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BENEFIT COST ANALYSIS

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UGPTI Staff Paper No. 114

May 1993

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MAY 1993

This report has been prepared with funds provided by the North Dakota Department of Transportation and the Federal Railroad Administration of the United States Department of Transportation. However, the data, methods, and findings presented herein do not necessarily reflect the views or policies of either agency, and are the sole responsibility of the Upper Great Plains Institute and the author.

Abstract

The Chaffee Junction to Chaffee Line segment (the *Chaffee Line*) has been analyzed using North Dakota's rail-line benefit-cost model that has been employed in previous studies. The methodology has been reviewed and accepted by the FRA. It was updated in 1992 so that the analysis period, discount rate, and treatment of project costs were consistent with the new FRA benefit-cost procedures. The benefit-cost methodology is described in Appendix C. Only the major assumptions, costing techniques, and results are included in this section.

The analysis was performed by the Upper Great Plains Transportation Institute using data provided by the Red River Valley and Western Railroad and transportation statistics maintained by the UGPTI. Using a discount rate of four percent, the overall benefit cost ratio for the project is 3.43. The project outlay will be recovered from discounted benefits by the year 2000. Thus, the pay-back period is approximately seven years.

Introduction

The Chaffee Junction-to-Chaffee Line (a.k.a. the *Chaffee Line*) consists of 11.6 miles of railroad in southeastern North Dakota on the Red River Valley & Western (RRVW) system. The line serves one elevator at two locations in Chaffee and Lynchburg. During the last three years, the line has generated around 450 cars per year, with over two-thirds of the carloads originated from Chaffee.

Some of the major aspects of the project are summarized in Table 1. This is a two year project which entails salvaging relay rail from another part of the RRVW system to replace light rail on the Chaffee line. In the first year of the project, jointed rail owned by the RRVW will be disassembled and relocated to the Chaffee line. In the second year of the project, the light rail currently in place on the Chaffee line will be disassembled and replaced with heavier relay rail.

Mile Posts	0.0 to 11.6; 2nd Subdivision
Cost Estimate	Year 1: $125,000 Year 2: $450,000
Project Type	Rail Relocation/ Replacement
Traffic Volume (1992)	596 Carloads
Affected Cities	Lynchburg, Chaffee

Table 1: Chaffee Line Rail Replacement Project Summary

Heavier rail is needed on the line for two major reasons. First, there is a shortage of tie plates on the line. With the existing light rail, the line is experiencing a severe plate-cut problem. This coupled with the load distribution of the lighter rail has resulted in poor track alignment Thus, the heavier rail will extend the life of existing ties as well as future ties laid in replacement.

Second, there has been an increase in traffic on the line. The baseline traffic consist entirely of grains and oilseeds. Last year, 596 carloads were originated or terminated on the line. This translates into a traffic density of over 50 cars per mile, making the Chaffee line a critical feeder segment of the RRVW system. The average train size is approximately 11 cars per trip, which translates into 54 trips per year. This is roughly equivalent to once a week service.

The remainder of the benefit-cost analysis is organized as follows. First, a description of operations over the line and existing line condition are presented. The next section details the costing procedures and calculations. Finally, the project benefits and costs are outlined.

Operations and Current Line Condition

Regular train service is scheduled twice weekly. Trains leave Breckenridge with two locomotives and all traffic destined for stations between Wahpeton and Casselton, plus traffic destined for the Alice and Chaffee lines (see Figure 1 for regional system configuration). Rail cars are distributed along the Casselton line until the train reaches Chaffee Junction. At this point, one locomotive and the cars to be distributed at Chaffee and Lynchburg are removed from the train. The train crew distributes the Chaffee Line traffic and leaves the locomotive at Chaffee. The crew then dead-heads back to Chaffee Junction and continues on its way to Casselton. The return trip is run in a similar fashion.

Trains are currently operated at ten miles-per hour as the track alignment is poor and the century-old 60 pound rail is failing at high rates. The light rail is failing primarily from vertical split-heads. This type of defect is the result of either the age of the rail or over-stressing the rail in the lower part of the head. Vertical cracks develop in the rail head until parts or all of it break off. The lengths of these defects could range from six inches to thirty feet. It appears that there are nearly thirty defects

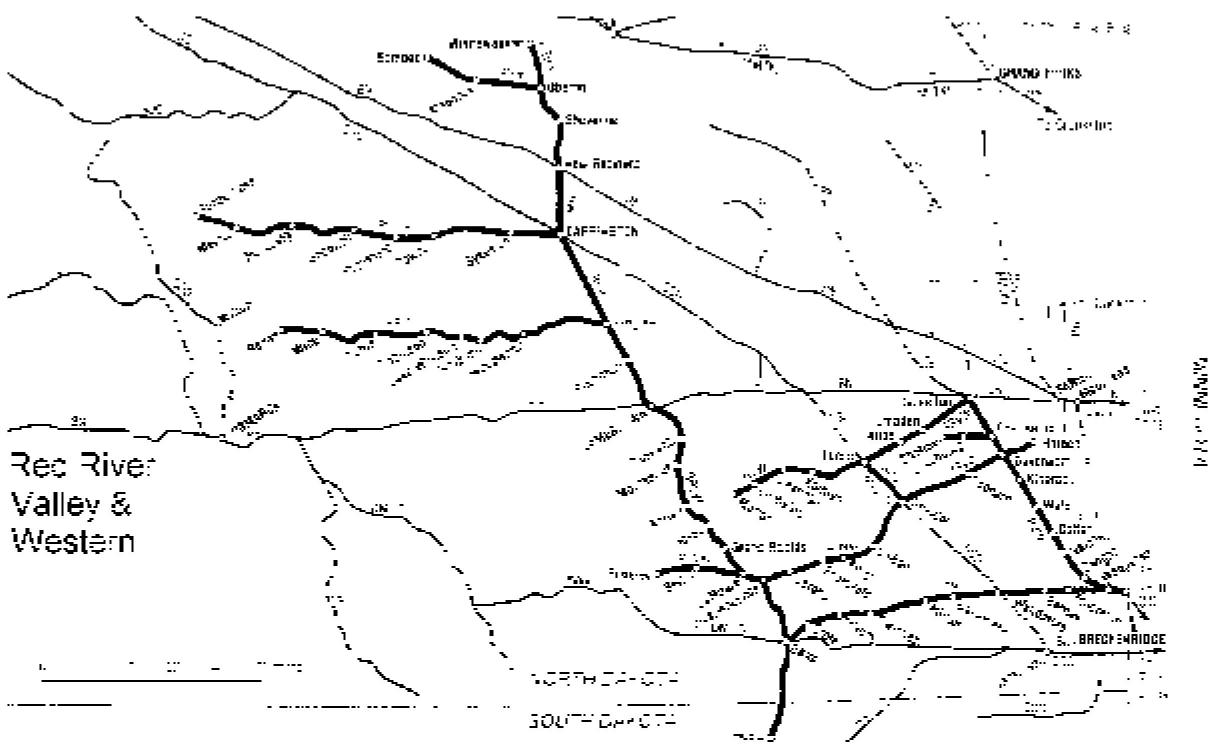

Figure 1: ©1989 Kalmbach Publishing Co, TRAINS, Mike Danneman. Modified by Brian Lindamood, 1993.

per mile in the light rail sections of the line. Of these, nearly fifty of the worst rails are being replaced annually in a continuing effort to keep the line open.

The track alignment is probably affecting the extent and severity of rail condition. Many sections of the track have poor alignment, both laterally and vertically. The probable cause is a combination of factors. The light rail is incapable of distributing the train loads over enough ties, thereby causing the ties to be over-stressed. This situation is magnified by the failure of Burlington Northern (BN) to place tie plates on the ties they replaced during the last tie program. It appears that the ties inserted during the BN tie campaign were of a soft wood variety, probably yellow pine. Consequently, most of the ties BN replaced (approximately 800 per mile) are severely plate-cut.

The over-stressed ties distribute an uneven pressure on the ballast and subgrade. The subgrade itself consists of poorly drained clay, which has very low bearing capacity. Many portions of the line, particularly the west end, have very shallow or no drainage ditches. Indeed, it appears as if water covered the track in one location during the last heavy rainfall. This combination of over-stressed ties and poor subgrade has lead to a deterioration of track alignment.

The condition of switches appears to be good. All four on-line switches are of 90 pound rail, and show no indication of deterioration. The highway crossings need some work. Most of the wooden planks used in these crossings are worn and deteriorated. Bridge condition is fair. Three of the four bridges need minor attention to the pilings in the bents. However, the bridge work can be taken care of under normal maintenance procedures. The highway crossing work is included in the rehabilitation project (which is described in detail in a later section of the report).

Base Case Scenario

If the line is not rehabilitated, the RRVW will probably file an abandonment application within five years. Thus, the base case analysis reflects abandonment (rather than continued operations). After abandonment, the only shipping option available to the elevator will be long-haul truck to final market. Trans-shipment of grains via another rail station on the RRVW, Soo Line, or BN is not feasible for two reasons.

First, the major markets for the grains are in Minnesota (Minneapolis and Duluth). The highway distance from Chaffee to Minneapolis is less than 300 miles. At this distance, the combination of a short-haul truck rate, trans-loading costs, and rail rate to final market is comparable to the long-haul truck rate. Casselton is the most likely trans-loading point. The lowest rail rate from Casselton to Minneapolis is $0.70 per hundred weight. The fully allocated cost of trucking (assuming no back-haul) is $0.63 per hundred weight. Thus, direct truck shipments will be price-competitive with combined truck-rail shipments via Casselton.

Second, it is doubtful if the Chaffee-Lynchburg elevator could remain viable without direct participation in final grain markets. Therefore, if the line is abandoned, it is expected that all traffic will be moved in trucks to Minneapolis and Duluth.

Since the base case reflects abandonment, the net liquidation value (NLV) of in-place track assets must be added to the project cost. Theoretically, the existing NLV includes both land and non-land assets. However, the alternative land use is agriculture. Thus, the railroad right-of-way (sold as small parcels) will have a zero or negative net liquidation value. Therefore, land is not considered in the NLV computation (shown in Table 2).

1000 Salvageable ties per mile * 11.6 miles * $9/tie	$ 104,400
1056 tons of 60# scrap rail * $88/ton	$ 92,928
179.52 tons of 85# relay rail * $250/ton	$ 44,880
63.36 tons of 90# relay rail * $250/ton	$ 15,840
4 90# SH switches * $12,000 complete	$ 48,000
92.8 tons of scrap material * $85/ton	$ 7,888
Removal costs @ $4.24/lf	($ 260,304)
Total Net Liquidation Value	**$ 53,632**

Table 2: Net Liquidation Value of Existing Assets

Project Scenario

The track structure will have to be rehabilitated to insure the long-term viability of operations. As noted earlier, the primary need is for replacement of the 60 pound rail. As Tables 3 and 4 show, the project will include two miles of rail relay work. The relay will include ties plates and 4,000 tons of ballast. Some highway crossing work is also included in the project.

There are no plans to increase train speed after rehabilitation. The time gained on such a small portion of track would not offset the additional fuel and maintenance cost. All analysis after rehabilitation is assumed to be at ten miles per hour. Furthermore, there is not expected to be any significant traffic growth after rehabilitation. Thus, the base-case traffic (of 596 cars) is used to estimate costs under the rehabilitation scenario.

Table 3: Red River Valley & Western R.R. Co. Year 1: Alice to Lucca Rail Salvage			
Cost Item	**Quantity (Units)**	**Unit Cost**	**Cash Cost**
Equipment:			
Track Dozer w/sled	35 days	$200.00	$ 7,000
Front End Loader	35 days	160.00	5,600
Flatbed Truck w/boom (2)	70 days	60.00	4,200
Flatbed Truck for rail (2)	70 days	60.00	4,200
Tool Truck (2)	90 days	30.00	2,700
Service Vehicle (2)	90 days	30.00	2,700
Motor Grader	10 days	80.00	800
Bolt Machine, Spike Pullers, and misc. tools and machines	45 days	60.00	2,700
Rail Crane	35 days	800.00	28,000
Gondola Rail Cars (15)	675 days	15.00	10,125
Labor:			
Supervisor	45 days	140.00	6,300
Foreman (2)	125 days	110.00	13,750
Laborers (14)	780 days	80.00	62,400
Subtotal - Year 1:			**$ 150,475**

Table 4: Red River Valley & Western R.R. Co. Year 2: Chaffee Line Rail Replacement			
Cost item	**Quantity (Units)**	**Unit Cost**	**Cash Cost**
Materials:			
Ballast	4,000 tons	$11.00	$ 44,000
Rail, 90# SH, 2 miles	316 tons	350.00	110,600
Comp. Bars	10 pairs	325.00	3,250
Tie Plates	25,600	1.25	16,000
Spikes	500 kegs	80.00	40,000
Bolts/Nuts/Washers	2,000 each	1.00	2,000
Scrap Rail (credit)	1056 tons	88.00	(92,928)
Scrap Material, OTM	80 tons	85.00	(6,800)
Surfacing-Equipment	52,800 lf	0.139	7,339
Labor:			
Install Rail	52,800 lf	5.10	269,280
Crossing Work	10	350.00	3,500
Surfacing-Labor	52,800 lf	0.131	6,917
Subtotal - Year 2:			**$ 403,158**

Table 5: Total Project Cost	
Project Subtotal, years 1 & 2	$ 553,633
Administration and Overhead Costs (5%)	$ 27,682
Project Contingencies (6%)	$ 33,218
Total Project Cost	**$ 616,194**

Operational Costs

Both on-branch and off-branch operating and equipment unit costs were computed for the Chaffee line from Red River Valley and Western's accounting and operational data. Most of the unit costs are averages for the entire railroad's system. However, they are specifically applied to the Chaffee line using actual train operating and performance factors. The unit costs were separated into fixed and variable components using data from previous analyses of shortline and regional carriers operating in the mid-west.

Four major categories of on-branch costs were computed: (1) maintenance of way, (2) train operations, (3) car hire, and (4) the opportunity cost of roadway investment. Table 6 documents the calculation of all on-branch cost elements for the Base Case.

Table 6: On-Branch Costs (Base Case)

Normalized Maintenance of Way (NMOW)	11.6 miles * 6 rails/mile/year * $78/rail + 3 people * 24 days * 8 hours/day * $16/hour/person + 11.6 miles * 150 ties/mile/year	$ 58,144.80
Maintenance Overhead (80% fixed)	11.6 miles * $500.37/mile	5,804.29
Train crew	54 trips * 5 hours/trip * 2 persons/trip * $16.8134/hour	9,079.24
Train Costs	54 trips * 5 hours/trip * $2.9167/locomotive hour + 54 trips * 23.2 miles/trip * $.2419/train mile	1,090.56
Fuel Expense	3,783 gallons * $.62/gallon	2,345.74
Overhead Costs (90% fixed)	54 trips * 23.2 miles/trip * $.45607/train mile	571.36
Car Hire Costs	596 cars * $.6538/car	389.66
Cost of Capital (10%)	$ 53,632 * 10%	5,363.20
Total On-Branch Costs		**$82,788.85**

Table 7: Off-Branch Costs		
NMOW	4.3 miles * 50 ties/mile/year * $25/tie * 25%	$ 1,343.75
Maintenance Overhead	4.3 miles * $500.37/mile * 25%	537.90
Train Crew	54 trips * 3.408 hours/trip * 2 persons/trip * $16.8134/person/hour * 48%	2,970.44
Train Costs	(54 trips * 3.408 hours/trip * $2.9167/hour + 54 trips * 85.2 miles/trip * $.2419/train mile) * 48%	791.86
Fuel Costs	54 trips * 3.408 hours/trip * 13.2 gallons/hour * $.62/gallon * 48%	722.94
Overhead Costs	54 trips * 85.2 miles/trip * $.45607/train mile * 48%	1,007.87
Cost of Capital	4.3 miles * $45,828/mile * 10% * 25%	4,926.51
Total Off-Branch Costs		**$ 12,301.27**

Line 1 of Table 6 shows the calculation of normalized maintenance of way costs, which average $5,012 per mile in the Base Case. In addition to the NMOW, the on-branch operating costs include crew wages and benefits (line 3); locomotive ownership, servicing, and related train-mile costs (line 4); fuel (line 5); and overhead costs such as train administration (line 6). The car-hire costs (line 7) reflect actual charges paid to Burlington Northern by the RRVW.

A cost of capital of ten percent has been used to compute the opportunity cost of rail-line assets (line 8 of Table 6). This is analogous to computing a return on investment (ROI) of NLV. The cost of capital rate should not be confused with the discount rate, which is used to convert future benefits into present value. The prescribed FRA discount rate of four percent has been used in the benefit-cost analysis.

Off-branch costs were developed for the movement of 596 cars over the RRVW system to the interchange point at Breckenridge. With the exception of car-hire costs, the RRVW off-branch costs (shown in Table 7) include the same components as on-branch calculations. Off-branch track maintenance and train operating costs have been allocated to the Chaffee line traffic based on its average share of the off-branch train volume that the Chaffee traffic comprised. However, the attributable costs associated with NMOW, track maintenance overhead, and opportunity cost of NLV are only computed for the 4.3 miles between Chaffee Junction and Davenport. On this portion of track, the Chaffee traffic comprises up twenty-five percent of the traffic base. However, traffic levels beyond Davenport are high enough that the Chaffee Line traffic does not constitute a significant percentage of the off-branch traffic. In essence, track maintenance costs and roadway investment would not change if the Chaffee line were abandoned. Thus, no costs for these items are allocated to the Chaffee traffic.

Off-branch train operating costs have been allocated to the Chaffee-Lynchburg traffic in relation to the average on-branch train sizes. Train service to Casselton averages twice per week. The eleven additional cars destined for the Chaffee Line equate to 48 percent of an average train. Therefore, 48 percent of the train costs associated with the Breckenridge to Chaffee trip are allocated to the Chaffee Line.

Project Benefits

North Dakota utilizes a detailed benefit-cost methodology which computes the change in producers' and consumers' surpluses resulting from rehabilitation. Five major classes of non-duplicative benefits are usually computed: (1) cost savings on existing traffic due to efficiency gains, (2) shipper profits on new traffic, (3) railroad profits on new traffic, (4) avoidable highway costs, and (5) secondary economic benefits (i.e. business volume and income effects) resulting from shipper profits on new traffic. The computational approaches yields conservative estimates of benefits since only the consumers' surplus on new traffic is considered in estimating secondary benefits. Furthermore, the process guards against double-counting of benefits.

In this analysis, it is unlikely that any new traffic will be generated from rehabilitation. Thus, only two classes of benefits (cost savings and avoidable highway costs) are considered. Due to the fact that railroad operations on the line will not change after rehabilitation, the only benefit directly gained by the railroad is a substantial decrease in normalized maintenance costs. The reduction in these costs is shown in Table 8. Normalized maintenance is reduced because of increased tie and rail life resulting from the project. However, this cost savings is partially offset by an increase in the cost of capital resulting from new rail assets being placed in the line.

Cost Item	Old Value	New Value	Change
NMOW	$ 58,144.80	$ 14,500.00	43,644.80
Cost of Capital	$ 5,363.20	$ 35,650.40	($ 30,307.20)
Annual Change in Costs			$ 13,337.60

Table 88: Annual Change in Railroad Costs

The cost savings on existing traffic results from the difference in truck and rail costs. In general, the cost to haul grains is such that railroads can provide cheaper transportation to most markets. In this analysis, if rail service is lost the only shipping alternative will be to truck grain from the two elevators to markets in Minneapolis and Duluth. Roughly half of the grain would go to each market, for an average distance of 288 miles. Statistics have shown that the average cost to move grain by truck is approximately $1.20 per vehicle mile[1]. Grain trucks are capable of hauling 53,400 pound of grain per trip (at 80,000 lbs gross weight). This load factor results in a unit cost of $0.6472 per hundred weight to ship grain to market by truck. Rail shipping costs in the Base Case and Rehabilitation Scenario have been computed using the Uniform Railroad Costing System (URCS), in conjunction with RRVW accounting data. URCS is used to compute the cost incurred by the BN in transporting grain from Breckenridge to Minneapolis and Duluth.

The unit cost to move grain to Minneapolis and Duluth will be reduced from $0.3188 per hundred weight to $0.3076 as a result of the project. This results in a shipment cost savings of 2.02 million dollars over ten years (see Appendix B).

In this analysis, it does not matter whether the cost efficiencies are passed on to shippers or retained by the railroad. As noted earlier, secondary economic impacts are not computed for this project.

By investing money in the Chaffee line, the state will prevent an increase in highway replacement and maintenance costs resulting from the increased truck traffic. This increase in costs would commence when the line is abandoned in the fifth year of the Base Case. Pavement damage from the 2,234 new truck trips was estimated using a pavement damage model developed by the Upper Great Plains Transportation Institute.

A savings in highway cost of 0.47 million dollars over ten years will be realized by avoiding abandonment of the line. Details can be found in Appendix A. The highway impact procedure is described in Appendix C.

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[1] From Truck Size and Weight Cost Study by Jack Faucett & Associates. This value is consistent with previous grain truck studies performed at the UGPTI.

Benefit Cost Analysis:

The benefit-cost equation is: cost savings on existing traffic plus pavement damage savings divided by the project cost plus the net liquidation value of the rail assets currently in place. All benefits are in present value. Specific year-by-year calculations can be found in Appendix B. The actual calculation of the benefit-cost ratio is as follows:

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Appendix A: Truck Traffic Calculations:

Basic costing parameters:

Fuel efficiency:	8 mpg
Fuel Tax	$0.17 per gallon
Registration cost:	$0.01056 per vehicle mile
Average rail car load:	200,000 pounds
Average truck load:	53,400 pounds
Trucks per carload:	3.75
Cost per ton-mile:	$0.01

Chaffee traffic: 1,492 truck loads

Route:

FAS 0994	7 miles
ND 18	18 miles
I-94	25 miles

Lynchburg Traffic: 742 truck loads

Route:

FAS 0994	1 mile
ND 18	18 miles
I-94	25 miles

Annual Increase in Highway Costs: 10,612,200 ton miles * $0.01/ton mile =

$106,122/year

Appendix B: Detailed Benefit Computation

Changes in Shipping Cost

Year	Unit Cost, Base Case	Unit Cost, Rehabilitation	Volume Shipped	Change in Shipping Cost	Present Value	Shipping Cost Savings
1	0.3188	0.3076	1168160	13083	0.961538	12580
2	0.3188	0.3076	1168160	13083	0.924556	12096
3	0.3188	0.3076	1168160	13083	0.888996	11631
4	0.3188	0.3076	1168160	13083	0.854804	11183
5	0.6472	0.3076	1168160	396707	0.821927	326064
6	0.6472	0.3076	1168160	396707	0.790315	313523
7	0.6472	0.3076	1168160	396707	0.759918	301464
8	0.6472	0.3076	1168160	396707	0.730690	289870
9	0.6472	0.3076	1168160	396707	0.702587	278721
10	0.6472	0.3076	1168160	396707	0.675564	268001

Changes in Pavement Damage

Year	Cost per Ton-Mile	In- State Ton-Miles	Annual Highway Cost	Present Value	Highway Costs
1	0.01	0	0	0.961538	0
2	0.01	0	0	0.924556	0
3	0.01	0	0	0.888996	0
4	0.01	0	0	0.854804	0
5	0.01	10612200	106122	0.821927	87224
6	0.01	10612200	106122	0.790315	83869
7	0.01	10612200	106122	0.759918	80644
8	0.01	10612200	106122	0.730690	77542

Cumulative Benefits

Year	Shipment Cost Savings	Avoidable Highway Costs	Annual Benefits	Cumulative Benefits
1	12580	0	12580	12580
2	12096	0	12096	24676
3	11631	0	11631	36307
4	11183	0	11183	47491
5	326064	87224	413288	460780
6	313523	83869	397393	858173
7	301464	80644	382108	1240282
8	289870	77542	367412	1607695
9	278721	74559	353281	1960976
10	268001	71692	339693	2300669
Total:	**1825136**	**475532**	**2300669**	