THE BENEFITS AND COSTS OF LOCAL AND REGIONAL RAILROADS

by

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North Dakota Rail Services Planning Study

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HIGHLIGHTS

The organizational structure of railroads in the Upper Great Plains is rapidly changing. Class I carriers such as the BN are selling branch lines to new rail operators. The objective of this study is to quantify the benefits and costs of transferring light-density branch lines in North Dakota to local and regional operators.

A set of rail cost and operations models is formulated in the study which predict the cost savings from short-line operations. The models project that short-line railroads can reduce average branch-line operating costs by 23 percent per car. Because of lower train-mile operating costs, short lines may help preserve service on marginal branch lines that might otherwise be abandoned. In addition, local or regional carriers may increase rail market share on light-density lines, thereby creating additional economic benefits. On the down-side of the equation, the sale of lines to local operators is expected to result in a loss of income to railroad employees.

Both positive and negative effects are considered in the study. If 2,010 miles of light-density line are sold to local and regional operators in North Dakota, approximately $69 million in lost rail income and related economic impacts may result. However, $159 million in primary and secondary efficiency benefits will be generated. Thus, even under a worst-case scenerio, approximately $90 million in economic benefits will accrue to North Dakota from short-line operation of light-density branch lines.

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INTRODUCTION

The American railroad industry is in a state of transition. Since 1980, over 200 new railroads have been formed, most as a result of Class I carrier line sales to independent operators. Many of the new local or regional railroads are operating light-density branch lines which Class I carriers cannot operate profitably.

At present, the Red River Valley & Western (RRV&W) is North Dakota's only regional carrier. The railroad was formed in 1987 from parts of Burlington Northern's system. The RRV&W operates 667 miles of track, providing service to shippers in the southeast and central parts of the state.

Other North Dakota line sales have been rumored, but none have occurred to date. However, both the Burlington Northern and the Soo Line have indicated their willingness to discuss the sale of any remaining branch lines in the state. Thus, many more miles of track may be sold to local or regional operators before the transition is complete.

The sale of lines to local and regional operators is shrouded in controversy. Some of the issues are legal in nature, others are economic. At the heart of the controversy is whether labor protection provisions should be required on line sales to non-operators.

The purpose of this study is not to analyze the laws and regulations affecting railway labor and line sales. These are quasi-legal questions which will be decided in the courts, or remanded to the ICC. The objective of this study is more fundamental in nature: to determine whether local and regional railroads are beneficial for North Dakota. This is the basic question which must be answered before informed public policy can be developed.

The objectives of the study are:

1. To quantify the potential efficiency gains of local and regional railroads,
2. To project the secondary economic and transportation infrastructure effects of line sales,

3. To estimate the overall benefits and costs of local and regional railroads,

4. To highlight the distributional effects on major groups.

ANALYTIC FRAMEWORK

The sale of Class I lines to local and regional operators can generate a wide range of impacts, affecting shippers, carriers, and governments. The goal of this study is to project the net societal benefits (or disbenefits) of line sales to local and regional operators.

Procedures for computing total benefits and costs will be introduced later in the report. But first, an important distinction must be made between societal benefits and distributional effects. Societal benefits (or disbenefits) are measured in terms of overall gains (or losses) to society. Although society as a whole may benefit from a change, individual groups may lose (and vice-versa). These individual effects are called "distributional impacts." They are important because they tell who wins and who loses in a transaction. However, they say little or nothing about the overall effects of a change on society.

Societal benefits are of two major types: (1) primary efficiency, and (2) secondary. In general, a change is beneficial to society if it increases the efficiency with which goods and services are produced. Efficiency means producing more of the same good or service with the same level of resources, or producing the same level of output with fewer resources. In the absence of monopolies, efficiency gains generally benefit the entire economy. The cost of production is lowered, the quality of services or goods is enhanced, and, in some instances, the price to consumers is reduced.

Primary efficiency benefits (PEB) are generally given most of the attention in benefit-cost studies. But PEB may be only the first step in a chain reaction. Efficiency gains in the basic sectors of an economy can spawn a range of secondary economic effects.

Secondary efficiency benefits (SEB) consist of changes in personal income and gross business volume attributable to enhanced productivity in the basic sectors. For example, if goods or services can be produced more cheaply as the result of a change, an industry's profit margin may improve. An increase in profits in the basic sectors can have several outcomes. First of all, dividends may be paid to stockholders. If the stockholders reside within the region being analyzed, then increases in personal income will occur. However, in many instances, the stockholders of a basic firm live outside of the regions or states where the change takes place. Thus, increases in personal income will not always accrue to the impacted society, even though dividends are paid. Second, a basic firm may retain the earnings to finance growth and expansion, or reduce its debt burden. Any growth or expansion will typically require capital goods, labor, or land from the region. Thus, a portion of the increased profits may be plowed back into the economy to purchase materials, supplies, direct labor, contractual services, or other items. Third, the profits may be invested elsewhere to generate returns for the firm. Some of these returns may eventually come back to the regional economy, but they are uncertain and difficult to trace. So, in the final analysis, only one type of secondary industrial impact can be attributed to a change: the increased spending by the firm to eliminate deferred maintenance, modernize plant and equipment, and expand production. These are the primary business effects which generate spending and re-spending cycles within state and local economies.

In addition to business income effects, other types of SEB can be generated by a change in the transportation sector. In competitive markets, some of the primary efficiency gains may be passed onto consumers in the form of lower rates. When this occurs, the personal income of consumers is enhanced, and additional household spending results.

The sale of light-density lines to local and regional operators can generate primary efficiency benefits in two major ways. First, line sales can reduce branch-line operating costs, thereby lowering the overall cost of originating traffic. The statewide scope and magnitude of these efficiency gains are described later in the report[1]. Second, the sale of lines to local and regional carriers may present an alternative to abandonment[2]. By reducing branch-line costs, local and regional carriers may preserve service on some lines that might otherwise be abandoned in the future. If branch lines are abandoned in North Dakota, shippers will have only one transportation alternative: truck. Truck rates for grain and other bulk commodities are typically higher than rail multi-car and trainload rates. Therefore, rail abandonment generally results in higher shipping costs for North Dakota businesses. Whenever shipping rates are reduced (or increases avoided) both primary and secondary efficiency benefits are generated.

The potential effects of a line sale are illustrated by the following example. Suppose that branch line "A" is a light-density line which is part of a network being considered for sale. If the network is sold, the cost of originating and terminating traffic on the line may be lowered. Thus, rail service may be preserved. If the network of lines is not sold, branch line "A" may be abandoned. After abandonment, trucks will handle the traffic. As a result, economic efficiency may decline, and rates may increase. These changes represent "avoidable impacts" in the sense that they could have been averted by the sale. Consequently, they may be considered as potential benefits of local and regional railroads.

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[1] The magnitude of these effects is detailed in a separate report entitled "The Economics of Short-Line Operations in North Dakota." As the report describes, local or regional carriers can generate significant branch-line economies on networks of sufficient size and density.

[2] Mr. Greenwood, Executive Vice-President of the BN, stated that if the RRV&W network was not sold, many of those lines would be abandoned in the future.

A line sale may also generate negative effects or disbenefits. Both positive and negative effects are considered in this analysis. However, many of the perceived negative impacts are in reality distributional effects. A clearer description of distributional impacts will be presented later in the report.

The preceding discussion has outlined a general framework for economic impact analysis. In the following section of the report, this framework is translated into a set of methods for analyzing the impacts of local and regional railroads in North Dakota.

METHODS OF ANALYSIS

The methods employed in this study are based on traditional economic impact assessment and rail benefit-cost techniques which have been developed over the years by Mishan (1983), Federal Railroad Administration (1982), and Mittleider, Tolliver, and Vreugdenhil (1983). Four concepts are of primary importance in understanding the methodology:

1. The base or comparison case,
2. The types of benefits generated,
3. Measurement techniques,
4. Input-output analysis.

Each of the concepts is explained in depth in this section of the report.

THE BASE CASE

In economic impact analysis, one must consider what will happen if the change being analyzed does not occur. This "base case" provides a frame of reference for evaluating the effects of a change, over time.

In the Rail Services Planning (RSP) study, two alternative scenarios are evaluated: (1) a status quo or "no-sale" scenario in which the rail system remains under Class I carrier ownership, and (2) a sale or impact scenario in which all the light-density branch lines with less than 3 million gross ton miles per mile (MGTMM) are sold to local or regional operators. Differences in social welfare are estimated over time using classical economic impact assessment techniques. The quantifiable differences between the two cases or scenarios constitute the long-term benefits and costs of local and regional railroads.

The time-frame for the study is 20 years. This period should be sufficient for the effects of railroad rationalization to play themselves out. The benefits and costs to each group in society are computed for each year in the period, and then summed to obtain net societal benefits.

POTENTIAL BENEFITS OF LINE SALES

As described earlier, there are two major types of benefits measured in this study; (1) primary efficiency, and (2) secondary. Primary efficiency gains can result from two sources: operator cost reductions and shipper cost savings. Both types of efficiency gains are discussed in the following paragraphs of the report.

Operator Efficiency Gains

Local and regional operators can reduce the cost of light-density operations in several ways. First, Class I carrier train crew wages are roughly 247 percent of local wages (Tolliver and Dooley, 1988). Furthermore, the wage rates for other union crafts (such as maintenance of way) are considerably higher than local wages. Second, local and regional railroads have fewer work rules than Class I carriers. Fewer work rules typically result in greater labor productivity. Third, local and regional carriers typically do not have the overhead costs of Class I carriers.

As will be illustrated later, local railroads in North Dakota can reduce average branch-line cost by roughly 23 percent per car. In other words, for the same level of output, 23 percent fewer resources are required.

Shipper Benefits

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

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 shipper inventory cost. More frequent service 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.

Shippers may also benefit from reduced transportation rates which sometimes flow from increased carrier productivity. Aggregate reductions in transportation rates may occur after a line sale for several reasons. First of all, if the line is not sold, 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, as service improves, shippers may utilize multiple-car and trainload rates more frequently. Third, efficiency gains from the carrier may be passed-on in the form of lower rates. This last point deserves expansion.

A line sale typically reduces the Class I carrier's cost while keeping the traffic on its network. Thus, the Class I carrier may be able to lower the rate structure on branch-line stations and still maintain an acceptable profit level.

State and Local Government Benefits

While carriers and shippers are the most direct beneficiaries of line sales, state and local governments can also benefit, indirectly. If a branch line is abandoned, the traffic which formerly moved by rail must be transported by truck. Many of the highways connecting North Dakota elevators and rural shippers to the interstate system are low-volume roads. The incremental pavement damage of heavy trucks on low-design highways typically exceeds the motor fuel taxes and registration fees generated (see: Tolliver and Lindamood, 1989). Consequently, net highway costs may accrue to state or local governments as a result of abandonment.

In addition, line sales can generate regional economic and community benefits. Unlike Class I carriers, local railroads are typically headquartered in North Dakota. So any operator efficiency gains may have multiplicative effects within the public and private sectors of the economy.[3] In a similar fashion, reductions in shipper costs may have a cascading economic effect[4].

Collectively, these effects constitute the potential benefits of line sales. A more concise definition of primary and secondary efficiency benefits, and techniques for measuring them, are discussed next.

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[3] 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 local carriers.

[4] Take grain shippers as an example. The North Dakota elevator industry can be quite competitive, so any shipper rate reductions may reappear 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 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.

PRIMARY EFFICIENCY BENEFITS

As noted previously, primary efficiency benefits are the direct efficiency gains experienced by rail operators and shippers. PEB include 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 and Economic Surpluses

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[5].

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[5] In freight transportation 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 railroad may own.

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[6]. Thus, at any rate above cost, the operator will realize a surplus, called the producer's surplus.

When a rail line is sold, it can be expected that the producers' surplus will increase. Local and regional railroads typically have lower crew and train operating costs. Furthermore, because of reduced wages and greater work-rule flexibility, efficiency gains in maintenance of way and other operational areas are possible. Collectively, these efficiency gains lower the carrier's cost structure, increasing the difference between the price and the cost of service. 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 line sales.

The computation of primary efficiency benefits is based largely on the demand for transportation and how costs and revenues to producers and consumers of transport services change with different levels of modal use. In the following section of the report, some important concepts in transportation demand are introduced.

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

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[7]. When displayed graphically, this schedule might look something like the hypothetical relationship depicted in Figure 1, 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[8]. 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.

Extending this basic relationship to Figure 2 permits a more detailed explanation of consumers' and producers' surpluses. In Figure 2, P_0 and C_0 denote the rate charged by the Class I operator and the cost of providing service respectively. If the line is sold to a local operator, it seems reasonable to assume that the resource cost will decline. Furthermore, because of reduced branch-line cost, 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 consumers' surplus.

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[7] 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.

[8] 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.

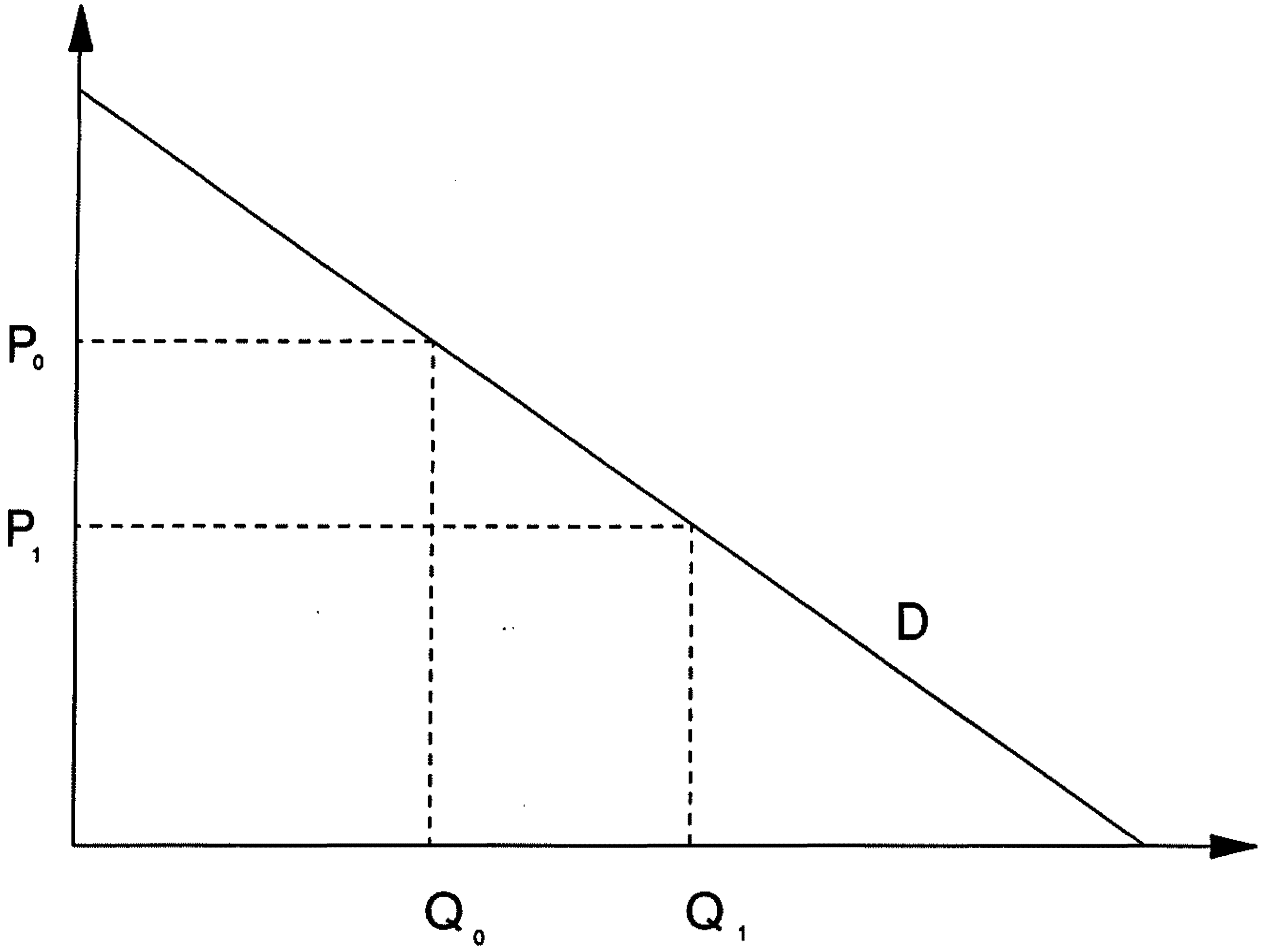

Figure 1. Demand for Transportation

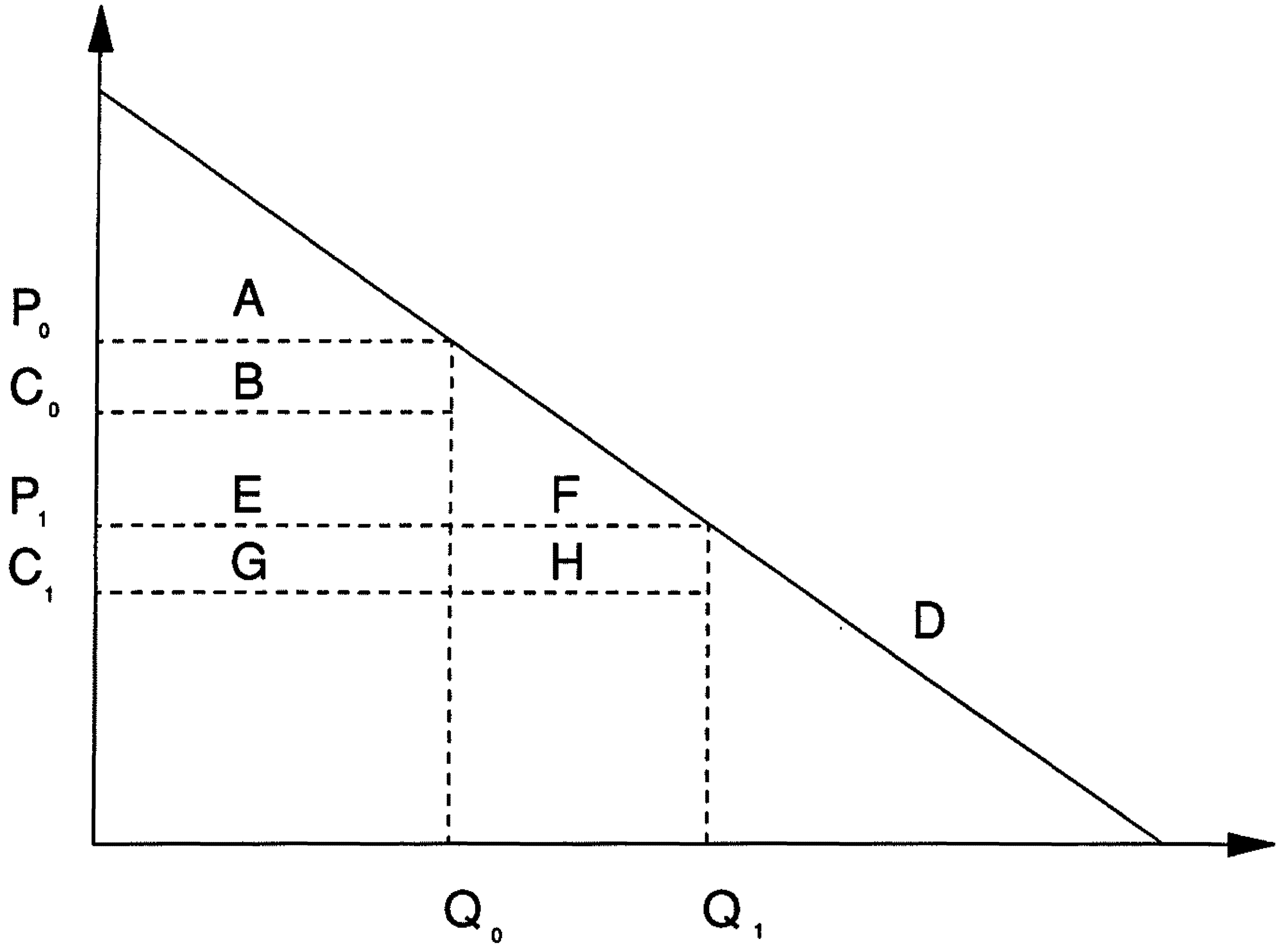

Figure 2. Consumers' and Producers' Surpluses

As Figure 2 denotes, consumers are willing to pay P_o for Q_o units of output under existing line and service conditions[9]. But the economic cost of Q_o units of output may only be C_o. Thus, some consumers' and producers' surpluses may exist in the base case. However, they are usually artificially low due to Class I work rules and wage levels.

At Q_o units of output, area A (in Figure 2) 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.

Changes in Operator and Shipper Surpluses

Three types of primary efficiency benefits may result from line sales: (1) a reduction in the cost of existing traffic (areas E + G in Figure 2), (2) consumers' surplus on new rail traffic (F), and (3) producers' surplus on new rail traffic (H). Because of short-line operations, a reduction in operating cost will occur on the existing traffic base, irrespective of new traffic. The cost reduction on existing traffic is computed as:

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[9] 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.

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

where: SC = Cost reduction on existing traffic

Q_o = Quantity shipped -- base case

C_o = Shipping cost, base case

C_1 = Shipping cost, impact case

In addition to cost savings on existing traffic, the sale of a branch line may increase rail market share[10]. A proportion of the traffic which was moving by truck under the base case will now move by rail because of more efficient operations and better service. This incremental traffic will result in additional consumers' surplus, which is calculated as:

$$CS = \frac{1}{2} [(P_o - P_1) (Q_1 - Q_o)]$$

where: CS = Consumers' surplus on new traffic

P_o = Shipping rate, base case

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[10] 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 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 deceases 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.

P_1 = Shipping rate, impact case

Q_1 = Quantity shipped, impact case

Q_o = Quantity shipped, base case

Incremental traffic will also result in additional producer's surplus, or the difference between the producer's price and the cost of providing service, which is calculated as[11]:

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

where:

PS = Producer's surplus on new traffic

P_1 = Shipping rate, impact case

C_1 = Shipping cost, impact case

Q_1 = Quantity shipped, impact case

Q_o = Quantity shipped, base case

Cost Savings on Existing Traffic

In order to project cost savings from local and regional railroad operations, four types of transportation costs must be estimated:

1. Class I carrier branch-line cost,
2. Local railroad branch-line cost,
3. Off-branch or mainline Class I carrier cost,
4. Truck cost.

Methods of estimating each type of cost are highlighted in the following section of the report, followed by a description of the statewide efficiency gains on existing rail traffic.

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[11] 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.

Costing Techniques

Ideally, the potential cost savings of short-line operations should be estimated for each light-density branch line in the state. However, this would require a great deal of resources, and even then, the data would not be perfect. So an alternative method has been devised for this study. For purposes of cost comparison, a hypothetical rail line has been defined, one with attributes that typify light-density grain branch lines in North Dakota. The abstract line is 43 miles long (the mean for ND branch lines). The assumed traffic density is 20 cars per mile (or roughly 150,000 gross ton miles per mile), a midrange estimate for light-density branch lines[12].

On-branch costs include both capacity and operating cost elements. Capacity costs for the hypothetical line (including normalized maintenance of way and return on roadway investment) have been computed from economic-engineering formulas. The costs reflect typical roadway or track assets and operating conditions for lines with less than 1 million gross ton miles per mile (MGTMM). Property taxes have been estimated directly from North Dakota Property Tax Department reports and local mill levies. Branch-line operating costs have been estimated with methods described in a technical paper by the author[13]. The crux of the paper is presented in Appendix A of this report, and is summarized in the following paragraphs.

In the first step of the procedure, a set of on-branch unit costs are computed from each carrier's R-1 report. The on-branch unit costs include:

1. Locomotive repairs and maintenance
2. Locomotive depreciation
3. Locomotive return on investment
4. Locomotive overhead and administration
5. Locomotive fuel and servicing

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[12] The mean grain traffic density on North Dakota branch lines during 1987 and 1988 was 21 cars per mile. This value was computed from unpublished grain and oilseed shipment data maintained at the UGPTI.

[13] See: Tolliver, Class I Carrier Light-Density Costing Methodology., UGPTI, 1989.

6. Car ownership
7. Crew wages
8. Train operations (i.e. signals, crossings, dispatching, etc.)
9. Transportation administration and overhead
10. Yard operations
11. General administration and support services.
12. Other expenses.

Most of the on-branch locomotive unit costs are expressed on an hourly basis. Time-sensitive transportation unit costs (such as crew wages and administration) are based on train hours of operation. The remaining transportation cost items are based on train miles. Car ownership costs (including repairs, depreciation, and return on investment) are estimated from data contained in Schedules 415, 710, and 755 of the carrier's R-1 report. The expenses are allocated among car miles and car days in accordance with standard ICC procedures.

A standardized set of operating and expense data does not exist for local and regional railroads. However, a nationwide survey of local and regional carriers was conducted in the winter of 1987 as part of the RSP study. Over 50 railroads responded to the survey (which is described in Appendix B). The survey information was supplemented by operating and cost data provided by the RRV&W. All local or regional branch-line unit costs used in this study have been estimated from the aforementioned survey data, or from actual Red River Valley & Western operations. For a list of the data sources and methods used in the short-line costing procedure see: Tolliver, Dooley, and Zink (1988), and Tolliver and Lindamood (1989).

Once the on-branch unit costs have been estimated for each type of railroad, annual on-branch expenses are estimated for the hypothetical line via a two step process. First, the number of annual service units (e.g. locomotive hours) required on the branch are projected using a set of operating models. Second, the service units are multiplied by the unit costs to derive annual expenses. Class I carrier off-branch costs are computed using a modified Rail Form A (RFA) procedure, which is detailed in Appendix A.

It is assumed that the hypothetical line will be maintained at FRA class II standards, at a level sufficient to handle unit train traffic. This translates into a normalized maintenance of way cost of approximately $8,880 per mile for Class I carriers and $7,100 for local and regional operators[14]. Because of greater work rule flexibility and lower wage rates, normalized maintenance costs tend to be lower for local and regional carriers. However, some of the wage and productivity gains are offset by their lower level of capital and technology. Local and regional carriers generally do not possess the specialized, high-cost equipment that Class I carriers do. Furthermore, they face diseconomies of scale in the acquisition of materials and supplies. These disadvantages tend to negate some of the wage and productivity savings[15].

Truck unit costs have been estimated from North Dakota survey data using economic-engineering methods. The methods and data are detailed in Dooley, Wilson, and Bertram (1989). In the study, truck costs per mile were estimated to each major market[16]. The unit costs from the Dooley, Wilson, and Bertram study have been updated to current levels and used in this analysis.

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[14] Normalized maintenance of way (NMOW) is an idealized concept or standard. It denotes the annualized sum necessary to maintain a track at some predefined level. NMOW cost may never agree with actual track expenditures during a given year. Actual expenditures are subject to budgetary constraints and management priorities. In the short-run, carriers can (and do) defer normalized maintenance. However, over a longer period of time, the cumulative effects of deferred maintenance will require rehabilitation of the line, or will lead to its abandonment. Nevertheless, it is important for the reader to understand that normalized maintenance of way costs are not reflected in short-term rail costs or profits

[15] A net liquidation value of $9,443 per mile has been used in the study.

[16] Both truck and line-haul rail costs are computed on a loaded mile basis. Therefore, a consistent method of estimating costs for the return portion of a movement is needed. Rail empty return costs have been calculated by applying an empty return ratio to the loaded train miles. Rail empty return ratios for each type of car are computed from the carrier's latest R-1 report, Schedule 755. Similarly, the empty truck mileage attributable to the loaded grain shipment has been computed by multiplying the loaded trip mileage by a factor of one minus the loaded backhaul percent.

Truck unit costs do not vary significantly with the commodity or type of service[17]. However, rail costs do. Rail costs have been computed separately for each commodity, and for each of three levels of service:

1. Single-car
2. 26-car
3. 52-car.

The results of the single-car analysis are shown in Table 1[18]. As Table 1 depicts, the total cost to the Burlington Northern of handling the traffic originated or terminated on the hypothetical line is 72 cents per cwt. Even on a branch line of median length (43 miles), BN's on-branch cost per cwt is greater than its off-branch cost.

TABLE 1. Comparison of Rail and Truck Cost per Cwt Assuming Single-Car Service

(a)	(b) Revenue Per Cwt	(c) Off-Branch Cost Per Cwt	(d) On-Branch Cost Per Cwt	(e) Total Cost Per Cwt
BN	$1.08	$.34	$.38	$.72
BN/Local	$1.08	$.34	$.29	$.63
Soo Line	$1.08	$.43	$.38	$.80
Truck	$1.08	--	--	$1.02

If the branch line is operated as part of a short-line railroad system, then the on-branch costs are reduced by 24 percent. As a result, the cost of handling the traffic on

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[17] In this study, it is assumed that all commodities load up to the maximum legal limit of 80,000 pounds. Through the use of sideboards and extensions, this is generally feasible for lighter-loading commodities.

[18] Both the revenues and costs shown in Table 1 represent weighted averages of the commodity mix and market distribution. The underlying costs and revenues were actually computed on a commodity and market basis. From the sector estimates, weighted means were computed. The rail costs reflect the on-branch mileage plus the distance from the division point to terminal market. Truck costs reflect the highway miles from each branch-line shipping point to final destination. Both costs reflect the empty miles of transportation equipment in each market.

the short-line/trunk-line system is reduced by nine cents per cwt.

After the line has been sold, the Burlington Northern no longer incurs the on-branch cost shown in column (d) of Table 1. Instead, the costs are absorbed by the local operator. Yet, BN retains the traffic on its system. In other words, BN's cost of handling the traffic has been reduced by 38 cents per cwt. If BN gives the local railroad $300 per car as a division, it is foregoing approximately 17 cents of the revenue per cwt. Thus, the Class I carrier is increasing its net revenue by 21 cents per cwt.

Single-car service is the most inefficient Class I operation. More switching time is required, and the scheduled way trains are typically smaller than under multi-car service. Table 2 shows the projected cost comparison's for 26-car branch-line traffic. As the table depicts, both the on-branch and off-branch costs per cwt have declined. But since the Class I carrier is more efficient under multiple-car service, the per cwt reduction from short-line operation is less (seven cents). Nevertheless, the reduction is quite significant[19]. The carrier is giving up 17 cents in revenue in exchange for 32 cents in cost savings[20].

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[19] It represents a 22 percent reduction in on-branch cost.

[20] The projected branch-line costs for the BN and Soo Line were quite similar under both scenarios. Under single-car service, the projected on-branch cost per car was $715 for the BN as opposed to $697 for the Soo Line. But on a cwt basis, the difference is not significant. The real difference between the two carriers surfaces in the off-branch costs. The BN operates long through and unit trains over high-density mainlines. The Soo Line's density is much less. To be precise, in 1988 the BN system-average traffic density (in millions of gross ton miles per mile of track) was 17.17 MGTMM (source: line 6, column (c), Schedule 720, 1988 R-1 Report). In comparison, the Soo Line's mean traffic density in 1988 was 7.22 MGTMM. In 1988, the average BN through train consisted of 81 cars; the mean was 82 in unit train service. Both values were computed from data contained in Schedule 755. In contrast, the average Soo Line through train contained 70 cars. Longer trains generally result in lower costs per ton mile as relatively fixed crew wages, locomotive capacity, and train administrative costs are spread over a greater number of revenue-generating units.

TABLE 2. Comparison of Rail and Truck Cost per Cwt Assuming 26-Car Service

(a)	(b) Revenue Per Cwt	(c) Off-Branch Cost Per Cwt	(d) On-Branch Cost Per Cwt	(e) Total Cost Per Cwt
BN	$.92	$.31	$.32	$.63
BN/Local	$.92	$.31	$.25	$.56
Soo Line	$.92	$.41	$.32	$.73
Truck	--	--	--	$1.02

In summary, the sale of a typical light-density line to a local or regional operator can reduce the on-branch cost by 23 percent[21]. Thus, a significant efficiency gain will occur on the existing traffic base. The statewide scope and magnitude of the potential efficiency gains are discussed next.

Scope of Efficiency Gains

In order to project the scope of potential cost savings on rail traffic, the values of two network variables must be forecast. First, the amount of branch-line track sold to local or regional operators under an unrestricted sale scenario must be estimated. Second, the miles of track abandoned under the base case or no-sale scenario must be forecast.

Over 2,200 miles of track in North Dakota have less than 3 MGTMM[22]. Of this total, 1,167 miles of track originate or terminate less than 30 cars of grains and oilseeds per mile[23]. Thus, many of the lines are potential candidates for short-line sales. Furthermore, some of the lines are candidates for abandonment. However, the 2,200 miles

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[21] This figure represents an average of the single-car efficiency gains (of 24 percent) and the multi-car savings of roughly 22 percent.

[22] Source: BN and Soo Line gross tonnage density charts, at 1987 levels.

[23] Source: mean UGPTI grain and oilseed shipment statistics for calendar years 1987 and 1988.

also includes some primary feeder and main rail lines which are not likely to be sold.

Altogether, 2,010 miles of track are projected to be sold to local and regional operators in North Dakota if labor protection provisions are not required[24]. Of this total, 672 miles are likely to be abandoned in the future if they are not sold to local or regional operators. This latter figure was computed through a multi-step process which is detailed in Appendix D.

In the first step, a minimum viable traffic density (MVTD) is computed for light-density grain branch lines. The MVTD is the lowest traffic density (in terms of grain cars originated and terminated per mile) that will make a light-density branch line profitable to the Class I carrier in the long-run. Separate MVTD's are calculated for the BN and the Soo Line, using the attributes of the hypothetical line discussed previously. In general, the analysis found that the MVTD of grain branch lines in North Dakota falls somewhere in the 11-to-15 car interval for Class I carriers.

In a second and related step, all light-density branch lines in North Dakota are grouped into five density categories: (1) less than six cars per mile, (2) six to ten cars per mile, (3) 11 to 20 cars per mile, (4) 21 to 30 cars per mile, and (5) lines with more than 30 cars per mile. A probability of abandonment is then assigned to each density group. This probability reflects the median density level of the group in relation to the MVTD.

All lines with more than 30 cars per mile are assumed to be viable in the long-run, and assigned an abandonment probability of zero. Lines with less than five cars per mile are assumed to be inviable and assigned a probability of 1.0. Table D.1 of Appendix D lists the miles of track in each density category and the probability of abandonment for each group.

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[24] This figure includes the 667 miles already sold to the RRV&W.

As Table 3 depicts, the expected value (of future abandonments in North Dakota) under the base case is 672 miles of track. This is a fairly conservative estimate since it assumes that no line with 31 cars per mile or more will be abandoned. Yet, previous estimates of light-density line viability have found that the threshold density is much higher (e.g. 34 cars per mile). So, the projections used in this study may understate the potential for abandonment of lines with traffic densities of 25 cars per mile or more.

TABLE 3. Projected Line Sales and Abandonments in North Dakota

	Miles of Track	Grain Cars	Grain CWT
Line Sales	2,010	42,321	76,177,800
Abandonments	672	7,880	14,184,000

Table 4 summarizes the cost savings from short-line operations that were detailed in Tables 1 and 2. From the numbers in Table 4, a weighted statewide mean savings (of 9.8 cents per cwt) has been calculated.[25] This value represents the average reduction in total cost resulting from line sales.

TABLE 4. Projected Cost Savings from Short-Line Operation of Light-Density Lines (in cents per cwt)

Service Level	BN	Soo Line
Single-car	9	17
Multi-car	7	10

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[25] This value reflects a weighting of .5 for single and multiple car savings, respectively. In addition, BN values are weighted by a factor of .667, while Soo Line values are weighted by .333. These latter weights reflect the distribution of grain among the two railroads. In 1988, the BN originated 6,020,180 tons of grains and oilseeds in North Dakota (Source: R-1, Schedule 941). In the same year, the Soo Line originated 3,001, 607 tons.

When a line is abandoned, the traffic which previously moved by rail must be transported by truck. The weighted average rail shipment cost for grains and oilseeds (as computed from data in Tables 2 and 3) is 70½ cents.[26] However, as depicted in Table 2, the mean trucking cost per cwt is $1.02. Thus, when branch lines are abandoned in North Dakota, operator costs will increase by 31½ cents. The avoidance of a cost increase, as noted earlier, is tantamount to a gain in transportation efficiency.

Projected Cost Savings

The projected cost savings on existing grain rail traffic are shown in Table 5. The rail cwts shown in column (a) represent the traffic handled on the 2,010 miles of track that are projected to be sold to local or regional operators. As noted previously, 672 miles of track are likely to be abandoned if they are not sold. It is assumed that the lines will be abandoned in 1993. At that time, a portion of the traffic previously moving by rail will be forced to travel by truck. This occurrence is reflected in the traffic totals shown in columns (a) and (b).

The estimated shipping cost in the base case -- column (g) -- reflects the weighted-average rail and truck unit costs in columns (c) and (d), respectively. The shipping cost under the impact scenario -- column (i) -- reflects the facts that: (1) the rail unit cost has been lowered due to short-line efficiency gains, and (2) the rail lines that might otherwise be abandoned have been preserved by the line sales. The discounted cost savings are shown in column (k), and the cumulative savings in column (l)[27]. The bottom line of Table 5 is that $88,892,011 in cost savings will accrue to rail operators in North Dakota if light-density branch lines are sold to local operators.

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[26] The rail shipment costs are weighted by commodity, railroad, and service level.

[27] A discount rate of eight percent has been used in the analysis.

TABLE 5. Cost Savings on Existing Rail Traffic

Year	(a)* Rail Cwts Base Case	(b)* Truck Cwts Base Case	(c) Rail Unit Cost Base Case	(d) Truck Unit Cost Base Case	(e)* Rail Costs Base Case	(f)* Truck Costs Base Case	(g)* Shipping Cost Base Case
1987	76,178	0	$.71	$1.02	$53,705	$0	$53,705
1988	76,178	0	$.71	$1.02	$53,705	$0	$53,705
1989	76,178	0	$.71	$1.02	$53,705	$0	$53,705
1990	76,178	0	$.71	$1.02	$53,705	$0	$53,705
1991	76,178	0	$.71	$1.02	$53,705	$0	$53,705
1992	76,178	0	$.71	$1.02	$53,705	$0	$53,705
1993	61,994	14,184	$.71	$1.02	$43,706	$14,468	$58,173
1994	61,994	14,184	$.71	$1.02	$43,706	$14,468	$58,173
1995	61,994	14,184	$.71	$1.02	$43,706	$14,468	$58,173
1996	61,994	14,184	$.71	$1.02	$43,706	$14,468	$58,173
1997	61,994	14,184	$.71	$1.02	$43,706	$14,468	$58,173
1998	61,994	14,184	$.71	$1.02	$43,706	$14,468	$58,173
1999	61,994	14,184	$.71	$1.02	$43,706	$14,468	$58,173
2000	61,994	14,184	$.71	$1.02	$43,706	$14,468	$58,173
2001	61,994	14,184	$.71	$1.02	$43,706	$14,468	$58,173
2002	61,994	14,184	$.71	$1.02	$43,706	$14,468	$58,173
2003	61,994	14,184	$.71	$1.02	$43,706	$14,468	$58,173
2004	61,994	14,184	$.71	$1.02	$43,706	$14,468	$58,173
2005	61,994	14,184	$.71	$1.02	$43,706	$14,468	$58,173
2006	61,994	14,184	$.71	$1.02	$43,706	$14,468	$58,173

* Values are in thousands

TABLE 5 Continued, Cost Savings on Existing Traffic

Year	(h) Rail Unit Cost Impact Case	(i)* Shipping Cost Impact Case	(j)* Cost Savings	(k)* Discounted Savings	(l)* Cumulative Savings
1987	$.61	$46,240	$7,465	$6,849	$6,849
1988	$.61	$46,240	$7,465	$6,283	$13,133
1989	$.61	$46,240	$7,465	$5,765	$18,897
1990	$.61	$46,240	$7,465	$5,289	$24,186
1991	$.61	$46,240	$7,465	$4,852	$29,038
1992	$.61	$46,240	$7,465	$4,451	$33,489
1993	$.61	$46,240	$11,933	$6,528	$40,017
1994	$.61	$46,240	$11,933	$5,989	$46,006
1995	$.61	$46,240	$11,933	$5,494	$51,501
1996	$.61	$46,240	$11,933	$5,041	$56,541
1997	$.61	$46,240	$11,933	$4,625	$61,166
1998	$.61	$46,240	$11,933	$4,243	$65,409
1999	$.61	$46,240	$11,933	$3,892	$69,301
2000	$.61	$46,240	$11,933	$3,571	$72,872
2001	$.61	$46,240	$11,933	$3,276	$76,148
2002	$.61	$46,240	$11,933	$3,006	$79,154
2003	$.61	$46,240	$11,933	$2,757	$81,912
2004	$.61	$46,240	$11,933	$2,530	$84,441
2005	$.61	$46,240	$11,933	$2,321	$86,762
2006	$.61	$46,240	$11,933	$2,129	$88,892

* Values are in thousands

Producers' Surplus on New Traffic

As noted previously, the sale of lines to local and regional operators may result in additional or incremental rail traffic. There are two primary reasons for this: (1) local and regional carriers enjoy lower resource costs on branch lines, and (2) they tend to be more service-oriented and aggressive in marketing their services.

There is no nationwide data base depicting traffic levels before and after line sales. However, data are available from the Red River Valley & Western experience in North Dakota. This information has been used to develop an expected change in traffic resulting from future line sales. The process is described below.

Expected Traffic Increases

North Dakota elevator shipment data have been compiled for calendar years 1986--1988, by station. There are several reasons why traffic levels may have changed in North Dakota during this period of time, other than line sales. So, a control strategy has been devised. The population (of elevators) has been partitioned into two groups: (1) Red River Valley & Western shippers, and (2) elevators located elsewhere on the BN and Soo Line system in North Dakota. The second group forms a "control group" of sorts, which is assumed to reflect traffic changes other than those attributable to the 1987 line sale by the BN.

The trends in modal share for the two groups are depicted in Figure 3. From the graph, it is apparent that the trend lines of the two groups prior to 1987 (the year of the RRV&W sale) are very similar. However, they diverge sharply afterwards. Rail share at RRV&W elevators grew by three percentage points between 1986 and 1988, while rail share within the control group declined by five percentage points during the same interval. So, the effective rate of increase in market share was much greater than the RRV&W data alone would indicate (approximately eight percentage points).[28]

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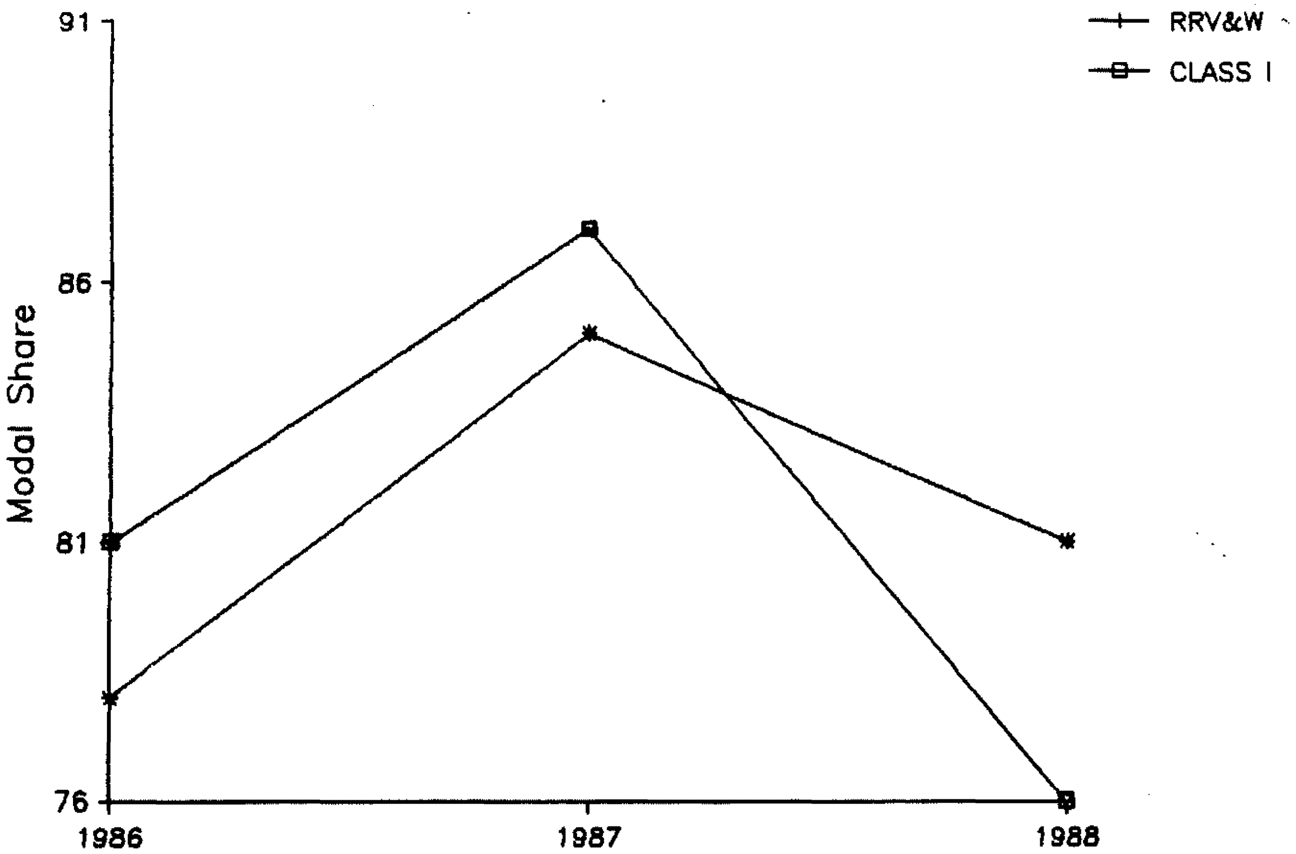
[28] This is probably a conservative estimate of future rail gains in market share on regional or local lines. First, the traffic gains on RRV&W's network south of Jamestown (on the major or core system) is higher than on the northern section. The northern lines have very light traffic and are in poorer condition than the southern section. Second, Soo Line competition in the North also restricts market gains. So, the expected traffic increases from line sales in other parts of the state may be much higher.

Figure 3.



TRENDS IN RAIL MARKET SHARE

North Dakota Grains & Oilseeds

Projected Producers' Surplus

The projected incremental cwts (or new rail traffic) under the impact scenario are shown in column (b) of Table 6. The rail rate and unit cost per cwt for the impact case are presented in columns (c) and (d), respectively. The projected producers' surplus on new traffic (column e) is computed by multiplying the values in column (b) by $.34, the projected margin per cwt. The values in column (f) reflect the present value of future efficiency gains, at a discount rate of eight percent. The discounted values are accumulated in column (g) of Table 6, with the last line yielding the cumulative producers' surplus on new traffic for the impact period ($21,719,000).

TABLE 6. Projected Producers' Surplus

(a) Year	(b)* Incremental Rail Cwts	(c) Rail Rate	(d) Rail Unit Cost	(e)* Producers' Surplus	(f)* Discounted Surplus	(g)* Cumulative Discounted Surplus
1987	6,094	$.97	$.61	$2,212	$2,048	$ 2,048
1988	6,094	$.97	$.61	$2,212	$1,897	$ 3,945
1989	6,094	$.97	$.61	$2,212	$1,756	$ 5,701
1990	6,094	$.97	$.61	$2,212	$1,626	$ 7,327
1991	6,094	$.97	$.61	$2,212	$1,506	$ 8,832
1992	6,094	$.97	$.61	$2,212	$1,394	$10,226
1993	6,094	$.97	$.61	$2,212	$1,291	$11,517
1994	6,094	$.97	$.61	$2,212	$1,195	$12,712
1995	6,094	$.97	$.61	$2,212	$1,107	$13,819
1996	6,094	$.97	$.61	$2,212	$1,025	$14,844
1997	6,094	$.97	$.61	$2,212	$ 949	$15,792
1998	6,094	$.97	$.61	$2,212	$ 878	$16,671
1999	6,094	$.97	$.61	$2,212	$ 813	$17,484
2000	6,094	$.97	$.61	$2,212	$ 753	$18,237
2001	6,094	$.97	$.61	$2,212	$ 697	$18,935
2002	6,094	$.97	$.61	$2,212	$ 646	$19,580
2003	6,094	$.97	$.61	$2,212	$ 598	$20,178
2004	6,094	$.97	$.61	$2,212	$ 554	$20,732
2005	6,094	$.97	$.61	$2,212	$ 513	$21,244
2006	6,094	$.97	$.61	$2,212	$ 475	$21,719

* Values are in thousands

Consumers Surplus on New Traffic

As noted previously, the consumers' or shippers' economic surpluses may also increase as the result of a line sale. First, the carrier may pass some cost savings along to the shippers in the form of reduced rates. Second, more frequent, efficient service can reduce the car days spent on the branch-line network, thereby saving the shipper additional inventory or interest cost on the cargo. Due to time and resource constraints, only potential rate effects are modeled in this study.

As stated previously, the change in consumers' surplus is computed only on new rail traffic. The calculation of additional CS due to line sales is shown in Table 7.

TABLE 7. Consumers' Surplus on New Rail Traffic

(a) Year	(b)* Incremental Cwts	(c) Base Case Rate	(d) Impact Case Rate	(e)* Consumers' Surplus	(f)* Discounted Surplus	(g)* Cumulative Surplus
1987	6,094	$1.08	$.97	$335	$310	$ 310
1988	6,094	$1.08	$.97	$335	$287	$ 598
1989	6,094	$1.08	$.97	$335	$266	$ 864
1990	6,094	$1.08	$.97	$335	$246	$1,110
1991	6,094	$1.08	$.97	$335	$228	$1,338
1992	6,094	$1.08	$.97	$335	$211	$1,549
1993	6,094	$1.08	$.97	$335	$196	$1,745
1994	6,094	$1.08	$.97	$335	$181	$1,926
1995	6,094	$1.08	$.97	$335	$168	$2,094
1996	6,094	$1.08	$.97	$335	$155	$2,249
1997	6,094	$1.08	$.97	$335	$144	$2,393
1998	6,094	$1.08	$.97	$335	$133	$2,526
1999	6,094	$1.08	$.97	$335	$123	$2,649
2000	6,094	$1.08	$.97	$335	$114	$2,763
2001	6,094	$1.08	$.97	$335	$106	$2,869
2002	6,094	$1.08	$.97	$335	$ 98	$2,967
2003	6,094	$1.08	$.97	$335	$ 91	$3,057
2004	6,094	$1.08	$.97	$335	$ 84	$3,141
2005	6,094	$1.08	$.97	$335	$ 78	$3,219
2006	6,094	$1.08	$.97	$335	$ 72	$3,291

* Values are in thousands

The new rail traffic in column (b) represents grain traffic captured from trucks. The average truck rate on branch-line traffic (depicted in Table 1) is $1.08 per cwt. In contrast, the weighted-average rail rate is 97 cents per cwt. These rates are shown in columns (c) and (d) of Table 7, respectively. The increase in consumers' surplus in column (e) is computed as: .5 * col. b * (col. c - col. d).

In summary, the sale of rail lines to local and regional carriers in North Dakota is projected to generate $113,902,000 in primary efficiency benefits. This value includes $88,892,000 in cost savings on existing traffic (Table 5), $21,719,000 in additional producers' surplus on new rail traffic, and $3,291,000 in new consumers' surplus (Table 7). Secondary economic benefits are discussed next.

SECONDARY EFFICIENCY BENEFITS

The secondary efficiency benefits computed in this study reflect both economic and infrastructure effects. As noted previously, changes in the value of goods and services may result indirectly from line sales. For example, elevators may experience improved service and reduced rates after the sale. If so, farmers may receive a higher price and hence a higher return for their product without a corresponding decrease in profit to the elevators. This would be classified as a secondary efficiency benefit. A secondary efficiency benefit would not be realized in a situation where a change is compensated by an opposite change elsewhere in the economy.

Local and regional economic effects are analyzed with input-output analysis. Input-output analysis relates changes that occur in the basic sectors of an economy to the level of activities in other sectors through a matrix of interdependency coefficients. Through this procedure, the effects of primary benefits are projected throughout local and state economies.

SEB may 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. 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 generate incremental 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.

Highway Impact Methodology

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 traffic gains by local and regional railroads 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 3S2 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.

Abandonment clearly generates incremental truck traffic. The net cost avoidance of the traffic may be considered a benefit. In addition, line sales may remove some truck traffic from the highways. Under local operation, railroads may increase their modal share. 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 line sales to local operators.

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:

$$\mathrm{ESAL} = f\,(V, L1, L2, STR, PSR, E)$$

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 (Tolliver, 1989).[29]

As the above discussion points out, the axle weights and configurations are important inputs to pavement damage analysis. Grain truck axle weights have been estimated from NDSHD truck weight data.[30] For other truck-types (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.

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[29] Tolliver, Denver. The Impacts of Grain Subterminals on Rural Highways, UGPTI, 1989.

[30] 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.

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

Projected Changes in Highway Infrastructure Costs

Potential changes in highway costs due to line sales in North Dakota are shown in Table 8. The incremental cwts in column (b) represent the additional truck traffic caused by the projected abandonment of 672 miles of track by 1993. While this trackage cannot be operated profitably by Class I carriers, it can be operated (at least at a marginal profit) by local operators. The values shown in columns (g) and (h) represent future highway costs which will be avoided if these rail lines are preserved (through sale to local operators).

The avoidable costs in columns (g) and (h) of Table 8 are net highway costs. They reflect both the increase in motor fuel taxes and vehicle registration fees shown in column (e) and the incremental pavement damage shown in column (f). As the unit costs in columns (c) and (d) suggest, the incremental revenues generated by grain trucks on low-volume roads in North Dakota are less than the pavement costs created.[31] So, preserving branch lines through sales to local or regional operators can actually have a positive effect on rural highways.

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[31] The exact units costs are $.0461978 and $.0792894. These values are based on a recent case study and reflect a median SN of 2.6. More details of the case study are given in Tolliver and Lindamood (1989).

TABLE 8. Change in Highway Cost

(a) Year	(b)* Incremental Cwts	(c) Revenue Per Cwt	(d) Pavement Cost Per Cwt	(e)* Incremental Revenue	(f)* Incremental Cost	(g)* Discounted Net Change	(h)* Cumulative Highway Costs
1987	0	$.05	$.08	$ 0	$ 0	$ 0	$ 0
1988	0	$.05	$.08	$ 0	$ 0	$ 0	$ 0
1989	0	$.05	$.08	$ 0	$ 0	$ 0	$ 0
1990	0	$.05	$.08	$ 0	$ 0	$ 0	$ 0
1991	0	$.05	$.08	$ 0	$ 0	$ 0	$ 0
1992	0	$.05	$.08	$ 0	$ 0	$ 0	$ 0
1993	14,184	$.05	$.08	$655	$1,125	($274)	($ 274)
1994	14,184	$.05	$.08	$655	$1,125	($254)	($ 527)
1995	14,184	$.05	$.08	$655	$1,125	($235)	($ 762)
1996	14,184	$.05	$.08	$655	$1,125	($217)	($ 980)
1997	14,184	$.05	$.08	$655	$1,125	($201)	($1,181)
1998	14,184	$.05	$.08	$655	$1,125	($186)	($1,367)
1999	14,184	$.05	$.08	$655	$1,125	($173)	($1,540)
2000	14,184	$.05	$.08	$655	$1,125	($160)	($1,700)
2001	14,184	$.05	$.08	$655	$1,125	($148)	($1,848)
2002	14,184	$.05	$.08	$655	$1,125	($137)	($1,985)
2003	14,184	$.05	$.08	$655	$1,125	($127)	($2,112)
2004	14,184	$.05	$.08	$655	$1,125	($117)	($2,229)
2005	14,184	$.05	$.08	$655	$1,125	($109)	($2,338)
2006	14,184	$.05	$.08	$655	$1,125	($101)	($2,439)

*Values are in thousands.

Projected Regional Economic Benefits

The projected regional economic benefits attributable to new producers' and consumers' surpluses are shown in Table 9. The gross business volume generated by new producers' surplus -- column (c) -- is derived from the transportation gross receipts multiplier shown in column (5), Table C.2 of Appendix C. Column (e) of Table 9 reflects both the increase in personal income and the change in gross business volume resulting from the new consumers' surplus. The projected gross business volume utilizes the household sector gross receipts multiplier in column (12) of Table C.2, while increases in personal income are calculated from the interdependency coefficient at line 12, column (12).

TABLE 9. Secondary Economic Benefits of Line Sales*

(a) Year	(b) Producers Surplus	(c) Gross Business Volume (PS)	(d) Consumer Surplus	(e) Personal Income & Gross Business Volume	(f) Cumulative Discounted SEB
1987	$2,212	$2,048	$335	$1,475	$3,523
1988	$2,212	$1,896	$335	$1,404	$6,824
1989	$2,212	$1,756	$335	$1,339	$9,918
1990	$2,212	$1,626	$335	$1,278	$12,822
1991	$2,212	$1,505	$335	$1,222	$15,550
1992	$2,212	$1,394	$335	$1,170	$18,113
1993	$2,212	$1,291	$335	$1,122	$20,526
1994	$2,212	$1,195	$335	$1,077	$22,798
1995	$2,212	$1,107	$335	$1,036	$24,941
1996	$2,212	$1,025	$335	$ 998	$26,963
1997	$2,212	$ 949	$335	$ 962	$28,874
1998	$2,212	$ 878	$335	$ 930	$30,682
1999	$2,212	$ 813	$335	$ 899	$32,394
2000	$2,212	$ 753	$335	$ 871	$34,019
2001	$2,212	$ 697	$335	$ 845	$35,561
2002	$2,212	$ 646	$335	$ 821	$37,028
2003	$2,212	$ 598	$335	$ 799	$38,424
2004	$2,212	$ 554	$335	$ 778	$39,756
2005	$2,212	$ 513	$335	$ 759	$41,028
2006	$2,212	$ 475	$335	$ 741	$42,244

*All values are in thousands of dollars.

Secondary Economic Disbenefits

Increases in CS and PS generate positive SEB. However, potential losses in rail income as a result of line sales may lead to losses in personal income and business volume. These regional disbenefits are shown in Table 10.

Column (b) of Table 10 shows the projected changes in rail income over a ten year period as a result of line sales. The methods and data used in developing these projections are detailed in a separate report by the author.[32] The loss in personal income and gross business volume in North Dakota attributable to reductions in rail employee's

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[32] Tolliver, The Impacts of Local and Regional Railroads on Rail Labor in North Dakota, UGPTI, 1989.

incomes is shown in column (c), and the discounted cumulative disbenefits are shown in column (e). The bottom line of Table 10 is that line sales to local and regional operators will result in a loss of income to rail workers and related gross business volume of $68,968,000. However, it should be noted that a loss of income does not necessarily mean a loss of rail jobs. In fact, in the labor component of the RSP, the author projected that a net increase of 27 rail jobs would be realized in North Dakota as a result of line sales.[33] This forecast considers the facts that: (1) some Class I carrier jobs will be lost in the future through abandonments if the lines are not sold, and (2) new local and regional jobs will be created in the state as a result of line sales.

TABLE 10. Secondary Economic Disbenefits*

(a) Year	(b) Reduction In Income	(c) Loss In Personal Income & Gross Bus. Vol.	(d) Discounted Secondary Disbenefits	(e) Cumulative Discounted Secondary Disbenefits
1987	$2,689	$12,452	$14,019	$14,019
1988	$2,025	$ 9,377	$ 9,775	$23,794
1989	$1,691	$ 7,831	$ 7,559	$31,353
1990	$1,316	$ 6,094	$ 5,447	$36,800
1991	$ 942	$ 4,362	$ 3,610	$40,410
1992	$ 567	$ 2,626	$ 2,012	$42,422
1993	$2,794	$12,938	$ 9,179	$51,601
1994	$2,419	$11,202	$ 7,359	$58,960
1995	$2,045	$ 9,470	$ 5,760	$64,720
1996	$1,629	$ 7,543	$ 4,248	$68,968

*All values are in thousands of dollars.

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[33] Ibid.

In summary, the sale of 2,010 miles of rail line to local and regional operators in North Dakota will generate a loss of $24,285,000 in SEB. The figures include $2,439,000 in avoidable highway infrastructure costs, $42,244,000 of positive regional economic benefits, and $68,968,000 in regional economic disbenefits. However, it should be noted that the projected disbenefits may not reflect the true long-run effects. They can be interpreted as disbenefits only if: (1) the impacted workers cannot transfer elsewhere or assume other jobs in the state, and (2) the affected rail workers cannot be retrained or find other employment in North Dakota. If either situation occurs, then the disbenefits resolve to distributional impacts, and cannot be considered as an offset against the primary and secondary efficiency gains.

SUMMARY AND CONCLUSION

The purpose of the study has been to project the net benefits of potential line sales in North Dakota. The net present value (NPV) of all future benefits and costs have been calculated, and presented in previous sections of the report. In the following paragraphs, the various types of impacts are summarized and considered collectively as elements of an overall welfare economic equation.

The equation for total net benefits is given by:

$$NPV = SC + PS + CS + SEB + RLI$$

where: NPV =Net present value of societal benefits

SEB = Secondary efficiency benefits generated by new producers' and consumers' surpluses

RLI = Decremental rail income and secondary economic effects

Substituting the estimated values (in thousands of dollars) into the equation yields:

$$NPV = \$88{,}892 + \$21{,}719 + \$3{,}291 + \$2{,}439 + \$42{,}244 + (\$68{,}968) = \$89{,}617$$

Altogether, the sale of 2,010 miles of light-density track to local and regional operators will generate $158,585,000 in primary and secondary efficiency benefits.[34] If displaced rail workers cannot find jobs elsewhere or be retrained, then the projected sales will also result in $68,968,000 of secondary economic disbenefits. If all of the potential disbenefits are realized, an aggregate efficiency gain of $89,617,000 will occur.

Several conclusions can be drawn from the data presented in this report. First, local and regional railroads can significantly reduce the cost of branch-line traffic (by roughly 23 percent per car). Thus, substantial cost savings on existing rail traffic will be realized if light-density lines are sold instead of abandoned. Second, line sales can actually increase rail traffic, as new local or regional railroads are typically more aggressive and market-oriented than Class I carriers.[35] Any increase in rail market share will generate additional economic surpluses in North Dakota for both transportation operators and shippers. So, the entire economy will benefit. Third, line sales may avoid incremental highway costs in future years by preserving some rail branch lines. Fourth, positive secondary economic benefits will be generated as cost savings and new producers' and consumers' surpluses are felt throughout state and local economies. Fifth, some negative secondary effects (or disbenefits) may result from a reduction in the rail workers' income stream in North Dakota. However, some of the effects may actually be distributional impacts rather than disbenefits.

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[34] The estimates of positive secondary efficiency benefits presented in the report are conservative. All of the new PS is assumed to remain in North Dakota, instead of being funneled out-of-state. This is not completely realistic. However, the transfer of lines to local and regional operators will create SEB because of increased local transportation sector spending on the existing traffic base. These SEB will probably be much greater than the projected SEB due to PS on new traffic. Thus, altogether, the actual secondary economic benefits of line sales in North Dakota may be substantially larger than those predicted in this study.

[35] The eight percent increase projected in this study (based on the RRV&W's experience) is probably conservative.

Overall, the transfer of light-density lines to local or regional carriers will enhance the economic welfare of the state. If displaced Class I carrier employees are able to transfer or find comparable employment in North Dakota, the quantifiable benefits could be as high as $158,585,000. Even if this does not occur, the quantifiable benefits will be in the vicinity of $90 million.

Several caveats must be set forth regarding the conclusions. First, the study assumes that branch lines will be sold to entities with competent, experienced personnel, and that the enterprises will be managed honestly and efficiently in the future. Second, adequate capital and financing will be available to the new firms, to allow the rehabilitation and normalized maintenance of key rail lines. Third, rail lines will be sold only in feasible networks which allow the short lines to achieve some economies of size or traffic density, and conduct efficient way train operations. Fourth, the selling Class I carrier will key gateways and interchange points open, efficiently interchanging cars with the local or regional railroads, and provide a division of revenues adequate to recover full capital and operating costs.

APPENDIX A

CLASS I CARRIER

LIGHT DENSITY COSTING METHODOLOGY

I. INTRODUCTION

Rail transportation is critical to North Dakota's economy. During the last three crop years, railroads transported 76 percent of the state's grains and oilseeds to market. Nearly 50 percent of these shipments originated on branch lines.[36]

As the shipment data suggest, North Dakota's branch line network is essential to the state's agricultural economy, and to the maintenance of a viable transportation system. Thus, the cost of branch-line traffic has always been an important issue to railroads, shippers, and state agencies. Branch-line costs are particularly important for rail planning, policy analysis, and regulatory oversight.

Each year, the state of North Dakota invests millions of dollars in rail-line rehabilitation. For each project, rail costs must be estimated both before and after rehabilitation. So, costing methods are an important part of the line analysis process.

Recent changes in the industrial organization of American railroads is impacting branch-line operations and costs. Since 1980, over 200 new local and regional railroads have been formed, most from parts of Class I carrier systems. These sales are primarily a result of branch-line economics. Short-line carriers can operate light-density lines more efficiently than Class I railroads.

Changes in branch-line ownership, coupled with an on-going need for policy analysis and planning, make rail costing methods important to research and analysis in North Dakota. The purpose of this report is to document a methodology for light-density cost analysis which is used in Phases I and II of the North Dakota Rail Services Planning (RSP) Study, as well as in line rehabilitation projects. The report describes a set of procedures for calculating Class I Carrier line-segment unit costs, and for applying them to

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[36] The exact percent for 1987 and 1988 was 49.89.

light-density lines or networks.

The report is organized as follows. In section II, a theoretical model of line-segment costs is formulated. In section III, a method is devised for computing on-branch unit costs from a carrier's R-1 annual report, and applying the costs to a line or set of lines. In section IV, a procedure for calculating the expense of moving traffic to and from the junction points or interchange points of a line is described.

II. THEORETICAL FRAMEWORK

2.1 Basic Propositions

Many transportation analysts are familiar with the Interstate Commerce Commission's (ICC) costing formulas which compute "shipment costs." However, line-segment costing differs significantly from shipment costing. In the case of the latter, costs are estimated for a typical movement, normally between a single origin and destination. In the case of the former, costs are estimated for all classes of traffic originating and/or terminating on a line segment. So, the traffic base typically entails an array of origins and destinations.

From a systems perspective, a line segment may be envisioned as a subsystem of a carrier's overall network. As a subsystem, a line segment possesses (on a smaller scale) many of the same attributes or characteristics of the larger system of which it is a part. However, each line or network of lines is somewhat unique in terms of traffic mix, density, track quality, condition, and other physical or geographic characteristics.

Some basic propositions regarding line segments are set forth below. The propositions underscore many of the assumptions and definitions found in the theoretical model.

1. A line has certain physical assets associated with its operation and existence (such as land, track, other roadway materials, roadway buildings and structures, etc.) which can be directly assigned to the segment.

2. A line-segment has a production function which is somewhat similar to that of the railway as a whole, in that the same factor inputs (i.e., track, equipment, labor, materials and supplies) are needed to generate output.
3. Because the production functions of the various subsystems utilize the same factors of production, the variable inputs such as locomotives, freight cars, containers, engineers, firemen, brakemen, and conductors can almost always be utilized on another subsystem of the carrier's network.
4. A line segment, as a subsystem of a carrier's network, is subject to short run economies of utilization or density in much the same manner as the rail network as a whole.
5. A line segment is not a self-contained subsystem of a carrier's network but interacts with other subsystems, interchanging freight cars, locomotives, and crews.

2.2 Cost Classifications and Definitions

Costs are frequently defined or classified in more than one manner, or according to several criteria. Four categories of cost are especially useful in developing a theory of light-density line analysis. In the following discussion, railroad costs are classified according to: (1) subsystem or function, (2) traceability, (3) behavior with output, and (4) accountability.

2.2.1 On-Line Versus Off-Line Costs

Two broad categories of cost may be defined according to subsystem function:

1. On-line or on-network costs;[37]
2. Off-line or off-network costs.

On-line costs comprise the operating, capital, and opportunity costs associated with serving and maintaining a set of light-density lines. Off-line costs represent the variable expense associated with moving traffic to and from the junction points, over other subsystems of a carrier's network.

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[37] These costs are frequently referred to as "on-branch" and "off-branch", particularly within the context of branch-line analysis.

2.2.2 Line-Specific Versus Allocated Costs

As proposition 1 states, a line or network of lines has certain clearly assignable physical assets associated with its existence. Items such as land, track, structures, roadway materials, and buildings are "line-related" or "line-specific" costs. The annual expense for each item can be directly assigned to a line or network.

Other factors of production such as equipment or train and engine crew labor may be used on several different networks or lines. The annual expenses for these items cannot be directly and solely attributed to any given line segment. Instead, they must be allocated among the various lines or networks in the carriers' system based on the level of activity on each. Such expenses are referred to as "allocated" costs.

2.2.3 Fixed Capacity Versus Variable Costs

On-line costs may also be classified according to behavior with output. Certain line-related costs are fixed in nature and do not vary with traffic. For example, a large proportion of maintenance of way (MOW) expenditures on light-density lines are constant per mile of track. Items such as superintendence, vegetation control, and time-related deterioration of track and roadway assets are largely independent of the level of traffic. Similarly, the opportunity cost of roadway investment is incurred regardless of whether 100 or 5,000 carloads are handled.

Other on-line costs such as locomotive ownership, fuel, and train crew labor vary directly with the level of activity on a line. If no traffic is generated or handled during the year, then no locomotive or freight car costs are incurred. Instead, the equipment is utilized on other subsystems.

2.2.4 Accounting Classifications

On-line expenses are normally classified according to four broad functional categories found in railroad accounting systems. These are:

1. Maintenance of Way
2. Maintenance of Equipment
   a) Locomotives
   b) Freight Cars
3. Transportation
   a) Train Operations
   b) Yard Operations
   c) Common Operations
   d) Specialized Service Operations
   e) Administrative Support Operations
4. General and Administrative

Each classification contains a range of individual cost items. For example, locomotive fuel, train and engine crew, train inspection, and dispatching costs constitute individual line items under the general heading of train operations.

2.3 Cost Finding Process

Estimating costs for a network of lines is a three step process. First, a series of on-branch and off-branch unit costs are calculated. The unit costs reflect the variable expense per unit of output (e.g., fuel cost per locomotive hour), or the fixed capacity cost per mile of track (e.g., opportunity cost on net liquidation value). Second, the number of annual output units or "service units" consumed in serving the branch lines and the number of track miles in the network are calculated. Third, the level of annual expenses attributable to the line or lines is computed by multiplying the service units by the related unit costs.

2.3.1 Sources of the Unit Costs

Fixed capacity on-branch unit costs are derived primarily from economic-engineering models or direct data sources. There are three primary unit costs in this group:

1. Normalized maintenance of way
2. Opportunity cost on net liquidation value (NLV)
3. Property taxes.

All are line-specific items which can be directly computed for a set of lines.

"Normalized" MOW per mile is estimated from asset deterioration models and railroad productivity factors.[38] NLV per mile is computed from resale or scrap value of track materials, alternative land-use values, and engineering estimates of recovery cost.[39] Variable and/or untraceable cost elements are estimated from accounting expenses and operating data contained in the carrier's R-1 report. The R-1 unit costs are "allocated" unit costs. They represent the cost per unit of output for items such as locomotive depreciation and return on investment which cannot be directly assigned to a particular line segment.

Off-line unit costs are derived from R-1 expense and operating data using the ICC's cost finding formula, Rail Form A (RFA). The most current Burlington Northern and Soo Line RFA's are used to generate a file of off-line cost coefficients each year. A more detailed explanation of the off-branch methods is provided in Section III of the report.

2.3.2 Operating Models

The second step in the cost-finding process (the estimation of annual service units for the line or lines) is accomplished with a set of operating models. The models predict the service units accumulated in consolidation and gathering activities on light-density lines. The models also predict the number of service units generated by the traffic as it moves to and from the junction points of the line.

Three concepts are of primary importance in operations modeling: (1) train class or service, (2) shipment service level, and (3) the scheduled frequency of service. Train service consists of way or local train service, through train service, or unit train service.

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[38] For a description of the detoriation models see: Tolliver and Lindamood. An Analysis of the Benefits of Rehabilitating the Wahpeton-to-Independence Rail Line, UGPTI, 1989.

[39] See: Mittleider, Tolliver, and Vreugdenhil (1983).

Way service reflects typical train operations on light-density networks. Way trains operate between classification yards and stations, spotting empty cars and pulling loaded ones. Through trains operate primarily between classification yards, and do not normally switch cars at individual stations. Through trains on light-density networks usually consist of bridge or overhead traffic which neither originates nor terminates on the lines. Unit trains provide direct service between stations and do not require yard classification.

Shipment service level is a composite variable which reflects the type and extent of activities that occur at individual stations, as well as the degree of classification off-line. There are four basic service levels: (1) single car, (2) multiple car, (3) trainload, and (4) unit train. A true unit train is a direct, cyclical, continuous movement between an origin and destination, normally involving a dedicated locomotive and freight car set. A trainload shipment also involves direct origin-destination service. But a trainload shipment is not a cyclical, continuous movement. Trainload shipments may be sporadic and spread out during the year. There are other operational differences between unit train and trainload service which are documented in: Tolliver (1984).

There are few, if any, unit train shipments originating or terminating on light-density networks. However, there may be trainload shippers. From a modeling perspective, a trainload shipment is treated as a separate, solid train. Multiple-car shipments are treated in one of two ways, depending on the service frequency.

Way trains typically operate between a classification yard and outlying stations along a designated route, according to a general timetable and schedule. Single-car, three-car, and other small multiple-car shipments are generally handled in scheduled way train service. The frequency of service is determined by the demand for cars along the route and by the operating condition of the lines. Light-density lines, because of low demand and poor operating conditions, typically receive service once or twice a week.

If large multiple-car shippers are located on a line, the scheduled frequency of way train service may be inadequate. If the frequency of service is less than three times per week, the detention/waiting time at stations will exceed tariff free time significantly. In such instances, large, multiple-car shipments may be handled in direct or shuttle way trains. Shuttle way trains operate between classification yards and large multiple-car shippers, providing expedited service where the frequency of scheduled way train service is low.[40] If the service frequency is twice a week or less, large multiple-car shipments are assumed to be handled in direct way train service.

2.4 Cost-Output Relationships

In calculating R-1 unit costs, accounts or groups of accounts are correlated with the output measures to which they are most closely related. Cost-output relationships may be derived through statistical analysis, engineering analysis, or operational knowledge. For the most part, the relationships adopted in this study reflect the ICC's cost-output relationships that are used in abandonment or light-density surcharge analysis. The most important ones are discussed in the following sections of the report.

2.4.1 Locomotive Operations and Ownership

Road locomotive repairs and maintenance are a function of the weight of the units and the distance traveled. This relationship is most appropriately represented by the output variable "road locomotive gross ton-miles." Unlike repairs, the servicing of road locomotives is not related to the weight of the unit, but is a function of distance. So, servicing expenses are correlated with road locomotive unit miles.

Locomotive depreciation, rentals, leases, and opportunity costs are more closely related to time than to distance or use. The logical output measure for these expenses is the hours of road locomotive operation. Locomotive fuel is primarily use-related. On light-density networks, locomotives operate much of the time at low speeds, idling, or

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[40] Direct way trains may also handle other traffic that is ready for the pickup on the day of the service.

switching cars at stations. These are fuel-intensive activities. Thus, the hours of operation is a better measure of branch-line fuel consumption than miles or gross ton-miles.

Yard locomotive activities involve the switching of cars over short distances. The principal measure of activity is yard locomotive hours. Unlike road locomotives which engage in running and switching activities under a variety of conditions, yard locomotive expenses are all directly related to the yard hours.

2.4.2 Transportation Expenses

Train operating expenses (other than fuel) are related to both train-hours and train-miles. Crews are paid on a dual basis, reflecting both mileage and time. During light-density operations, crews spend a large proportion of their time running at low speeds, or switching at industry sidings. Thus, the basic day is determined most often on the basis of hours instead of miles. For this reason, on-branch crew wages are computed on a train-hour basis.

Most other train operating expenses are related to train-miles. They include train inspection and lubrication, operating signals and interlockers, operating highway grade crossings, and train dispatching. All yard operating expenses are developed on a yard switching-hour basis.

2.4.3 Other Equipment Costs

Freight car repairs and depreciation are a function of time and usage. The ICC has developed factors for the apportionment of each expense among car-days and car-miles. Freight car opportunity costs are solely time-related, and are expressed on a car-day basis.

Trailer and container ownership costs are primarily time-related. While on the rail leg of an intermodal shipment, most of the repairs and maintenance are due to weather, environment, or time instead of use. All TOFC/COFC ownership costs are computed on a trailer- or container-day basis.

2.4.4 General and Administrative Expenses

General and administrative expenses involve items such as marketing, sales, legal and secretarial services, accounting and finance, and research and development. These expenses are primarily related to the level of activity for the system as a whole. However, they are partially related to the level of activity on individual subsystems. Certain accounting, financial, and other functions are required whenever carloads are originated or terminated, regardless of the size of the load. So, these expenses are more closely related to car-miles than gross ton-miles.

This section of the report has presented an overview of the theory and methods of light-density cost analysis. First, some basic propositions were introduced. Second, definitions were given for allocated, fixed capacity, variable, off-line, and on-line costs. Third, a cost-finding process was introduced, which features unit cost calculations and operations model. And fourth, some basic cost-output relationships were formulated.

The report now turns to a more detailed description of the costing methods and procedures.

III. ON-LINE COSTING METHODOLOGY

3.1 Locomotive Operating, Maintenance, and Ownership Unit Costs

Road locomotive unit costs reflect all direct and indirect expenses associated with the activity of units outside of classification yards. Road locomotive operating and maintenance costs include: (1) repairs, (2) fuel or power, (3) servicing, (4) machinery, and (5) overhead. Ownership costs include: depreciation, rentals, and leases (DRL) and return on investment (ROI).

3.1.1 Road Locomotive Repairs and Ownership

Road locomotive repairs, DRL, and ROI are calculated directly from expenses contained in Line 2 of Schedule 415. Table 1 shows the location of each expense item within Schedule 415, as well as the related output measure.

As Table 1 depicts, all but one of the unit costs have been developed on a locomotive-hour basis. This is consistent with the theoretical model constructed in Section II, wherein the depreciation, repairs, and fuel consumption of locomotive units operating over light-density lines were felt to be more closely related to locomotive hours than unit miles.

TABLE 1. ROAD LOCOMOTIVE OPERATING, MAINTENANCE AND INVESTMENT UNIT COSTS.

Unit Costs	Schedule 415 Columns	Production or Output Measure
Repairs	(b)	Locomotive Gross Ton-Miles
Depreciation, Rentals and Leases	(c)+(d)+(e)+(f)	Locomotive Hours
Net Investment Base	[(g)+(h)]-[(i)+(j)]	Locomotive Hours

Locomotive repairs for each class of unit are obtained directly from column (b) of Schedule 415. Locomotive depreciation, rentals, and leases (DRL) are calculated by adding the expenses for depreciation [Schedule 415, col. (c) + col. (d)], retirements [Schedule 415, col. (e)], and leases and rentals [Schedule 415, col. (f)]. Locomotive investment (the net investment base) is calculated for each type of unit by subtracting accumulated depreciation [Schedule 415, col. (i) + col. (j)] from the investment base [Schedule 415, col. (g) + col. (h)]. The unit cost for locomotive ROI is computed by multiplying the net investment base by the current cost of capital.

3.1.2 Locomotive Machinery

Locomotive machinery costs include maintenance and ownership expenses for machinery used exclusively in the upkeep of locomotives. The Schedule 415 expenses reflect both yard and road locomotive activities. So, some allocation of expenses among road and yard units must be performed.

Total locomotive machinery repairs, DRL, and net investment base are calculated from line 38 of Schedule 415 using the same columns as shown in Table 1. The expenses are then allocated to each class of locomotive on the basis of the ratio of the repair expenses for that class to total repairs for all locomotive types. For example, the allocation ratio for diesel yard locomotives is determined by dividing the repair expenses for yard diesel locomotives [Schedule 415, col. (b)] by the total repair expenses for all locomotives. The logic behind this procedure is that the costs associated with locomotive machinery are proportional to the repairs for each type of unit.

The production or output unit for road locomotive machinery is road locomotive gross ton-miles. The output measure for yard locomotive machinery is yard locomotive switching hours.

3.1.3 Locomotive Fuel and Power Unit Costs

Locomotive fuel and power expenses are computed on a locomotive-hour basis. The expenses for locomotive fuel are taken from Schedule 410 of the carriers' R-1 report. Table 2 documents the source of the expenses and the output measures used.

TABLE 2. LOCOMOTIVE FUEL AND POWER UNIT COSTS.

Unit Costs	Schedule 410 Line Number	Production or Output Measure
Road Locomotive Fuel	409	Diesel Road Locomotive Hrs
Yard Locomotive Fuel	425	Diesel Yard Locomotive Hrs
Road Locomotive Power	410	Other Road Locomotive Hrs
Yard Locomotive Power	426	Other Yard Locomotive Hrs

Road locomotive hours are developed from Schedule 755 as follows. First, the average road train speed (running) is calculated as: [(Line 115) - (Line 116)] / Line 5. Second, using the average train speed, the number of road locomotive-hours (running) is calculated as the quotient of the annual road locomotive unit miles and the average speed. Third, the number of train switching locomotive-hours is computed by dividing the number of locomotive switching miles (Line 12) by the average switching speed (6 MPH).[41] The sum of the running hours and the train switching hours gives the annual road locomotive hours of operation.

3.1.4 Locomotive Servicing and Overhead Unit Costs

The unit cost of servicing road locomotives is calculated by dividing the annual expenses (Schedule 410, Line 411) by the number of road locomotive-miles (Schedule 755, Line 11). Road locomotive-miles is used instead of road locomotive hours, because the servicing of road locomotives is more closely related to the miles of operation than to time.[42]

Locomotive overhead costs consist of administrative and other expenses which result from maintaining, servicing, and managing the fleet. Overhead expenses vary with the level of activity on a given subsystem. So, they are allocated to various subsystems on the basis of the primary activity measure: locomotive hours.

The various elements of locomotive overhead are displayed in Table 3.

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[41] This constant was developed and is used by the Interstate Commerce Commission.

[42] The road locomotive unit mile service unit was stipulated by the ICC in Ex Parte 402.

TABLE 3. ROAD LOCOMOTIVE OVERHEAD EXPENSE ITEMS.

Item	Schedule 410 Line Number
Administration	201
Equipment Damage	204
Fringe Benefits	205
Other Casualties and Insurance	206
Dismantling Road Property	217
Other	218

3.2 Transportation Unit Costs

Train and engine crew wages are developed on an hourly basis from the ICC's Quarterly Wage Statistics, Form B. The remaining transportation expenses are organized into four classifications: (1) train operations, (2) yard operations, (3) common train and yard expenses, and (4) specialized service operations.

Train operating and overhead costs reflect administration, dispatching, and other activities related to road train operations. The various components of train operating and overhead costs are shown in Table 4. With the exception of fringe benefits and administration, all items are computed on a train-mile basis. Fringe benefits and administration are more closely related to the hours of operation than to the distance traveled.

TABLE 4. TRAIN OPERATING EXPENSE ITEMS.

Item	Schedule 410 Line Number
Administration	401
Dispatching Trains	404
Operating Signals & Interlockers	405
Highway Crossing Protection	407
Train Inspection & Lubrication	408
Clearing Wrecks	413
Fringe Benefits	414
Other Casualties & Insurance	415
Joint Facilities	416 & 417
Other	418

The components of yard operating and overhead cost are depicted in Table 5. All yard operating and overhead items are computed on a yard switching-hour basis.

Specialized services and common train and yard expenses are typically not relevant to branch-line operations. So, unit costs are not computed for these items. Instead, they are handled individually during each line analysis. For example, if marine facilities are located on a line, the pickup, delivery, and marine line-haul costs are calculated directly. Otherwise, they are excluded.

TABLE 5. YARD OPERATING EXPENSE COMPONENTS.

Item	Schedule 410 Line Number
Administration	420
Controlling Operations	422
Yard Terminal Clerical	423
Operating Switches, Signals, Retarders and Humps	424
Clearing Wrecks	429
Fringe Benefits	430
Other Casualties and Insurance	431
Joint Facilities	432-433
Other	434

3.3 General and Administrative Expenses

General and administrative expenses, with the exception of property taxes, are developed from Schedule 410, Lines 601-618. Property taxes are treated as a line-related expense, and are developed from state tax records on a track-mile basis.

The various elements of general and administrative expenses are enumerated in Table 6. As noted in Section II, these expenses are computed on a car-mile basis. They represent an allocation of common system costs to a line in proportion to the annual level of revenue-generating activity.

TABLE 6. GENERAL AND ADMINISTRATIVE COST ELEMENTS.

Item	Schedule 410 Line Number
Officers-General & Administrative	601
Accounting, Auditing & Finance	602
Management Services & Date Processing	603
Marketing	604
Sales	605
Industrial Development	606
Personnel & Labor Relations	607
Legal & Secretarial	608
Public Relations & Advertising	609
Research & Development	610
Fringe Benefits	611
Casualties & Insurance	612
Writedown of Uncollectibles	613
Other Taxes	615
Joint Facility	616 & 617
Other	618

3.4 Freight Car Expenses

Car repairs, depreciation, and ROI unit costs are developed from Schedules 415, 710, and 755. The process is somewhat analogous to the locomotive procedure. It involves an economic-engineering approach set forth by the ICC in Ex Parte 334. The method uses the replacement value of a particular type of freight car and its anticipated usage to derive a cost per car-mile and car-day. The procedures are detailed later in the report.

3.5 Service Unit Calculations

Annual service units are calculated for a given network of lines in accordance with the theoretical model described in Section II. As noted previously, operations models are used to predict the number of way trains per year on each line.

3.5.1 Trip Mileages

Round trip way train miles are estimated directly for each route from carrier timetables or distance tariffs. The estimates account for the actual movement of the train as closely as possible.

In addition to round-trip miles, the distance from each station to the division point, and from each division point to each major market are computed.

3.5.2 Calculation of Annual Trains

The number of scheduled way trains per year is calculated as follows:

$$SCWT_i = 365/SERV_i \tag{1}$$

where:

$SCWT_i$ = Scheduled way trains on route "i"

$SERV_i$ = Weekly service frequency, route "i"

If the scheduled service frequency is < = 2, each large multiple-car or trainload shipment is assumed to constitute a separate shuttle way train. Otherwise, all multiple-car and trainload shipments are assumed to be handled in scheduled way train service.

3.5.3 Calculation of Train-Miles and Train-Hours

The annual train-miles on each route are calculated from the estimated number of scheduled and shuttle way trains. Scheduled way trains are assumed to run the length of the route each trip. Shuttle way trains are assumed to run directly between a given station and the classification yard. Shuttle way train-miles reflect the distance between the station and the division point, rather than the branch-line length.

Train-hours on-branch include two components: (1) train-hours running, and (2) train-hours switching. The annual train-hours running on a given route are calculated as follows:

$$THR_i = TM_i/MPH_i \tag{2}$$

where:

THR_i = Train-Hours Running, Route "i"

TM_i = Annual Train Miles, Route "i"

MPH_i = Average Train Speed, Route "i"

The average train speed reflects the operating conditions and any speed limitations that might exist on a route.

Train-hours switching reflect the total switching time at each station during the year. The minutes required at each station are a function of the number of cars switched and the shipment service level. A separate calculation must be performed for each level of service.

$$LSM_{ij} = CS_{ij} * ASM * SMR_j * SPR \tag{3}$$

where:

LSM_{ij} = Locomotive switching minutes at station "i", for service class "j"
CS_{ij} = Cars switched at station "i", service level "j".

ASM = Average switching minutes in single-car service (11 minutes)

SMR_j = Switching minute ratio for service level "j"

SPR = Spotted-to-pulled ratio

Each service level corresponds to a shipment class size. So, there are twelve possible classes or values for "$_j$." The switching efficiency ratio expresses the relative switching time for a given service in comparison to the single-car average.[43] The spotted-to-pull ratio indicates the frequency with which an empty car must be spotted for every load which is pulled. The SPR is 2 for most car types.

Total train-hours switching at a given station are computed as:

$$LSM_i = \sum_j LSM_{ij} \tag{4}$$

3.5.4 Calculation of Road Locomotive Service Units

Road locomotive-miles (RLM) are computed separately for each train class, as follows:

$$RLM_{ij} = TM_{ij}{*}ALU_j \tag{5}$$

where:

ALU_j = Average locomotives required for service class.

The number of units required for each train class will vary with the average train weight and network conditions. On North Dakota branch lines, a 26-car shuttle way train will usually require a single unit, while a 52-car train typically requires two. Scheduled way trains normally need at least one unit. Two or more units are required for heavier trains or under extreme conditions.

The road locomotive unit hours consumed at each station on a line are a function of the switching time and the number of units required. For a given class of service, the

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[43] From previous analysis, it has been determined that approximately 10-12 minutes are required to spot a cut of one-to-three cars at a branch-line station.

locomotive unit hours required at a particular station are computed as:

$$LHS_{ij} = LSM_{ij}*ALU_{j}. \tag{6}$$

Individual class totals are summed to obtain the station total.

Road locomotive hours running (LHR) are calculated on each route from the annual RLM, as:

$$LHR_{i} = RLM_{i}/MPH_{i}. \tag{7}$$

3.5.5 Calculation of Car-Miles and Car-Days

Car-miles on-line are calculated for each station as follows:

$$CM_{i} = SW_{i}*CS_{i}*SPR \tag{8}$$

where:

SW_i = Station way train miles

CS_i = Cars switched at station "i".

Network car-miles are given by:

$$CM = \sum_{i}*CM_{i} \tag{9}$$

Car days on-line consist of four elements:

1. Running,
2. Loading and unloading,
3. Spotting and pulling,
4. Waiting.

Car days running depend on the distance from the yard and the average train speed (both running and switching). They are computed as follows:

$$CDR = SW_i / TS \tag{10}$$

where:

CDR = Car days running

TS = Average train speed, running and switching

The average train speed is computed via a three-step process. First, the mean number of cars consigned at each station is estimated, and divided by the trains per year. Second, the raw switching time at each station (per train trip) is adjusted for the frequency of multiple cars and trainloads consigned. Third, the cumulative mean switching time for each route is added to the running time, and divided by the distance to yield the average train speed. This set of calculations, it should be noted, also generates the spotting and pulling times (the actual switching activities at each station).

Waiting time is the interval during which the car is loaded, but is waiting to be pulled. The waiting time is a function of the service frequency and direct train service. For direct multiple-car and trainload shipments, a maximum of two days is assumed for both loading (or unloading) and waiting. In scheduled train service, multi-car waiting times may be somewhat higher, depending on the service frequency.

Waiting time for single-car traffic is computed as follows:

$$WT_i = (365/SERV_i * 52) - 2 \tag{11}$$

Once the service units have been calculated for all categories, annual expenses are obtained by multiplying the network service units by the unit costs.

IV. OFF-LINE PROCEDURE

Off-line costing is a variant of shipment costing. The objective of off-line costing is to estimate the average variable cost associated with the transportation of all network traffic from the point of origin to the junction point, or from the junction point to the destination (in the case of outbound traffic). This section of the report describes the principal off-line unit costs and service units.

4.1 Cost Estimation Procedures

The cost coefficients used in the off-branch procedure are derived from Rail Form A (RFA), a cost-finding formula developed by the Interstate Commerce Commission (ICC). Rail Form A is a computer program which generates unit costs for a variety of output measures, for individual railroads or groups of railroads (Table 7).

TABLE 7. 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	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	Car Miles, Less Mileage Cars, Loaded & Empty
Car Day Costs	Car Days, Total
Engine Minute Expense	Total Switching Minutes, Yard & Way Switching
Heating and Refrigeration	Refrigerator Car Miles, Loaded & Empty

RFA utilizes railroad accounting and operating data to produce estimates of variable costs. Many railroad costs are common or joint in nature. A series of allocation ratios are contained within the formula for distributing common expenses. The results of the ICC regression studies are contained in a separate file.

The manner in which the data flow through the formula is depicted in Figure 2. 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.

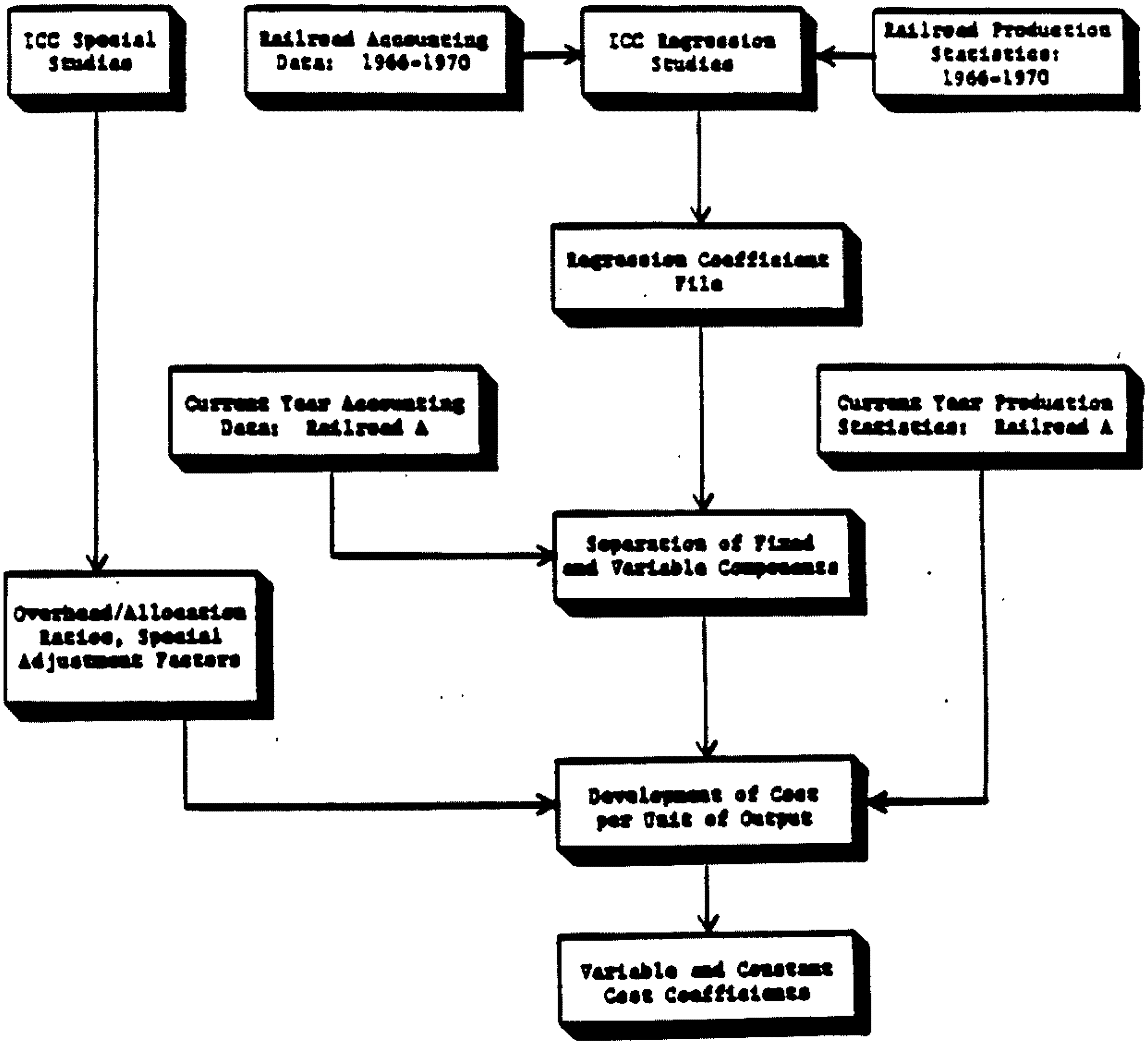

Figure 2. Rail Costing Finding Process

Within the cost-finding formula, accounting expenses and production data are transformed into unit costs via a multi-step process. Each group of accounts (e.g. maintenance of running track) 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.[44] 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 8. This process is illustrated below using the gross ton mile service unit as an example.

$$UC = (AC \times APV) / TGM \tag{12}$$

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

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[44] 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 8. 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) off-branch unit costs are shown in Tables 9 through 14. 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 elements. In addition, most of them include a return on roadway or equipment investment.

TABLE 9. 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 9 - 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)

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 9 - 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)

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

Account Number	Item or Account Title	Rail Form A Core No.
	<u>Transportation Portion</u>	
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)
	<u>Maintenance of Equipment</u>	
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 10 - 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)
	<u>Maintenance of Way & Structure</u>	
227,266-16	Station & office buildings	B(1838)
249,266-27	Signals & interlockers	B(1906)
201	Superintendence	B(1997)
266-1 267-1	Engineering	B(2026)
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)
	<u>Traffic and General Administration</u>	
	Distribution of general overhead	B(2272)
	Total Traffic	B(2317)
	<u>Cost of Capital: Road</u>	
16	Station-other, including running	B(2794)
	Total Road	B(2794)

Table 10 - 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 11. 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 11 - 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 11 - 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 12. DERIVATION OF RAIL FORM A LOCOMOTIVE UNIT MILE COST: B(3262).

Account Number	Item of Account Title	Rail Form A Core No.
	<u>Transportation</u>	
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)
	<u>Maintenance of Equipment:</u>	
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 12 - continued

Account Number	Item or Account Title	Rail Form A Core No.
	Maintenance of Way and Structures	
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)
	Traffic and General Administration	
	Distribution of general overhead	B(2270)
	Total expenses, rents and taxes	B(2315)
	Cost of Capital	
20	Fuel Stations	B(2580)
21	Shops and enginehouses	B(2581)
	Total road	B(2822)
52	Locomotive	B(2668)
	Variable Unit Cost Calculation:	
	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 13. DERIVATION OF RAIL FORM A STATION CLERICAL UNIT COST: B(3265).

Account Number	Item or Account Title	Rail Form A Core No.
	Transportation	
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 joint 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)
	Maintenance of Way:	
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 13 - 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 14. 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 14 - continued

Account Number	Item or Account Title	Rail Form A Core No.
	Traffic and General Administration:	
	Distribution of General Overhead	B(2283)
	Cost of Capital: Road	
16	Other road capital, including running	B(2800)
	Variable Unit Cost Calculation:	
	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 off-branch. Table 15 illustrates the process, using regional RFA data. However, individual railroad data are used in actual analyses.

The adjustment process accounts for the fact that different train performance factors (e.g. locomotive units and average trailing weights) result in different costs per train-mile. Logically, unit train gross ton-mile costs will be lower than way train.

The raw RFA GTM core number is B(3261). The average train weights and locomotive units for each class of train service are computed from Schedule 755 of the carrier's latest R-1 report.

TABLE 15. DEVELOPMENT OF RAIL FORM A 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 (L3 + L6 + L7 + (L7 * L8))	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 mile (Line 11/Line 12)	RFA(3325)	1.01198764

4.2 Calculation of Off-Line Service Units

Off-line service units may be classified as:

1. line-haul, distance-related service units;
2. line-haul, switching service units; and
3. terminal service units.

Three fundamental operating/performance factors must be computed prior to the determination of line-haul service units. These are: (1) the average freight train speed, running; (2) the actual (route) mileage for the shipment; and (3) the number of intermediate yard switching events. The average train speed for the Burlington Northern and Soo Line is computed from data contained in Schedule 755 of their R-1 reports. Loaded train miles are calculated from distance tariffs and timetables.

4.2.1 Intermediate Yard Switching Events

There are two types of classification yard switching: (1) intertrain/intratrain (I & I), and (2) interchange (IC). Off-branch IC switches are estimated directly for some carriers and markets. Where direct estimation is not possible, the number of IC events is estimated using an average distance interval. This interval is calculated from the current North Dakota waybill sample.

I & I switches are estimated differently for each service level. Unit train shipments, by definition, do not require yard classification. So, the number of I & I events is assumed to be zero. For trainload and large multiple-car shipments, one I & I switch normally occurs at the regional classification yard serving the line. A second one is usually required at the destination yard to declassify the block. Additional I & I switching is generally not needed, as these shipments typically travel in solid trains between origin and destination yards. So, two I & I switches are normally assumed for single-line multi-car or trainload shipments.

If the traffic is interline in nature, the frequency of events cannot be specified with certainty. So, the originating and terminating carrier are each given at least one I & I switch. Additional I & I switches are computed on a mileage basis. A distance interval of 400 miles is assumed.

I & I switches in single-car service are assumed to be distance-related. An interval of 200 miles between switches is used.

4.2.2 Car Day Cycle

The car day cycle contains three basic components: (1) car-days running, (2) car-days terminal switching, and (3) car-days switching, intermediate yards. Car-days running (CDR) are computed from the train speed and the line-haul mileage (13).

$$\mathrm{CDR} = \mathrm{TM} \;/\; \mathrm{Speed} \;/\; 24 \tag{13}$$

where:

CDR = Car days running

TM = Off-branch train miles

The number of car-days per terminal switch, as well as the number of car-days switching at intermediate yards, are computed from Rail Form A operational factors. On the average, one day is consumed in the delivery of the empty (or loaded) freight car to the shipper's siding. Rail tariffs normally require loading and unloading within 48 hours of constructive placement. Once the freight car is loaded (or unloaded) and is ready for pick-up, it is "pulled" back to the classification yard for blocking and classification. This usually occurs on the fourth day of the cycle at origin or destination.

The total car-days at origin and destination differ among car-types. Because of its versatility, the inbound boxcar can be reloaded twenty percent of the time. Thus, there is no need for the spotting of an empty at origin, as a suitable empty car is already available from the previous shipment.

To account for this occurrence, a different "spotted-to-pulled" ratio is used. For most car-types a spotted-to-pulled ratio (SPR) of 2.0 is used. But, for a boxcar, the ratio is 1.8.

The estimation of intermediate yard events are as described in Section 4.2.1. Once the number of events is determined, the number of car days is computed as follows:

$$CDY = (CDIC * IC * ERR) + (CDII * II * ERR) \tag{14}$$

where:

CDY = car days intermediate yard switching

CDIC = car days per interchange switch: 1/2 day

CDII = car days per intertrain or intratrain switch: 1/2 day

ERR = ratio of total to load miles for the particular car-type

IC = the number of loaded interchange switches

II = the number of loaded intertrain and/or intratrain switches

The days per intermediate yard switch (CDIC and CDII) are engineering estimates developed by the ICC.

4.2.3 Locomotive Switching Minutes

Locomotive switching minutes are the result of both line-haul and terminal activities. Line-haul LSM result from intermediate yard switching events, and are computed as follows:

$$LSMLH = (LSMII * II * ERR) + (LSMIC * IC * ERR) \tag{15}$$

where:

LSMLH = total line-haul switch engine minutes

LSMII = average minutes per intertrain/intratrain switch

LSMIC = average minutes per interchange switch

The average number of LSM per event are developed from ICC formulas which equate the number of carloads originated and terminated with each class of switching. Similar estimates are developed for LSM at origin and destination. They are used to compute terminal switching minutes as depicted below.

$$LSMOD = LSMLE * SPR * 2 \tag{16}$$

where:

LSMOD = locomotive switching minutes: origin-destination

LSMLE = average LSM per loaded or empty car at origin or destination

4.2.4 Car Miles Switching

Car miles running can be calculated directly from distance tariffs, using circuity and empty-return factors. Car miles switching, however, rely upon ICC engineering estimates for various classes of switching.

Car miles switching are computed as follows:

$$CMS = (CMII * II * ERR) + (CMIC * IC * ERR) + (CMTS * SPR * 2) \qquad (17)$$

where:

CMS = total car miles switching

CMII = car miles, intertrain-intratrain switching: 1.00, RFA -- A(105)

CMIC = car miles, interchange switch: 2.75, RFA -- A(104)

CMTS = car miles per terminal switch: 4, RFA -- A(100)

4.3 Calculation of Multi-Car Service Units and Costs

A series of adjustments are built into the off-line procedure to account for the efficiencies associated with multiple-car and trainload handling. The methodology calls for a reduction of origin/destination switching minutes per car, based on a sliding scale of adjustment factors (Table 16). This scale results in a 60 percent reduction from the single-car base for a 26-car shipment.

The number of car-days at origin and destination are reduced by 25 percent for multiple-car shipments. In addition, station clerical (billing) costs are adjusted downward for multiple-car shipments by assuming that 25 percent of the costs are associated with the shipment and 75 percent with the carloads.

TABLE 16. ORIGIN-DESTINATION ENGINE MINUTE ADJUSTMENT FACTORS

CUTSIZE*	PERCENT REDUCTION PER CAR
6	12
7	19
8	24
9	28
10	31
11	34
12	37
13	39
14	41
15	43
16-17	45
18-20	47
21-25	54
26-30	60
31-40	66
41-49	72
50 or more	75

*The term cutsize refers to the number of cars switched at each station.

4.4 Procedure for Computing Car Ownership Unit Costs

Car ownership costs are computed annually for each railroad and car-type. Most of the source data come from Schedules 414, 415, 710, and 755 of the R-1 report.

Two car ownership costs are computed for railroad cars: a car-day cost and a car mile cost. In addition, a private-line mileage rent is computed for shipper-owned cars. The process is illustrated in Table 17.

TABLE 17. COMPUTATION OF CAR-DAY AND CAR-MILE UNIT COSTS

Item	Source
1. Net Repairs	Sch. 415, L. 11, Col. (b)
2. Depreciation	Sch. 415, L. 11, Col. (c) + Col. (d)
3. Lease & Rentals	Sch. 415, L. 11, Col. (f)
4. Investment Base	Sch. 415, L. 11, Col. (g) + Col. (h)
5. Accumulated Depreciation	Sch. 415, L. 11, Col. (i) + Col. (j)
6. Net Investment Base	Line 4 - Line 5
7. Units Owned/Leased: Beg. of Year	Sch. 710, L. 41, Col (b)
8. Units Owned/Leased: End of Year	Sch. 710, L. 41, Col (k)
9. Units Owned/Leased: Average	(Line 7 + Line 8)/2
10. Car Miles: Loaded (RR Owned/Leased)	Sch. 755, L. 20, Col. (b)
11. Car Miles: Empty (RR Owned/Leased)	Sch. 755, L. 36, Col. (b)
12. Total Car Miles (RR Owned/Leased)	Line 10 + Line 11
13. Car Miles: Loaded (Private)	Sch. 755, L. 52, Col. (b)
14. Car Miles: Empty (Private)	Sch. 755, L. 70, Col. (b)
15. Total Car Miles (Private)	Line 13 + Line 14
Railroad Owned and Leased	
16. Active Car Days Per Car	Ex Parte 334 or AAR
17. Average Annual Miles Per Car	Line 12/Line 9
18. Average Annual Repairs per Car	Line 1/Line 9
19. Mileage Portion of Repairs	Ex Parte 334
20. Mileage Portion of Depreciation	Ex Parte 334
21. General Overhead Ratio	RFA= 1.0 + B(2268)
22. Rail Form A Variability Ratio-Repairs	RFA= A(150)
23. Rail Form A Variability Ratio-Depr.	RFA= A(151)
24. Rail Form A Variability Ratio-Taxes	RFA= A(159)
25. Property Tax Ratio	AAR: Ex Parte 334
26. Variable Repair Cost Per Car Mile	(Line 18 * Line 19)/Line 17 * Line 22 * Line 21
27. Variable Depreciation Cost Per Car Mile	(Line 2 * Line 20)/Line 12 * Line 23 * Line 21
28. Variable Cost/Car Mile	Line 26 + Line 27
29. Average Book Value	Line 6/Line 9
30. Cost of Capital	RFA= A(338)
31. Freight Car ROI	Line 29 * Line 30 * Line 21
32. Variable Property Taxes	(Line 29 * Line 24 * Line 25) Line 16 * Line 21
33. Variable Depreciation Per Car Day	(Line 2/Line 4)/Line 16 * Line 23 * Line 21
34. Leases & Rentals	(Line 3/ Line 9)/Line 16 * Line 21
ROI Per Car Day	Line 31/Line 16
35. Leases & Rentals Per Car Day	Line 2/Line 9/352/Line 21
36. Variable Repair Cost Per Car Day	Line 18/352 *Line 22 * Line 21
37. Cost Per Car Day	Line 33 + Line 35 + Line 36 + Line 37
	Traffic and General Administration:
38. Gross Per Diem Payable	Sch. 414, Col. (e)
39. Cost Per Car Mile: Private	Line 39 + Line 13
40. Loaded to Empty Ratio RR Cars	Line 12/Line 10
41. Loaded to Empty Ratio (Private)	Line 15/Line 13

V. CONCLUSION

The purpose of this report has been to explain and document a Class I carrier costing procedure that can be used to estimate costs for North Dakota branch-lines. The methods utilize data from each railroad's R-1 report and Rail Form A. These inputs can be obtained from public sources each year. The unit costs are used in conjunction with branch-line operating models to project annual expenses for a line or set of lines under Class I ownership.

APPENDIX B

SHORT-LINE SURVEY

The purpose of this appendix is to document the national short-line survey which was conducted as part of the RSP.

The survey was designed in the Winter of 1987, and mailed to over 150 local or regional railroads. Over 50 of the carriers responded. The primary objective of the survey was to obtain data on short-line labor costs, job classifications, and wage levels.

The complete survey, and the mean (or median) response to each question, are shown in the following exhibit. For most questions, the number of respondents selecting a given choice or option is shown in parentheses after the item. For example, 12 respondents chose answer "a" of question #1.

SURVEY # 2/11/88
(Revised)

SHORT LINE SURVEY

1. When was this railroad formed? (percent)

22.6% a) 1986 - present (12)
67.9% b) 1980 - 1985 (36)
1.9% c) 1970 - 1979 (1)
7.5% d) before 1970 (4)

2. Does this railroad primarily perform switching services? (percent)

35.8% a) Yes (19)
64.2% b) No (34)

3. How many miles of track does this railroad operate? X = mean value for group.
1-10 miles = 5.08 (5); 11-20 miles = 13.33 (6); 21-30 miles = 27.6 (5); 31-50 miles = 39.1 (10); 51-100 miles = 75.8 (10); 101-300 miles = 142.0 (12); 301+ = 657.4 (5)

4. What type of owner does this railroad have? (percent)

11.5% a) shipper (6)
21.2% b) local entrepreneur (11)
13.5% c) outside entrepreneur (7)
17.3% d) short line or short line holding company (9)
5.8% e) government unit (3)
5.8% f) non-profit community group (3)
11.5% g) other (please specify) (6) ____________
1.9% h) A & E (1)
1.9% i) A, B & E (1)
5.8% j) B & C (3)
1.9% k) D & E (1)
1.9% l) D & F (1)

5. What are the principle types of commodities hauled? (check as many apply)

Yes
24.5% a) coal (13)
7.5% b) metallic ore (4)
26.4% c) non-metallic minerals (14)
54.7% d) farm products (please specify) (29)
    41.5% outbound grain (22)
    20.8% other outbound ag. products (11)
    34.0% inbound ag. products (18)

43.4% e) chemicals (23)
60.4% f) lumber/wood (32)
20.8% g) glass/stone (11)
22.6% h) primary metal products (12)
30.2% i) pulp/paper (16)
15.1% j) petroleum (8)
22.6% k) waste/scrap (12)
3.8% l) autos/vehicles (2)
15.1% m) mixed freight (8)
30.2% n) other (16) ________

6. Has this railroad increased its operations?

77.4% a) yes (41)
22.6% b) no (if no, skip question 7) (12)

7. How has this railroad increased its operations?

Yes
26.4% a) purchased additional lines (14)
32.1% b) purchase additional equipment (17)
    13.2% cars (7)
    30.2% locomotives (16)

43.4% c) employed additional full-time workers (31)
22.6% d) employed additional part-time workers (3)
58.5% e) increased yearly traffic volume (1)
7.5% f) other (4) ___________
________ g) this railroad has not increased its operations

8. On average, how many total carloads per mile originated on your lines last year?

31.3% a) under 10 (15)
4.2% b) 10 - 20 (2)
25.0% c) 21 - 40 (12)
18.8% d) 41 - 100 (9)
20.8% e) over 100

9. How many of the following types of employees are presently working for your railroad? (please distinguish between full-time and part-time or temporary workers).

		full-time			part-time	
	range		med	range		med
a) train crew	65	8.77	4	8	2.36	2
b) yard crew	50	8.22	3	4	1.00	0
c) maintenance of way	55	10.24	5	25	6.21	3.5
d) shop crafts	10	2.25	2	1	.25	0
e) mechanical (cars & engines)	35	6.09	2	6	1.44	1
f) communications and signals	5	1.29	1	1	.57	1
g) clerks & freight handlers	30	5.62	3	5	1.14	1
h) administrative	25	3.85	2		1.2	

10. What is the average hourly pay for these employees? (without benefits)

		full-time			part-time	
	range		med	range		med
a) train crew	10.6	10.81	10	9.4	9.95	10
b) yard crew	3.5	12.06	12.5			
c) maintenance of way	8	8.97	9	5.9	7.60	7
d) shop crafts	5.5	10.59	11	6.5	7.75	7.75
e) mechanical (cars & engines)	7.5	10.60	10	10.5	9.80	10
f) communications and signals	5.9	10.92	10.4	7.3	8.49	9
g) clerks & freight handlers	8	9.26	9.6	1.0	6.32	6
h) administrative	19	12.96	13	11	9.81	7.5

11. What is the average annual income (including overtime and fringe benefits) for these employees?

	full-time			part-time		
	range		med	range		med
a) train crew	36.7	23637	22	24	14167	14
b) yard crew	20.8	33067	40			
c) maintenance of way	21.6	21398	21	24.8	15200	13.5
d) shop crafts	10.3	25233	26		5000	
e) mechanical (cars & engines)	14.5	25090	25.4	5.4	8880	10
f) communications and signals	24	25000	25	17	10000	8.5
g) clerks & freight handlers	23	21813	21.5	1	7500	7.5
h) administrative	37.7	27721	27.5	25.8	16114	15.3

12. What type of fringe benefits are offered to employees? (such as retirement, profit-sharing, etc.)

Pension Plan - 12.8%
Profit Sharing - 17.0%
Paid Vacation - 23.4%
*Investment Plan - 2.1%
*401K - 4.3%
Paid Holiday - 12.8%
*Bereavement - 2.1%
R Retirement - 57%

Health Insurance - 78.7%
Dental Insurance - 38.3%
Bonuses - 8.5%
Life Insurance - 34.0%
Unemployment - 8.5%
*Longterm Disability - 2.1%
*Jury Pay - 2.1%

13. What employee classifications are used? (please describe briefly)

14. What is the average train crew size?

2.15 mean; median - 2; (range - 3)

15. How long is the standard work day? 8.33 hours (range - 8; med - 8)

16. How is overtime calculated? 1½ - 64% (32); other - 4.0% (2); no overtime - 32.0% (16)

17. Do most employees have union contracts?

9.4 a) yes (5)
90.6 b) no (48)

18. How many different unions are represented? .28 mean (range - 6; med - 0)

19. What type of work is contracted out?

62.3 a) track maintenance (33)
37.7 b) equipment repairs (20)
54.7 c) car and engine repairs (29)
26.4 d) other (14) ____________
9.4 e) none (5)
9.4 f) clerical (5)
7.5 g) communications (4)

20. Approximately, what percentage of those employees working for the previous owner of these lines was hired by this owner?

26.58% (range - 100; median - 10)

21. How do the wages offered by the new or present owner compare to previous wages?

14.0% a) (increase/X) a percentage increase in pay was given (please specify)
3 cases (range - 17; median - 15)
(frequency distribution - 14.6%)

21.39% b) (decrease/X) a percentage decrease in pay was made (please specify)
13 cases (range - 34; median - 20)
(frequency distribution - 58.5%)

________ c) wages remained approximately the same
(frequency distribution - 26.8%)

Are there any additional comments you would like to make concerning rail labor or your railroad?

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 is 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 respending 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.[1]

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[1] 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[2]
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, and Real Estate	Division G - finance, insurance, and real estate
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

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

12. Households	Not applicable
13. Government	Division I - government
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	0.0060	0.0057	0.0000	0.0032	0.0019	0.0045	0.0037
4. Construction	0.0646	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	0.1056	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	0.4526	0.6668	0.7447	0.0000	0.3996	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

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[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

PROJECTING FUTURE ABANDONMENTS AND LINE SALES

Forecasting future abandonments is an important part of the base-case analysis. Abandonments typically occur because the density of traffic on branch lines is insufficient; in other words, diseconomies of utilization are present. There is no hard and fast number of gross ton-miles per mile (GTMM) or carloads per mile which will make a line viable. Most abandonment applications in North Dakota have been filed on lines with 10 cars per mile or less. For example, both the York-to-Dunseith and Streeter-to-Edgeley lines, which the Burlington Northern filed abandonment applications on in the early 1980's, generated only five cars per mile. But abandonment applications have been filed at higher densities. For example, a recent Union Pacific abandonment application was for a line with a density of 12 cars per mile.

Ideally, the viability of each line should be evaluated individually under the base-case. But, it would be difficult (if not impossible) to develop detailed revenues and costs for each branch line in the state[1]. So, an alternative method of forecasting has been devised, one which considers the traffic density and the characteristics of the line. This approach is based on a minimum viable traffic density (MVTD) for North Dakota branch lines.

The MVTD is the lowest traffic density which will make a light-density line profitable to a Class I carrier in the long-run. The MVTD is an abstract concept, based on a typical grain branch line.

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[1] This would require, among other things, that: each line in the state be surveyed; a physical inventory be compiled; shipments, rates, distances, and routes to and from each individual market be determined for each commodity; and a host of other resource-intensive tasks be undertaken. Even if these tasks could be accomplished, the resource costs would be extremely high.

This concept is not new. Measures such as the "34-car per-mile rule" have been used by federal and state agencies in the past to forecast line viabilities. Although the MVTD is similar in concept to the 34-car rule, it is much more specific in nature. It is based on the actual attributes of North Dakota branch lines, and is computed from detailed line operating and cost data.

A MVTD of eleven cars per mile has been estimated for North Dakota branch lines under single-car parameters. The threshold drops to around eight cars per mile under trainload operations. Both of these figures, it should be noted, are conservative in nature. They do not reflect the efficiency losses of deferred maintenance, nor the speed restrictions and limitations that exist on individual lines. Furthermore, the off-branch expenses reflect only variable costs, at embedded interest rates. They do not include any allocation of fixed system costs (as do the so-called "fully allocated expenses"). Furthermore, do they account for the replacement cost of roadway and locomotive capital. If fully allocated off-branch costs and the current cost of capital for roadway investment are used, the break-even density increases to 14 cars per mile (see Fiugre D1).

Previous estimates have placed the threshold of viability much higher than the estimates given here. However, recent line abandonments by the BN in North Dakota clearly reflect densities below the break-even threshold (roughly five cars per mile). Perhaps the best way to interpret the eleven-car threshold is as a lower boundary of a viability range. It is doubtful that the upper boundary of the range is as high as the 34 cars per mile predicted by R. L. Banks. Instead, it is probably in the neighborhood of 25 cars per mile.

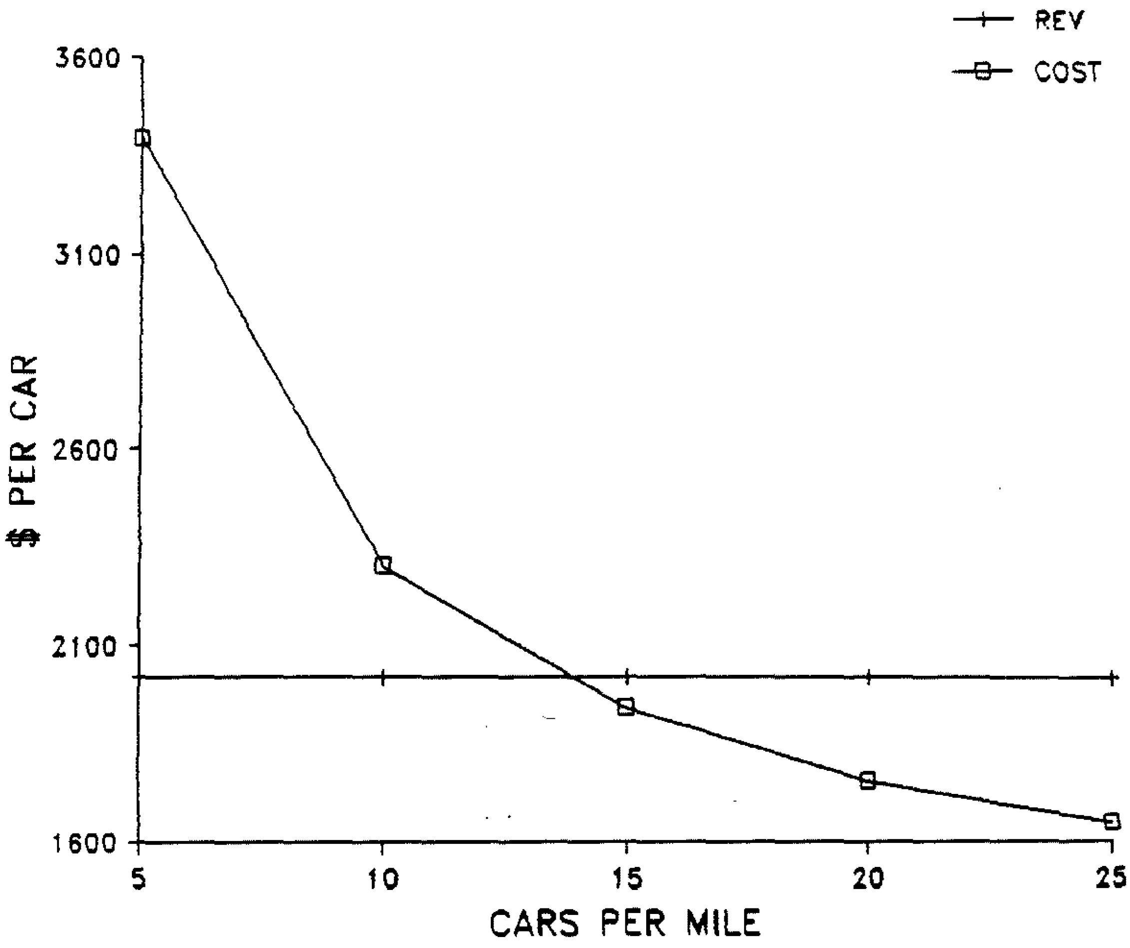

Figure D1. Minimum Viable Traffic Density for North Dakota Branch Lines

Column (b) of Table D1 shows the miles of road in North Dakota which fall into each of five density categories. Column (c) shows the probability of abandonment attached to each subgroup.

TABLE D1. MILES OF TRACK AND PROJECTED ABANDONMENTS BY DENSITY CATEGORY

(a) Cars Per Mile	(b) Miles of Track	(c) Probability of Abandonment	(d) Projected Miles Abandoned
0-5	111	1.00	111
6-10	323	.90	291
11-20	359	.50	180
21-30	354	.25	89
Total	1167	.58	672

Experience suggests that any line which cannot sustain a density of at least five cars per mile will be abandoned. Furthermore, any line with less than ten cars per mile is typically inviable unless it has substantial trainload traffic. Most branch-line traffic consists of single-car shipments. So, there is a rather high probability (say 90%) that lines in this class will be abandoned. The remaining probabilities in column (c) are more subjective in nature. As noted earlier, Class I carriers in North Dakota are usually not covering fixed off-line expenses or earning a return equal to the replacement cost of capital until the density has reached 14 cars per mile. If the traffic on lines in category 4 (10-to-20 cars per mile) declines even marginally over time, the lines will be prime candidates for abandonment. So, a probability of 50% has been assigned to this group. Lines with 20-to-30 cars per mile are generally viable in the long-run. However, problems may be present (or develop) on specific lines which could lead to some abandonments in the base case. So, a probability of 25% has been attached to this group. Altogether, as column (d) depicts, 672 miles of track could be abandoned if no action is taken and things continue as before.

Projecting the miles of track that might be sold in the future is also a difficult process. Both the BN and the Soo Line have suggested that any line with a traffic density of less than 3 million GTMM is a potential candidate for sale or rationalization. But this subgroup includes some main and feeder lines which are not likely to be sold.

Altogether, over 2,200 miles of track in North Dakota fall into the light-density or branch-line category (less than 3 million GTMM). Approximately 607 miles of this track have already been sold to the RRV&W.

Not all of the remaining lines are likely to be viable as local railroads. As depicted in Table 1, 111 miles of track have a density of five cars per mile or less. Another 291 miles fall into the six-to-ten car density range. Some of this track cannot be operated profitability even as part of a local railroad. So, it is assumed that a portion of the miles in this group (250) will not be sold (or bought). This leaves a total of 1,343 miles of potential track for sale, not including the 667 miles already sold to the RRV&W

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