 80 loaded cars, of which the Mitchell cars are one block. This train is called and run on an as-needed basis. However, in the recent past, this train has run frequently enough to be called a regular train. Two road crews - one from Corbin to Etowah and another from Etowah to Atlanta - operate the train over its 296 mile trip. At Tilford Yard in Atlanta, the Mitchell cars are classified as a block and delivered to SCL. L&N crews involved in the total movement are:

- Mine Crew
- Yard Crew
- Road Haul Crews
  - Corbin - Etowah
  - Etowah - Atlanta

Tilford Yard is jointly operated by L&N and SCL. The cars are interchanged routinely. Interchange papers are prepared and an inspection performed. As SCL and L&N are Family Line railroads, some of the interchange requirements are waived. SCL runs the cars to Waycross, Georgia on its regular train. Upon arrival at Waycross, the cars are taken to the destination by a local train. Since the plant has conventional unloading facilities, it is allowed 24 hours to unload the cars.

Points	Distance	Cars moved by
Roaring-Corbin	44	L&N mines crews
Corbin-Atlanta	296	L&N main line train
Atlanta-Waycross	250	SCL main line train
Waycross-Mitchell	112	SCL local train



Notes:

1. Cars are gathered from mines by mine run crews and brought to Corbin, KY
2. The cars are blocked in Mitchell, GA block for a train going to Atlanta
3. At Atlanta, cars are interchanged with Seaboard Coast Lines
4. SCL main line train brings the cars to Waycross
5. A local train hauls the cars to Mitchell

Figure 3.14 Multi-Car Interchange Movement.

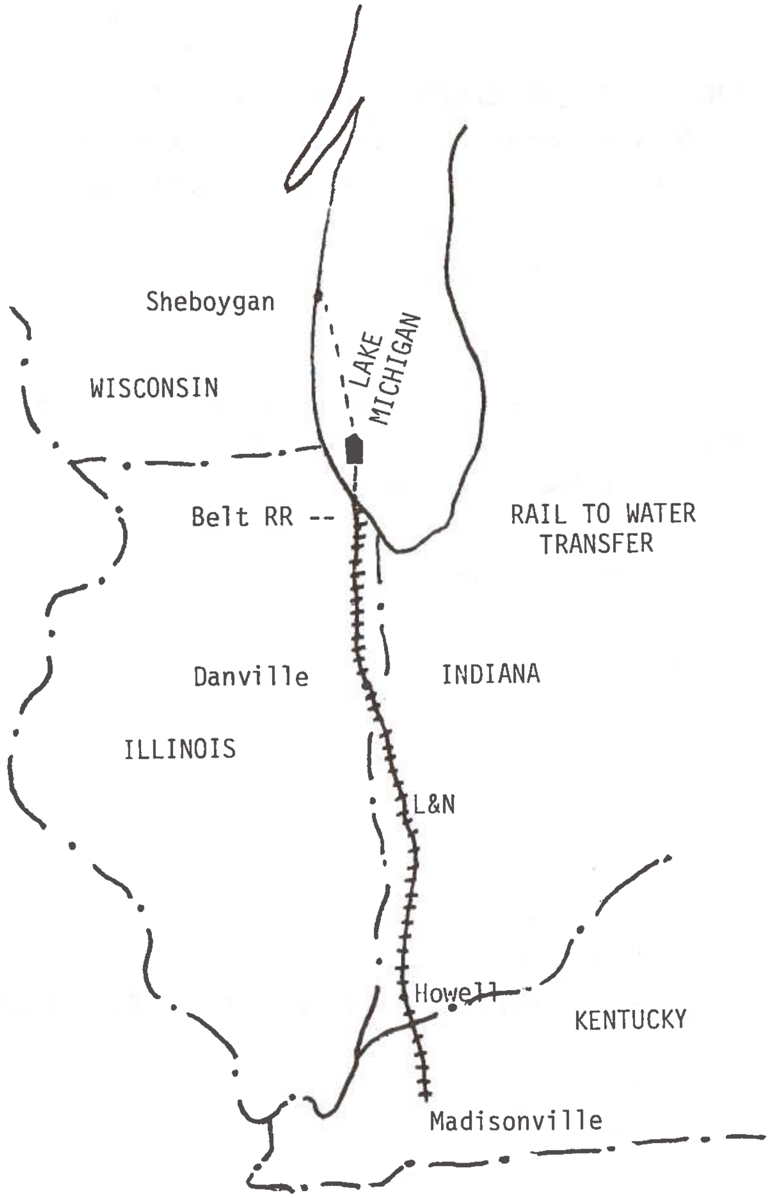
L&N is under ICC Service Order 1043, which requires connecting railroads to return empty hopper cars to the nearest L&N interchange without reloading. Thus SCL returns the empty cars to Atlanta. The total turnaround time between Roaring and Mitchell is approximately 18 days.

3.3.4.3 Lake Cargo Coal Movement

Coal moves to the Lower Great Lake ports for transshipment by water from both the Appalachian fields and the Illinois-Indiana-western Kentucky (midwestern) fields.

Lake cargo coal from midwestern mines moves to Chicago by rail for transshipment to Upper Great Lakes destinations. Coal moving via Chicago docks normally moves by boat to destinations in Wisconsin, Michigan, and Minnesota as far as the city of Duluth. Much of the coal traffic from midwestern mines moves under annual volume or trainload rates. One such move from western Kentucky to a Wisconsin power plant is described below.

Four of five large producing mines in western Kentucky supply coal to a Wisconsin power plant located on Lake Michigan. Coal moves over rail vial L&N and Belt (BRC) Railroads to Chicago and then over water by boat to Sheboygan, Wisconsin. This movement is illustrated by Figure 3.15. The movement is very complex and requires close coordination among several organizations. The organizations include the utility plant, rail-water transfer facility operators, and origin and destination railroads and mines. The coordination of the various elements - boat schedules, car unloading, train movements, car loading, coal production, etc. - is accomplished by a permit system. A permit, based on vessel arrivals, is issued to an originating carrier (L&N) and mines for car loading and movement. The permit is issued by Rail to Water Transfer Corporation, the transloading facility operators. The permit system helps prevent accumulation of unmanageable numbers of cars on destination railroads and facilities and insures better equipment utilization.



Location	Distance from Madisonville, KY	Remarks
Howell	65 miles	crew change
Danville	230 miles	crew change
Chicago	347 miles	rail-water transfer
Chicago (87th St.)	350 miles	interchange with BRC
Sheboygan	493 miles	water movement

Figure 3.15 Lake Cargo Coal Movement

Coal is recovered from deep and strip mines and is brought to the tipple near a railhead by trucks. Trucks are large, heavy duty, with 50-ton capacity and travel distances of 2 to 3 miles over private roads.

Cars in this service are unassigned and drawn from a 50-to-80 ton hopper car pool in the area. Based on permits and mine track holding capacity, cars are dropped at mines by mine crews. Mines are allowed 24 hours to load these cars.

L&N mine crews pick up the loaded cars and marshall them at Atkinson yard, near Madisonville, Kentucky. Depending on the number of cars and coal volumes, L&N consists one or two trains for Chicago. The train size varies depending on coal volume and car sizes. Each train usually carries between 7,000 and 10,000 tons of coal.

A road crew with four six-axle locomotives operates the train from Atkinson Yard to Howell, Indiana. Another crew moves the train to Danville where a crew change is made. The last crew then delivers the train to BRC. A BRC crew and motive power then move the train to transloading facilities located on the Calumet River in Chicago.

The transloading facility is operated by the Rail to Water Transfer Corporation. The facility, due to space limitations, has no ground storage area for its coal. Coal is transported directly from rail cars to vessel or barges. Coal is bottom dumped from cars into a hopper. The hopper feeds the coal to a conveyor leading into a vessel. The facility owns a locomotive to switch cars as required. The facility can store up to 220 railroad cars on its tracks. Vessel sizes calling on the facility vary from 10,000 to 30,000 tons. A new vessel about to be commissioned into this service will have a capacity of 40,000 tons. The facility also loads jumbo barges with 1,500 ton capacity. Pertinent information on the facility is provided in Table 3.15.

Location: Mile 1.8 on the Calumet River--Chicago, Illinois

Served By: The Belt Railway Co. of Chicago

Storage: Yards for holding 2,200 railroad cars

Berths: North Berth 735 Feet--South Berth 726 Feet

Draft: Water depth at dock--27 Feet LWD.

Loading Mechanisms: Two moveable loading towers with telescopic chutes

Product Handling Equipment: 72 inch conveyor belts

Loading Capacity: 3,000 TPH* each dock

Special Equipment: High speed trimming machine for stowing meals and foods

Rail Equipment: Bottom dump, open top or covered, hopper cars--no size limitation

Services Available: Trimming--Separations--Documentation

Operating Season: March 15 through December 15

Ground Storage: none

Number of boats that can be loaded at a time: 2

Boat sizes: 27,000 to 60,000 tons

* Tons per hour

Table 3.16 Pertinent Operational Parameters Rail-To-Water Transfer Facility, Chicago, Illinois.

On the average, it takes two days for rail cars to unload. Total turnaround time between mines and transloading facility is about six days. Empty cars follow the same route in reverse and can be diverted to other movements depending on the need at the time. Inspection is performed at Atkinson Yard.

Frozen water during the winter season inhibits the vessel operations and hence facilities and rail movements are usually stopped between December 15 and March 15. This period varies from year to year, depending upon the weather conditions. The utility plant builds up a large stock of coal during the summer months. In case of emergencies in the winter, coal is shipped all the way to the plant via alternate rail routes.

The vessel takes about twelve hours to go from Chicago to Sheboygan, Wisconsin. Vessels used in this service are self-unloading and have their own boom and cranes to unload the coal. Depending on the size, it takes about 6-8 hours to unload the vessel. Coal is sometimes shipped from Sheboygan via rail or water to other Wisconsin power plants.

4. EASTERN RAILROAD DISTRICT/ASSOCIATION

4.1 Overview

Railroads are assigned to the Eastern District by the ICC on the basis of primary area of operations. Geographically the Eastern District comprises the section from Maine along the Canadian boundary to the westerly shore of Lake Michigan down through Chicago and Peoria to St. Louis, thence along the Mississippe River to the mouth of the Ohio River, and north of the Ohio River to a point near Kenova, West Virginia, thence southward along the Kentucky and West Virginia boundary to the southwestern corner of Virginia, thence east to the Atlantic. This area was previously shown in Figure 1.2.

The Eastern Railroad Association (ERA) is a voluntary association of railroads that operate in the Eastern District. Railroads that operate over a wide geographic area generally belong to more than one regional association. The list that follows identifies major coal carrying Eastern District roads and denotes railroads that participated in the study by completing questionnaires and assessing the validity of certain key Project Independence transportation assumptions. In addition, the Norfolk and Western Railroad Company cooperated and worked with the contractor to prepare descriptions of coal operations, flows, etc. These descriptions are presented in Section 4.3 and are considered similar to operations on other railroads operating within the district.

Major Coal Carriers - Eastern District:

*Baltimore and Ohio Railroad
*Bessemer and Lake Erie Railroad
Chicago and Eastern Illinois Railroad
*Chesapeake and Ohio Railroad
Erie - Lackawana Railroad
*Pittsburgh and Lake Erie Railroad
*Penn Central Transportation Company
*Norfolk and Western Railroad
Reading Company
Western Maryland Railroad

*Denotes study participant.

Tables 4.1 and 4.2 that follow present a profile of 1974 Eastern District bituminous coal operations. The material is organized and presented in terms of volume of traffic handled, revenues received, and cars furnished by the six participating railroads, total Eastern District railroads, and all U. S. railroads accounted for some 49.0 per cent of the total coal carried and 48.5 per cent of revenues earned.

In the sections that follow 1974 profile information is used to help focus changes in expected 1980 levels of operations, distribution patterns, and associated investment requirements.

4.2 Survey Responses and Findings

4.2.1 Estimated Coal Traffic Volumes, 1980

Participating railroads were asked to project 1980 Eastern District coal movements on the basis or origin and destination states and the type of movement involved. Consolidated traffic projections for these parameters are presented in Tables 4.3 and 4.4. When possible 1974 - 1980 comparisons are made to illustrate the magnitude and direction of expected changes, if any.

The participating railroads expect to originate over 288 million tons of coal in 1980 as compared to about 195 million tons in 1974. During the same time period, the total coal tonnage carried by these railroads is estimated to increase from 287 million to over 393 million tons, an increase of about 37 per cent.

About 77 per cent of the above rail originated coal will be produced in the states of West Virginia, Pennsylvania, and Kentucky. Coal originating in the Eastern District is expected to be transported to thirty-six states. However, some 268 million tons or about 93 per cent of the originated coal will terminate in only nine states. They are Ohio,

RAILROAD	(In thousands of tons) ORIGINATED AND TERM. ON LINE	DEL. TO CONNECT.	TOTAL ORIGINATED	TOTAL CARRIED	($000's) REVENUE RECEIVED	% EASTERN RR TONS	% EASTERN RR REV.	% TOTAL US TONS	% TOTAL US REV.
B & LE	12	5,174	5,186	8,746	21,698	2.6	1.9	1.5	1.2
PC	27,926	9,435	37,361	72,628	236,949	21.6	20.9	12.4	13.0
P & LE	1,799	690	2,489	9,181	12,779	2.7	1.1	1.6	0.6
Chessie (1)	39,872	42,879	82,751	118,217	266,518	35.2	23.5	20.1	14.6
N & W	42,913	23,927	66,840	78,864	349,348	23.5	30.8	13.4	19.1
Sub Total	112,522	82,105	194,627	287,636	887,292	85.7	78.1	49.0	48.5
Other Eastern Railroads	3,307	8,752	12,059	47,979	248,765	14.3	21.9	8.1	13.7
Total Eastern District	115,829	90,857	206,686	335,615	1,136,057	100.0	100.0	57.1	62.2
Total All Districts	216,382	171,322	387,704	587,783	1,826,029	--	--	100.0	100.0
% Eastern to Total	53.5	53.0	53.3	57.1	62.2				

Source: Coal Traffic Manual, 1975

Notes: 1. Includes BO, CO and WM totals

Table 4.1 Bituminous Coal Handled by Selected Eastern Railroads - 1974

Railroad	Cars (1)	Capacity (000 net tons)	100 Ton Equiv. Cars	% of Eastern District Cars	% of Total U. S. Cars
B & LE	6,949	552	5,520	3.5	2.0
PC	51,884	4,074	40,740	26.0	15.1
Chessie (2)	71,098	5,294	52,940	35.6	20.7
N & W	55,901	4,572	45,720	28.0	16.3
Sub Total	185,832	14,492	144,920	93.0	54.1
Other Eastern Railroads	14,037	(3)	(3)	7.0	4.1
Total Eastern District	199,869			100.0	58.2
Total All Districts	343,392				

Source: Coal Traffic Annual, 1975

Notes:
1. Car totals include new, rebuilt, leased, and returned cars
2. Includes BO, CO, and WM cars.
3. Data not Available

Table 4.2 Profile of Hopper Car Fleet: Eastern District, 1974

ORIGINATED TONNAGE BY ORIGIN STATE

State	000's Of Tons	% Of Total
Illinois	4,908	1.7
Indiana	6,400	2.2
Iowa	93	--
Kentucky	47,485	16.5
Maryland	1,997	0.7
Missouri	93	--
Ohio	25,265	8.8
Pennsylvania	57,554	20.0
Virginia	27,558	9.6
W. Virginia	116,926	40.5
Total	288,279	100.0

ORIGINATED TONNAGE BY DESTINATION STATES

State	000's Of Tons	State	000's Of Tons
Alabama	840	Missouri	142
Arkansas	2	New Hampshire	1,834
California	57	New Jersey (2)	2,876
Colorado	30	New York	11,703
Conneticut	13	North Carolina	12,284
Delaware	768	Ohio (1)	74,861
District of Columbia	747	Oklahoma	1
Georgia	131	Oregan	12
Illinois	3,818	Pennsylvania (2, 3)	29,783
Indiana	18,179	Rhode Island	1
Iowa	311	South Carolina	1,124
Kentucky	3,059	Tennessee	606
Louisiana	11	Texas	235
Maine	32	Vermount	11
Maryland (2)	16,600	Virginia (2)	50,967
Massachusetts	125	Washington	5
Michigan	29,961	W. Virginia (3)	24,208
Minnesota	1,007	Wisconsin	1,935
		Total	288,279

Notes: 1. Includes all rail and lake transshipment.
2. Includes all rail and tide-water transshipment.
3. Includes all rail and river transshipment.

Table 4.3. Projected Rail Coal Originations and Destinations: Selected Railroads, Eastern District, 1980

Year	Thousands of Tons: Originating & Terminating On Line	Originating & Delivered To Connection	Received From Connection & Term. on Line	Received From Connection & Del. To Conn.	Total Carried
1980 (1)	184,614	103,665	67,178	38,066	393,523
1974 (2)	112,522	82,105	93,009(3)		287,636
Tonnage Increase	72,092	21,560	12,235		105,887
% Increase	64.1	26.3	13.2		36.8

Notes: 1. Source: IOCS questionnaire

2. Coal Traffic Annual 1975

3. Includes received interchanged traffic terminated on-line and/or delivered to connection.

Table 4.4. Projected Increase In Coal Traffic: Selective Eastern District Railroads, 1974-1980.

Virginia, West Virginia, Pennsylvania, Michigan, Maryland, Indiana, New York, and North Carolina. The smaller long distance moves are assumed to be for metalurgical coal. These movements exist today and are expected to continue through 1980.

Note that the portion of coal tonnage terminating in Ohio will be transshipped further north via the Great Lakes. Similarly coal terminating in Maryland, New Jersey, Virginia and Pennsylvania is exported overseas via the Atlantic ports.

To check the reasonableness of submitted projections an independent survey of major coal producing states was performed. The responses to questionnaires received from the states serviced by Eastern District railroads that participated in the survey are presented in Table 4.5 together with the expected rail share of total State markets.

As can be noted, some states served by the Eastern Railroads are also served by the Western and Southern railroads. The coal mined in Ohio traditionally has been transported not only over rail but also over river and roads. Approximately 55 per cent of the coal mined in Ohio in 1974 was carried by barges and trucks and the rest by rail. As can be noted, the rail share of Ohio coal is not expected to change substantially.

West Virginia and Pennsylvania are two major coal producing states serviced by Eastern District railroads. New mine capacity for these states as projected through 1980 by the FEA Coal Office in April, 1975 are given below:

	Type Mine				Totals	
	Surface		Deep			
	#Mines	1000 Tons	#Mines	1000 Tons	#Mines	1000 Tons
WV	5	6201	24	27690	29	33891
PA	3	1340	29	24430	32	25770
	8	7541	53	52120	61	59661

State	Thousands of Tons		Rail Percent of Total Production
	Production (1)	Rail Originations (2)	
Illinois (3)	73,500	4,908	6.7
Indiana (3)	35,000	6,400	18.3
Iowa (6)	900	93	10.3
Kentucky (4)	184,400	47,485	25.8
Maryland	2,700	1,997	73.0
Missouri	5,500	93	1.7
Ohio	63,000	25,265	40.1
Pennsylvania	NA (5)	57,554	--
Virginia (4)	NA	27,558	--
W. Virginia	137,500	116,926	85.0
Total	502,500	288,279	--

Notes:
1. Source: IOCS survey of coal producing states.
2. Source: IOCS survey of selected railroads in Eastern District.
3. Coal from Indiana and Illinois is also originated by railroads in Southern and Western Districts.
4. Coal From Kentucky and Virginia is also originated by railroads in Southern Districts.
5. NA - Not available.
6. Coal from Iowa is also originated by railroads in Western District.

Table 4.5. Projected 1980 Coal Production and Rail Originations in the Eastern District.

As shown in terms of both number of mines and tonnage, the great majority of new coal will come from deep mines. For new deep mines through 1982 the combined projected total for Pennsylvania and West Virginia is 57.1 million tons, some 45 per cent of the total new capacity for all new deep mines.

The Department of Mines for West Virginia reported that their State mines have a much larger percentage of underground coal versus strip and auger mined coal than other Appalachian States. With some 41.1 per cent of the total Appalachian underground production they assume their coal production projections would not be greatly affected by stringent reclamation controls, as might other Appalachian States and States in other producing areas. Projected coal production for 1980 and 1985 are some 125 to 150, and 180 to 210 million tons respectively.

State markets for West Virginia coal for 1975 as reported by the State's Bureau of Mines are given in Table 4.6.

The Department of Environmental Resources, Commonwealth of Pennsylvania, preliminary estimates of 1975 coal production are given below. For comparison purposes, 1974 figures are also shown.

	1974 Actual	1975 Estimates
Bituminous Coal	80,042,191 Tons	83,211,154 Tons
Anthracite Coal	6,090,421 Tons	5,130,078 Tons
Total	86,132,612 Tons	88,341,232 Tons

Estimates for coal production for the ten year period 1975 - 1985 were obtained from the Governor's Energy Council which conducted a statewide survey for coal production, market projections, and employment needs of the coal industry. The study is based on responses received from 75 of the 250 companies contacted. The preliminary findings are that the average tonnage for 1975 - 1985 will be some 68.9 million tons,

Destination State	1975 (Tons)
South Atlantic	
Delaware	59,400
Maryland	2,663,280
District of Columbia	314,280
Virginia	2,451,600
West Virginia	17,452,800
North Carolina	1,806,840
South Carolina	628,560
Georgia	199,800
East South Central	
Kentucky	1,541,160
Tennessee	218,160
Alabama	934,200
West South Central	
Texas	280,800
Mountain	
Colorado	21,600

Destination State	1975 (Tons)
New England	
Massachusetts	492,480
Connecticut	4,320
Maine	28,080
Vermont	55.080
New Hampshire	68,880
Rhode Island	37,800
Mid Atlantic	
New Jersey	1,885,680
New York	4,848,120
Pennsylvania	14,472,000
East North Central	
Ohio	13,053,960
Illinois	1,029,240
Indiana	6,145,200
Michigan	7,054,560
Wisconsin	983,880

Destination State	1975 (Tons)
West North Central	
Minnesota	603,720
Iowa	59,400
Missouri	5,400
Exports	
Canada	7,425,000
Overseas	23,706,000
Total Exports	31,131,000
Total U.S.	80,316,000
	111,447,000

Source: Department of Mines, State of West Virginia

Table 4.6. Markets For West Virginia Coal

an increase of some 23.5 million tons over their 1974 productions. Estimated mine openings and closings for the period are summarized below.

	Strip Mines	Deep Mines	Total
Present	180	61	241
New, 1975-85	455	32	487
Closing, 1975-85	(385)	(16)	(401)
	250	77	327

4.2.2 Estimated Equipment in Coal Service, 1980

Cars, locomotives, and cabooses required to transport estimated coal traffic volumes were also reported by participating railroads. Consolidated equipment requirements for these categories are presented in Tables 4.7 and 4.8. Again, when applicable, 1974 data is included for comparison purposes. The figures represent estimates of car requirements expressed in the number of units that normally will be used in coal service throughout the year. As such, the figures may vary in accordance with the level of demand.

The participating railroads project to increase the car fleet in coal service from 127,002 100-ton equivalent cars in 1974 to 151,990 in 1980 to accommodate the expected traffic. All existing 50-ton cars are expected to be retired by 1980. As can be noted, the smaller cars will continuously be replaced by larger cars in the future. All cars on order or planned for future coal service are 100-tonners.

Gross measurements of car and locomotive utilization were calculated to determine the direction and magnitude of expected change 1974-1980. These measurements are summarized in Table 4.9 and indicate that loads per car per year will increase from 15 in 1974 to 19 in 1980. This is due to improved car utilization. The average length of coal hauls is not expected to change substantially.

Type	Capacity	Existing Fleet 1974 (1)	Retirements Through 1980	Now On Order	Additional Planned Through 1980	1980 Equipment Projections: Railroad		1980 Equipment Projections: Shipper (2)		1980 Projected Requirements	
						Cars	100-ton Equiv.	Cars	100-ton Equiv.	Cars	100-ton Equiv.
Hopper	100	25,073	--	13,388	21,675	79,271 (3)	79,271	--	--	79,271	79,271
Hopper	85	5,629	25	--	--	5,604	4,763	--	--	5,604	4,763
Hopper	78	70,839	16,284	--	--	54,555	42,553	--	--	54,555	42,553
Hopper	77	26,009	5,545	--	--	20,464	15,757	--	--	20,464	15,757
Hopper	70	26,600	12,820	--	--	13,780	9,646	--	--	13,780	9,646
Hopper	50	5,225	5,225	--	--	--	--	--	--	--	--
Total		159,375	39,899	13,388	21,675	173,674	151,990	--	--	173,674	151,990

Notes:
1. Includes Totals for PC, Chessie, N & W, B & LE, P & LE.
2. Includes cars on hand, on order and planned. Eastern Railroads did not report this figure.
3. Includes 19,135 cars tentatively under consideration but not presently ordered or planned.

Table 4.7 Estimated Cars In Coal Service: Selected Eastern District Railroads, 1980

Horsepower	Existing (1) Fleet	Retirements Through 1980	Presently On Order	Additional Planned Through 1980	Total Required
1000	1	--	--	--	1
1500	15	3	--	--	12
1800	26	--	--	--	26
2000	20	--	1	15	36
2150	944	96	38	133	1019
2500	54	--	--	--	54
2800	22	--	--	--	22
3000	73	--	--	--	146 (2)
3600	115	--	--	--	115
Total	1270	99	39	148	1431

Notes: 1. Includes total for PC, N & W, Chessie, B & LE and P & LE.

2. Includes 73 locomotives tentatively under consideration but not presently planned or ordered.

Table 4.8. Estimated Locomotives In Coal Service: Selective Eastern District Railroads, 1980.

Year	Originated Coal (000 tons)	Car Fleet 100 Ton Equivalent	Ton/Car Per Year	Loads/Car Per Year	Days/Load
1974	194,627 (1)	126,372 (2)	1,540	15	24
1980	288,279 (2)	151,990 (2)	1,897	19	19

	Originated Coal	Loco Fleet 3000 HP Equivalent	Tons/Loco Per Year	% Increase
1974	194,627	990	196,593	30.2
1980	288,279	1,126	256,020	

Notes: 1. Includes PC, Chessie, N & W, B & LE and P & LE originated coal as reported in Coal Traffic Annual, 1975

2. Consolidated totals and projections furnished by Eastern Railroad Association for the same railroads.

TABLE 4.9. Projected Coal Originations and Gross Measurements of Equipment Utilizations: Selected Eastern District Railroads, 1974 and 1980

4.2.3 Estimated Additional Maintenance Facilities, 1980

Participating Eastern Railroads reported an increase of 25,618 100-ton equivalent cars in coal service by 1980. This increase is not substantial, when considering the total car fleet. The railroads indicated that a nominal increase in service facilities will be required. The additional service will be generally provided through expanding the existing facilities. The railroads did not report any dollar investments required for this purpose.

4.2.4 Estimated Physical Plant Improvements, 1980

Two of the five participating railroads reported physical plant improvements needed to meet increased coal traffic requirements. These two railroads will carry approximately 30 percent of the 1980 coal estimates submitted by ERA. Other lines, whose figures are not included, are studying the expansion of the yard facilities, new lines and other improvements but those estimates are not available at this time.

Results of the survey are summarized in Table 4.10. As can be noted Eastern Railroads are planning to invest over $182 million by 1980 to accommodate the increased coal traffic. This should not be considered "cost" to handle the coal as these facilities will also be used to transport other commodities. The majority of investment, some 76 per cent is allocated to improving the existing railwork.

4.3 Description of Coal Operations: Norfolk and Western Railway

4.3.1 Overview

During 1974, 66,840,291 tons of coal were produced by some 200 mines located on the NW. The major classifications, markets, and selective statistics for this traffic are summarized below.

Category	Planned/Under Construction (1)		Total Required		Average
	Miles	(000's) 1975 Dollars	Miles	(000's) 1975 Dollars	Cost/Mile
Rail Relay	257	18,162	1185	83,743	$ 70,669
Signalling	17	916	52	1,766	33,962
Ballasting	1451	1,974	7255	8,865	1,222
New Lines (2)	16	17,100	34	36,800	1,082,353
Supplemental Lines (3)	12	4,700	13	5,600	430,769
Yard Facilities	12	25,000	15	25,800	---
Other	22	11,500	36	19,600	---
Total	1787	79,352	8590	182,174	

Notes: 1. Includes totals for two major Eastern Railroads.

2. Includes mine spurs and industrial plant spurs.

3. Includes double track, sidings, etc.

TABLE 4.10. Projected Track Improvement Requirements: Participating Eastern Railroads.

In addition to originated tonnage, 7.2 million tons of raw coal moved within the mine field territory to cleaning plants, and 12.3 million tons were received in interchange. Further, some 2.7 million tons of coke were handled.

Revenues received for transporting coal, coke, and iron ore in 1974 amounted to $376,939,000 some 40 per cent of the net freight revenues.

Major Classifications

East via Bluefield and Elmore	West via Williamson and Norton
34.4%-Tidewater, Lamberts Point	30.4%-Commercial, West
22.3%-Commercial, East	8.5%-River, Kenova
	4.4%-Lake, Sandusky

Markets

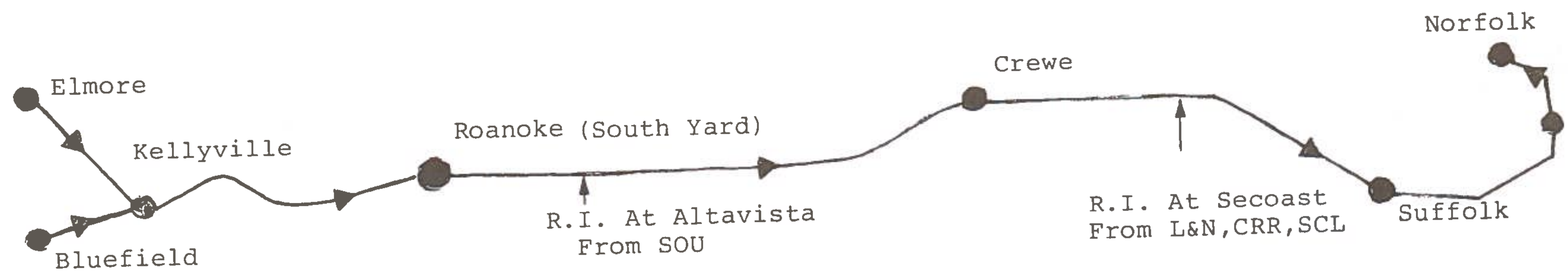
Steel and Other Coke Plants	29.6
Electric Utilities	32.5
Export	32.6
Coastwise & Other	5.3
	100.0%

Statistics

Average Tons/Cars	84.8
Average NW Rev./Ton	$ 4.68

4.3.2 Major Coal Flows

As shown below, coal is produced at some 234 mines located in 14 districts served by the NW. The movement of coal from producers to end users, or transshipment points, results in the seven major coal flows identified in Figure 4.1 through 4.6. Track mileages between key coal route segments are presented in Table 4.11.



At Lamberts Point, Norfolk, Virginia, Coal is transferred to vessels for water movement to countries or ports as shown.

Foreign	Costal And New England
Japan	Trenton, NJ
Italy	Baltimore, Md
Holland	Philadelphia, Pa
Spain	Salem, Ma
Brazil	Providence, RI
United Kingdom	Somerset, Ma
France	
Belgium	
Argentina	
Portugal	
Germany	
Korea	
Chile	
Romania	
Sweden	
Nova Scotia	
Norway	
Canada	
Uruguay	

Note: Some coal destined for Norfolk is also received from the SOU and L&N at Norton, and from the CRR at St Paul which is East of Norton.

Figure 4-1 Tidewater Coal Flows

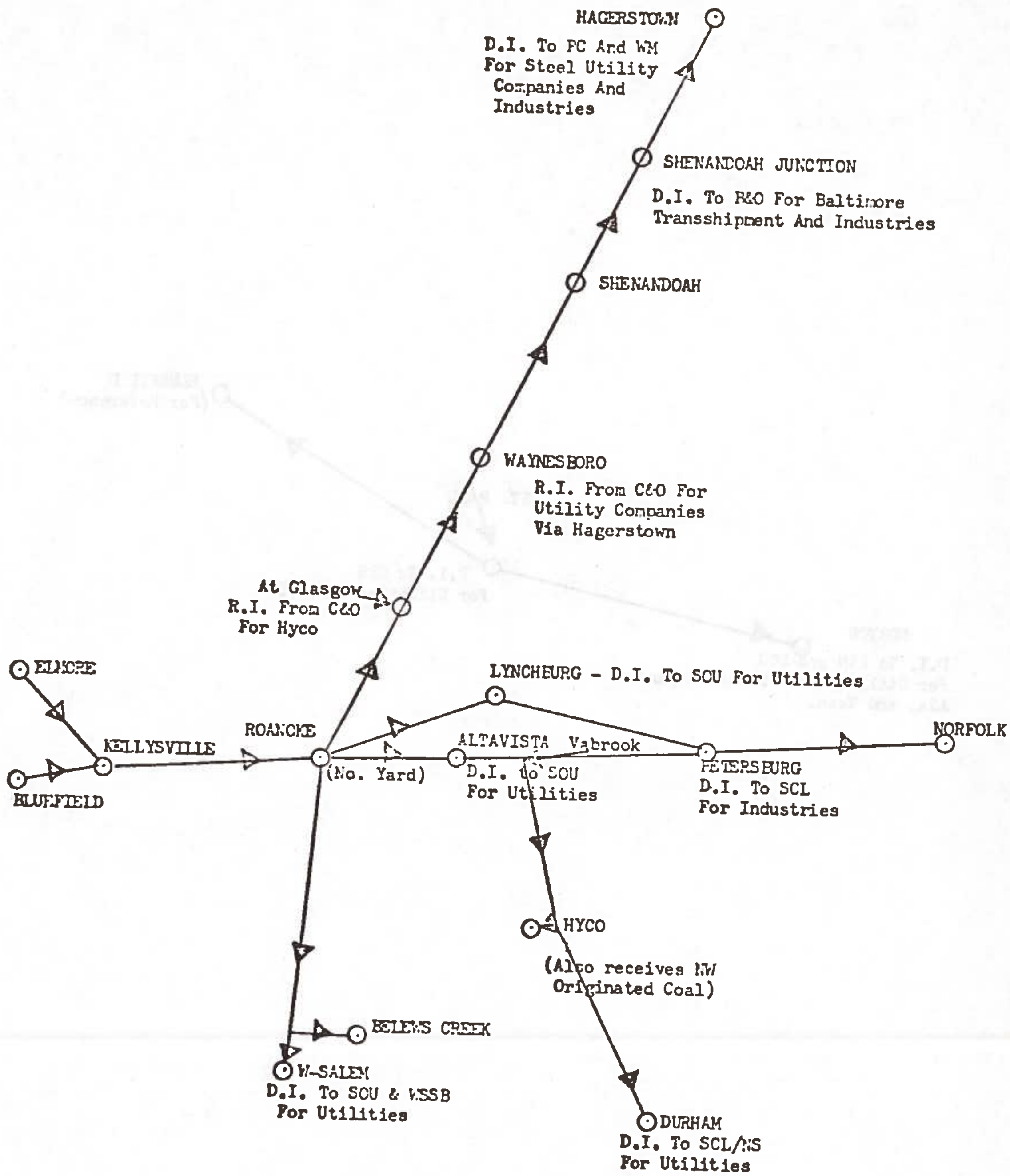


Figure 4-2 Commercial East Coal Flows

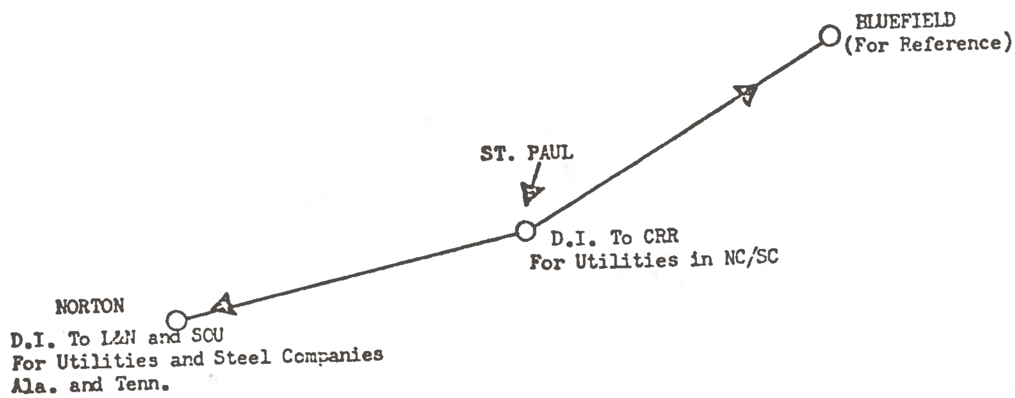
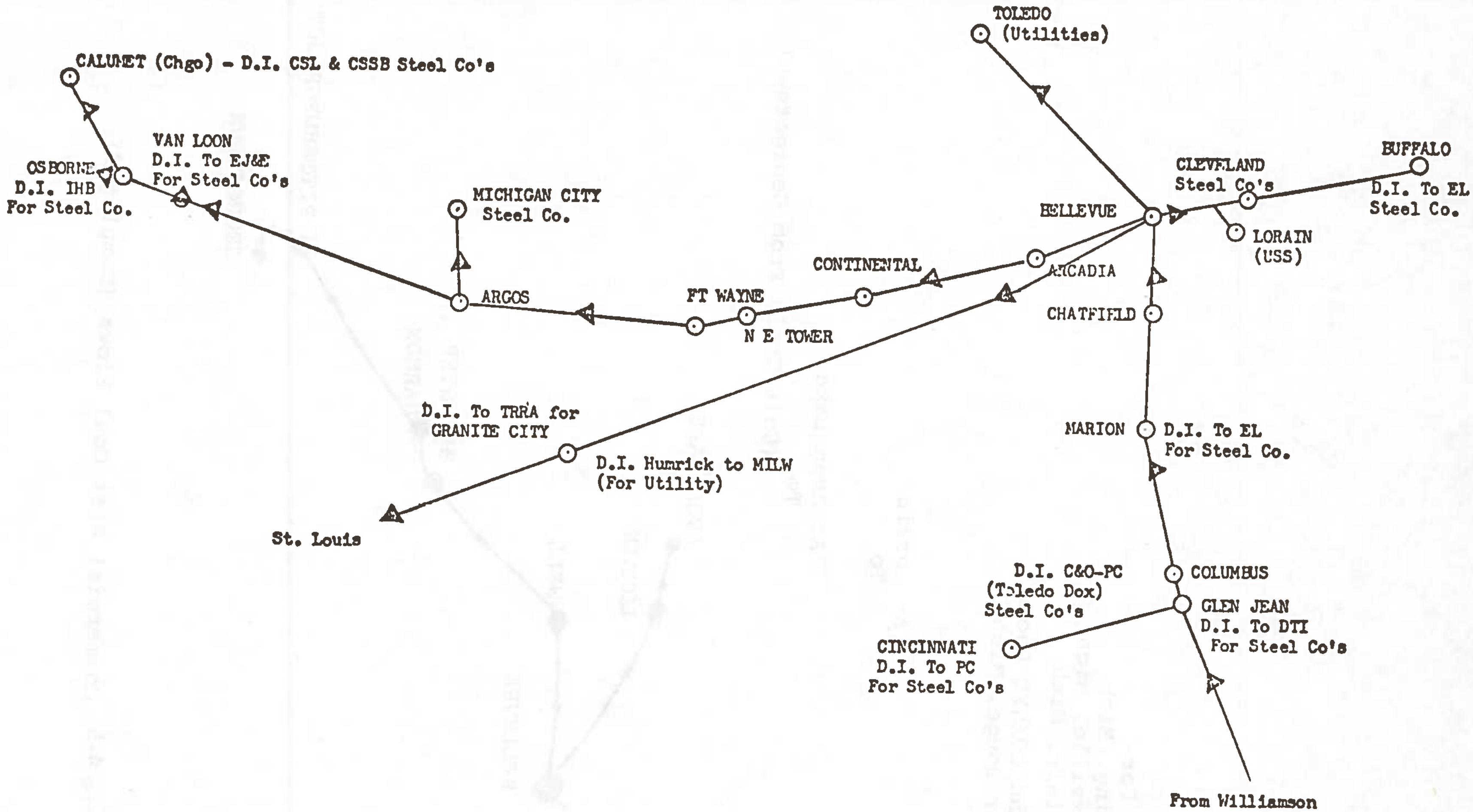


Figure 4.3 Commercial East Coal Flows (Completed)



RI from CRR at St. Paul and SOU at Norton for Above Points

Figure 4.4 Commercial West Coal Flows

At Toledo
To

To DTSL For
Lansing, Mich
Essexville, Mich
St Clair, Mich

To BO And CO/NYC Docks
River Rouge, Mich

At Lorain
To

At Avon Lake
To
(Unit Train From Georgetown)

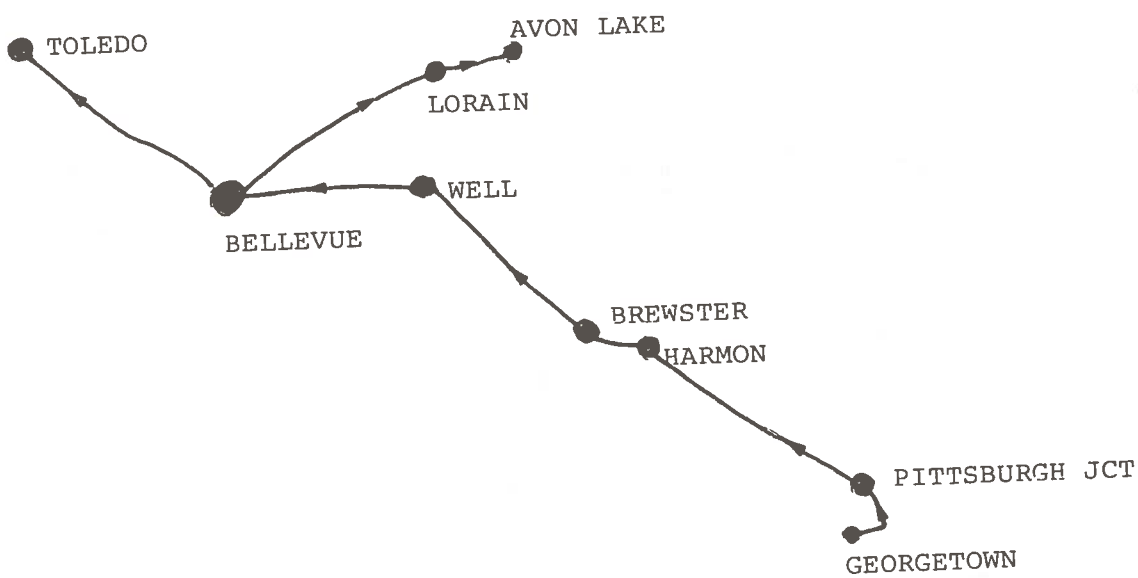


Figure 4-5 Commercial West Coal Flows (Completed)

At Sandusky coal is transferred to vessels
for water movement to:

Steel Companies

River Rouge, Michigan

Ecorse, Michigan

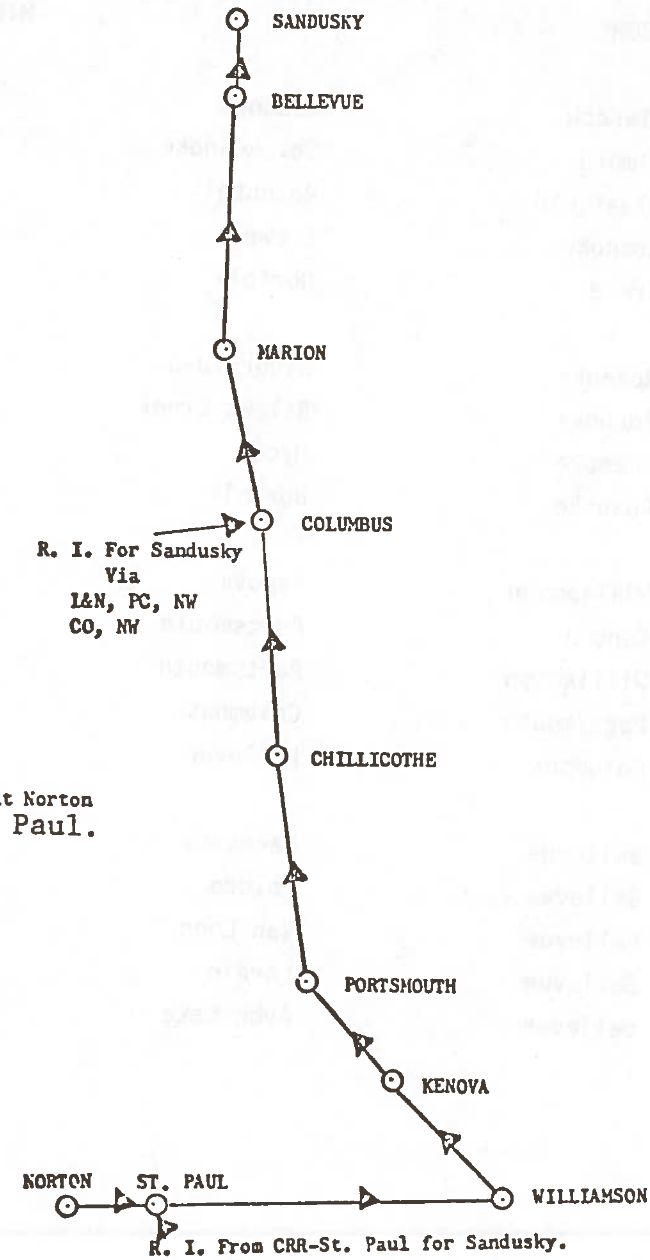
Hamilton, Ontario

Hamilton, Ontario

Utilities

Montreal, Quebec

Marquette, Michigan



Note: Coal for Sandusky is also received at Norton
from the SCU and CRR at St. Paul.

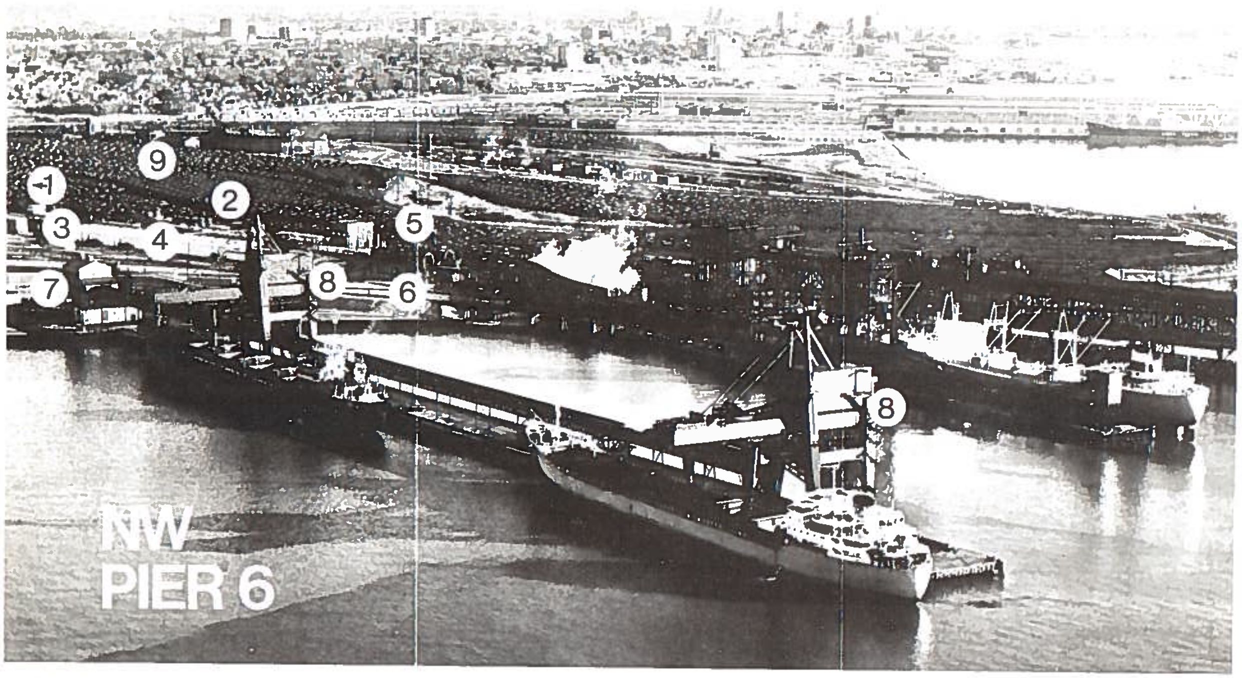
Figure 4-6 Lake Coal Flows

FROM	TO	MILES
Glascow	Roanoke	44
Elmore	So. Roanoke	133
Bluefield	Roanoke	100
Roanoke	Crewe	123
Crewe	Norfolk	132
Roanoke	Hagerstown	238
Roanoke	Belews Creek	104
Roanoke	Hyco	138
Roanoke	Norfolk	255
Williamson	Kenova	73
Kenova	Portsmouth	39
Williamson	Portsmouth	112
Portsmouth	Columbus	97
Columbus	Bellevue	96
Bellevue	Sandusky	15
Bellevue	Toledo	53
Bellevue	Van Loon	249
Bellevue	Lorain	38
Bellevue	Avon Lake	44

Table 4-11 Mileage Between Key Coal Route Segments

the pier, custom blending four types of coal simultaneously, eight-foot conveyor belts, and cola mixed three times between blending and loading. Figures that follow show the location and describe the work and processes performed at key system stations.

Present pier capacity is sufficient to support estimated 1980 operating requirements. The continued increase in average capacity per car, which has moved from 75 tons in 1965 to 85 tons in 1975, will continue to simplify and improve the efficiency of pier-side car movement operations. As the average capacity approaches 100 tons, the annual through-put capacity of the facility will increase by some 20% without need of significant capital expenditures.



1. Barney Yard. This switching yard is where loaded coal cars are assembled before dumping. NW sorts cars containing various classes of coal as the first step in blending exactly the right coal mixture for each customer.

2. Scale Retarders. These retarders slow each car rolling toward the weighing station so it will pass over the scales at not more than 5 mph. Car speed is determined by radar, which relays data to the retarder which then slows the car to the proper speed.

3. Scale Office. Two Fairbanks-Morse mechanical scales, each with a capacity of 400 tons, weighs each car and records its weight automatically.

The scales are accurate within 0.2 per cent, or within 400 pounds, on a 100-ton coal load.

4. Thawing Shed. The car leaves the weighing station and rolls down to the thawing sheds. In the winter, frozen coal is thawed here so it can be dumped easily.

Electrically-powered infra red heating elements, operating at 1550° F, are grouped on each side and beneath the cars. Cars pass through the sheds in six to nine minutes.

5. Tandem Rotary Dumpers. Together these high-speed dumpers can empty 252 cars per hour. The dumper mechanism pushes each car into position with an automatic chain drive, locks it in position, rotates it 165°, then turns it upright and releases it. The dumped coal falls into blending bins.

6. Custom Blending Station. This is where coal from various mines is precision blended electronically to customer specifications.

Blending ratios of up to 7-to-1 can be preset at each of three blending points. Coal falls from two bins at rates that are automatically varied. The coal falls onto the moving shuttle conveyors. A third control further varies blend proportions by presetting the relative speed at which the two shuttle conveyors deposit coal on the main transfer conveyor belt.

7. Transfer House. Here coal is transferred to the pier conveyor belts. As the coal falls onto the pier conveyor belts it is mixed, increasing the homogeneity of the blend. More mixing is also accomplished at three other transfer points.

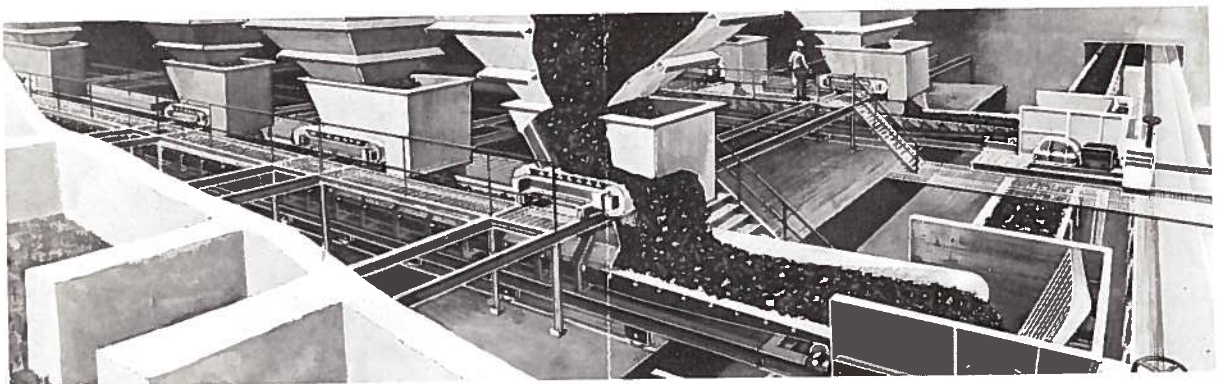
8. Loading Towers. Each of these massive towers weighs 2,800 tons and stands 192 feet above the water. They travel the length of the pier on 90 wheels. The towers can load two ships at once or both can concentrate on a single ship. Retractable booms reach down 120 feet and telescopic chutes with mechanical trimmers distribute the coal rapidly and evenly into the ship's hold.

9. Empty Yard. Empty cars leaving the dumpers move to the kickback, reverse direction and continue to the empty yard. From the retarder tower, cars are classified for return to the railroad that owns them. Cars needing repairs are switched to the modern repair shop.

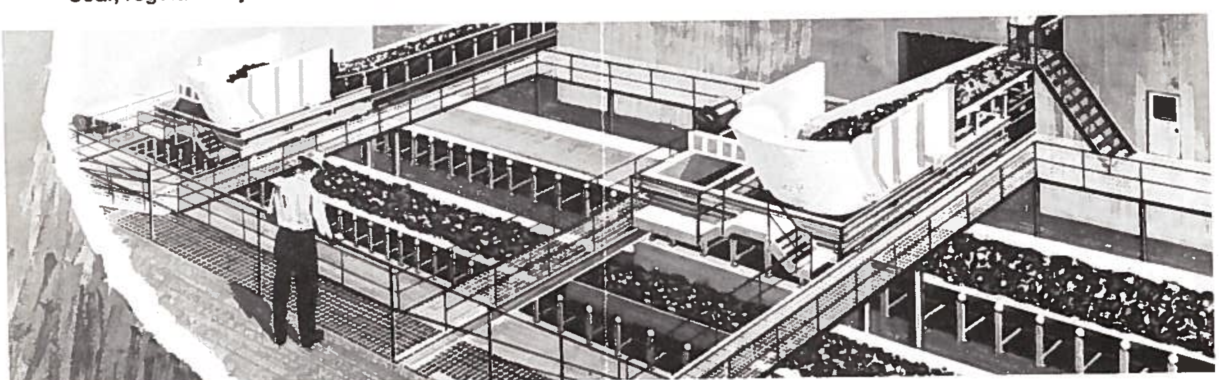
The empty yard has 38 tracks with a total capacity of 2,330 cars.

Figure 4-13 Work and Processes Performed at System Stations.

Rotary dumpers at Custom Blending Station empty four coal cars into transfer bins.



Coal, regulated by feeder mechanism, is placed on variable-speed shuttle conveyors.



Blended coal is mixed at the transfer house when it is transferred to pier conveyors.

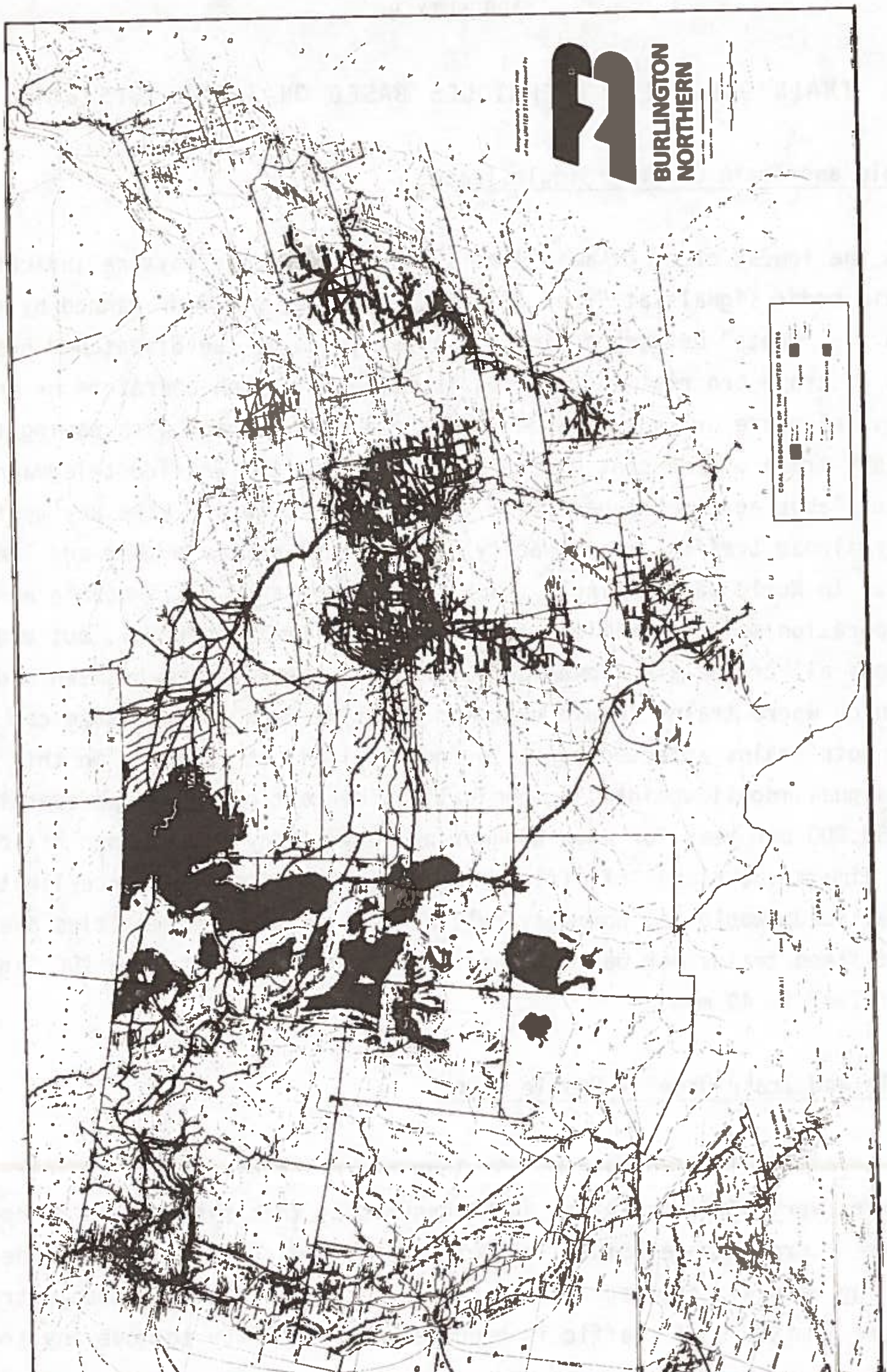
Coal is mixed for a third time at the loading towers, and is deposited aboard ship.

Figure 4.14 Work and Processes Performed at System Stations.

5. APPENDIXES

APPENDIX A

BN SYSTEM MAP



APPENDIX B

TRAIN OPERATING TECHNIQUES BASED ON SIGNAL SYSTEMS

Timetable and Train Order - Single Track

This is the lowest order of main line signals. The only wayside indications are the train order signals at "open offices"; that is, stations manned by telegraph operators. "Meets" between trains are established by the dispatcher based on reports of train progress he receives from the telegraph operators or from train crews by telephone or radio. Some roads have experimented with having train crews copy train orders sent by radio, eliminating the wayside telegraph operators, but labor agreements have been an obstacle to this. Like any system for moving railroad traffic, its capacity is dependent on the number and length of sidings. In World War II single track lines dispatched by timetable and train order operation moved densities of upwards of 40 trains per day, but under such conditions all trains are slowed considerably. The time lag between a dispatcher's decision on where trains should meet and the time when this message can be delivered to both trains affected is the principal limit to capacity in this system from a signalling viewpoint. Economically, the cost of telegraph operators (over $50,000 per year for each 24-hour per day, 7-day a week open office) quickly limits the number of offices which are practical and hence limits capacity. Railroads would not normally rely on this system for densities over about ten to fifteen trains per day. The maximum speed allowed by the ICC Signalling Order of 1947 is 49 mph.

Timetable and Train Order - Double Track

This is a relatively rare system. So long as trains do not have to overtake each other, very high densities can be handled by this system with no open office between crew change points, or between the beginning and end of the double track. The main disadvantage is the very high capital cost of double tracking and, where a mixture of traffic is handled, the inability to move any train faster than the slowest train ahead. Train spacing can be the minimum required for flag protection. The maximum speed allowed by the ICC Signalling Order of 1947 is 49 mph.

Automated Block Signals - Single or Double Track

From a traffic movement standpoint this system is the same as the timetable and train order system. Telegraph operators are still required to establish "meets" on a single track. However, because of the greater protection which the automatic block signals (ABS) offer in keeping trains apart, the ICC Signalling Order of 1947 allows a maximum speed of 79 mph. Since the railroads operate coal trains at 50 mph anyway for equipment maintenance reasons, ABS does not give them any great advantage in coal train operation.

Centralized Traffic (CTC) - Single Track

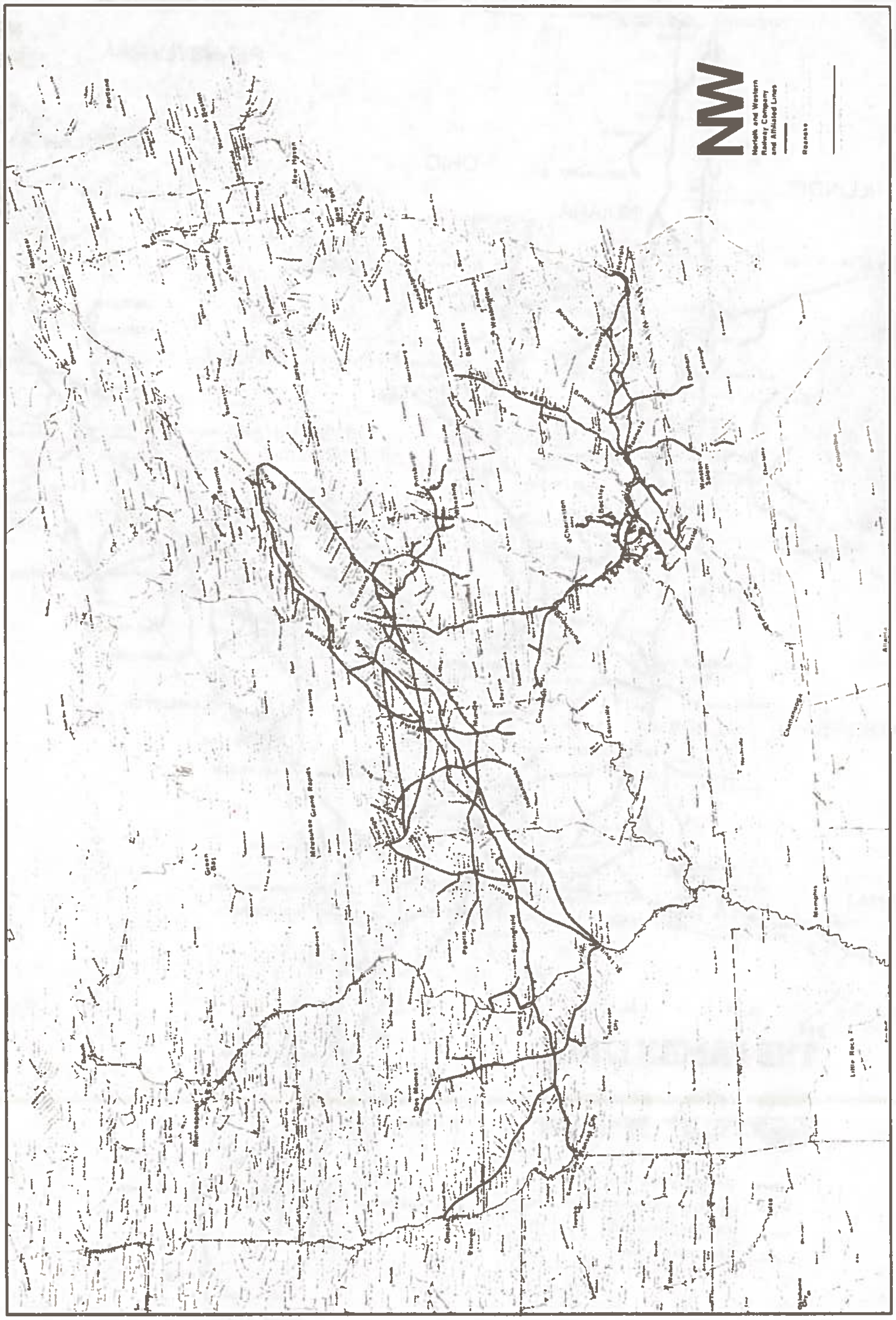
This system permits the dispatcher to establish meeting points by signal indication. A control panel in the dispatcher's office operates remotely all of the siding switches and signals, replacing the open offices. The time lag in effecting a meet is reduced. The capital cost of this system is about $90,000 per siding, plus about $200,000 fixed cost per 100 miles for the control panel and cable. Where sidings have been spaced at five to seven mile intervals, train capacities of over 35 per day have been achieved without serious delay. In the more normal siding spacing of 10 to 13 miles, a capacity of 25 trains per day is more reasonable. As these high densities are achieved, however, the speed of all traffic is reduced. The ICC Signalling Order of 1947 would theoretically permit 79 mph operation.

Reverse Signal - Double or Multiple Track

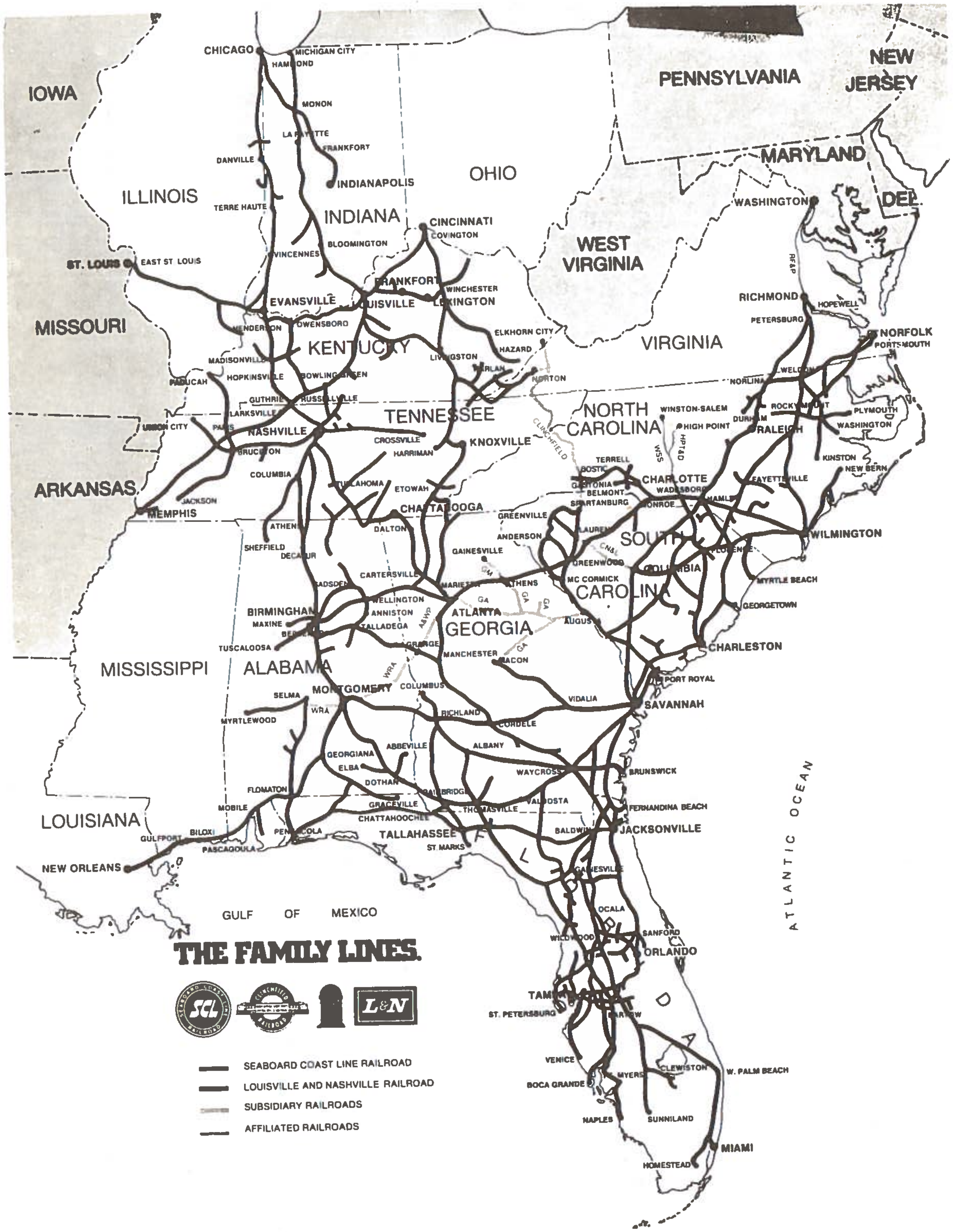
This system permits the dispatcher to move traffic by signal indication on any track in any direction. High-speed crossovers and siding turnouts are used to allow closely-timed overtaking meets as well as maximum flexibility in meeting opposing trains. With this system, a density of 75 to 125 trains per day can be handled without significant delay to faster trains, where the spread is 45-50 mph for slower trains, such as coal trains, and 65-70 mph for fast trains, such as TOFC movements. This system is more than double the cost of a single track CTC system, even if the double track is already in place.

APPENDIX C

N&W SYSTEM MAP



APPENDIX D
L&N SYSTEM MAP



APPENDIX E

LIST OF ABBREVIATIONS

AAR	American Association of Railroads
ABS	Automatic Block Signalling
ATSF	Atchison, Topeka, and Santa Fe Railroad
B&O	Baltimore and Ohio Railroad
BN	Burlington Northern, Inc.
C&IM	Chicago and Illinois Midland Railroad
CNW	Chicago and North Western Railroad
C&O	Chesapeake and Ohio Railroad
CTC	Centralized Traffic Control
D&RG	Denver and Rio Grande Western Railroad
D.I.	Delivered Interchange
DOT	Department of Transportation
EJ&E	Elgin, Joliet, and Eastern Railroad
EL	Erie Lalcawanna Railroad
ERA	Eastern Railroad Association
FEA	Federal Energy Administration
FED	Fossil Energy Division, FEA
ICC	Interstate Commerce Commission
ICG	Illinois Central Gulf Railroad
L&N	Louisville & Nashville Railroad
MILW	Chicago, Milwaukee, St. Paul, and Pacific Railroad
MP	Missouri Pacific Railroad
MPH	Miles per hour
NCA	National Coal Association
N&W	Norfolk and Western Railroad
PC	Penn Central Railroad
PI	Project Independence
R.I.	Received Interchange
RI	Chicago, Rock Island, and Pacific Railroad
SCL	Seaboard Coast Line Railroad
SFA	Southern Freight Association
SLSF	St. Louis - San Francisco Railroad
SOU	Southern Railroad
TSC	Transportation Systems Center
TPH	Tons per hour
UP	Union Pacific
WRA	Western Railroad Association

APPENDIX F

REPORT OF INVENTIONS

After diligent investigation, no new inventions resulted from the research presented in this report. However, key areas of improvement in rail transportation of coal technology were identified for further analysis.

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