AN ANALYSIS OF THE BENEFITS AND COSTS OF REHABILITATING THE WAHPETON-TO-INDEPENDENCE RAIL LINE

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WAHPETON-TO-INDEPENDENCE BENEFIT-COST ANALYSIS

ABSTRACT

The line was analyzed using a new short-line benefit-cost procedure developed at the Upper Great Plains Transportation Institute. The project is actually part of a series of capital projects on the line. The overall benefit cost ratio for the projects is 14.3. The outlay will be paid back on the basis of discounted benefits before 1995.

A discount rate of 8 percent was used in the analysis. Costs were developed for the line from detailed inspection, surveys, and operating data. Revenues were computed from current tariffs. The methods are detailed in the text of the report.

INTRODUCTION

The Wahpeton-to-Independence line is part of Red River Valley & Western's mainline in North Dakota. The line is approximately 89 miles long. It helps connect the Red River Valley & Western (RRV&W) to the Burlington Northern's system at Breckenridge and Jamestown (Figure 1).

The line handles both originated and terminated (O&T), and bridge (overhead) traffic. It generates a significant portion of RRV&W's annual carloads, and serves as a connector line to the yard at Breckenridge for much of the traffic north of Oakes. Thus, the line is a critical segment of the carrier's network.

Project History and Analytical Approach

The benefit-cost analysis covers three separate but related projects. In 1988, North Dakota loaned the RRV&W money to perform tie and ballast work on a portion of the Oakes-to-Independence line, and to lay five miles of rail on the Wahpeton-to-Mooreton section of the line. A benefit-cost study was undertaken at that time. It was determined that both projects (considered separately) would generate net benefits for the state.

Since then, a more detailed scrutiny of the line, and a more concise formulation of network capital requirements by RRV&W, have disclosed additional capital needs on the mainline. The RRV&W and the Upper Great Plains Transportation Institute (UGPTI) high-railed and walked the entire line in June, and developed a detailed projection of capital needs and maintenance costs through the year 2000. The evaluation (detailed in Appendix A) indicates the need

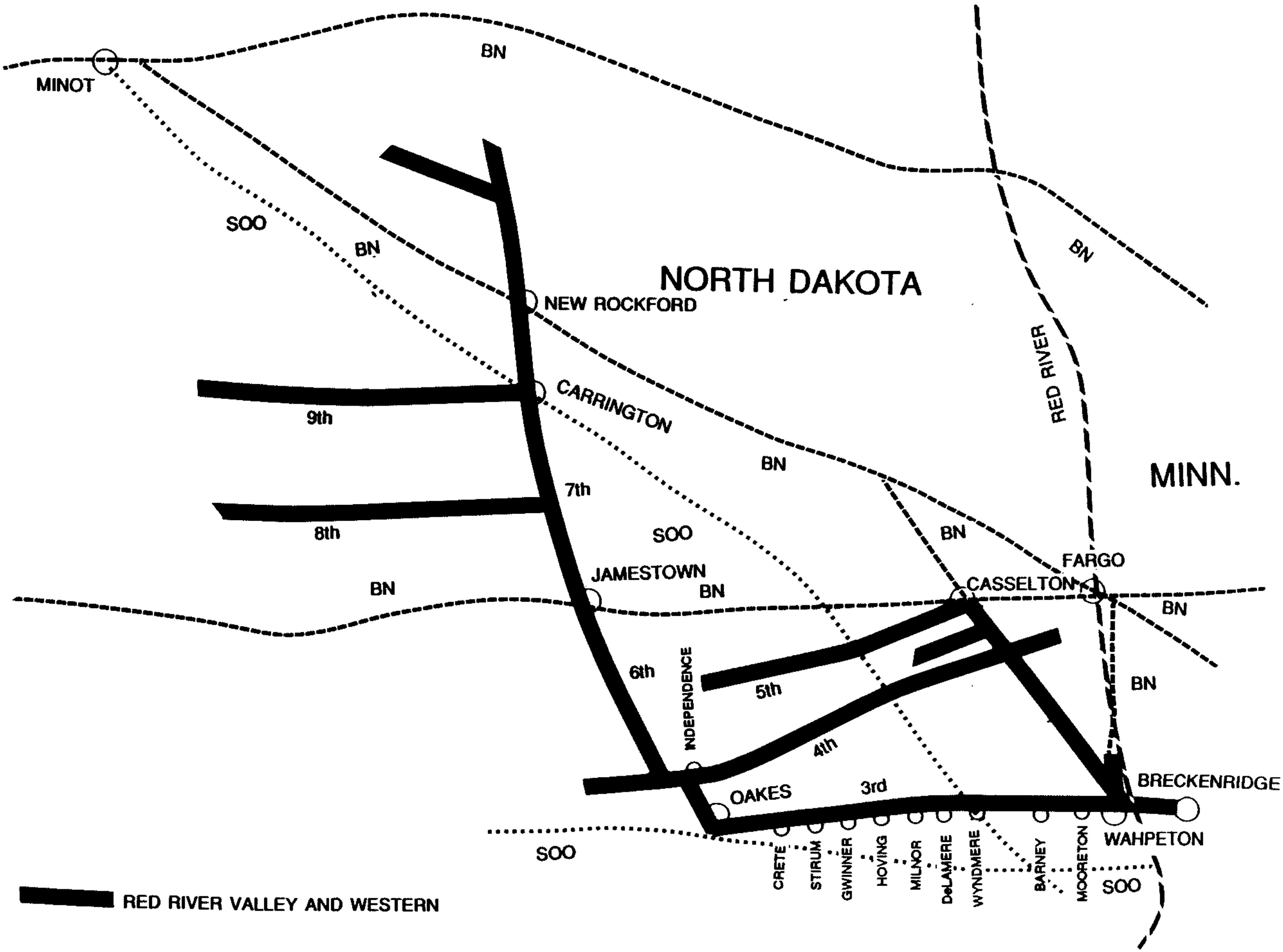

FIGURE 1. RED RIVER VALLEY AND WESTERN NETWORK

for additional tie and ballast work on the Wahpeton-to-Milnor segment of the line. Without renewal of ties and ballast in this area, the life of the in-place rail, ties, and ballast will be greatly reduced. Consequently, from a life-cycle cost and economic efficiency perspective, it makes sense to consider additional tie and ballast work on the line this year.

Since two state-supported projects were undertaken last year on this division, and since all three projects are interrelated, it makes sense to consider the three individual projects as one. It would be difficult (if not impossible) to assign benefits and costs to each project. Any such assignment would be somewhat arbitrary. As a result, double-counting of benefits (and/or costs) could occur. Furthermore, the synergistic effects of the individual projects may be different from the individual effects. All things considered, the projects should be evaluated jointly. In taking this approach, the North Dakota Highway Department (NDHWD), the Federal Railroad Administration (FRA), and the RRV&W are assured that the investments being made will return benefits sufficient to justify the capital outlays.

So the approach which is taken in this study is to re-evaluate the entire Wahpeton-to-Independence line, and assess the net benefits generated from public investment in all three projects. The total cost of the projects (including the two in 1988 and the one proposed for 1989) is 1.774 million dollars. The state's share (70%) comes to 1.242 million dollars. The work involved in all three projects is shown in Table 1.

TABLE 1
1988 RED RIVER VALLEY & WESTERN RAILROAD COMPANY
PROJECT ESTIMATES

RRVW 88-1

Estimated cost to relay 5 miles of track between Wahpeton & Mooreton
MP 78.2 & MP 83.2
Relay 72# with 112# rail using contract labor

QUANTITY	DESCRIPTION	LABOR	MATERIAL	TOTAL
988 Tn	112# Rail Grade #1	$132,000	$256,880	$388,880
2704 ea	24# 112# Angle Bars		17,576	17,576
5412 ea	Track Bolts		15,240	15,240
5412 ea	Washers		3,150	3,150
59,560 ea	Track spikes		14,890	14,890
29,780 ea	5 1/2" base plates		74,450	74,450
21,680 ea	Rail Anchors		17,344	17,344
2 PR	112/90 Comp. Joints		250	250
2 PR	112/72 Comp. Joints		220	220
Total Estimated Cost		$132,000	$400,000	$532,000

RRVW 88-2

Estimated cost of rehabilitating line between Independence and Oakes
MP 1.0 to MP 15.0
Replace ties, Raise & Line W/Prod. Tamper 15 miles
Using contract labor

QUANTITY	DESCRIPTION	LABOR	MATERIAL	TOTAL
3,00 ea	Cross Ties	$60,000	$ 42,480	$102,480
12,000 ea	Track Spikes		3,000	3,000
7,500 Tn	Crushed Rock	79,200	118,800	198,000
		$139,200	$164,280	$303,480

TABLE 1 CONT.
1989 RED RIVER VALLEY & WESTERN RAILROAD COMPANY
CAPITAL PROJECT ESTIMATES
OUT OF FACE SURFACE & TIES, M.P. 77 TO 117, 3RD SUBDIVISION

A. INSTALLATION

1. Distribute Ties	16,000 Ea	@	$ .50	$8,000.00
2. Replace Ties	16,000 Ea	@	12.00	192,000.00
3. Distribute Ballast	12,000 TN	@	1.00	12,000.00
4. Work Train Service	5 DA	@	2,500.00	12,500.00
5. Surface Track	211,200 TF	@	.50	105,600.00
6. Clean Up	1 LS	@	5,000.00	5,000.00
SUBTOTAL				$335,100.00

B. MATERIALS

1. Cross Ties	16,000 Ea	@	15.75	$252,000.00
2. Track Spikes	275 Kg	@	65.00	17,875.00
3. Ballast - Crushed Granite	12,000 Tn	@	13.50	162,000.00
4. Credit for Salvage				
Ties (50%)	8,000 Ea	@	(1.00)	(8,000.00)
Spikes (50%)	14 Tn	@	(55.00)	(770.00)
5. ND Sales Tax	6.0%		423,105.00	25,386.30
SUB-TOTAL				$448,491.30

C. OTHER

RRVW Administration Engineering, etc	3.0%	$783,591.30	$ 23,507.74
Project Contingencies	5.0%	$807,99.04	40,354.95
SUBTOTAL			63,862.69
TOTAL			$847,453.99

BENEFITS OF RAIL LINE REHABILITATION

Rehabilitation of rail lines can generate benefits to railroads, shippers, the state, and local communities. The benefits which typically flow from rehabilitation are highlighted in this section of the report. Methods of measuring project benefits will be discussed later.

Operator Efficiency Gains

Benefits to the carrier primarily result from: (1) reductions in normalized maintenance of way, (2) increased train speeds, (3) changes in shippers' utilization of rate/service structures, (4) increases in traffic volume, and (5) reductions in derailments and associated road property damage.

Rehabilitation typically extends the life of rails, ties, ballast, and other track materials (OTM). As a result, the intervals between renewal of basic track assets is lengthened. Furthermore, spot maintenance (e.g. replacing broken jointed-rails or emergency tie installation to raise track depressions) is also reduced.

Some lines have speed restrictions over various segments due to poor track conditions. Rehabilitation can remove these restrictions, allowing the carrier to operate at faster speeds. Increased operating speeds have a cascading effect on various elements of railroad costs. Faster speeds reduce crew costs (including overtime and layovers), locomotive and car ownership costs, and related operating expenses.

Shippers may consign freight in single-car, multiple-car, trainload, or unit train lots. Multiple car shipments, trainloads, and unit trains generate efficiencies in switching, car ownership, and clerical costs. Shippers on light-density lines are typically reluctant to upgrade their sidings and facilities so that they can consign multi-car or trainload shipments. Rehabilitation of the line reduces their uncertainty, and sometimes induces shippers to invest in multiple-car facilities. Any increase in multiple-car or trainload/unit train traffic generates operator (railroad) efficiencies.

Rehabilitation can also increase the volume shipped over a line. Faster, more frequent rail service can enhance the competitive position of grain elevators on the line, as well as make industrial location sites more attractive. Generally, there will be some induced traffic as a result of line rehabilitation.

Any increase in annual volume will reduce the carrier's cost per carload as economies of utilization are realized. This is particularly true on light-density lines, where a significant portion of the costs are fixed over a short-to-intermediate time period. For example, over a certain range of output, maintenance of way costs will not increase (or will increase only marginally). This is because a minimal level of basic track maintenance, vegetation control, snow removal, track inspection, and other roadway activities must be carried on regardless of whether 500 or 5,000 cars are handled.

Roadway investment poses an even more striking example. The opportunity cost of the capital invested in land and roadway assets is constant during a given year regardless of traffic. Many other cost elements are also partially fixed in nature. Because of high fixed costs, the incremental cost of new traffic is typically much lower than the average total cost per carload on light-density lines.

Rehabilitation typically improves operating conditions and safety. As a result, it reduces the risks of derailments, loss and damage.

Shipper Benefits

Many shipper benefits flow directly from carrier efficiency gains. These cascading effects typically take the form of improved service or lower rates.

Improved services generally entail more frequent train service and reduced transit times. But other service factors (such as the reliability of car delivery) may also be enhanced by rehabilitation.

Changes in service cannot always be measured quantitatively. Some service elements may affect shippers' risk perceptions and enter into long-range planning considerations, even though a dollar value cannot be attached to them. One partial measure of service effects is the reduction in shipper inventory cost that typically occurs from rehabilitation.

More frequent service and increased train speeds can reduce the interval between the time the loaded car is ready for pickup and the time it reaches its destination. Consignees generally are not paid for the shipment until the car reaches the consignor's facilities. Thus, the shipper incurs an interest premium or opportunity cost on the inventory in the car. For grain shippers, a delay of even five days can be significant from a cash-flow perspective. In addition, the commodities themselves may depreciate enroute (particularly during long delays).

For example, perishables may incur spoilage in transit, and high-value commodities may be susceptible to theft or damage while waiting at freight yards or sidings. All of these consequences are a result of lengthy travel times. Thus, improvements in service gains due to line rehabilitation can generate real monetary benefits for shippers.

Shippers may also benefit from reduced transportation rates which sometimes flow from line rehabilitation. Reductions in transportation rates may result from several factors. First of all, if the line is not rehabilitated, it may be abandoned in the future. After abandonment, North Dakota shippers will have only one alternative: truck. Truck rates may be higher than rail rates, particularly rail multiple-car and trainload rates. Second, after rehabilitation, shippers may be better able to take advantage of multiple-car and trainload rates. Third, efficiency gains from the carrier may be passed on in the form of lower rates. This last point deserves expansion.

Because of inefficient way train operations and high fixed roadway costs, branch-line rates are generally higher than rates for similar distances on high-density lines. As the carrier's costs are reduced by rehabilitation, some of the increased operator's surplus may be passed on as a means of inducing new traffic. Thus, the entire rate structure may be lowered.

State and Local Government Benefits

While carriers and shippers are the most direct beneficiaries of line rehabilitation, the state also benefits. The NDHWD is responsible for most of the highway replacement and maintenance cost of roads serving elevators and other major shippers. If the line under study is abandoned, the traffic which formerly moved by rail must be transported by truck. Many of the highways connecting elevators and rural shippers to the interstate system are low-volume roads. The incremental pavement damage of heavy trucks on low-design highways may exceed the motor fuel taxes and registration fees generated. Consequently, net highway costs may accrue to state or local governments as a result of abandonment. Thus, from an intermodal perspective, state money invested in light-density rail lines may reduce public infrastructure costs in the long-run.

In addition, rail line rehabilitation may generate regional economic and community benefits. Unlike the BN and the Soo Line, the RRV&W railroad is headquartered in North Dakota. So any operator efficiency gains may have multiplicative effects within the public and private sectors of the economy.[1] In a similar fashion, reductions in shipper costs may have a cascading economic effect. Take grain shippers as an example. The North Dakota elevator industry can be quite competitive, so any shipper rate reductions may re-appear in the form of higher elevator bid prices. Even if higher prices do not occur, farmers will benefit indirectly from rate reductions. This is because many elevators in North Dakota are cooperatively owned. Consequently, farmers are likely to receive patronage refunds as a result of any long-term rate reduction. So either way, rate reductions will flow back to the household sector of the local economy. The effects of both

[1]In the case of Class I carriers such as the BN, many of these benefits would be transferred out-of-state. That is not the case with the RRV&W.

operator ("producer") and household ("consumer") surpluses on the regional economy are simulated through means of input-output (I/O) analysis. As will be detailed later, a North Dakota I/O model is used to estimate the dollar effects of changes in the farmer (household) and railroad (transportation) sectors of the economy.

Collectively, these effects constitute the benefits of rail line rehabilitation. A more concise definition of benefits, and techniques for measuring them, are discussed next.

Types of Benefits and Measurement Rules

The various benefits discussed previously fall into three broad categories:

1. Primary efficiency benefits (PEB);
2. Secondary efficiency benefits (SEB);
3. Community benefits.

The methods of measuring each type of benefit are different, as will be detailed later. Some can be quantified in a straightforward and timely fashion; others cannot.

Traditionally, benefit-cost studies have sought to quantify as many variables as possible, leaving the remainder outside of the analysis. This has created tremendous pressure to translate all potential benefits and costs into dollar estimates, including those variables which do not readily lend themselves to quantification. Unwarranted attempts at quantification can cause several problems:

1. They can produce meaningless dollar estimates of social or community benefits and costs.

2. They can paint a misleading picture of a scientific or

quantitative endeavor where none actually exists.

3. They can distort the true benefit-cost ratio of a project when they are factored into the equation.

The line analysis procedure described in this report entails a mixture of techniques; some are quantitative, others qualitative. In general, the rule of analysis is: as many effects as possible are quantified, but only those which can logically be reduced to dollar terms without a loss of meaning. Those which cannot be quantified are addressed qualitatively.

The most difficult area to quantify is community impacts. Line abandonments can clearly have negative impacts on specific communities or jurisdictions. They can result in the loss of rail jobs, the closing of industry, and a variety of other socioeconomic effects. When viewed from a statewide perspective, many of the effects may even out; that is, losses in some areas will be compensated for by the re-deployment of resources elsewhere. Thus, from a statewide perspective, many community impacts are "distributional effects", rather than net losses or gains. Nevertheless, they are quite real to the local communities or individuals affected[2].

Because of time and resource limitations, community impacts are not addressed in this analysis. Only primary and secondary effects are measured.

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[2]Both PEB and SEB can be quantified in the majority of cases with a reasonable data collection and modeling effort. Some community impacts (such as a net loss of jobs from line abandonment) can be quantified if the data and resources are available. However, most such measures are speculative and projective in nature, for it cannot be known apriori that industries will relocate or fold because of the loss of rail service. Other community impacts (or intangible effects) cannot be quantified under any conditions and must be addressed in a qualitative manner.

PRIMARY EFFICIENCY BENEFITS

As noted previously, PEB constitute the direct efficiency gains experienced by rail operators and shippers due to line rehabilitation. For purposes of analysis, PEB may be decomposed into three components : (1) change in producers' surplus, (2) change in consumers' surplus, and (3) change in shipper inventory costs.

The definition of consumers' surplus and producers' surplus is grounded in microeconomic theory and requires a brief explanation of the demand for rail transportation. The discussion begins with the concept of "willingness to pay", a major criterion in benefit-cost analysis.

Willingness To Pay Criterion

In general, consumers' surplus represents the difference between what shippers (as a group) would be willing to pay for rail transportation and what they actually pay (based on existing tariffs or contract rates). What a given shipper would be willing to pay for rail service depends on his or her unique circumstances. For example, captive rail shippers (with no alternate mode) would theoretically be willing to pay a rate equal to the cost of providing their own transportation. In the case of unit train shippers, this upward bound might be the rate level at which shippers could just as cheaply build and operate their own railroad. In less extreme cases, the amount that captive rail shippers would be willing to pay is generally equal to the cost of owning and operating a fleet of trucks[3].

The producer's or operator's surplus constitutes the difference between the rate charged by the transportation operator and the cost of providing the service (including the opportunity cost of capital assets and working capital). Theoretically, the operator will continue to provide service (all things equal) until the point of zero economic profits is reached[4]. Thus, at any rate above cost, the operator will realize a surplus: called the producer's surplus.

When a rail line is rehabilitated, it can be expected that the producers' surplus will increase. Reduced maintenance of way costs, increased operating speed, and other operational efficiencies brought about by rehabilitation will lower the railroad's cost of service, thereby increasing the difference between the rate charged and the resource cost incurred. For reasons discussed previously, part of the cost reduction which accrues to the carrier may be passed on to shippers in the form of lower rates. If this occurs, consumers' surplus will also increase as a result of rehabilitation.

The computation of primary efficiency benefits is based largely on the demand for transportation and how costs and revenues to producers of transport services (railroads and truckers) and consumers of transport services (shippers)

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[3]In the Upper Great Plains, an alternate mode (truck) is typically available. Consequently, the maximum amount that a shipper would actually be willing to pay for rail transport would be the price level at which the rate of competing motor carriers is low enough to offset the rate rail and overcome any perceived service advantages which railroads may own.

[4]Zero economic profits include a rate of return equal to the opportunity cost of the capital which is tied up in the operations.

change with different levels of modal use. In this section of the report, some concepts in transportation demand are introduced. Some will be intuitive in nature. Others will use more precise terms from which measuring techniques can be derived.

A Model of Transportation Demand

If (for any given time period) the units of transportation purchased by a shipper at different rates are recorded, a schedule of his or her demand for rail transportation can be constructed[5]. When displayed graphically, this schedule might look something like the hypothetical relationship depicted in Figure 2, where the demand curve "D" reflects an inverse linear correlation between transportation prices and demand. As the rail price increases from P_1 to P_0, the number of (adjusted) carloads decreases from Q_1 to Q_0[6]. Conversely, as the rail price declines from P_0 to P_1, the adjusted volume consigned by the shipper will increase from Q_0 to Q_1.

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[5]For example, if the rate in January is $2.20 per hundred pounds (cwts), then the number of cars shipped in January (adjusted for seasonal variance) would reflect the shipper's demand at a rate level of $2.20. Suppose that in February, the rate increases by ten cents, then the number of cars shipped (adjusted for seasonal variance) would reflect the shipper's demand at a rate of $2.30. If evaluated over several rate periods, the rates and volumes collected in this manner would form a demand schedule. This schedule assumes that all other things, such as the prices of substitutes and complements, are held constant.

[6]This decrease is partially due to a shift to alternative modes and partly due to a displacement of shippers from competitive markets brought about by an increase in the total delivered price of the good.

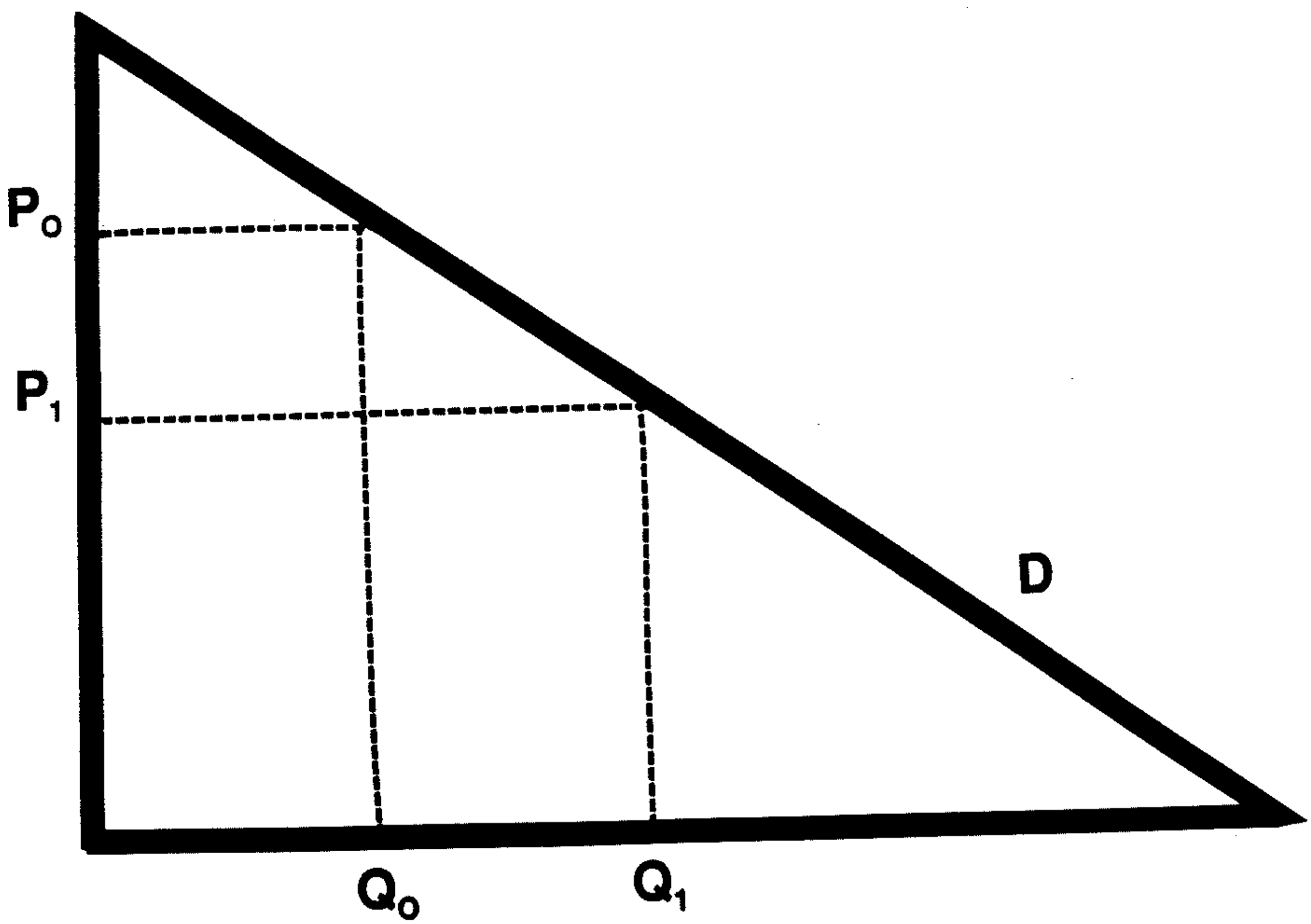

Figure 2. Demand for Transportation

Extending this basic relationship to Figure 3 permits a more detailed explanation of consumers' and producers' surpluses. In Figure 3, P_0 and C_0 denote the rate charged by the rail operator and the cost of providing service respectively (under current line conditions). If the line is rehabilitated, it seems reasonable to assume that the cost to the operator will decline. Furthermore, because of increased economies, the carrier may be able to lower the rate. If this occurs, a shift in price from P_0 to P_1 may occur. The result is an increase in producers' surplus.

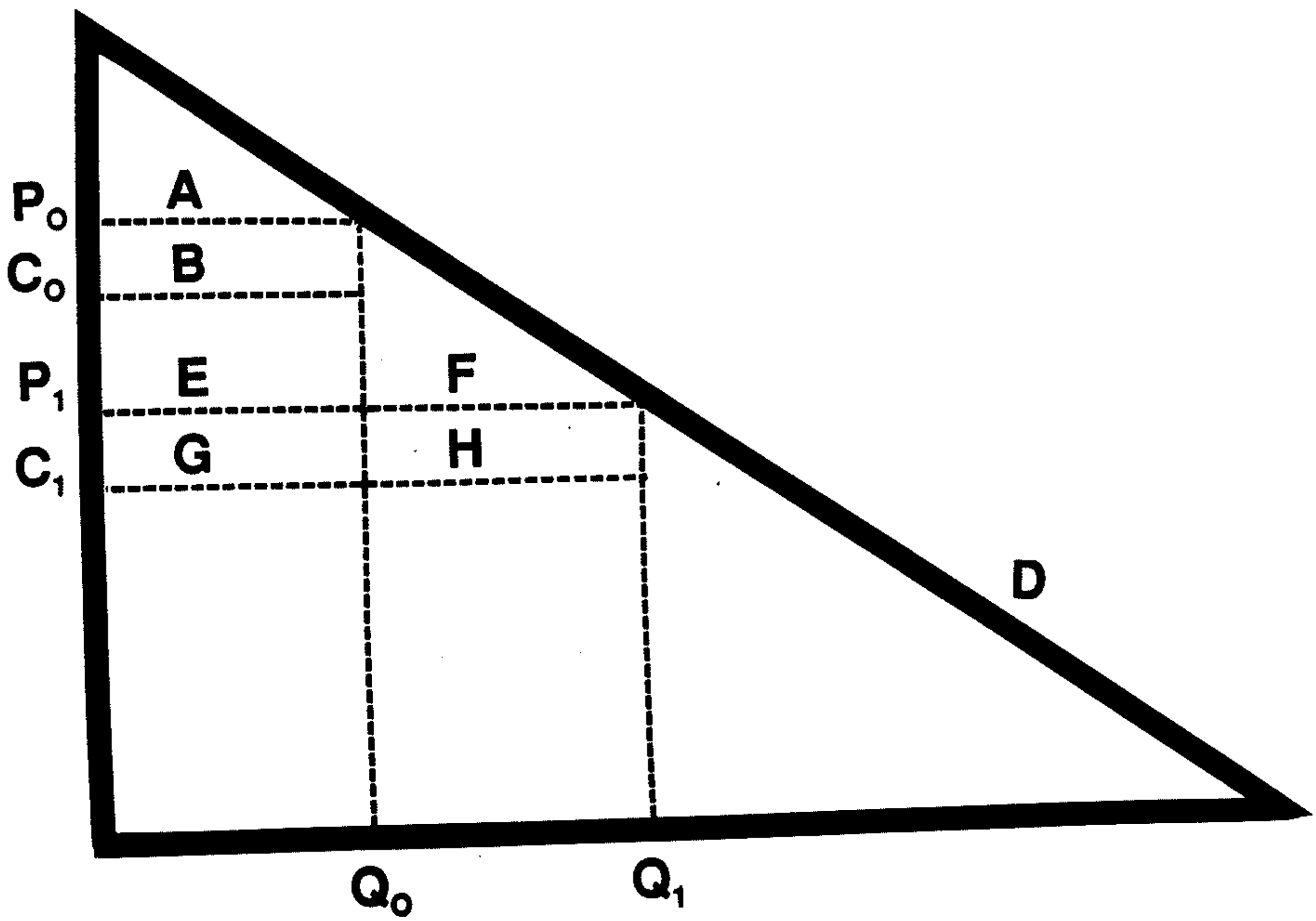

Figure 3. Consumers' and Producers' Surpluses

Computing Changes in Shipper and Operator Benefits

Primary efficiency benefits are estimated by analyzing two possible scenarios over time. Under the first scenario (the base case), it is assumed that things will go on as they have, and that the line will not be rehabilitated by the carrier. Without rehabilitation or upgrading, service on the line will probably continue to decline, resulting in abandonment during some future interval in time. If, however, the line is rehabilitated, service and operator profitability will improve. It is these changes in cost, service, and operating performance between the base case to the rehabilitation scenario which determine the extent of the primary efficiency benefits generated.

As Figure 3 denotes, consumers are willing to pay P_o for Q_o units of output under existing line and service conditions[7]. But the economic cost of Q_o units of output may only be C_o. So some consumers' and producers' surpluses may exist in the base case. However, they are usually artificially low due to line conditions.

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[7]From the previous discussion, it is apparent that the amount that a shipper would actually be willing to pay for rail service will vary from shipper-to-shipper. If all of the shippers located on an affected line are considered collectively, then a (collective) demand schedule can be constructed. This hypothetical schedule will tell how many units of transportation (e.g. carloads or tons) that shippers as a group would purchase from the railroad at various rates. If Figure 2 is taken as an aggregation of individual demand curves, then it may be said to represent the market demand for rail transportation in the area being analyzed. From the demand curve (D) in Figure 2, it can be seen that even at very high rates (considerably in excess of P_0), some shippers would be willing to purchase rail transport because of lack of alternatives, sunken investments, or service attributes. Thus the shippers' surplus (in a collective sense) may be different than the consumers' surplus for any given individual. It is the collective shippers' surplus which is measured in line-segment benefit-cost studies.

At Q_o units of output, area A (in Figure 3) constitutes the consumers' surplus, and area B the producers' surplus. When the price of the good is reduced from P_o to P_1, consumers will purchase Q_1 units. The consumers' surplus for Q_1 units of output at a price of P_1 is areas A + B + E + F. The cost of producing Q_1 units of output is C_1; the producers' surplus is areas G + H. The change in benefits as a result of a change in quantity demanded (from Q_o to Q_1) and a reduction in price (from P_o to P_1) is (A + B + E + F + G + H) - (A + B), or the sum of areas E, F, G, and H.

The primary efficiency benefits which accrue from rehabilitation consist of three types: (1) a reduction in cost on existing traffic (E + G), (2) consumers' surplus on new rail traffic (F), and (3) producers' surplus on new rail traffic (H). A reduction in operating cost will occur on the existing traffic base due to rehabilitation, irrespective of the addition of new traffic. The cost reduction on existing traffic is computed as:

$$S_c = Q_o(C_o - C_1)$$

where:

S_c = Shipping cost reduction on existing traffic

Q_o = Quantity shipped -- base case

C_o = Shipping cost, base case

C_1 = Shipping cost, rehabilitation alternative

In addition to cost savings on existing traffic, rehabilitation of a branch line may increase rail market share[8]. Thus, a proportion of the traffic which was

[8] The extent to which new rail traffic will be attracted by a rate reduction depends in part on the cross-price elasticity of demand. The cross-price elasticity is a measure of how the volume of truck shipments will change as rail prices

moving by truck under the base case will now move by rail because of more efficient service and the possibility of multiple-car or trainload rates. This incremental traffic will result in additional consumers' surplus, which is calculated as:

$$C_s = 1/2\ [(P_o - P_1)\ (Q_1 - Q_o)]$$

where:

C_s = Consumers' surplus on new traffic

P_o = Shipping rate, base case

P_1 = Shipping rate, rehabilitation alternative

Q_1 = Quantity shipped, rehabilitation alternative

Q_o = Quantity shipped, base case

Any incremental traffic also results in additional producer's surplus, or the difference between the producer's price and the cost of providing service, and is

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change. If demand is cross-elastic, then decreases in rail prices will lead to greater than proportional increases in rail traffic. That is, a one percent decrease in the rail rate will result in more than a one percent increase in rail shipments. On the other hand, if demand is cross-inelastic, then decreases in rail rates will result in less than proportionate traffic increases. If demand is perfectly cross-inelastic, then reductions in rail rates will generate no additional rail traffic. Cross-price elasticities are difficult to measure because of the inability to control for all of the factors which contribute to modal shifts. Preliminary analysis has shown that grains and oilseeds in North Dakota are cross-price elastic in some markets and cross-price inelastic (although not perfectly inelastic) in others. In general, trends in North Dakota rail shipments and rates over the last 8 years clearly show that truck share has declined with decreases in rail rates. For example, in the fall and early winter of 1980, the rail rate on wheat to the Pacific Northwest was $2.51 per cwts. (in single-car shipments). During crop year 1980-1981, trucks held 46% of the market. In the spring of 1987, rates from North Dakota to the PNW ranged from $1.47 (for 52-car shipments) to $1.90 for single-car shipments. Accordingly, the truck share of the market fell from 46 percent in 1980 to 16 percent in crop year 1986-1987. While other forces were at work in the market, clearly some level of cross-price elasticity existed.

calculated as[9]:

$$P_s = (P_1 - C_1)(Q_1 - Q_o)$$

where:

P_s = Producer's surplus on new traffic

P_1 = Shipping rate, rehabilitation alternative

C_1 = Shipping cost, rehabilitation alternative

Q_1 = Quantity shipped, rehabilitation alternative

Q_o = Quantity shipped, base case

These three components capture the change in benefits which occur from rehabilitating the line instead of letting it continue as is. But in order to actually compute the primary efficiency benefits, the net rehabilitation cost of the project must be calculated.

Net rehabilitation cost is defined as the cost of rehabilitating the line minus the sum of the net present salvage value of the rehabilitated line (discounted from the end of the project life to present year value) and the net present value of reusable or resalable fixed capital items removed from the original branch line. The net cost of rehabilitation is subtracted from the net present value of the PEB to determine the net present value of the project. Whenever the net present value of the PEB exceeds the net rehabilitation cost, the project is considered viable. A benefit/cost ratio also is calculated from these two values, as the ratio of the PEB to net rehabilitation cost. A benefit/cost ratio of 1.00 or greater indicates project viability.

[9]As noted earlier, the incremental cost of traffic on light-density lines will usually be lower than the average total cost because of economies of utilization.

SECONDARY EFFICIENCY BENEFITS

Secondary efficiency benefits are the changes in the value of goods and services produced which are an indirect result of the rehabilitation alternative. For example, farmers may receive a higher price and hence a higher return for their product under the rehabilitation alternative without a corresponding decrease in profit to the elevators. This would be classified as a secondary efficiency benefit of the rehabilitation alternative. A secondary efficiency benefit would not be realized in a situation where a change in the economy is compensated by an opposite change elsewhere in the economy.

Secondary efficiency benefits (SEB) are computed using input-output analysis. Input-output analysis relates changes that occur in the basic sector of an economy to the level of activities in other sectors through a matrix of interdependency coefficients. Through this procedure, the effects of the benefits realized from rehabilitation are projected throughout the economy.

SEB also arise from the avoidance of adverse highway impacts which would occur due to abandonment. As noted earlier, firms relying on rail service preceding abandonment will be required to truck their product to or from the nearest railhead or truck the entire distance from origin to destination after abandonment, assuming they remain in business and do not relocate. This increased truck traffic may cause additional deterioration of highways, reducing the life expectancy of roadbeds and necessitating increased maintenance and resurfacing costs.

However, increases in truck traffic also will generate additional revenues in the form of license fees and fuel tax collections. These increased revenues are calculated and subtracted from increased highway costs to determine the net cost of additional truck traffic.

Methods of computing changes in highway infrastructure costs are described in the following section of the report. A description of input-output analysis and the computation of regional economic effects are detailed in Appendix C.

Forecasting changes in highway costs is a multi-step process. A range of data elements and models are required. The various tasks which must be performed in highway impact assessment are enumerated in order of their discussion.

1. The number of incremental annual truckloads resulting from abandonment must be projected.

2. The number of decremental annual truckloads removed from the highways as a result of rehabilitation must be computed.

3. The average axle loads for each type of highway equipment must be determined.

4. The truck shipment routes must be defined from each elevator to each market.

5. The attributes of the highways in the route must be compiled.

6. The distance and annual truck trips over each route must be projected.

7. The equivalent single axle loads (ESALs) and the ESALs per VMT (vehicle mile of travel) must be computed.

8. The life of each highway section (in terms of ESALs) must be calculated.

9. The replacement cost per mile of road must be estimated.

10. The cost responsibility (of each ESAL) must be computed.

11. The revenues generated from vehicle registration and motor fuel taxes must be projected.

The number of incremental truckloads depends upon the type of equipment used and the density of the commodity. For example, a 100-ton jumbo hopper car is equivalent to roughly 3.7 3-S2 grain semi's. But for indivisible commodities such as farm machinery, the ratio may be 2 to 1 (or even 1:1). Grain and oilseed carloads are converted to truckloads using 534 net cwts as a rule. Other commodity volumes are translated into truckloads using survey data or regional averages.

Abandonment clearly generates incremental truck traffic. The net cost avoidance of the traffic may be considered a benefit. In addition, rehabilitation may remove some truck traffic from the highways. Under the rehabilitation scenario, railroads may increase their modal share as a result of the cascading effects of efficiency gains. The removal of traffic from rural roads (previously captured by motor carriers) may also create net highway benefits. Both types of benefits occur as a result of abandonment. So the two may be added to generate estimates of incremental cost savings (or revenue gains) emanating from rehabilitation.

Pavement damage is measured through the metric of equivalent single axle loads, or ESALs. An ESAL is an expression of the equivalent pavement damage which a particular axle weight (e.g. 40,000 pounds) and axle type (e.g. dual) will cause from a single pass over a particular type of highway, when compared to the damage attributable to a "reference axle" (say, an 18,000 pound single axle). More concisely, incremental ESALs are a function of:

ESAL = f (V, L1, L2, STR, PSR, E)

where:

V = Annual truck trips

L1 = Axle weight in kips or thousand pounds

L2 = Axle configuration

STR = Strength of the highway section; some function of D or SN

D = Slab thickness for rigid or PCC pavements

SN = Structural number for asphaltic-concrete pavements

PSR = Present serviceability rating of the pavement

E = Environmental concerns, including weathering, short-run climatic effects, and related factors

Clearly, a 20-kip axle on a low-volume road is not equivalent to the same axle pass on a high-design interstate. In analogous fashion, a 12-kip axle load on the same highway is not equivalent to a 20-kip axle-pass. However, an equivalent measure of damage can be attained for different axles on the same road (and vice versa). AASHTO road test and subsequent empirical data exist which allow such an equating. The pavement damage functions and underlying theory cannot be described here. But, they are documented in a 1989 study by the author.[10]

As the above discussion points out, the axle weights and configurations are important inputs to pavement damage analysis. Grain truck axle weights have

[10]The Impacts of Grain Subterminals on Rural Highways, UGPTI, February, 1989. Tolliver, D.

been estimated from NDHWD truck weight data.[11] For other types of trucks (e.g. tanker) axle weights have been developed from regional or national surveys (e.g. FHWA).

Highway attribute data were collected for each major link in the route. Both the strength rating (SN or D) and the serviceability rating (PSR) were estimated directly from NDHWD data. Truck miles were computed from milepost-to-milepost on each link.

Once the shipments were routed and the highway attributes determined, the raw axle weights were converted to equivalent single axle loads (ESALs) using AASHTO rigid and flexible equations. The life of each highway link (in ESALs) was estimated using an adjusted AASHTO model developed by FHWA for use in the Highway Performance Monitoring System (HPMS). The HPMS ESAL-life equations have been previously tested on flexible pavements in North Dakota, and have been shown to produce reasonable results.

When the useful life of a pavement section (in ESALs) expires, the section must be replaced or rehabilitated. Replacement costs per mile for each class of highway have been developed from NDHWD data.

Since an ESAL is an equivalent unit of pavement damage or consumption, the replacement cost of a section may be computed on an ESAL-mile basis. For example, if the replacement cost of a section is $200,000, and the useful life is 1 million ESALs, the cost responsibility of each ESAL is 20 cents. The annual

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[11] Grain traffic constitutes the preponderance of shipments on the line(90%). The confidence placed in grain truck estimations is high, and is based on the best data available.

incremental ESALs generated from abandonment are multiplied by the cost per ESAL to evaluate the cost responsibility of the diverted traffic.

COMPUTATION OF REVENUES AND COSTS

The computation of net benefits necessitates a range of calculations. Two of the most important are carrier revenues and costs.

Both truck and rail rates are needed for the analysis. The methods of estimating each are discussed in the following section of the report, with particular emphasis to the line under analysis.

Rail Revenues

Two types of revenue are generated by the Wahpeton-to-Oakes line: (1) revenues from originated and terminated traffic, and (2) bridge traffic revenues. All of the revenue generated by O&T traffic can be attributed to the line. But this is not the case with bridge or overhead traffic. Yet some bridge traffic is partially sustained by the line. Without it, any bridge traffic headed East would have to be hauled to another interchange point, requiring a restructuring of way train routes. Any such change may increase the circuity of movements and/or result in additional time delays. Thus, it is appropriate that some bridge revenues be attributed to the Wahpeton-Oakes line. As a practical matter, this must be done since bridge traffic causes part of the operating and maintenance costs on the mainline.

The method of apportionment used in this study is based on car-miles. If 75% of the car-miles occur on the mainline, then 75% of the revenues are attributed to the line. This method of allocation should provide consistent treatment of both bridge revenues and costs.

Grain traffic accounts for most of the carloads handled on the line. So great care has been taken to forecast grain revenues accurately. Grain rail rates have been developed directly from the BN 4022 tariff series. Rail rates for fertilizer and other nongrain traffic have been developed from the North Dakota rail waybill sample.

The RRV&W's share of the revenues have been computed by multiplying their per car division by the annual carloads. The remainder of the revenues accrue to the Burlington Northern or other carriers in the route.

Truck Revenues

Truck rates are difficult to project because they literally fluctuate from day-to-day and from elevator-to-elevator. They are affected by factors such as backhaul, the time of the year, and the distance of haul. They are based on both operator (cost) and shipper (demand) factors.

Rates for North Dakota agricultural haulers are developed from survey data compiled at the UGPTI (Dooley, Bertram, and Wilson, 1988). Table 2 juxtaposes the mean predicted grain truck rates for RRV&W stations with the mean BN rail grain rates to major markets. As the Table depicts, the truck rates to Duluth are

TABLE 2. TRUCK AND RAIL GRAIN RATES TO MAJOR MARKETS

Rates	Duluth	Minneapolis	Pacific Northwest
Rail Single-car	72	72	161
Rail Multi-car	67	68	131
Rail Trainload	57	50	120
Truck	71	62	210
Costs			
Rail Single-car	46	47	136
Rail Multi-car	43	43	122
Rail Trainload	37	38	109
Truck	50	44	238

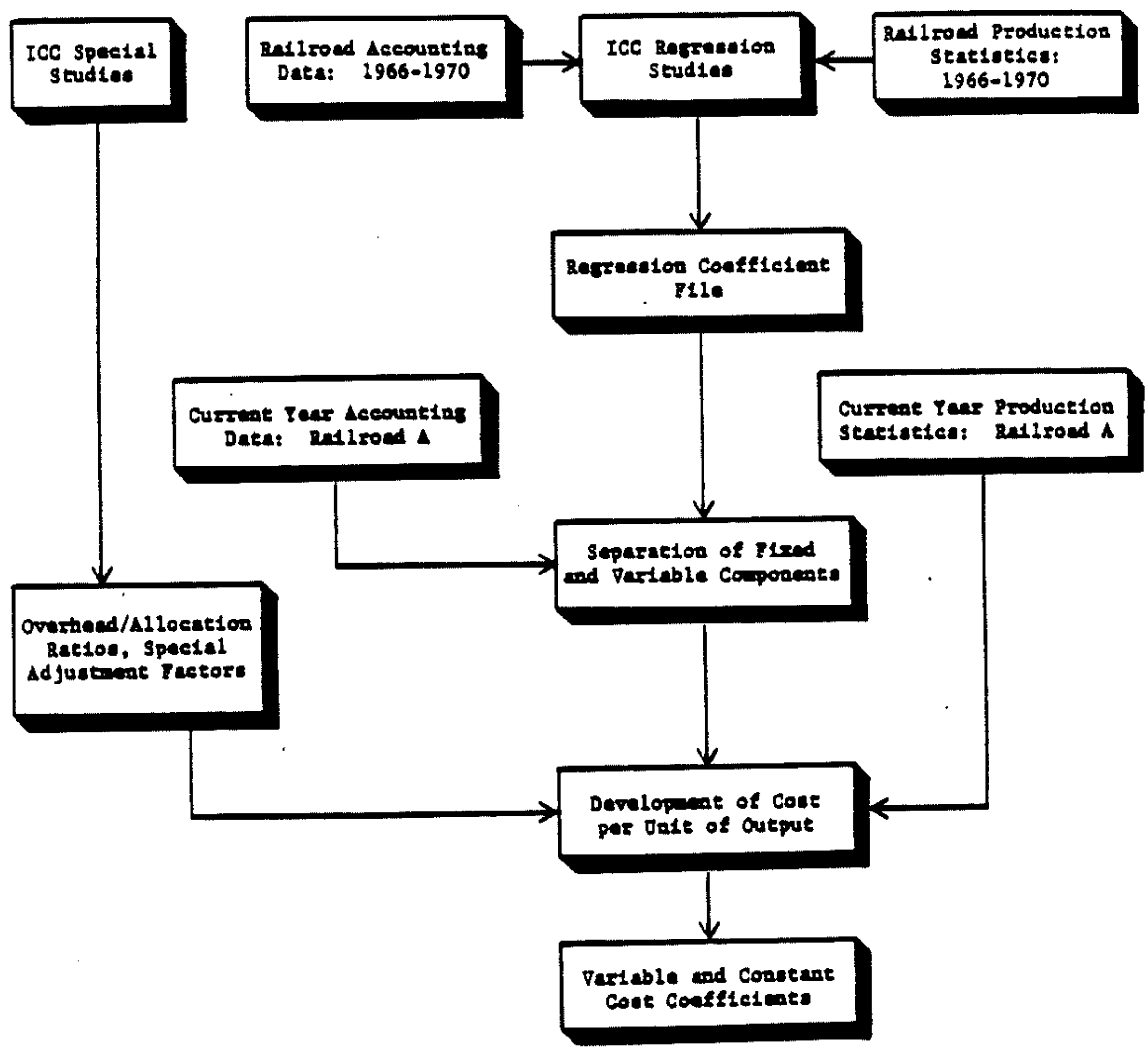
between the single-car and multi-car rail rates. Truck rates to Minneapolis (which has a higher backhaul probability) are below multi-car rates. But truck rates to the Pacific Northwest (PNW) are considerably higher than even the single-car rail rate.

Truck Costs

Truck unit costs have been estimated on a per mile basis for grain, fertilizer (dry and liquid), lumber, and farm machinery -- the principal branch-line commodities in North Dakota. All "other" commodities are assumed to be shipped via a 3-S2 flatbed semi with a payload of 30 tons.

Truck unit costs are derived from multiple sources. North Dakota agricultural commodity carrier costs have been developed from UGPTI surveys and research findings. Fertilizer, lumber, and other costs have been developed from secondary sources, and adjusted to fit North Dakota circumstances. The derivation of truck cost factors is discussed in Appendix B.

Figure 4


ICC Special Studies
Railroad Accounting Data: 1966-1970
ICC Regression Studies
Railroad Production Statistics: 1966-1970
Regression Coefficient File
Current Year Accounting Data: Railroad A
Current Year Production Statistics: Railroad A
Separation of Fixed and Variable Components
Overhead/Allocation Ratios, Special Adjustment Factors
Development of Cost per Unit of Output
Variable and Constant Cost Coefficients

Rail Costs

Rail costs must be estimated for both the Red River Valley & Western and the interlining Class I carrier -- the BN.

Most RRV&W unit costs have been developed from economic-engineering methods. Cost components such as normalized maintenance of way, opportunity cost on roadway investment, and property taxes are based on actual line data and operating conditions. Other RRV&W cost elements (such as transportation administration and overhead expenses) cannot be attributed directly to any given line-segment. Unit costs for these factors have been computed from RRV&W data for 1987 and 1988. These are the same unit costs used in last year's project applications.

BN off-system costs are estimated using a modified Rail Form A (RFA) procedure. The off-branch rail costing procedure is discussed at length in the following section of the report.

RAIL COSTING PROCEDURES

The determination of primary efficiency benefits depends, to a large degree, on the underlying revenue and cost calculations in the base case and under the rehabilitation alternative. The Class I Carrier costing methodology generates off-system cost estimates for the BN portion of the movement. These costs can be quite important in line analysis.

Cost Estimation Procedures

The cost coefficients used in this study have been calculated from Rail Form A (RFA), a statistical cost-finding formula developed by the Interstate Commerce Commission (ICC). Rail Form A is essentially a statistical software package which is used to generate unit costs for a variety of output measures (Table 3), for

TABLE 3. RAIL FORM A UNIT COSTS AND OUTPUT MEASURES

Expense Item	Output Measure
Gross Ton Mile	Gross Ton Miles of Cars, Contents, & Caboose
Locomotive Unit Mile	Locomotive Unit Miles
Crew Wages	Train Miles
Other Train Mile	Train Miles
Station Clerical Cost	Carload Shipments Originated/Terminated
TOFC Clerical	TOFC Shipments Originated/Terminated
Intraterminal Clerical	Cars Switched Intraterminal
Interterminal Clerical	Cars Switched Interterminal
Station Employee Special Services	Carload Shipments Originated/Terminated
TOFC Special Services	TOFC Shipments Originated/Terminated
Train Supplies, Running	Revenue Car Miles, Including Mileage Cars, Loaded & Empty
Train Supplies, Terminal	Carload Shipments Originated/Terminated
Loss & Damage	Carload Tons Originated/Terminated
Carload Claims Clerical	Carload Tons Originated/Terminated
TOFC Claims Clerical	TOFC Tons Originated/Terminated
Interterminal Claims Clerical	Cars Switched Interterminal
Intraterminal Claims Clerical	Cars Switched Intraterminal
Mileage Cars Inspection	Car Miles, Mileage Cars, Loaded & Empty
Car Mile Costs Empty	Car Miles, Less Mileage Cars, Loaded &
Car Day Costs	Car Days, Total
Engine Minute Expense	Total Switching Minutes, Yard & Way Switching
Heating and Refrigeration	Refrigerator Car Miles, Loaded & Empty

individual railroads or groups of railroads.

RFA utilizes source input data, both accounting and operating, to derive estimates of variable costs. A series of allocation formulas and distribution ratios for allocating common and/or joint costs to various activities are contained within the formula. The results of the ICC regression studies also are contained in a separate file.

The manner in which the various data flow through the formula is depicted in Figure 4. As illustrated, several independent but interrelated steps are involved in the process. Determination of cost variability is not performed within the formula, but is developed external to Rail Form A. The coefficient file containing regression results is read into the formula for use in later application.

Within the cost-finding formula, accounting expenses and production data are transformed into unit costs via a multi-stage process. Each grouping of accounts (for example, maintenance of roadbed and structures) is separated into fixed and variable components on the basis of the variability ratios developed through regression analysis. If the accounting expenses must be allocated to more than one output measure, this allocation is performed in a related step.[12] The total expenses are divided by the number of productive units consumed during the year to produce a cost per unit of output or "unit cost" for each of the categories depicted in Table 4. Using the gross ton mile service unit as an example, this process is illustrated below:

UC = (AC x APV) / TGM

where: UC = Unit cost per gross ton mile

AC = Total expenses for groups of accounts

APV = Annual percent variable of the account or group

TGM = Total system gross ton miles

[12]For example, maintenance of roadway expenditures are primarily allocated between gross ton mile and train mile service units, with a small residual allocated to locomotive unit mile.

TABLE 4. RAILROAD SERVICE UNITS AND COST ELEMENTS.

Service Unit	Cost Elements
Car miles running	Ownership and non-ownership costs running
Car days	Daily ownership cost: running and switching
Car miles switching	Ownership costs switching
Locomotive switching minutes	Ownership, and non-ownership costs due to way and/or yard switching
Carloads originated/ terminated	Station clerical, terminal supplies and expenses, specialized terminal services
Carload tons originated/ terminated	Loss and damage, carload claims clerical
Road locomotive unit miles	Ownership and non-ownership costs: running
Train miles	Labor and non-labor expenses
Gross ton miles	Running track and various operating costs.

The derivation of the principal Rail Form A (RFA) unit costs used in computing BN off-branch costs are shown in Tables 5 through 10. As the tables depict, the unit costs are actually compilations of detailed cost elements. Most of the summary unit costs contain transportation, maintenance of way, maintenance of equipment, and traffic and general administrative cost elements. In addition, most of them reflect BN's cost of capital for road and/or equipment.

TABLE 5. DERIVATION OF VARIABLE LOCOMOTIVE SWITCHING MINUTE COST: B(3281).

Account Number	Item or Account Title	Rail Form A Core No.
	<u>Transportation:</u>	
377	Yard masters and yard clerks	B(482)
378	Yard conductors and yard brakemen	B(490)
379	Yard switching and signal tenders	B(498)
380	Yard enginemen	B(506)
382	Yard switching fuel	B(514)
383	Yard switching power produced	B(522)
384	Yard switching power purchased	B(530)
388	Servicing yard locomotives	B(538)
389	Yard supplies and expenses	B(570)
392	Train enginemen	B(626)
394	Train fuel	B(651)
395	Train power produced	B(678)
396	Train power purchased	B(681)
400	Servicing train locomotives	B(703)
401	Trainmen	B(754)
404	Signal and interlocker operation	
405	Crossing protection	
406	Drawbridge operation	
415	Clearing wrecks	
	Total Accts. 404, 405, 406, 415	B(782)
371	Superintendence	B(852)
390,391	Operating joint yards and terminals	B(874)
409	Employee H, W & Payroll taxes	
410	Stationery and printing	
411	Other expenses	
414	Insurance	
420	Injuries to persons	
	Total Accts. 409,410,411,414,420	B(903)
416	Damage to property	B(916)
	Total Transportation	B(945)
	<u>Maintenance of Equipment</u>	
311	Diesel locomotive repairs, yard	B(1100)
311	Diesel locomotive repairs, road	B(1124)
311	Other locomotive repairs, yard	B(1132)
311	Other locomotive repairs, road	B(1143)
	Total Acct. 311	B(1154)

Table 5 - continued

Account Number	Item or Account Title	Rail Form A Core No.
331	Locomotive depreciation, yard	B(1286)
331	Locomotive depreciation, road	B(1296)
330	Locomotive retirements	B(1351)
301	Superintendence	
332	Injuries to persons	
333	Insurance	
384	Stationery and printing	
335	Employee H, W & Payroll taxes	
339	Other expenses	
	Total Acct. 301,332,333,334,335,339	
302	Shop machinery	
304	Power plant machinery	
305	Depreciation of S&P plant machinery	
306	Dismantling retired S&P plant mach.	
329	Dismantling retired equipment	
336	Joint maintenance of equip.-debit	
337	Joint maintenance of equip.-credit	
	T.Accts.302,304,305,306,329,336,337	B(1541)
504,537	Net locomotive rents	B(1617)
	Total Maintenance of Equipment	B(1637)
	<u>Maintenance of Way and Structure</u>	
202	Yd. & way switching tracks: roadway main	B(1670)
206	Yard and way switching tracks: tunnels and subways	B(1679)
208	Yard and way switching tracks: bridges, trestles & culverts	B(1688)
210	Yard and way switching tracks: elevated structures	B(1697)
221	Yard and way switching tracks: fences, snowsheds & signs	B(1706)
	Total Accts. 202,206,208,210,221	B(1717)
212	Yield & way switching tracks: ties	B(1734)
214	Yard & way switching tracks: rails	B(1743)
216	Yard & way switching tracks: other track material	B(1752)
218	Yd. & way switching tracks: ballast	B(1761)
220	Yard and way switching tracks: track laying and surfacing	B(1770)
	T Acts. 202,206,212,214,216,218,220	B(1781)

Table 5 - continued

Account Number	Item or Account Title	Rail Form A Core No.
229	Roadway buildings	B(1857)
233	Fuel stations	B(1870)
235	Shops & enginehouses	B(1885)
241	Wharves and docks	B(1895)
249	Signals and interlockers	B(1907)
253,266	Power plants	B(1932)
257,266	Power transmission systems	B(1943)
	Total Accts.229,233,235,241,249	
201	Superintendence	B(2013)
266,267	Engineering	B(2042)
266	Road property depreciation	
267	Retirement of road property	
270	Dismantling retired road property	
271,268	Small tools and supplies	
278,279	Maintenance of joint tracks and other facilities	
274	Injuries to persons	
275	Insurance	
276	Stationery and printing	
277	Employer H,W & payroll taxes	
282	Other expenses	
	Total Accts. 274,275,276,277,282	B(2100)
269,266	Roadway machines	
272-3,266	Removing snow, ice, etc.	
267	Public improvements-maintenance of right of way expenses	
281	Right of way expenses	
	Total Accts. 296,266,272,273,267,281	B(2112)
	Total Accts. 229,233,235,241,249, 253,266,257,201,267,274,269,272,273,281	B(2139)
	Work Equipment	B(2167)
	Total Maintenance of Way & Structures, Accts. 229,233,235,241,249,253,266,257,201,267,274, 269,272,272,273,281,and Core No. B(2167)	B(2196)
	<u>Traffic and General Overhead</u>	
	Distribution of General Overhead	B(2296)
	Class I Switching and Terminal Co.	
	Railway Operating Expense	B(2365)
	Railway tax accrual, excluding FIT	B(2373)
	Net equipment rents	B(2381)
	Tot Core No B(2365),B(2373),B(2381)	B(2389)

Table 5 - continued

Account Number	Item or Account Title	Rail Form A Core No.
	<u>Cost of Capital Road, Other Than Switching & Terminal Co.</u>	
2.5-13,17 26-45	Road property other than land: switching, includes train switching	B(2765)
2	Land: switching, including train switching	B(2744)
18	Water stations	B(2812)
19	Fuel stations	B(2823)
20	Shops and enginehouses	B(2833)
23	Wharves and docks	B(2841)
	Total Road	B(2852)
	<u>Cost of Capital Equipment, Other Than Switching and Terminal Company</u>	
52	Locomotives	B(2868)
57,58	Work & miscellaneous equipment	B(2922)
	Total Equipment	B(2955)
	<u>Cost of Capital Road: Switching & Terminal Company</u>	
2.5-13,17, 26-45	Road property, excluding land	B(2972)
2	Land	B(2980)
16	Stations and office buildings	B(2988)
18	Water stations	B(2996)
19	Fuel stations	B(3004)
20	Shops and enginehouses	B(3012)
23	Wharves and docks	B(3020)
	Total Road	B(3030)
	<u>Cost of Capital Equipment: Switching & Terminal Co.</u>	
52	Locomotives	B(3038)
53	Freight train cars	B(3040)
54	Passenger train cars	B(3041)
56	Floating equipment	B(3042)
57,58	Work & miscellaneous equipment	B(3043)
	Total Equipment	B(3052)

Table 5 - continued

Account Number	Item or Account Title	Rail Form A Core No.
	<u>Total Cost of Capital</u>	
	Total Road, Core Numbers B(2852, B(3030)	B(3096)
	Total Equipment, Core Numbers B(2955), B(3052)	B(3106)
	Total Cost of Capital, Core Numbers B(3096), B(3106)	B(3116)
	<u>Variable Unit Cost Calculation</u>	
	Variable Operating Expenses, Rents and Taxes	B(2399)
	Number of Service Units	B(346)
	Unit Cost: Operating Expenses, Rents & Taxes B(2399)/B(346)	B(3198)
	Unit Cost: Cost of Capital Road: B(3096)/B(346)	B(3232)
	Unit Cost: Cost of Capital Equipment: B(3106)/B(346)	B(3245)
	Unit Cost: Total Expenses, Rents & Taxes, Including Cost of Capital	B(3281)

TABLE 6. DERIVATION OF RAIL FORM A OTHER TRAIN MILE EXPENSE: B(3263).

Account Number	Item or Account Title	Rail Form A Core No.
	Transportation Portion	
372	Dispatching trains	B(411)
373,421	Station exp. TOFC, COFC Term.	B(449)
376	Station supplies & expenses	B(471)
402	Remainder of Acct. 402	B(764)
404	Sig. & interlocker operator	
405	Crossing protection	
406	Drawbridge operation	
415	Clearing wrecks	
	Total Accts. 404,405,406,415	B(781)
371	Superintendence	B(836)
390,391	Operating jt. yd. & term.	B(863)
409	Employee H, W & payroll taxes	
410	Stationery & printing	
411	Other expenses	
414	Insurance	
420	Injuries to persons	
	Total Acct. 409,410,411,414,420	B(887)
412,413	Oper. jt. tracks & facilities	B(913)
416	Damage to property	B(915)
417	Damage to livestock	B(924)
	Total Transportation	B(929)
	Maintenance of Equipment	
314	Freight train car repairs	
	-mileage	B(1183)
	-time	B(1208)
331(53)	Freight train cars - mileage	B(1324)
	- time	B(1337)
330(53)	Freight train cars - mileage	B(1390)
	- time	B(1403)
301	Superintendence	
332	Injuries to persons	
333	Insurance	
334	Stationery & printing	
335	Employee H, W, & payroll taxes	
339	Other expenses	
	Total Acts. 301,332,333,334,335,339	B(1506)

Table 6 - continued

Account Number	Item of Account Title	Rail Form A Core No.
302	Shop machinery	
304	Power plant machinery	
305	S & P plant machinery-depr.	
306	Dism. ret. S&P plant machinery	
329	Dism. ret. equipment	
336	Jt. maint. of equip.-debit	
337	Jt. maint. of equip.-credit	
	Total Accts. 302,304,305,306,329,336,337	B(1535)
503,536	Per diem cars - mileage	B(1561)
	- time	B(1574)
	Cars on other basis - mileage	B(1588)
	- time	B(1601)
	Total maintenance of equipment	B(1603)
	Maintenance of Way & Structure	
227,266-16	Station & office buildings	B(1838)
249,266-27	Signals & interlockers	B(1906)
201	Superintendence	B(1997)
266-1	Engineering	B(2026)
267-1		
266	Road Prop. depr. - all other	
267	Ret. road - all other accts.	
270	Dism. retired road property	
271,267-38	Small tools and supplies	
278,279	Maint. jt. tracks & other fac.	
	Total Accts. 266,267,270,271, 267(38),278,279	B(2055)
274	Injuries to persons	
275	Insurance	
276	Stationery & printing	
277	Employee H, W & payroll taxes	
282	Other expenses	
	Total Accts. 274,275,276,277,282	B(2084)
	Work Equipment	B(2151)
	Tot. Maintenance of Way & Structure	B(2180)
	Traffic and General Administration	
	Distribution of general overhead	B(2272)
	Total Traffic	B(2317)
	Cost of Capital: Road	
16	Station-other, including running	B(2794)
	Total Road	B(2794)

Table 6 - continued

Account Number	Item of Account Title	Rail Form A Core No.
	<u>Cost of Capital: Equipment</u>	
53	Freight train cars	B(2894)
54	Passenger train cars	B(2906)
	Total Equipment	B(2932)
	<u>Unit Cost Calculation:</u>	
	Total Expenses, Rents & Taxes	B(2317)
	Number of Service Units	A(178)
	Unit Cost-Expenses, Rents & Taxes B(2317)/A(178)	B(3174)
	Unit Cost-Cost of Capital Road: B(2794)/A(178)	B(3242)
	Variable Unit Cost / Sum of Expenses, Road & Equipment	B(3263)

TABLE 7. DERIVATION OF RAIL FORM A GROSS TON MILE EXPENSE: B(3261).

Account Number	Account Title		Rail Form A Core No.
	Transportation Portion:		
394	Train fuel		B(649)
395	Train power produced		B(676)
396	Train power purchased		B(679)
400	Servicing train locomotives		B(98)
371	Superintendence		B(833)
407	Employee H, W, & payroll taxes		
410	Stationery and printing		
411	Other expenses		
414	Insurance		
420	Injuries to persons		
	Total Accts., 409,410,411,414,420		B(884)
	Total Transportation		B(926)
	Maintenance of Equipment:		
311	Diesel locomotive repairs (road)		B(1122)
311	Other locomotive repairs (road)		B(1141)
314	Freight train car repairs -	mileage	B(1182)
		time	B(1207)
331-53	Freight train cars	- mileage	B(1323)
		- time	B(1336)
330-53	Freight train cars	- mileage	B(1389)
		- time	B(1402)
301	Superintendence		
332	Injuries to persons		
333	Insurance		
334	Stationary and printing		
335	Employee H, W & payroll taxes		
339	Other expenses		
	T. Accts. 301,332,333,334,335,339		B(1504)
302	Shop machinery		
304	Power plant machinery		
305	S & P plant machinery-depr.		

Table 7 - continued

Account Number	Account Title	Rail Form A Core No.
306	Dism. Ret. S&P plant machinery	
329	Dism. Ret. Equipment	
336	Joint maintenance of equipment -debit	
337	-credit	
	T.Acts. 302,204,205,206,219,336,337	B(1533)
503-536	Per diem cars - mileage	B(1560)
	- time	B(1573)
	Cars on other basis - mileage	B(1587)
	- time	B(1600)
	Locomotive rent (net)	B(1615)
	Total Maintenance of Equipment	B(1628)
	<u>Maintenance of Way & Structures</u>	
202	Roadway Maintenance - running	B(1678)
206	Tunnels & Subways - running	B(1687)
208	Bridges, Trestles & Culverts - running	B(1696)
210	Elevated Structures - running	B(1705)
221	Fences, snowsheds, & signs - running	B(1714)
212	Ties - running	B(1742)
214	Rails - running	B(1751)
216	Other track material - running	B(1760)
218	Ballast - running	B(1769)
220	Track Laying & Surfacing - running	B(1778)
226/2.5-13	Road property - depreciation	B(1799)
267/2.5-12	Retirements - roads	B(1809)
229,266/17	Roadway buildings	B(1856)
233,266/19	Fuel stations	B(1868)
235,266/20	Shops & enginehouses	B(1884)
253,266/29	Power plants	B(1930)
257,266/31	Power trans. system	B(1941)
201	Superintendence	B(1995)
266,267/1	Engineering	B(2024)
266	Road prop. - depr. all other	
267	Retire. road - all other	
270	Dism. retired road property	
271,267/38	Small tools & supplies	
278,279	Maint. J.T. tracks & other facilities	
	Total Acct. 266,267,270,271,267/38,278,279	B(2053)
274	Injuries to persons	
275	Insurance	
276	Stationery & printing	

Table 7 - continued

Account Number	Account Title	Rail Form A Core No.
277	Employee H, W & payroll taxes	
282	Other expenses	
	Total Accts. 274,275,276,277,282	B(2082)
269,266/37	Roadway machines	
272	Removing snow, ice	
267/39	Public improvements - maint.	
281	Right of way expenses	
	T. Accts. 269,266/37,272,267/39,281	B(2111)
	Work equipment	B(2149)
	Total NW&S Incl. Work Equipment	B(2178)
	<u>Traffic and General Administration</u>	
	Distribution of general overhead	B(2269)
	<u>Cost of Capital: Road</u>	
2.5-13,17, 26-45	Other road property - running	B(2773)
2	Land - running	B(2782)
18	Water stations	B(2810)
19	Fuel stations	B(2821)
20	Shops & enginehouses	B(2832)
	Total Road Cost of Capital	B(2851)
	<u>Cost of Capital: Equipment</u>	
53	Freight train cars	B(2893)
54	Passenger train cars	B(2905)
57-58	Work & misc. equipment	B(2921)
	Total Equipment Cost of Capital	B(2930)
	<u>Unit Cost Calculation:</u>	
	Total Expenses, Rents & Taxes	B(2314)
	Number of Service Units	B(86)
	Unit Cost/Expenses, Rents & Taxes: B(2314/B(86)	B(3171)
	Unit Cost-Cost of Capital Road: B(2851)/B(86)	B(3214)
	Unit Cost-Cost of Capital Equipment B(2930)/B(86)	B(3240)
	Variable Unit Cost: Sum of Expenses, Road & Equipment	B(3261)

TABLE 8. DERIVATION OF RAIL FORM A LOCOMOTIVE UNIT MILE COST: B(3262).

Account Number	Item of Account Title	Rail Form A Core No.
	Transportation	
394	Train fuel	B(650)
395	Train power produced	B(677)
396	Train power purchased	B(680)
400	Servicing train locomotives	B(99)
409	Employee H & W & payroll taxes	
410	Stationery & printing	
411	Other expenses	
414	Insurance	
420	Injuries to persons	
	Total Acct. 409,410,411,414,420	B(885)
	Total Transportation	B(927)
	Maintenance of Equipment:	
311	Diesel locomotive repairs, road	B(1123)
311	Other locomotive repairs, road	B(1142)
331	Locomotive depreciation	B(1295)
330	Locomotive retirements	B(550)
301	Superintendence	
332	Injuries to persons	
333	Insurance	
334	Stationery & printing	
335	Employee H, W & payroll taxes	
339	Other expenses	
	Total, Line 117 to 122	B(1505)
302	Shop machinery	
304	Power plant machinery	
305	Depreciation of S&P plant machinery	
306	Disman. retired S&P plant machinery	
329	Dismantling retired equipment	
336	Joint maintenance of equip.-debit	
337	Joint maintenance of equip.-credit	
	Total lines 124-130	B(1534)
504,537	Net locomotive rents	B(1616)
	Total Maintenance of Equipment	B(1629)

Table 8 - continued

Account Number	Item or Account Title	Rail Form A Core No.
	<u>Maintenance of Way and Structures</u>	
233,266	Fuel stations	B(1869)
253,266	Power plants	B(1931)
257,266	Power transmission system	B(1942)
201	Superintendence	B(1996)
266,267	Engineering	B(2025)
266	Road property depreciation	
267	Retirement of road property	
270	Dismantling retired property	
271,267	Small tools and supplies	
278,279	Maintenance of joint tracks and other facilities	
	T. Accts. 266,267,270,271,278,279	B(2054)
274	Injuries to persons	
275	Insurance	
276	Stationery and printing	
277	Employee H, W & payroll taxes	
282	Other expenses	
	Total, Line 297 to 201	B(2083)
	Work Equipment	B(2150)
	Total Maintenance of Way Structures	B(2179)
	<u>Traffic and General Administration</u>	
	Distribution of general overhead	B(2270)
	Total expenses, rents and taxes	B(2315)
	<u>Cost of Capital</u>	
20	Fuel Stations	B(2580)
21	Shops and enginehouses	B(2581)
	Total road	B(2822)
52	Locomotive	B(2668)
	<u>Variable Unit Cost Calculation:</u>	
	Number of Service Units	A(230)
	Unit Cost: Operating Expenses, Rents & Taxes B(2315)/A(230)	B(3172)
	Unit Cost: Cost of Capital Road B(2822)/A(230)	B(3215)
	Unit Cost: Cost of Capital Equipment B(2668)/A(230)	B(3241)
	Unit Cost: Total Expenses, Rents, Taxes & Cost of Capital, Line 9 + Line 10 + Line 11	B(3262)

TABLE 9. DERIVATION OF RAIL FORM A STATION CLERICAL UNIT COST: B(3265).

Account Number	Item or Account Title	Rail Form A Core No.
	<u>Transportation</u>	
373 other	Current actual station expense: other than platform	B(450)
376	Station supplies and expense	B(472)
	Total Accts. 373,376	B(581)
371	Superintendence	B(839)
390,391	Operating foint yards & terminals	B(864)
409	Employee H, W & payroll taxes	
410	Stationery & printing	
411	Other expenses	
414	Insurance	
420	Injuries to persons	
	Total Accts. 409-411,414,420	B(890)
	Total: B(581),B(839),B(864),B(890)	B(932)
452	Current year variable cost	B(988)
	Total Transportation Including Acct. 452	B(1040)
	<u>Maintenance of Way:</u>	
227,266/16	Station and office buildings	B(1839)
201	Superintendence	B(1998)
266-67/1	Engineering	B(2027)
266	Road property depreciation-all oth.	
267	Retire. of rd. property-all other	
270	Dismant. of retired roadway prop.	
271,267/38	Small tools & supplies	
278,279	Maint. of joint tracks & facilities	
	Total Accts. 266-271,278,279	B(2056)
274	Injuries to persons	
275	Insurance	
276	Stationery & printing	
277	Employee H, W & payroll taxes	
282	Other expenses	
	Total Accts. 274-277,282	B(2085)
	Total Maintenance W & S Excluding Work Equipment	B(2124)
	Work Equipment	B(2152)
	T. Maintenance of Way & Structure: B(2152) & B(2124)	B(2181)

Table 9 - continued

Account Number	Item or Account Title	Rail Form A Core No.
	<u>Traffic and General Administration:</u>	
	Distribution of General Overhead	B(2275)
16	<u>Cost of Capital: Road</u>	B(2795)
	<u>Variable Unit Cost Calculation</u>	
	Total Expenses, Rents & Taxes	B(2320)
	Cost of Capital Road	B(2795)
	Number of Service Units	B(3165)
	Unit Cost: Expenses, Rents & Taxes B(2320)/B(3165)	B(3176)
	Unit Cost: Cost of Capital, Road: B(2795)/B(3165)	B(3217)
	Unit Cost: Total Expense & Cost of Capital: B(3176)/B(3217)	B(3265)

TABLE 10. DERIVATION OF RAIL FORM A STATION SPECIAL SERVICES UNIT COST: B(3273).

Account Number	Item or Account Title	Rail Form A Core No.
373	Current actual station expense: other than platform	B(455)
376	Station supplies & expenses	B(480)
	Total Accts. 373,376	B(589)
371	Superintendence	B(847)
390,391	Operating joint yards & terminals	B(872)
409	Employee H, W & payroll taxes	
410	Stationery & printing	
411	Other expenses	
414	Insurance	
420	Injuries to persons	
	Total Accts. 409-411,414,420	B(898)
	Total Transportation, Including Acct. 452	B(898)
	<u>Maintenance of Way & Structure</u>	
277,266/16	Station & office buildings	B(1847)
201	Superintendence	B(2006)
266-67/1	Engineering	B(2035)
266	Road property depreciation-all oth.	
267	Retire. of road property-all other	
270	Dismant. of retired road property	
271,267/38	Small tools & supplies	
278,279	Maint. of joint track & facilities	
	Total Accts. 266-271,278,279	B(2065)
274	Injuries to persons	
275	Insurance	
276	Stationery & printing	
277	Employee H, W & payroll taxes	
282	Other expenses	
	Total Accts. 274-277,282	B(2093)
	Total Maintenance of W & S	
	Excluding Work Equipment	B(2132)
	Work Equipment	B(2160)
	Total Maintenance of Way & Structures: B(2132) + B(2160)	B(2189)

Table 10 - continued

Account Number	Item or Account Title	Rail Form A Core No.
	<u>Traffic and General Administration:</u>	
	Distribution of General Overhead	B(2283)
	<u>Cost of Capital: Road</u>	
16	Other road capital, including running	B(2800)
	<u>Variable Unit Cost Calculation:</u>	
	Total Expense, Rents & Taxes	B(2328)
	Cost of Capital, Road	B(2800)
	Number of Service Units	B(3165)
	Unit Cost: Expenses, Rents & Taxes B(2328)/B(3165)	B(3184)
	Unit Cost: cost of Capital Road B(2800)/B(3165)	B(3225)
	Unit Cost: Expenses & Cost of Capital B(3184)+B(3225)	B(3273)

The raw RFA gross ton mile (GTM) expense is adjusted for the type of train service. Table 11 illustrates the process, using regional RFA data. The adjustment process accounts for the fact that different train performance factors (e.g. locomotive units and average trailing weights) will result in different costs per train-mile. Logically, unit train gross ton-mile costs will be lower than way train.

BN's raw RFA GTM unit cost was adjusted in this study for unit, through, and way trains. The average train weight and locomotives required in each class of train service were computed from their latest R-1 report.

The number of interchange and intertrain switches off-branch are estimated for each major destination. The BN is automatically allotted one interchange switch at Breckenridge on all traffic. The frequency of interchange to miscellaneous markets is computed from North Dakota waybill data.

It is impossible to fully document the Class I Carrier costing methods within the scope of this report. Hopefully, the tables and illustrations will illuminate the process, and highlight some of the more substantive computations. A detailed description can be found in a 1987 report by the author.[13]

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[13]Light Density Costing Methodology, UGPTI Staff Paper 84, 1987, Tolliver, D.

TABLE 11. RAIL FORM A DEVELOPMENT OF ADJUSTED WAY TRAIN GROSS TON MILE EXPENSE.

Item		Source	Amount
1.	Cost per revenue and non-revenue gross ton	RFA, B(3261)	0.00292072
2.	Train weight	RFA, B(3298)	1780.7222
3.	Cost per train mile and gross ton mile (Line 1 * Line 2)	RFA, B(3311)	5.20098603
4.	Cost per locomotive unit mile	RFA, B(3262)	1.93196982
5.	Locomotive units per train	RFA, B(3303)	2.22108209
6.	Cost per train mile and gross ton mile (Line 4 * Line 5)	RFA, B(3314)	4.29106355
7.	Train mile expense, other than wages	RFA, B(3263)	1.09699082
8.	Train mile expense, crew wage	RFA, B(3173)	5.93536532
9.	Ratio, way train to average train wages	RFA, B(3308)	1.21620546
10.	Total variable cost per train mile (Line 3 * Line 6)	RFA, B(3319)	17.80766420
11.	Variable cost per revenue and non-revenue	RFA, B(3861)	1.00002483
12.	Ratio, revenue to total gross ton miles	RFA, B(88)	.98817889
13.	Variable cost per revenue gross ton miles (Line 11/Line 12)	RFA(3325)	1.01198764

So far in the report, the primary methods and data sources have been highlighted. The results of the Wahpeton-to-Independence line analysis are presented next, in the concluding section of the report.

ANALYSIS AND RESULTS

Primary Efficiency Benefits

Table 12 shows the primary efficiency benefits of the project, and illustrates the computations described earlier. The final column depicts the cumulative discounted efficiency benefits. As the table shows, the project generates benefits which exceed the raw outlay costs by 1991. So the payback period is only four years.

A conservative project salvage value has been computed, reflecting only the salvageable value of materials used in the rehabilitation itself. This value ($585,000) has been discounted from the end of the analysis period (2007), using a discount rate of 8 percent.[14] When subtracted from the outlay, this credit results in a net rehabilitation cost of $1.618 million dollars. Again, this is paid back early on in the project's life. As Table 12 shows, the efficiency gains (cost savings) alone are enough to pay back the project outlay. Over 7,000 cars are handled on the line. So it is not surprising that considerable annual savings would result from rehabilitation.

As discussed earlier, it is assumed that RRV&W will carry out normalized maintenance on the line and replace the 28 miles of 72-pound rail by 1995. The projected cost of the replacement is $120,000 per mile, or a total of $3.4 million. Assuming a conservative salvage value of 35 percent, discounted to present value, yields a net cost of 3.15 million dollars; or a total of $4.768 million for all of the projected capital needs on the line during the next 20 years. As Table 12 shows, these outlays will be paid back by 1993, before all of the projects are actually completed.

Part of the cost savings shown in Table 12 will accrue to the railroads. Their

[14]This is the same discount rate used to compute the net present value of project benefits.

TABLE 15. PRIMARY EFFICIENCY BENEFITS

YEAR	BASE CASE VOL.(CWT)	BASE CASE COST	REHAB. CASE COST	COST CHANGE	COST SAVINGS	BASE CASE RATE	REHAB. CASE RATE
1988	12,992,400	$.89	$.85	$.04	$519,696	$1.03	$1.00
1989	12,992,400	$.89	$.85	$.04	$519,696	$1.03	$1.00
1990	12,992,400	$.89	$.85	$.04	$519,696	$1.03	$1.00
1991	12,992,400	$.89	$.85	$.04	$519,696	$1.03	$1.00
1992	12,992,400	$1.63	$.85	$.78	$10,134,072	$1.62	$1.00
1993	12,992,400	$1.63	$.85	$.78	$10,134,072	$1.62	$1.00
1994	12,992,400	$1.63	$.85	$.78	$10,134,072	$1.62	$1.00
1995	12,992,400	$1.63	$.85	$.78	$10,134,072	$1.62	$1.00
1996	12,992,400	$1.63	$.85	$.78	$10,134,072	$1.62	$1.00
1997	12,992,400	$1.63	$.85	$.78	$10,134,072	$1.62	$1.00
1998	12,992,400	$1.63	$.85	$.78	$10,134,072	$1.62	$1.00
1999	12,992,400	$1.63	$.85	$.78	$10,134,072	$1.62	$1.00
2000	12,992,400	$1.63	$.85	$.78	$10,134,072	$1.62	$1.00
2001	12,992,400	$1.63	$.85	$.78	$10,134,072	$1.62	$1.00
2002	12,992,400	$1.63	$.85	$.78	$10,134,072	$1.62	$1.00
2003	12,992,400	$1.63	$.85	$.78	$10,134,072	$1.62	$1.00
2004	12,992,400	$1.63	$.85	$.78	$10,134,072	$1.62	$1.00
2005	12,992,400	$1.63	$.85	$.78	$10,134,072	$1.62	$1.00
2006	12,992,400	$1.63	$.85	$.78	$10,134,072	$1.62	$1.00
2007	12,992,400	$1.63	$.85	$.78	$10,134,072	$1.62	$1.00

YEAR	RATE CHANGE	CHANGE IN VOL.	CONSUMER SURPLUS	RATE/ COST REHAB.	PRODUCER'S SURPLUS	TOTAL BENEFITS
1988	$.03	194,900	$2,924	$.15	$29,235	$551,855
1989	$.03	194,900	$2,924	$.15	$29,235	$551,855
1990	$.03	194,900	$2,924	$.15	$29,235	$551,855
1991	$.03	194,900	$2,924	$.15	$29,235	$551,855
1992	$.62	194,900	$60,419	$.15	$29,235	$10,223,726
1993	$.62	194,900	$60,419	$.15	$29,235	$10,223,726
1994	$.62	194,900	$60,419	$.15	$29,235	$10,223,726
1995	$.62	194,900	$60,419	$.15	$29,235	$10,223,726
1996	$.62	194,900	$60,419	$.15	$29,235	$10,223,726
1997	$.62	194,900	$60,419	$.15	$29,235	$10,223,726
1998	$.62	194,900	$60,419	$.15	$29,235	$10,223,726
1999	$.62	194,900	$60,419	$.15	$29,235	$10,223,726
2000	$.62	194,900	$60,419	$.15	$29,235	$10,223,726
2001	$.62	194,900	$60,419	$.15	$29,235	$10,223,726
2002	$.62	194,900	$60,419	$.15	$29,235	$10,223,726
2003	$.62	194,900	$60,419	$.15	$29,235	$10,223,726
2004	$.62	194,900	$60,419	$.15	$29,235	$10,223,726
2005	$.62	194,900	$60,419	$.15	$29,235	$10,223,726
2006	$.62	194,900	$60,419	$.15	$29,235	$10,223,726
2007	$.62	194,900	$60,419	$.15	$29,235	$10,223,726

YEAR	DISCOUNTED BENEFITS	CUMULATIVE BENEFITS
1988	$551,855	$551,855
1989	$473,127	$1,024,982
1990	$438,080	$1,463,062
1991	$405,630	$1,868,692
1992	$6,958,096	$8,826,788
1993	$6,442,682	$15,269,470
1994	$5,965,446	$21,234,916
1995	$5,523,561	$26,758,477
1996	$5,114,408	$31,872,885
1997	$4,735,563	$36,608,448
1998	$4,384,781	$40,993,229
1999	$4,059,982	$45,053,211
2000	$3,759,243	$48,812,454
2001	$3,480,780	$52,293,234
2002	$3,222,945	$55,516,179
2003	$2,984,208	$58,500,387
2004	$2,763,156	$61,263,543
2005	$2,558,478	$63,822,021
2006	$2,368,961	$66,190,982
2007	$2,193,482	$68,384,464

discounted savings on existing traffic is $5.14 million. In addition, the present value of the producers surplus generated by the project is $2.89 million, yielding a total of $8.03 million in operator benefits. So the projects will also pay back the additional $3.15 million in future capital needs through producer savings alone.

The overall benefit-cost ratio of the project, considering PEB alone, is 14.3 (68,384,464 divided by 4.768 million). This does not even consider the SEB, which are discussed next.

Highway Costs

Table 13 shows the projected highway benefits accruing from rehabilitation. The base-case costs and revenues show the streams which will be generated starting in 1992 if the line is abandoned, and the traffic which now moves by rail goes by truck. The rehabilitation-case streams reflect the changes which occur because of the shift in modal split after rehabilitation. Approximately 3,650 truck trips will not be required because of an increase in rail share.

The highway costs in columns (a) and (c) are both avoidable highway costs, so they may be summed to yield gross impacts. The sum of the two revenue streams constitutes a credit against the highway costs. However, as Table 13 shows, the revenues are not sufficient to cover the incremental costs.[15] In fact, the cumulative discounted net highway costs to state and local governments will more than offset the rehabilitation costs, without consideration of other effects. This is because an average journey of 33 miles will be required by heavy trucks over collector and minor arterial highways if the line is abandoned. The average strength rating of the highways is 2.6, and the average ESAL life is only 302,000. So considerable damage will occur.

[15]The revenues include both incremental motor fuel taxes and incremental registration fees.

TABLE 13

YEAR	(a) BASE CASE HIGHWAY COST	(b) BASE CASE REVENUES	(c) REHAB. CASE HIGHWAY COST	(d) REHAB. CASE REVENUES
1988	$0	$0	$-811,802	$-128,030
1989	$0	$0	$-811,802	$-128,030
1990	$0	$0	$-811,802	$-128,030
1991	$0	$0	$-811,802	$-128,030
1992	$1,030,160	$600,221	$-811,802	$-128,030
1993	$1,030,160	$600,221	$-811,802	$-128,030
1994	$1,030,160	$600,221	$-811,802	$-128,030
1995	$1,030,160	$600,221	$-811,802	$-128,030
1996	$1,030,160	$600,221	$-811,802	$-128,030
1997	$1,030,160	$600,221	$-811,802	$-128,030
1998	$1,030,160	$600,221	$-811,802	$-128,030
1999	$1,030,160	$600,221	$-811,802	$-128,030
2000	$1,030,160	$600,221	$-811,802	$-128,030
2001	$1,030,160	$600,221	$-811,802	$-128,030
2002	$1,030,160	$600,221	$-811,802	$-128,030
2003	$1,030,160	$600,221	$-811,802	$-128,030
2004	$1,030,160	$600,221	$-811,802	$-128,030
2005	$1,030,160	$600,221	$-811,802	$-128,030
2006	$1,030,160	$600,221	$-811,802	$-128,030
2007	$1,030,160	$600,221	$-811,802	$-128,030

TABLE 13 continued

YEAR	(e) CHANGE IN COSTS	(f) CHANGE IN REVENUES	(g) NET COST	(h) DISCOUNTED COSTS	(i) CUMULATIVE COSTS
1988	$811,802	$128,030	$-683,772	$-683,772	$-683,772
1989	$811,802	$128,030	$-683,772	$-586,224	$-1,269,996
1990	$811,802	$128,030	$-683,772	$-542,800	$-1,812,796
1991	$811,802	$128,030	$-683,772	$-502,593	$-2,315,389
1992	$1,841,962	$728,251	$-1,113,711	$-757,973	$-3,073,362
1993	$1,841,962	$728,251	$-1,113,711	$-701,827	$-3,775,189
1994	$1,841,962	$728,251	$-1,113,711	$-649,840	$-4,425,029
1995	$1,841,962	$728,251	$-1,113,711	$-601,703	$-5,026,732
1996	$1,841,962	$728,251	$-1,113,711	$-557,133	$-5,583,865
1997	$1,841,962	$728,251	$-1,113,711	$-515,864	$-6,099,729
1998	$1,841,962	$728,251	$-1,113,711	$-477,652	$-6,577,381
1999	$1,841,962	$728,251	$-1,113,711	$-442,270	$-7,019,651
2000	$1,841,962	$728,251	$-1,113,711	$-409,509	$-7,429,160
2001	$1,841,962	$728,251	$-1,113,711	$-379,175	$-7,808,335
2002	$1,841,962	$728,251	$-1,113,711	$-351,088	$-8,159,423
2003	$1,841,962	$728,251	$-1,113,711	$-325,082	$-8,484,505
2004	$1,841,962	$728,251	$-1,113,711	$-301,002	$-8,785,507
2005	$1,841,962	$728,251	$-1,113,711	$-278,705	$-9,064,212
2006	$1,841,962	$728,251	$-1,113,711	$-258,060	$-9,322,272
2007	$1,841,962	$728,251	$-1,113,711	$-238,945	$-9,561,217

Regional Economic Impacts

Table 14 shows the regional effects of the changes in consumer surplus attributable to the project. Over $625,000 in additional household income will be generated. In addition, $1.24 million dollars in gross business volume will be created. This covers (almost exactly) the state's share of expenditures for the project.

These are very conservative estimates, it should be noted, because they do not consider the economic effects of gains in producer surplus. Some of this surplus accrues to the Red River Valley and Western, a portion of which will probably be spent in-state.

TABLE 14. SECONDARY IMPACTS ON HOUSEHOLD INCOME AND BUSINESS VOLUME

Year	Consumer Surplus	Household Income	Cumulative Discounted Increase	Gross Business Volume	Cumulative Discounted Increase
1988	$2,924	$4,538	$4,202	$9,006	$8,339
1989	$2,924	$4,538	$8,093	$9,006	$16,060
1990	$2,924	$4,538	$11,695	$9,006	$23,209
1991	$2,924	$4,538	$15,031	$9,006	$29,829
1992	$60,419	$93,770	$78,849	$186,091	$156,479
1993	$60,419	$93,770	$137,940	$186,091	$273,747
1994	$60,419	$93,770	$192,654	$186,091	$382,329
1995	$60,419	$93,770	$243,315	$186,091	$482,868
1996	$60,419	$93,770	$290,224	$186,091	$575,960
1997	$60,419	$93,770	$333,658	$186,091	$662,156
1998	$60,419	$93,770	$373,874	$186,091	$741,967
1999	$60,419	$93,770	$411,112	$186,091	$815,866
2000	$60,419	$93,770	$445,591	$186,091	$884,291
2001	$60,419	$93,770	$477,516	$186,091	$947,648
2002	$60,419	$93,770	$507,076	$186,091	$1,006,311
2003	$60,419	$93,770	$534,447	$186,091	$1,060,629
2004	$60,419	$93,770	$559,790	$186,091	$1,110,924
2005	$60,419	$93,770	$583,256	$186,091	$1,157,493
2006	$60,419	$93,770	$604,984	$186,091	$1,200,612
2007	$60,419	$93,770	$625,102	$186,091	$1,240,537

APPENDIX A

DESCRIPTION OF LINE CONDITION

The Third Subdivision extends 89 miles from Oakes Junction, near Wahpeton, to Independence. Though the line is treated as a whole, it can be broken into three subsegments according to track condition.

The first segment, from Oakes Junction to Milnor, is distinctive in three ways. It is the closest link to a major interchange point (in Wahpeton) and therefore carries more traffic than the rest of the line. Secondly, it stands out by it's condition. Finally, it is the focus of the 1989 rehabilitation project.

The types of problems vary from place to place. However, most are the result of poor tie condition partially due to the presence of fifteen miles of 72 pound rail. There are no records showing any tie work on this segment in the last twenty years, although extensive spot work is evident. Approximately 30 percent of the ties have failed where the 72 pound rail is present. Another ten to twenty percent will fail in the next five years. Ties under the rest of the subsegment are in a little better shape. But they too suffer from a sparse population.

Tie failure counts and the type of failure indicate that the 72 pound rail is a major factor in deteriorating track condition. Most of the tie problems under the heavier rail (90 pounds or greater) can be traced to age and rotting wood; not too surprising considering that they are virtually sitting in mud. Much of the failure under the 72 pound rail is plate-cutting; a condition where the pressure from the rail pushes the tie plate into the tie. This condition is probably a result of the lack of vertical stiffness in the lighter rail, and the small tie plates attaching the rail to the tie.

Cross level and subgrade problems also exist on this section of the subdivision. Though rail stiffness plays a part in the condition of the subgrade, subgrade problems seemed to be scattered evenly throughout the subsegment. The terrain seems to be much more of a factor at this point than the rail conditions. Ballast conditions are equally poor due to sufficient lack of depth and coverage. This has led to tie rot and alignment problems.

The third characteristic that sets this segment apart is the rehabilitation work to be done this year. The tie and ballast work should solve most of the above mentioned problems. Tie life under heavier sections of the rail will be raised from their present 23 years to around 30 to 35 years. Tie life under the lighter 72 pound rail, though increased, is and will continue to be unacceptable, due again to the rail and tie plates. The work to be done on the section is badly needed and will restore it to a reasonable level. However, the 72 pound rail should be removed as soon as feasible.

The second segment is from Milnor to Oakes. It is distinguished both by the fact that it is laid exclusively with 90 pound welded rail, and that Oakes is the last point of originating traffic. The previous owner (BN) did extensive work on this segment. As a result, the rail, ties and ballast are the best in the subdivision.

Most of the future work on this segment will probably consist of normalized maintenance, though the addition of six to eight thousand ties would certainly not hurt.

The third section from Oakes to Independence is in by far the worst shape. Though extensive work was done last year, more will have to be undertaken to bring this segment up to the same level as the rest of the line. Though there is no originating or terminating traffic on this fifteen mile segment, its geographic location makes it a vital part of the system. Much of the traffic north of Independence travels over this route on its way to interchange.

The rail is the same 72 pound variety found on the first section, and the associated problems are similar. Tie condition was better than expected, but still not to a level equated with traffic volume. Indeed, the tie problem is such that there are nearly as many ties missing as failed.

Though the subgrade problems do not seem to be as bad as the first section, the ballast condition is about the same and will require some more work in the not too distant future.

The work to be done on the Third Subdivision of the Red River Valley and Western is both warranted and necessary for the long term service of the line. The current project application is an important first step. However, more work will need to be done in the near future to insure that past work will be beneficial.

The economic life of the track materials is hard to predict at this time. Rail life will undoubtedly be at least fifty to seventy years. Ballast cycles should be in the five to ten year range, depending on several factors (mostly ties). Tie life is rather hard to predict. Assuming the 72 pound rail will be removed in two years and all sections of rail are brought up to around 2200 good ties per mile, tie life should be 30-35 years. This, under normal conditions, means 11,500 ties will fail per year. But with all the tie work being performed, most of the ties will not be at the end of their economic life for another five to ten years. Therefore, it may be assumed that once all the work is completed, only spot maintenance will be needed for at least five years, at which time a five year maintenance interval could be maintained.

APPENDIX B

GRAIN TRUCK REVENUE AND COSTING PROCEDURES

Grain truck costs for North Dakota carriers have been developed by Dooley, Bertram and Wilson (1988). Truck unit costs are developed in the study from North Dakota survey data using economic-engineering techniques. In addition, grain rate predictive equations were designed in the study. Both the unit costs and the rate equations are used in this analysis.

The equations used to predict grain rates to major markets are shown below.

$$\text{Duluth Rate} = 15.523 + .176*\text{DIST} - .032*\text{PBH}$$

$$\text{MSP Rate} = 27.367 + .142*\text{DIST} - .080*\text{PBH}$$

$$\text{PNW Rate} = 823.186 + .045*\text{DIST} - 7.28*\text{PBH}$$

where: DIST = one-way distance

PBH = percent backhaul

The computed rates and costs reflect 1986 levels. Both have updated to 1989 using the Producer Price Indexes. The predicted truck rates and costs for stations on the Wahpeton-to-Independence line were shown in Table 2 of the report.

APPENDIX C

DESCRIPTION OF NORTH DAKOTA INPUT-OUTPUT MODEL

Input-Output Model

Input-output analysis is a technique for tabulating and describing the linkages or interdependencies between industrial groups within an economy. The economy may be the national economy or an economy as small as that of a multicounty area served by one of the state's major retail trade centers. The north Dakota economy is divided into 17 industrial groups corresponding to standard industrial classification (SIC) codes. These codes are presented in Appendix Table C1.

The input-output analysis used in this analysis assumes that economic activity in a region is dependent upon the basic industries that exist (referred to as its economic base). The economic base is largely a region's export base, i.e., those industries (or "basic" sectors) that earn income from outside the area. These activities in North Dakota consist of livestock and crop production, manufacturing, mining, tourism in the area, and federal government outlays. The remaining economic activities are the trade and service sectors, which exist to provide the inputs required by other sectors in the area.

The North Dakota input-output model has three features which merit special comment. First, the model is closed with respect to households. In other words, households are included in the model as both a producing and a consuming sector. Second, the total gross business volume of trade sectors was use (both for expenditures and receipts in the transactions table) rather than the value added by those sectors. This procedure results in larger activity levels for those sectors than would be obtained by conventional techniques, but this is offset by correspondingly larger levels of expenditures outside the region by those sectors for goods purchased for resale. The advantage of this procedure is that the results of the analysis are expressed in terms of gross business volumes of the respective sectors, which is usually more meaningful. The third feature is that all elements in the column of interdependence coefficients for the local government sector were assigned values of zero, except for a one (1.00) in the main diagonal. This was intended to reflect the fact that expenditures of local units of government are determined by the budgeting process of those units, rather than endogenously within the economic system.

Production by any sector requires the use of production inputs, such as materials, equipment, fuel, services, labor, etc., by that sector. These inputs are referred to as the direct requirements of the sector. Some of these inputs will be obtained from outside the region (imported), but many will be produced by and purchased from other sectors in the area economy. When this occurs, other sectors will require their own inputs from still other sectors, which in turn will require inputs from yet other sectors, and so on. These additional rounds of input requirements that are generated by production of the direct input requirements (of the initial sector) are known as the indirect requirements.

The total of the direct and indirect input requirements of each sector in an economy is measured by a set of coefficients that is known as the input-output interdependence coefficients. Each coefficient indicates the total (direct and indirect) input requirement that must be produced by the row sector per dollar of output for final demand by the column sector. Final demand is defined as output by a basic sector that is sold to purchasers from outside the region. Final demand consists of receipts from sales of livestock (receipts of Sector 1); sales of crops (Sector 2); federal government outlays for construction, processed agricultural products and other manufacturing items (Sector 7); tourist expenditures (Sectors 8 and 10); exports of mine products (Sector 14); electricity exports (Sector 15); crude oil exports (Sector 16); and exports of refined petroleum products. For any of the basic sectors which produce for final demand, the sum of the values for that column indicates the multiplier effect in the region's economy resulting from a dollar's worth of sales outside the region by that sector. For example, if the column total of interdependence coefficients for the livestock producing sector is 4.49, $4.49 worth of output is required by all sectors in the economy in order that $1.00 worth of livestock be produced for final demand. Thus, it can be said that the output multiplier for the livestock producing sector is 4.49, or that the original dollar "turns over" about 4.5 times in the region.

If the level of output of any of the basic sectors were to increase, the level of output of other sectors would also be expected to increase. The amount of the increase in other sectors would be equal to the dollar amount of the increase in the basic sector's output times the respective interdependence coefficients in the column for the basic sector. For example, the effect of a $1 million increase in federal government outlays for construction in the region could be estimated from Column 4, Appendix Table C2. Livestock production in the region could be expected to increase by $30,000 (0.03 times $1 million); crop production by $10,000 (0.01 times $1 million); retail trade volume by $410,000 (0.41 times $1 million); personal income (the income of households, Sector 12) by $610,000 (0.61 times $1 million); and the total for all sectors in the economy by $2,440,000 (2.44 times $1 million). These increases in the respective sectors represent both the direct and the indirect effects of expanded final demand that is injected into the region via the contract construction sector because of increased federal expenditures.

Given these basic procedures, the gross business volumes of each sector in the area economy can be estimated by multiplying the output of the "basic" sectors (payments received from outside the area) by the interdependence coefficients for those sectors.

The multiplier effect for a sector (which is measured by the sum of the sector's column of interdependence coefficients) results from the spending and re-spending within the region's economy of income that is received from sale of its exports. For example, the establishment of a new manufacturing plant in a region would result in expenditures by the plant for some locally supplied inputs, such as materials, labor, etc. These expenditures will generate additional rounds of spending in the region because the firms providing materials to the plant will now purchase some additional inputs in the region and employees of the plant will spend a part of their income in the region. These expenditures, in turn, will generate another round of spending and so on.

Multiplication of the interdependence coefficients by the sales of the basic sectors (income received from outside the region or sales for final demand) yields estimates of the gross business volumes of each of the sectors in the region. Sales of the basic sectors can be baseline or project/industry specific (which are appropriate in the case of impact analysis). The resulting product for the household sector (Sector 12) is personal income received from the respective business sectors in the form of wages and salaries, profits, rents, and interest income of individuals.

Interdependence Coefficients

The input-output technical and interdependence coefficients for the North Dakota economy were derived from actual expenditure data collected in 1965 for business firms, households, and units of government in southwestern North Dakota (Sand, 19868; Bartch, 1968; and Senchal, 1971). The North Dakota input-output interdependence coefficients were calculated originally for a 13-sector model.

The original coefficients were derived when energy production (coal, electricity, crude petroleum, and refined petroleum products) was not a very large component of the North Dakota Economic base. Increasing importance of North Dakota energy exports made expansion of the model necessary. Survey expenditure data of the energy-related industries were collected in 1975 (Hertsgaard et al., 1977). These data yielded technical coefficients (direct requirements) for four addition economic sectors. The coefficients were simply appended to the 13-sector direct requirements matrix to form an augmented 17-sector direct requirements matrix. The technical coefficients for the four energy sectors were included as columns 14-17. Rows 14 to 17 for columns 1-13 were assigned a value of zero. This was appropriate because the original 13 sectors have insignificant amounts of expenditures to the energy sectors, but the energy sectors had a considerable amount of expenditures to the original 13 sectors. Inverting the 17 X 17 technical coefficients matrix yielded the 17-sector model are presented in Appendix Table C2.

Gross Business Volumes

Application of the input-output multipliers to the final demand vectors provides estimates of gross business volume of all sectors of the economy. Final demand vectors can be baseline or project/industry and historic or projected. Multipliers applied to the historic final demand vectors yield estimates of historic gross business volumes. Gross business volume of the household sector (Sector 12) is personal income. Applying the household sector's gross receipts and household row multipliers to consumers' surplus will give estimates of the gross business volumes and personal incomes, respectively, that are directly or indirectly attributable to the additional income received as a result of branch line rehabilitation for the specified time period.

The accuracy of the input-output model has been tested by comparing personal income from the model with personal income reported by the Bureau of Economic Analysis, U.S. Department of Commerce. For the time period 1958 to 1980, estimates of North Dakota personal income from the input-output model had an average deviation of 5.13 percent from Department of Commerce estimates (Appendix Table C3). The Theil's coefficient of .031 also indicates the model is quite accurate for predictive purposes.[16]

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[16]The Theil U_1coefficient is a summary measure, bounded to the interval 0 and 1. A value of 0 for U_1 indicates perfect prediction, while a value of 1 corresponds to perfect inequality (i.e., between the actual and predicted values). For further discussion on the Theil coefficient, see Leuthold, 1975 and Pindyck, Robert S. and Daniel L. Rubinfeld, 1981.

APPENDIX TABLE C1. ECONOMIC SECTORS OF THE NORTH DAKOTA INPUT-OUTPUT MODEL AND STANDARD INDUSTRIAL CLASSIFICATION CODE OF EACH

	Economic Sector	SIC Code[17]
1.	Ag., Livestock	Group 013 - Livestock
2.	Ag., Crops	All of major group 01 - agricultural production, except group 013 - livestock
3.	Sand & Gravel Mining	Major group 14 - mining and quarrying of nonmetallic minerals, except fuels
4.	Construction	Division C - contract construction (major groups 15, 16, and 17)
5.	Transportation	All division E - transportation, communications, electric, gas and sanitary services, except major groups 48 and 49.
6.	Communications & Public Utilities	Major group 48 - communications and major group 49 - electric, gas, and sanitary services, except industry no. 4911
7.	Ag. Processing & Miscellaneous Manufacturing	Major group 50 - wholesale trade, and major group 20 - food and kindred products manufacturing
8.	Retail Trade	All of division F - wholesale and retail trade, except major group 50 - wholesale trade
9.	Finance, Insurance, estate and Real Estate	Division G - finance, insurance, and real
10.	Business and Personal Service	All of division H - services, except major groups 80, 81 82, 86, and 89
11.	Professional and Social Services	Major group 80 - medical and other health services, major group 8, legal services, major group 82 - educational services, major group 86 - nonprofit membership organizations, and major group 89 - miscellaneous services
12.	Households	Not applicable
13.	Government	Division I - government

[17]Executive Office of the President/Bureau of the Budget, 1967.

14.	Coal mining	Major group 12 - bituminous coal and lignite mining
15.	Electric Generating	Industry number 4911 - electric companies and systems
16.	Petroleum and Natural natural Extraction	Major group 13 - crude petroleum and Gas Exploration and gas
17.	Petroleum Refining	Major group 29 - petroleum refining and related industries

APPENDIX TABLE C2. INPUT-OUTPUT INTERDEPENDENCE COEFFICIENTS, BASED ON TECHNICAL COEFFICIENTS FOR 17-SECTOR MODEL FOR NORTH DAKOTA

Sector	Lvstk. (1)	Crops (2)	S&G (3)	Const. (4)	Trans. (5)	C&U (6)	W&AP (7)	Ret. (8)	FIRE (9)
1. Ag. Livestock	1.2072	0.0774	0.0445	0.0343	0.0455	0.0379	0.1911	0.0889	0.0617
2. Ag. Crops	0.3938	1.0921	0.0174	0.0134	0.0178	0.0151	0.6488	0.0317	0.0368
3. Sand & Gravel	0.0083	0.0068	1.0395	0.0302	0.0092	0.0043	0.0063	0.0024	0.0049
4. Construction	0.0722	0.0794	0.0521	1.0501	0.0496	0.0653	0.0618	0.0347	0.0740
5. Transportation	0.0151	0.0113	0.0284	0.0105	1.0079	0.0135	0.0128	0.0104	0.0120
6. Comm. & Util.	0.0921	0.0836	0.1556	0.0604	0.0839	1.1006	0.0766	0.0529	0.1321
7. Wholesale & Ag. Proc.	0.5730	0.1612	0.0272	0.0207	0.0277	0.0239	1.7401	0.0452	0.0704
8. Retail	0.7071	0.8130	0.5232	0.4100	0.5475	0.4317	0.6113	1.2734	0.6764
9. Fin., Ins., Real Estate	0.1526	0.1677	0.1139	0.0837	0.1204	0.1128	0.1322	0.0577	1.1424
10. Bus. & Pers. Services	0.0562	0.0684	0.0430	0.0287	0.0461	0.0374	0.0514	0.0194	0.0766
11. Prof. & Soc. Services	0.0710	0.0643	0.0559	0.0402	0.0519	0.0526	0.0530	0.0276	0.0816
12. Households	1.0458	0.9642	0.8424	0.6089	0.7876	0.7951	0.7859	0.4034	1.2018
13. Government	0.0987	0.0957	0.0853	0.0519	0.2583	0.0999	0.0796	0.0394	0.1071
14. Coal Mining	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
15. Electric Generating	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
16. Pet. Exp./Ext.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
17. Pet. Refining	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Gross Receipts Multiplier	4.4931	3.6851	3.0284	2.4430	3.0534	2.7901	4.4509	2.0871	3.6778

- Continued -

APPENDIX TABLE C2. INPUT-OUTPUT INTERDEPENDENCE COEFFICIENTS, BASED ON TECHNICAL COEFFICIENTS FOR 17-SECTOR MODEL FOR NORTH DAKOTA (CONTINUED)

Sector	B&PS (10)	P&SS (11)	HH (12)	Govt. (13)	Coal (14)	E. Gen. (15)	Pet. Exp./Ext. (16)	Pet. Ref. (17)
1. Ag. Livestock	0.0384	0.0571	0.0674	0.0000	0.0376	0.0251	0.0159	0.0145
2. Ag. Crops	0.0152	0.0229	0.0266	0.0000	0.0285	0.0321	0.0062	0.0057
3. Sand & Gravel	0.0043	0.0050	0.0057	0.0000	0.0032	0.0019	0.0045	0.0037
4. Construction	0.0546	0.0787	0.0902	0.0000	0.0526	0.0328	0.1148	0.0929
5. Transportation	0.0118	0.0100	0.0093	0.0000	0.0084	0.0048	0.0180	0.0172
6. Comm. & Util.	0.1104	0.1192	0.1055	0.0000	0.0712	0.0378	0.0510	0.0444
7. Wholesale & Ag. Proc.	0.0237	0.0362	0.0417	0.0000	0.0618	0.0782	0.0097	0.0089
8. Retail	0.4525	0.6668	0.7447	0.0000	0.3995	0.2266	0.1838	0.1675
9. Fin., Ins., Real Estate	0.1084	0.1401	0.1681	0.0000	0.0771	0.0977	0.0388	0.0358
10. Bus. & Pers. Services	1.0509	0.0455	0.0605	0.0000	0.0289	0.0201	0.0139	0.0127
11. Prof. & Soc. Services	0.0497	1.1026	0.0982	0.0000	0.0493	0.0301	0.0210	0.0195
12. Households	0.7160	1.0437	1.5524	0.0000	0.6666	0.3973	0.3205	0.2951
13. Government	0.0774	0.0881	0.1080	1.0000	0.0511	0.0444	0.0280	0.0285
14. Coal Mining	0.0000	0.0000	0.0000	0.0000	1.0000	0.1582	0.0003	0.0002
15. Electric Generating	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
16. Pet. Exp./Ext.	0.0000	0.0000	0.0000	0.0000	0.0138	0.0084	1.0981	0.8227
17. Pet. Refining	0.0000	0.0000	0.0000	0.0000	0.0168	0.0102	0.0000	1.0000
Gross Receipts Multiplier	2.7133	3.4159	3.0783	1.0000	2.5664	2.2057	1.9245	2.5693

APPENDIX TABLE C3. ESTIMATES OF PERSONAL INCOME AND DIFFERENCES IN ESTIMATES, STATE OF NORTH DAKOTA, 1958-1980

Year	Estimates by Input-Output Techniques ($000)	Estimates by U.S. Department of Commerce ($000)[a]	Percent Difference
1958	$1,022,412	$1,027,000	- 0.5
1959	978,420	956,000	2.3
1960	942,488	1,066,000	-11.6
1961	1,011,460	955,000	1.7
1962	1,285,790	1,353,000	- 5.0
1963	1,353,864	1,280,000	5.8
1964	1,521,191	1,277,000	19.1
1965	1,470,128	1,508,000	- 2.5
1966	1,662,393	1,553,000	7.0
1967	1,573,010	1,592,000	- 1.2
1968	1,684,451	1,645,000	2.4
1969	1,890,973	1,830,000	3.3
1970	2,117,318	1,904,000	11.2
1971	2,156,642	2,158,000	- 0.1
1972	2,601,416	2,676,000	- 2.8
1973	3,674,738	3,875,000	- 5.2
1974	4,104,667	3,740,000	9.8
1975	4,009,826	3,755,000	6.8
1976	3,860,970	3,728,000	3.6
1977	3,829,503	3,833,000	- 0.1
1978	4,481,330	4,984,000	-10.1
1979	4,763,620	5,047,000	- 5.6
1980	5,430,915	5,415,000	0.3

Average Error = 5.13

Theil's Coefficient = 0.031429843

[a]Survey of Current Business, August 1979, pp. 28-31 (1958-1976), Survey of Current Business, April 1980, p. 25 (1977) and Survey of Current Business, April 1981, p. 38 (1978-1979).

APPENDIX D

ON-BRANCH COST COMPUTATIONS AND RRV&W VIABILITY ANALYSIS

The purpose of this appendix is to show the computation of on-branch costs and evaluate the viability of the line in the context of local railroad operations. The benefits and costs described in the report consider both RRV&W and BN revenues and costs. However, the rehabilitated line must also generate profits to the RRV&W or the project will not be viable.

Table D1 depicts the computation of on-branch costs and revenues under the base and rehabilitation scenarios. The RRV&W's revenue division is approximately 300 dollars per car. As the table shows, their net revenue per car in the base case is $36. The projected net revenue under the rehabilitation scenario is roughly $63, an increase of $27 per car.

The estimated net revenue in the base case is somewhat misleading since it fails to consider the effects of deferred capital and maintenance needs. Even if the RRV&W expends normalized maintenance funds per mile, they will be playing catchup, and will not be able to keep the in-place track materials from deteriorating at an accelerated pace. Over time, these deferred maintenance and capital costs will become a real expense. As the lives of roadway assets are reduced, they will have to be replaced sooner than would otherwise be the case. In addition, more spot maintenance will be required.

The computed annualized cost of deferred capital and maintenance needs is shown in line 2 of Table D1. Even though deferred maintenance does not require an expenditure of funds, it is still a real long-run cost which must be reckoned with. When the costs are considered under the base case, the real net revenue per car becomes negative.

TABLE D1. ON-BRANCH COST AND REVENUE COMPUTATIONS

COST ITEM	BASE CASE	REHAB. CASE
Normalized MoW per mile	$7,730.00	$7,730.00
Deferred Maintenance per mile	$3,369,00	$.00
Net. Liq. per Mile	$17,600.00	$17,600.00
Cost of capital	10%	10%
Opportunity Cost of Net Liq/mi	$1,760.00	$1,760.00
Taxes per Mile	$111.00	$111.00
Miles	89.00	89.00
Total Fixed Costs	$854,489.00	$854,489.00
Train Fuel	$73,605.00	$91,455.00
Locomotive Ownership	$75,000.00	$112,500.00
Car Ownership	$151,879.68	$174,661.63
MoW and Signal Vehicles	$37,778.90	$37,778.90
Radios	$384.66	$384.66
Small Tools and Supplies	$2,032.87	$2,032.87
Crew Wages	$44,100.00	$35,721.00
Crew Layover Costs	$8,100.00	$8,100.00
Train Inspection	$8,915.50	$8,915.50
Dispatching and Admin.	$15,479.68	$15,479.68
Clearing Wrecks	$55,050.00	$26,700.00
Total On-Branch Costs	$1,326,815.29	$1,368,218.24
Off-Branch Terminal Cost	$87,669.17	$92,000.00
General Admin Ratio	27%	27%
General Administration Expense	$381,910.80	$394,258.92
Total Short-Line Costs	$1,796,395.26	$1,854,477.16
Gross Revenue per car	$300.00	$300.00
Carloads O & T	5118	5886
Bridge Carloads	2100	2415
Total Carloads	7218	8301
O/T Gross Revenue	$1,535,400.00	$1,765,800.00
Bridge Gross Revenue	$504,000.00	$579,600.00
Bridge Traffic Allocat. Ratio	80%	80%
Total Gross Revenue	$2,039,400.00	$2,345,400.00
Net Revenue	$243,004.74	$490,922.84
Cost per Car	$264.25	$237.21
Net Revenue per Car	$35.75	$62.79
Assuming Deferred Maintenance		
Cost per Car	$325.66	
Net Revenue per Car	($25.66)	

As deferred maintenance costs accumulate over time, the viability of the line becomes questionable. Carriers typically cannot fund themselves out of this type of "hole." So the line is generally abandoned. In this case, it is projected that deferred capital and maintenance needs could result in the line being abandoned by 1992.

Normalized maintenance of way (NMOW) costs were computed using rail, tie, and ballast deterioration models. These models predict the lives of various track assets under certain operating and climatic conditions. Once the asset lives are predicted, the replacement or renewal costs are computed from railroad productivity factors. Estimates of the cost to surface a mile of track and perform other renewal activities were obtained from the firm which performs track work for the RRV&W. These dollar estimates were then used, in conjunction with the predicted asset lives, to computed the normalized maintenance cost of basic track assets. The cost of structures and crossings was developed directly from line data using typical replacement unit costs per foot. Normal spot maintenance, vegetation control, snow removal, ditch cleaning, track inspection, and other overhead costs were also computed.

The transportation and operating costs shown in the table are specific to the RRV&W. They were primarily developed from data compiled by the RRV&W for the 1988 application. They account for all train operating costs (including crew wages), all locomotive costs, and other operating items.

The car ownership costs shown in Table D1 reflect the car day and car mile costs of Burlington Northern freight cars. It is not known whether RRV&W actually pay car-hire charges to the BN. If they do not, then the net revenue figures per car will improve slightly. But regardless of the transaction, these costs must be included in the line analysis because they are incurred by one of the carriers.

Fuel consumption was computed from a detailed engineering model. The line was broken into 70 subsegments. The gross weight of the train on each segment was estimated. Using track subsegment conditions (such as grade and curvature), the number of gallons consumed on each link was estimated. The gallons consumed were then multiplied by RRV&W's cost per gallon to derive the fuel estimates shown in Table D1.

APPENDIX E

MAINTENANCE OF WAY AND FUEL CONSUMPTION FORMULAS

The purpose of this appendix is to document the track asset deterioration models and the fuel consumption procedure used in the line analysis.

Much of the track life costing procedure was derived from four life cycle models. Rail life was computed from the modified TOPS Model, as follows:

$$K * MGT^{.565}$$

where:

MGT = MGT/mile 1 year

K = a constant derived from rail weight, type, speed, grade, curve, wheel load, and the number of good ties per mile.

This model was double checked by a model derived by CSX from Europe, then later modified for more precise results.

$$\frac{K * MGT * A}{((MGT * .00056) * (WLd/23)^2) * (1 + .023 * G^2))) + R)}$$

A = area of allowable wheel loss in^2

WLd = Wheel Load in kips

G = Grade in percent

R = area lost due to corrosion per year

The following tie-life model was used in the analysis.

$$L=((EXP(4.0925 - D * .06077)MGT^{.816872}) * K$$

D = Curvature in degrees

K = Constant derived from several constants dealing with rail weight, type, wheel load, truck support, speed, tie plate size, grade, tie spacing and condition, rainfall, tie material and size.

The equation is of TOPS origin, but nearly all constants have been modified or empirically derived.

Finally, the subgrade model used is also of TOPS origin.

$$(10 * ((MGT - 121.31)/(-149.5)) * K)$$

K again consists of a mix of modified and unmodified constants.

Fuel consumption and operating figures were determined from a theoretical train consist derived from yearly traffic averages. The base case train consisted of two 1500 horsepower locomotives, one boxcar, one flatcar, and 62 grain cars, 14 of which are considered bridge traffic and merely hauled from one end of the line to the other. The 89 mile line was then broken into 74 segments each denoting a section with its own unique characteristics. Once the segments were in place, analysis of train performance was measured individually for each segment.

Train resistance was measured by the Davis Formula:

$$R=(1.3 + 29/W + a + bcv^2/WN) * WN + WNG20 + .8DWN$$

W = weight rail (tons)

a,b,& c = constants for railroad equipment types

N = number of axles

V = velocity

G = gradient in percent

D = degree of curvature

These results were matched with locomotive power figures and adjustments in speed were made when necessary. Locomotive power was found using:

$$TE = \frac{308.25 * horsepower}{V}$$

Acceleration and deceleration were computed from basic physics equations. The resulting power used was then formulated over the length of the segment to get the horsepower hours.

Fuel consumption was finally computed from the horsepower hours.

$$Fuel = hph * \# \text{ of cylinders} * efficiency$$

Efficiency constants were interpolated from a Canadian model used for fuel consumption and environmental pollution.

Switching times were assumed to be 10-20 minutes per customer served and dependent on the number of cars spotted. Fuel consumption for switching operations was computed to be three gallons per hour per locomotive.