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IMPACT OF KANSAS GRAIN TRANSPORTATION ON KANSAS HIGHWAY DAMAGE COSTS

Michael W. Babcock
James L. Bunch

Kansas State University
Manhattan, Kansas

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16. Abstract

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Changes have occurred in the Kansas grain transportation system that have increased trucking of grain. Class I railroads in Kansas have encouraged the construction of unit train (100 or more railcars) loading facilities on their main lines. Kansas farmers will truck their grain a much greater distance to obtain the higher grain price at the unit train loading location. Farmers will bypass the local grain elevator, and the shortline railroad servings it, and truck the grain to the unit train loading facility, resulting in increased road damage costs.

The increasing size of grain railcars threatens to reduce shortline railroad grain traffic and increase grain trucking. The new super jumbo covered hopper cars have loaded weights of 286,000 pounds, much higher than most of the shortline railroad track in Kansas is capable of handling. As the percentage of the grain car fleet that can move on shortlines declines, grain shippers will have not alternative but to truck their grain to terminal markets.

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Final Report

Prepared by

Michael W. Babcock
Professor
Kansas State University
Department of Economics

and

James L. Bunch
Kansas State University
Department of Economics

A Report on Research Sponsored By

THE KANSAS DEPARTMENT OF TRANSPORTATION
TOPEKA, KANSAS

KANSAS STATE UNIVERSITY
MANHATTAN, KANSAS

March 2002

PREFACE

The Kansas Department of Transportation's (KDOT) Kansas Transportation Research and New-Developments (K-TRAN) Research Program funded this research project. It is an ongoing, cooperative and comprehensive research program addressing transportation needs of the state of Kansas utilizing academic and research resources from KDOT, Kansas State University and the University of Kansas. Transportation professionals in KDOT and the universities jointly develop the projects included in the research program.

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The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the views or the policies of the state of Kansas. This report does not constitute a standard, specification of regulation.

PREFACE

This research project was funded by the Kansas Department of Transportation K-TRAN research program. The Kansas Transportation Research and New Developments (K-TRAN) Research Program is an ongoing, cooperative and comprehensive research program addressing transportation needs of the State of Kansas utilizing academic and research resources from the Kansas Department of Transportation, Kansas State University, and the University of Kansas. The projects included in the research program are jointly developed by transportation professionals in KDOT and the universities.

ACKNOWLEDGEMENTS

This research project could not have been completed without the assistance and cooperation of many people. John Rosacker of the Kansas Department of Transportation (KDOT) was helpful in obtaining funding for the research project, and the KDOT monitor, John Maddox, managed the project in a professional manner. Richard Miller of KDOT helped develop the methodology employed to measure road damage cost resulting from hypothetical abandonment of study area shortline railroads. Kristi Smith typed the final report.

Special thanks go to the managers of companies with elevators located on study area shortlines, to the managers of unit train loading facilities located on study area Class I railroads, to the Vice Presidents of Agricultural Products for the Class I railroads serving the study area, and to the managers of study area shortline railroads who completed the surveys on which this report is based. Without their cooperation, this study would not have been possible.

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EXECUTIVE SUMMARY

According to the publication *Kansas Grain Transportation* (2001), the motor carrier share of wheat shipped from Kansas grain elevators increased from 37 percent in 1990 to 47 percent in 1999. The corresponding percentages for corn shipped from Kansas grain elevators were 62 percent in 1990 and 72 percent in 1999. In 1990, motor carriers accounted for 35 percent of the sorghum shipments which rose to 56 percent in 1999. For soybeans, the motor carrier market shares were 35 percent and 53 percent for 1990 and 1999 respectively.

Changes have occurred in the Kansas grain transportation system that have increased trucking of grain. Class I railroads in Kansas have encouraged the construction of unit train (100 or more railcars) loading facilities on their main lines. Kansas farmers will truck their grain a much greater distance to obtain the higher grain price at the unit train loading location. Farmers will bypass the local grain elevator, and the shortline railroad serving it, and truck the grain to the unit train loading facility, resulting in increased road damage costs.

Kansas agriculture has consolidated into fewer, larger farms. With the increased scale of operations, farmer ownership of semi-tractor trailer trucks has increased. With these trucks, Kansas farmers can bypass the local elevator and the shortline railroad serving it, and deliver grain directly to more distant markets, which will result in increased damage costs for county and state roads.

The increasing size of grain railcars threatens to reduce shortline railroad grain traffic and increase grain trucking. The new super jumbo covered hopper cars have loaded weights of 286,000 pounds, much higher than most of the shortline railroad track in Kansas is capable of handling. As the percentage of the grain car fleet that can move on shortlines declines, grain shippers will have no alternative but to truck their grain to the terminal markets.

The most important determinant of shortline railroad profitability is carloads per mile of track. Thus increased grain trucking threatens the economic viability of shortlines, possibly resulting in abandonment of these railroads. This would cause a large diversion of grain traffic to Kansas roads and a concomitant increase in road damage costs.

Abandonment of shortlines would have additional negative effects on Kansas rural areas such as:

- Lower Grain Prices Received by Farmers
- Higher Transportation Costs and Lower Profits for Rail Shippers
- Loss of Market Options for Shippers
- Lost Economic Development Opportunities for Rural Communities
- Loss of Local Tax Base Needed for Basic Government Services
- Potential Increase in Highway Accidents due to Increased Highway Traffic

Thus it is important to identify the causes of increased grain trucking, to measure the impact on Kansas shortline railroads, and identify strategies that Kansas could use to avoid the increased road damage costs associated with shortline abandonment. Accordingly, the objectives of this study are as follows:

Objective A – Identify changes in Kansas grain transportation that are diverting more grain traffic to trucking.
Objective B – Measure the effect of the changes identified in Objective A on Kansas shortline grain traffic and financial condition.
Objective C – If the impacts measured in Objective B are significant, measure the increase in Kansas road damage costs attributable to increased trucking of grain due to abandonment of Kansas shortlines.
Objective D – Suggest strategies that the state of Kansas could use to avoid the increased road damage costs accompanying shortline abandonment.

The study area for this research corresponds to the western two-thirds of Kansas. During the 1998-2000 period the study area accounted for 92 percent of the total Kansas wheat production, 79 percent of the state's sorghum production, 82 percent of Kansas corn production, and 40 percent of the soybean production.

The objectives of the study were achieved through personal interviews of shippers located on Kansas shortline railroads serving the study area. A questionnaire was also distributed to these shippers, and 74 companies accounting for 177 grain elevator stations returned completed questionnaires.

Executives of each of the four shortline railroads serving the study area were interviewed and they also completed questionnaires. The Vice Presidents of Agricultural Products for the two major Class I railroads serving the study area were interviewed and they completed questionnaires as well.

The objectives of the study were also accomplished by interviewing managers of unit train loading facilities located on Class I railroads in the study area, excluding facilities in the traditional terminal locations, i.e., Wichita, Hutchinson and Salina. Of the 12 such defined facilities, questionnaires were complete and returned by nine of them.

The methodology employed to calculate road damage costs due to abandonment of Kansas shortline railroads serving the study area is the following 12 step procedure.

1. The incremental increase in truck traffic was determined given the simulated removal of shortline rail service.
2. The least cost route (origin-destination) was determined for the incremental truck traffic.
3. Pavement characteristics along the truck routes were ascertained.
4. Axle load equivalency factors for a standard grain truck were calculated given truck and road characteristics.
5. The maximum tolerable decline in pavement serviceability (PSR) was quantified given KDOT design and pavement management policies.
6. The maximum feasible life of the pavement in the study area in the absence of traffic was estimated.
7. The total number of standardized truck passes until pavement failure (ESAL life) for each impacted pavement segment was calculated.
8. The expected percentage of loss in pavement serviceability (PSR) as a result of temporal-environmental decay was estimated.
9. The adjusted unit cost per mile per truck pass (ESAL) was calculated for each impacted pavement segment by separating estimated non-traffic costs.
10. The total cost of the incremental increase in traffic was determined for each shortline's grain traffic.
11. The pavement characteristics for county paved roads were estimated using the pavement characteristics of nearby state highways with similar traffic patterns and steps 3 through 9 were

used to estimate damage using the approximated road characteristics.
12. Damage to county roads was estimated by determining an average cost to apply aggregate (gravel) and multiplying that cost by the amount of aggregate expected to be lost due to incremental grain truck traffic.

The principal conclusions (results) of the study are as follows:

1. Most of the wheat grown in the study area is transported out of Kansas by Class I railroads to U.S. flour mills and export ports. For the 1997-2000 period, Class I railroad (Union Pacific System plus Burlington Northern Santa Fe) wheat carloadings in Kansas were 347,400. During the same period their combined Kansas carloadings of sorghum, corn, and soybeans were 193,854.

A total of 70 percent of the Class I railroad carloadings in the study area originate at the terminal elevators in Salina, Hutchinson and Wichita, and at the unit train loading locations identified in Table 2 (on page 9). The majority of the grain received by the terminals in Salina, Hutchinson and Wichita is delivered by truck, and all of the grain received by the unit train shipping locations on Class I railroads arrives by motor carrier. It is estimated that the dozen unit train locations in the study area receive 184,500 truckloads per year or 15,375 truckloads per facility. These are semi-tractor trailer and tandem axle trucks with about one-third of the receipts delivered by farmers and two-thirds from commercial elevators.

The principal destination for the wheat shipments from unit train locations is the Texas Gulf (export). Other primary wheat destinations are Mexico and U.S. flour mills. The two primary destinations for sorghum shipments from these facilities are the Texas Gulf (export) and Mexico.

In the 1997-1999 period, nearly 860 million bushels were received by elevators located on the shortline railroads serving the study area. Nearly 80 percent of this volume was delivered by farmers in semi-tractor trailers and tandem axle trucks. During the same time period, about

45 percent of the wheat shipments of these elevators were transported by shortline railroads and 55 percent by motor carrier. Trucks dominated the shipments of sorghum, corn and soybeans from these elevators, accounting for 83 percent of the sorghum shipments and nearly 98 percent of the combined corn and soybean shipments. In total, shortlines accounted for only 28 percent of the grain shipments from the elevators located on their systems.

U.S. flour mills (including those in Kansas), Hutchinson and Wichita were major destinations for both truck and shortline wheat shipments from the elevators located on the shortline railroads serving the study area. Unit train locations on Class I railroads were major destinations for truck wheat shipments. The major destinations for truck shipments of sorghum from these facilities are feedlots in Kansas, Oklahoma and Texas. Other major destinations for sorghum truck shipments were unit train loading locations and alcohol manufacturing plants. The principal destination for sorghum shipped by shortlines from these elevators was Wichita. Motor carriers dominate the corn and soybean shipments from elevators located on shortlines. The major destinations for the corn shipments are Kansas, Oklahoma and Texas feedlots, with Wichita being the dominant destination for truck soybean shipments.

2. The two most frequently cited reasons for increased grain trucking by shippers located on shortlines serving the study area were the same for wheat, sorghum and soybeans, which are (1) truck service is more frequent and dependable than rail service, and (2) truck rates are lower than rail rates. For corn, the two most frequently cited reasons for increased grain trucking are (1) the best corn markets are not rail-served, and (2) truck service is more frequent and dependable than rail service. When the reasons for increased trucking of grain are aggregated for wheat, sorghum, corn and soybeans the following results are obtained.

Reasons for Increased Grain Trucking	Number of Shippers Citing the Reason
1. Truck service is more frequent and dependable than rail service	121
2. Truck rates are lower than rail rates	102
3. Uncompetitive rail rates	94
4. Best markets are not rail-served	76
5. Railcar shortages	70
6. Construction of rapid loadout facilities on Class I railroads	53

These results indicate that shippers on study area shortlines have increased their trucking of grain primarily because they view motor carrier service and prices as superior to that of railroads. This result closely correlates with the results of a carrier choice analysis which indicated that shippers emphasize the transportation rate and ability to ship to many markets as the primary factors that they consider when choosing a transportation mode. Therefore, they are shipping more grain by truck because the shippers (as a group) can obtain a lower transportation rate by selecting motor carriers, and because the best sorghum, corn and soybean markets are better served by motor carriers than by railroads.

Increased ownership and use of large trucks gives farmers greater flexibility in terms of markets and timing of sale if the farmer has sufficient on-farm storage. If this is the case, the producer can store some of his grain on farm, and then later transport the grain a greater distance to a more profitable market (i.e., a unit train shipping facility) at a time of the farmer's choosing. Thus increased farmer ownership of large trucks has contributed to increased trucking of grain.

The Vice Presidents of Agricultural Products of UP and BNSF said that low truck rates relative to rail rates was a cause of increased grain trucking, but that this was due to many shippers buying their transportation on the spot market (as opposed to a guaranteed car supply system) where truck prices are less than rail prices. Other factors mentioned by the vice presidents as causes of increased grain trucking included increased demand for truck transport to move feed grains to the feedlots of Kansas, Oklahoma and Texas; and Kansas highway construction projects (front haul of construction materials and grain backhaul).

There was a substantial difference of opinion between the executives of study area shortlines and the shippers located on these railroads concerning the significance of construction of rapid loadout facilities on Class I railroads as a reason for increased grain trucking. The shippers ranked several other causes as more important, but three of the four executives of the shortlines designated this factor as a significant cause of increased grain trucking.

3. According to executives of study area shortlines the impact of increased grain trucking on shortline grain traffic was estimated to range from a low of 6 to 10 percent on one railroad to a high of 21 to 30 percent on another. Based on these estimates, the combined 1998 and 1999 grain carloadings of the four shortlines would have been 17 percent greater if increased grain trucking had not occurred.

The shortline railroad executives estimated the impact of increased grain trucking on their railroad's profits, and all agreed that profits were reduced by 11 to 20 percent.

Executives of study area shortlines ranked adequate traffic levels as the most important determinant of shortline railroad success (profits). The closely related determinant "strong shipper support" tied for the third most important factor. Thus grain is the most important commodity of study area shortlines and traffic volume is the most important determinant of shortline profitability. As more grain has been shipped by truck, shortline traffic and profits have been negatively affected, perhaps threatening the long run viability of these railroads.

4. Another challenge facing Kansas shortlines is the increasing use of 286,000 pound covered hopper cars to transport Kansas grain. All the study area shortlines would have to upgrade their tracks and bridges to handle the larger cars and would face increased costs to

maintain their tracks and bridges as more heavy axle load (HAL) cars move on their lines. The majority of the shortline executives stated that their system infrastructure can't handle the larger car and they would need government assistance to sufficiently improve track quality.

An executive of a Class I railroad serving Kansas stated that shortlines have time to make the investments in tracks and bridges that would enable them to handle the HAL cars since there will be an ample supply of smaller grain cars for several years into the future. However, this executive said that shortlines that are unable to handle the larger cars will lose grain traffic if they are competing with a unit train shipping facility located on a rail line that is capable of handling 286,000 pound cars. Both Class I railroad executives that participated in this study stated that if shortlines are unable to handle HAL cars, then the share of grain transported by truck would continue to increase.

5. If the structural changes in the Kansas grain transportation system continue, the long run viability of Kansas shortlines could be threatened. Should this happen, several consequences could occur. One of the most important impacts would be increased road damage as the grain the shortlines would have transported is diverted to motor carriers.

It is estimated that the study area shortline rail system saves the state of Kansas $49.5 million in pavement damage costs annually, with the average damage cost of incremental truck traffic costing approximately $0.17 per truck mile. The total pavement damage cost savings for the study area is apportioned with 37 percent of the savings being provided by the Central Kansas Railroad (CKR), 37 percent by the Kyle, 21 percent by the Cimarron Valley Railroad (CV), and 5 percent by the Nebraska, Kansas and Colorado Railnet (NKC). The CV provides a disproportionate amount of positive benefit (in terms of average road damage cost per mile of abandoned track) due to the poorer pavement conditions in the CV's area of operation. The

CV's average road damage cost per mile of abandoned track as well as its average road damage per incremental truck mile are about double that of the other study area shortlines. The CKR and Kyle railroads each prevent over $18 million in pavement damage cost per year, the CV prevents over $10 million, and the NKC prevents about $2.5 million annually.

6. Increased grain trucking in Kansas has reduced shortline railroad grain traffic and harmed profitability. Thus we asked grain shippers and railroad executives to address the question, "Does shortline railroad transportation have a future in Kansas?" The question had three possible responses which were yes, no, and maybe.

With respect to the grain shippers located on study area shortlines, about half (49.4 percent) said that shortlines have a future in Kansas. A little over one-third (36.4 percent) stated that shortlines may have a future under certain conditions, and only 14.2 percent said that shortline railroads do not have a future in the Kansas grain transportation system.

For the grain shippers located on shortlines which agreed that shortlines have a role to play in the Kansas grain transportation system, the most frequently mentioned reason was that shortlines provide better service than their previous Class I railroad. Another frequently mentioned reason was that wheat and sorghum markets are better served by rail transport.

Concerning the grain shippers located on study area shortlines that believe shortlines do not have a future in Kansas grain transportation, the principal reasons were "shortlines don't serve the best feed grain markets," and "unit train shipping facilities on Class I railroads have reduced shortline grain traffic."

For the grain shippers who said that shortlines may have a future in Kansas grain transportation, the most frequently mentioned factor was the need for more competitive rates. These shippers also emphasized that shortlines must obtain the capital necessary to maintain their tracks to provide faster service and handle larger railcars.

Managers of 9 of the 12 unit train shipping facilities listed in Table 2 (on page 9) responded to the question. Managers of four companies responded “yes” to the question. Managers of three companies responded “no,” and two selected the “maybe” alternative.

With regard to the unit train facility managers that believe shortlines have a future in Kansas grain transportation, three of them emphasized the significance of large wheat production in Kansas. According to these managers, the shortline’s function is to move wheat from areas with large wheat production to domestic flour mills. The flour mills provide a stable demand for shortline transport throughout the year.

One of the unit train facility managers who stated that shortlines do not have a future in Kansas said that elevators on shortlines will ship grain by truck to unit train facilities on Class I railroads who will be the rail shippers. Another manager said that the poor service of some shortlines won’t allow them to survive in the long run.

Executives of the four study area shortline railroads were asked if shortline railroad transportation has a future in Kansas. Two of the executives responded “yes” to the question and two responded “maybe”. One of the two executives responding in the affirmative to the question said that shortlines have a future, especially if a “level playing field” is established between railroads and trucks. The other executive in this group noted that railroads have cost advantages relative to trucks for long haul grain shipments.

One of the executives expressing a “maybe” opinion on the future of shortlines in Kansas said that shortlines are needed to serve the domestic flour mill market. The other shortline executive in this group said that the main shortline survival issue will be how (if) Kansas helps shortlines overcome the heavy axle railcar problem.

In summary, while the study area shortlines face significant challenges, the majority of the participants in the Kansas grain logistics system believe that they have a viable and important role to play in the marketing of Kansas grain.

Since the study area shortline railroads annually save the state of Kansas nearly $50 million in avoided road damage cost, the state has an economic interest in the preservation of shortline rail service. Thus the following policy recommendations should be considered.

Kansas has two shortline railroad assistance plans which are the Federal Local Rail Freight Assistance to States (LRFA) and the State Rail Service Improvement Funds (SRSIF). The LRFA program provides low interest revolving loans below the prime rate to shortlines. The SRSIF was established in 1999 to provide shortline railroads operating in Kansas with low interest, 10 year revolving loans to be used primarily for track rehabilitation. For SRSIF projects the shortline must pay 30 percent of the cost of the project and the state provides a combination of grants (30 percent) and loans (40 percent) for the remaining 70 percent.

In order for Kansas shorline railroads to be able to safely and efficiently handle HAL cars and provide better service, the funds in the SRSIF program need to be greatly increased. In order to reduce the impact of SRSIF on debt burdens of shortlines, the state's 70 percent share of track rehabilitation projects should be increased to 90 percent with the grant portion at 60 percent and the loan portion at 30 percent, if SRSIF funds are increased.

The federal government needs to change the Railroad Rehabilitation and Improvement Financing (RRIF) program which has not been used at all in Kansas. The program provides for up to one billion dollars in direct loans and loan guarantees for projects benefiting freight railroads other than Class I carriers (i.e., shortline railroads). The maximum repayment period is 25 years and the current interest rate is about 6 percent. One unique feature of the RRIF program is the payment of a credit risk premium prior to an appropriation of funds. The credit risk premium is a cash payment to be provided by the loan applicant or a non-Federal infrastructure partner on behalf of the loan applicant.

The RRIF program could provide a source of loans for Kansas shortline railroads to improve their system infrastructure to accommodate HAL cars and attract more traffic. Currently there are no RRIF loan applicants in Kansas. The federal government needs to modify the provisions of RRIF in order to make it attractive to shortlines. The maximum repayment period could be extended to 30 years and the interest rate reduced to 3 percent to conform to the interest rate available on LRFA and SRSIF loans. The credit risk premium should be modified to be more user friendly since, as noted above, there are currently no RRIF loan applicants in Kansas.

It is recommended that Port Authorities, as an economic development goal, purchase covered hopper cars, new or used, and lease them to shortline railroads for use in Kansas. Given periodic car shortages and railroad congestion, the Class I railroads can not always supply shortline railroads with covered hopper cars in a timely manner. Having an adequate covered hopper car supply to move Kansas grain to market is paramount to the continued success of shortline railroads operating in the state.

STRUCTURAL CHANGE IN GRAIN TRANSPORTATION: A KANSAS CASE STUDY

Abstract

Since the early 1990s, an increasing amount of Kansas grain tonnage has been diverted from shortline railroad shipment to truck shipment. Grain is the principal commodity of most Kansas shortlines and the most important determinant of shortline profitability is carloads per mile of track. Thus increased grain trucking threatens the economic viability of shortlines. Consequently, the objectives of the paper are (a) to identify changes in Kansas grain transportation that are diverting more grain traffic to trucking, and (b) to measure the effect of the changes identified in objective (a) on Kansas shortline grain traffic and financial condition. The objectives of the paper were achieved through questionnaires and personal interviews of shippers located on Kansas shortline railroads, executives of Kansas shortline railroads, and executives of the two major Class I railroads serving Kansas.

Questionnaires and personal interviews of shippers located on Kansas shortlines indicated that the shippers are moving more of their grain by truck because they believe that truck service is more frequent and dependable than rail service, and that truck rates are lower than rail rates. Other reasons identified as contributing to increased grain trucking are increased farmer ownership of large trucks, the increased demand for truck transport of feed grains to livestock feedlots, and construction of unit train facilities on Class I railroads.

It was estimated that total grain carloadings of the four shortline railroads serving the study area would have been 17 percent greater had increased grain trucking not occurred. The shortline executives estimated that increased grain trucking reduced their profits by 11 to 20 percent.

CHAPTER 1

INTRODUCTION

1.1 Research Problem and Objectives

In 2000, Kansas produced 347.8 million bushels of wheat, 416 million bushels of corn, 188.8 million bushels of sorghum, and 50 million bushels of soybeans. This amounts to a total of 28.9 million tons, most of which was shipped from Kansas country grain elevators to Kansas terminal markets. Since the early 1990s, an increasing amount of grain tonnage has been diverted from shortline railroad shipment to truck shipment. According to the publication *Kansas Grain Transportation* (2001), published by Kansas Agricultural Statistics, the motor carrier share of wheat shipped from Kansas grain elevators increased from 37 percent in 1990 to 47 percent in 1999. The corresponding percentages for corn shipped from Kansas grain elevators were 62 percent in 1990 and 72 percent in 1999. In 1990, motor carriers accounted for 35 percent of the sorghum shipments which rose to 56 percent in 1999. For soybeans, the motor carrier market shares were 35 percent and 53 percent for 1990 and 1999 respectively.

Changes have occurred in the Kansas grain transportation system that have contributed to increased trucking of grain. Class I railroads in Kansas are encouraging the construction of unit-train (100 railcars) loading facilities (subterminals) on their main lines. According to Rindom, Rosacker, and Wulfkuhle (1997, p. ii) Kansas farmers will truck their grain a much greater distance to obtain the higher grain price at the subterminal location. Farmers will bypass the local grain elevator, and the shortline railroad serving it, and truck the grain to the subterminal, resulting in increased road damage costs.

Kansas agriculture has consolidated into fewer, larger farms. With the increased scale of operations, farmer ownership of semi-tractor trailer trucks has increased. With these trucks, Kansas farmers can bypass the local grain elevator, and the shortline railroad serving it, and deliver grain directly to more distant markets, which will result in increased damage costs for county and state roads.

The increasing size of grain railcars threatens to reduce shortline railroad grain traffic and increase grain trucking. The new super jumbo covered hopper cars have loaded weights of 286,000 pounds, much larger than most of the shortline railroad track in Kansas is capable of handling. As the percentage of the grain car fleet that can move on shortlines declines, grain shippers will have no alternative but to truck their grain to the terminal markets.

The increasing share of Kansas grain transported by motor carrier has negative financial implications for shortline railroads. According to Babcock et al. (1993, p. 80) grain is the principal commodity of most Kansas shortlines. The negative impact on shortlines of increased trucking is especially significant for rural Kansas since shortlines have assumed operation of an increasing amount of the Kansas rail system. According to *Kansas Rail Plan Update, 2000-2001*, published by Kansas Department of Transportation, the principal Class III railroads operating in Kansas are:

Railroad	Mileage (including leased trackage but not trackage rights)
Central Kansas Railway	931*
Kyle Railroad	466
South Kansas and Oklahoma	271
Cimarron Valley Railroad	182
Nebraska, Kansas and Colorado	122

*The Kansas and Oklahoma Railroad began operating the former Central Kansas Railway on June 29, 2001.

These five railroads account for 39 percent of total Kansas railroad mileage. According to Babcock, Prater, and Russell (1997, p. 121) the most important determinant of shortline railroad profitability is carloads per mile of track. Thus increased grain trucking threatens the economic viability of shortlines, possibly resulting in abandonment of these railroads. This would cause a large diversion of grain traffic to Kansas highways and a concomitant increase in road damage costs.

Abandonment of shortlines would have additional negative effects on Kansas rural areas such as:

- Lower Grain Prices Received by Farmers
- Higher Transportation Costs and Lower Profits for Rail Shippers
- Loss of Market Options for Shippers
- Lost Economic Development Opportunities for Rural Communities
- Loss of Local Tax Base Needed for Basic Government Services
- Potential Increase in Highway Accidents due to Increased Highway Traffic

Increased trucking of grain could have other negative impacts in Kansas. For example, increased road congestion may produce more vehicle accidents and reduce average speeds, resulting in a rise in the opportunity cost of time in transit. The significant increase in heavy truck movements will increase the frequency and magnitude of rutting and cracking of the pavement, causing additional vehicle maintenance costs for passenger vehicle owners.

If additional motor carrier user fees are equal to the increment in truck attributable road damage cost, then other highway users and the state of Kansas are no worse off. However, Russell, Babcock, and Mauler (1995, p. 119) found that truck attributable road damage costs increase by a much greater percentage than the increase in grain transported by motor carrier. Thus it is highly unlikely that additional truck user fees will cover the increase in road damage costs.

What are the causes of increased grain trucking in Kansas? One possible cause could be a decrease in the Kansas railroad network. In the 1970s, 415 miles of track were abandoned;

abandonment nearly doubled in the 1980s to 815 miles with an additional 1252 miles abandoned in the 1990-1999 period. Other hypothesized causes include railcar shortages, uncompetitive shortline prices, and construction of grain subterminals (unit train shipper) on Class I railroads. Other factors such as increased use of 286,000 pound jumbo covered hopper cars by Class I railroads have the potential to damage shortlines in the future and divert more grain to truck shipment, resulting in increased road damage cost. Thus it is important to identify the causes of increased grain trucking, to measure the impact on Kansas shortline railroads, and identify strategies that Kansas could use to avoid the increased road damage costs associated with shortline abandonment. Accordingly, the objectives of this study are as follows:

Objective A – Identify changes in Kansas grain transportation that are diverting more grain traffic to trucking.

Objective B – Measure the effect of the changes identified in Objective A on Kansas shortline grain traffic and financial condition.

Objective C – If the impacts measured in Objective B are significant, measure the increase in Kansas road damage costs attributable to increased trucking of grain due to abandonment of Kansas shortlines.

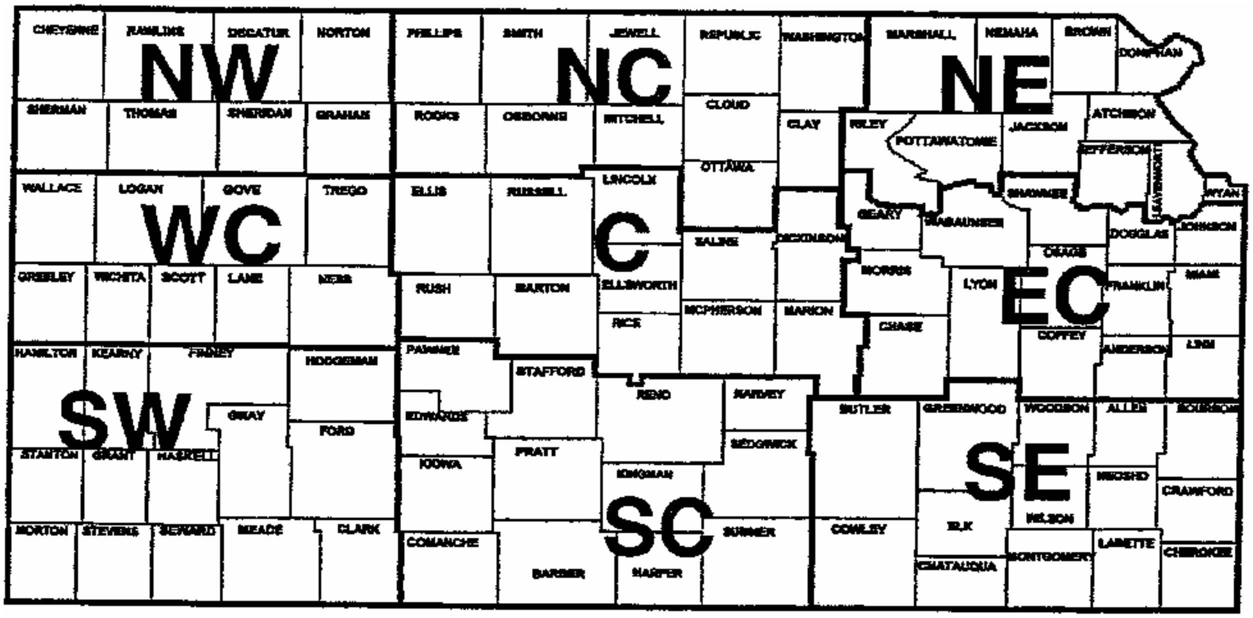
Objective D – Suggest strategies that the state of Kansas could use to avoid the increased road damage costs accompanying shortline abandonment.

1.2 Methodology

The study area corresponds to the western two-thirds of Kansas encompassing the three central and three western Kansas crop reporting districts (see Figure 1). Table 1 displays study area grain production for the 1998-2000 period. During this period the study area accounted for

Figure 1

Kansas Crop Reporting Districts



Kansas is divided into nine agricultural statistics districts for convenience in compiling and presenting statistical information on crops and livestock. These nine districts are outlined in the above map. The districts are designated as follows: Northwest (NW), West Central (WC), Southwest (SW), North Central (NC), Central (C), South Central (SC), Northeast (NE), East Central (EC), and Southeast (SE).

Table 1

Study Area Grain Production, 1998 – 2000

Thousands of Bushels

Year	Wheat	Corn	Sorghum	Soybeans	Total
1998	452,488	342,565	206,672	26,277	1,028,002
1999	407,378	359,505	210,216	33,025	1,010,124
2000	311,785	328,685	142,322	23,738	806,530
Total	1,171,651	1,030,755	559,210	83,040	2,844,656

Sources: (1998) Kansas Department of Agriculture, *Kansas Farm Facts 2000*. (1999 and 2000) Kansas Department of Agriculture, *Kansas Farm Facts 2001*.

92 percent of total Kansas wheat production, 79 percent of the state's sorghum production, 82 percent of Kansas corn production, and 40 percent of the soybean production. The study area produced 83 percent of Kansas output of the four crops combined.

The objectives of the study were achieved through personal interviews of shippers located on Kansas shortline railroads serving the study area. A questionnaire (see Appendix A) was also distributed to these shippers, and 74 companies accounting for 177 grain elevator stations returned completed questionnaires. In 1999, the grain receipts of these companies were 36% of study area wheat production, 33 percent of the sorghum production, 21 percent of corn output, and 20 percent of soybean production.

Executives of each of the four shortline railroads serving the study area were interviewed and they also completed questionnaires (see Appendix B). The Kansas Southwestern Railroad began operations in 1991, and the Central Kansas Railroad initiated service in 1993. These two railroads merged in June 2000 and became Central Kansas Railway (CKR). The CKR sold its Kansas system to Kansas and Oklahoma Railroad which began operating on June 29, 2001. The Kansas and Oklahoma serves the central part of the study area from Wichita west to the Colorado border. It also serves south central Kansas and has a line from Salina to Osborne. At the time of the sale the CKR had 943 route miles and 81 full time employees.

The Kyle Railroad serves the northern part of the study area with a 466 mile system. Of this total, 16 miles are owned by the Kyle, 272 miles are leased from Mid States Port Authority with the remainder of the system leased from Union Pacific Railroad System. The Kyle began operations in 1982 and has 110 full time employees.

The Cimarron Valley Railroad has 260 route miles with 182 miles in southwest Kansas. The Cimarron Valley Railroad was purchased from the Santa Fe Railroad and began operations in February 1996. The railroad has 18 full time employees.

The Nebraska, Kansas and Colorado Railnet serves five Kansas counties in the northwest part of the study area. The railroad has 122 miles in Kansas and 17 miles of trackage rights on the Kyle Railroad. The railroad began operations in December 1996 and has 30 full time employees.

The Vice-Presidents of Agricultural Products for the two major Class I railroads serving the study area were interviewed and they completed questionnaires as well (see Appendix C). The Burlington Northern Santa Fe (BNSF) has 1067 miles of main line track in Kansas and 188 branchline miles. The Union Pacific System (UP) has 1734 main line miles in Kansas and 315 branchline miles.

The objectives of the study were also accomplished by interviewing managers of unit train loading facilities located on Class I railroads in the study area, excluding facilities in the traditional terminal locations, i.e., Wichita, Hutchinson and Salina. Of the 12 such defined facilities, questionnaires were completed and returned by nine of them (see Appendix D). The BNSF and UP facilities are described in Table 2.

The methodology employed to calculate road damage costs due to abandonment of Kansas shortline railroads serving the study area is discussed in Chapter 6.

Table 2

Unit Train Loading Stations on Class I Railroads in the Study Area
Excluding Wichita, Hutchinson, and Salina

BNSF Facilities

Company Name	Location
Right Coop Association	Wright, Kansas
Wind River Grain LLC	Garden City, Kansas
Ag Mark LLC	Concordia, Kansas
Farmland Grain Division	Wellington, Kansas
DeBruce Grain Inc.	Abilene, Kansas
Collingwood Grain Inc.	Dodge City, Kansas

UP Facilities

Company Name	Location
Farmers Coop Co.	Haviland, Kansas
Cargill North American Grain	Wakeeney, Kansas
Farmland Industries	Ogallah, Kansas
Wallace County Coop Equity Exchange	Sharon Springs, Kansas
Cornerstone Ag LLC	Colby, Kansas
DeBruce Grain Inc.	Abilene, Kansas
Collingwood Grain Inc.	Plains, Kansas

CHAPTER 2

TRENDS IN KANSAS GRAIN TRAFFIC

2.1 Kansas Grain Carloadings of Class I Railroads

Most of the wheat grown in the study area is transported out of Kansas by Class I railroads to domestic flour mills and export ports. Thus an examination of Class I railroad grain carloadings provides perspective on the size of the Kansas grain transportation market. According to *Kansas Rail Plan Update*, 2000-2001 (p. 29), Union Pacific (UP) and Burlington Northern Santa Fe (BNSF) together accounted for 92 percent of the 2000 Farm Products Carloadings originated in Kansas. Thus in the discussion that follows the term "Class I railroads" refers to the combined total for UP and BNSF.

Table 3 contains Class I railroad wheat carloadings in Kansas by month for the years 1997 through 2000. Wheat carloadings increased from 72,550 in 1997 to 102,180 in 1999 before falling to 73,370 in 2000. The decline in year 2000 carloadings is likely due to much lower wheat production in 2000 compared to 1998 and 1999. The data in Table 3 reveal that July, August and September are the peak months for Class I railroad wheat carloadings.

In contrast to wheat, much of the corn, sorghum, and soybeans produced in the study area is transported by motor carrier to local Kansas markets. Much of the corn and sorghum is shipped by motor carrier to Kansas feedlots and alcohol plants while soybeans are transported by truck to Kansas soybean processing plants. Nevertheless, Class I railroad carloadings of these crops are substantial. Table 4 contains Class I railroad sorghum, corn and soybean carloadings in Kansas by month for the years 1997 through 2000. Carloadings declined from 54,164 in 1997 to 41,979 in 2000. The decrease in carloadings may be partly due to declining sorghum and

Table 3

Class I Railroad Wheat Carloading in Kansas by Month*

1997 - 2000

Month	1997 Carloadings	Percent of Total	1998 Carloadings	Percent of Total	1999 Carloadings	Percent of Total	2000 Carloading	Percent of Total
January	2,661	3.7	6,080	6.1	5,463	5.3	3,236	4.4
February	2,975	4.1	5,781	5.8	5,383	5.3	3,711	5.0
March	2,867	3.9	6,450	6.5	5,367	5.2	3,966	5.4
April	3,082	4.2	6,692	6.7	6,266	6.1	4,368	6.0
May	1,801	2.5	6,386	6.4	7,398	7.2	4,728	6.4
June	3,019	4.2	8,688	8.7	7,146	7.0	6,582	9.0
July	15,476	21.3	13,263	13.4	16,582	16.2	9,361	12.8
August	13,135	18.1	14,275	14.5	16,405	16.1	11,886	16.2
September	12,060	16.6	12,796	12.9	14,290	14.0	9,841	13.4
October	5,818	8.0	7,574	7.6	7,832	7.7	5,395	7.4
November	4,685	6.5	5,099	5.1	5,690	5.6	5,864	8.0
December	4,971	6.9	6,216	6.3	4,358	4.3	4,432	6.0
Total	72,550	100.0	99,300	100.0	102,180	100.0	73,370	100.0

*Combined carloadings of UP and BNSF

Table 4

Class I Railroad Sorghum, Corn, and Soybean Carloading in Kansas by Month*

1997 - 2000

Month	1997 Carloadings	Percent of Total	1998 Carloadings	Percent of Total	1999 Carloadings	Percent of Total	2000 Carloading	Percent of Total
January	8,842	16.3	6,088	11.3	6,096	13.9	6,801	16.2
February	7,495	13.8	6,378	11.9	4,849	11.0	5,514	13.1
March	7,616	14.1	3,857	7.2	3,460	7.9	4,907	11.7
April	5,859	10.8	4,434	8.2	3,530	8.0	3,507	8.4
May	4,376	8.1	4,055	7.5	3,576	8.1	3,931	9.4
June	2,269	4.2	2,763	5.1	2,265	5.2	2,100	5.0
July	1,462	2.7	1,912	3.6	670	1.5	1,275	3.0
August	700	1.3	2,120	3.9	531	1.2	961	2.3
September	920	1.7	3,771	7.0	1,416	3.2	3,205	7.6
October	5,418	10.0	8,347	15.5	5,998	13.7	3,747	8.9
November	4,632	8.6	5,469	10.2	5,582	12.8	2,941	7.0
December	4,575	8.4	4,619	8.6	5,925	13.5	3,090	7.4
Total	54,164	100.0	53,813	100.0	43,898	100.0	41,979	100.0

*Combined carloadings of UP and BNSF

soybean production in Kansas during this period. The peak period for Class I railroad carloadings of sorghum, corn and soybeans is October through March.

Table 5 compares Class I railroad carloadings of wheat to the combined total carloadings of sorghum, corn and soybeans for the 1997-2000 period. The data in Table 5 highlight the significance of wheat to Class I railroads serving Kansas. For the four year 1997-2000 period, wheat carloadings were 79 percent greater than the combined carloadings of sorghum, corn, and soybeans (347,400 vs. 193,854). The data in Table 5 also highlight the seasonal distribution of Class I railroad grain carloadings in Kansas. Nearly 46 percent of the wheat carloadings occur in the July-September period. Carloadings of sorghum, corn and soybeans are greater in the first and fourth quarters of the year.

The majority of Class I railroad grain carloadings in the study area originate at the large terminal elevators in Salina, Hutchinson and Wichita and at the unit train loading locations listed in Table 2. The Vice President of Agricultural Products for one of the Class I railroads estimated that about 70 percent of the railroad's grain carloadings in Kansas originated at these locations during the 1997-2000 period. Another Class I railroad that provided more detailed data by origin of shipment also shipped an average of 70 percent of its study area grain carloadings from these locations during the 1997-2000 period. However, the percentage of this railroad's total Kansas grain carloadings shipped from terminals and unit-train loading stations rose from 65.5 percent in 1997 to nearly 74 percent in 2000.

All of the grain shipped by the unit train loading stations listed in Table 2 is received by truck. The large terminal elevators in Salina, Wichita and Hutchinson receive grain by truck and rail. According to *Kansas Grain Marketing and Transportation* (1991) and *Kansas Grain Transportation* (2001) the percent of wheat receipts of terminals received by truck in the July

Table 5

Class I Railroad Grain Carloading in Kansas for the 1997 - 2000 Period by Month*

Month	Grand Total Wheat Carloadings	Percent of Total	Grand Total Sorghum, Corn, and Soybean Carloadings	Percent of Total	Grand Total Grain Carloadings	Percent of Total
January	17,440	5.0	27,827	14.5	45,267	8.4
February	17,850	5.1	24,236	12.6	42,086	7.8
March	18,650	5.4	19,840	10.2	38,490	7.0
April	20,408	5.9	17,330	8.9	37,738	7.0
May	20,313	5.8	15,938	8.2	36,251	6.7
June	25,435	7.3	9,397	4.8	34,832	6.4
July	54,682	15.8	5,319	2.7	60,001	11.1
August	55,701	16.0	4,312	2.2	60,013	11.1
September	48,987	14.1	9,312	4.8	58,299	10.8
October	26,619	7.7	23,510	12.1	50,129	9.3
November	21,338	6.1	18,624	9.6	39,962	7.4
December	19,977	5.8	18,209	9.4	38,186	7.0
Total	347,400	100.0	193,854	100.0	541,254	100.0

*Combined carloadings of UP and BNSF

1990-June 1991 period was 62 percent which increased to 71 percent during the June 1, 1999 to May 31, 2000 period. The corresponding truck market shares for corn were 22 percent and 100 percent. In the July 1990-June 1991 period, 53 percent of the sorghum received by terminals arrived by truck which increased to 75 percent during the June 1, 1999-May 31, 2000 period. In the early period (1990-1991) 60 percent of the soybeans received at terminals arrived by truck which increased to 78 percent in the later period (1999-2000).

2.2 Grain Receipts and Shipments of Study Area Unit Train Shipping Locations on Class I Railroads

In this report we will use the term "unit train shipping location," to refer to the shipping locations listed in Table 2. That is, the locations on Class I railroads that ship 100 car unit grain trains, excluding terminal elevators in the traditional trans-shipment cities of Salina, Wichita and Hutchinson. With the exception of Cornerstone in Colby and DeBruce Grain in Abilene, most of these facilities began shipping unit grain trains in the latter half of the 1990s.

In 1999, eight of the dozen unit train locations received 67.5 million bushels of wheat, 21.8 million bushels of sorghum, and 9 million bushels of corn. If the four unit train locations that did not provide grain receipts have the same receipts characteristics as the eight locations that provided their grain receipts, then total grain receipts for the dozen locations would be 147.6 million bushels. If each truck carried a load of 800 bushels it would take 184,500 truckloads to deliver 147.6 million bushels to these facilities or 15,375 trucks per facility.

Unit train facilities on Class I railroads draw grain receipts from a large area. The managers of unit train shipping locations were asked to estimate the percent of their total grain receipts that originate at various distances from their facility. For the unit train shipping locations as a group, about 32 percent of their receipts originated within 10 miles of their location. An additional 20 percent of receipts originated 11 to 25 miles from the facility. At distances of 26 to 50 miles and 51 to 70 miles the percents of total receipts were 32 percent and 13.5 percent respectively. Thus about 97 percent of the grain receipts originate within 70 miles of the facility.

Ten of the dozen managers of the unit train facilities said that the semi-tractor trailer was the major type of trucking equipment used to transport grain to their location. In the other cases, the tandem axle truck was the principal type of equipment.

According to the managers of the unit train facilities (as a group) 36.8 percent of their wheat receipts were obtained from farmers and 63.2 percent from country grain elevators. For sorghum, the corresponding percentages were 34.8 percent (farmers) and 65.2 percent (country grain elevators). Thus a little over one-third of the grain received by unit train facilities on Class I railroads is delivered by farmers in either a semi-tractor trailer or tandem axle truck.

Loading of unit trains is very efficient since railcars are loaded by computer so that a 100 car train can be loaded in a short time. Efficiency is further enhanced by reliance on 286,000 pound covered hopper cars which are also referred to as heavy axle load (HAL) cars. As a group, 73 percent of the railcars shipped from unit train loading locations are HAL cars.

Most shipments from these facilities are in 100-110 car trains which are often referred to as shuttle trains. As a group, 85 percent of the wheat and 83 percent of the sorghum is shipped on shuttle trains. The remaining 15 percent of the wheat and 17 percent of the sorghum is shipped on unit trains of 50-99 cars.

The principal destination for the wheat shipments from unit train locations is the Texas Gulf (export) as 10 of the 12 shippers indicated the Texas Gulf (export) as the primary destination for wheat. Four of the shippers listed Mexico as a primary destination, and three shippers each said Kansas City, and U.S. and Kansas flour mills are primary destinations for wheat shipments.

The two primary destinations for sorghum shipments by unit train facilities are the Texas Gulf (export) and Mexico. Ten of the shippers indicated the Texas Gulf as a primary destination and seven indicated Mexico as a principal market.

2.3. Grain Receipts and Shipments of Companies with Elevators Located on Shortline Railroads Serving the Study Area

Table 6 contains 1997-1999 grain receipts of elevators located on shortline railroads serving the study area. Wheat constitutes about half of the grain receipts of these elevators (437.3 million bushels). Corn and sorghum receipts were about the same while soybeans account for only 1.8 percent of total grain receipts (859.6 million bushels) during the period.

Grain is delivered by farmers to these elevators in large trucks. For the elevators as a group, 21.6 percent of the grain receipts were delivered in single axle trucks, 35.1 percent was delivered in tandem axle trucks, and 42.9 percent in semi-tractor trailers. These results are consistent with the finding that farmers use large trucks to deliver their grain to unit train loading locations. In interviews with managers of elevators located on shortlines, many noted that they have had to increase the elevating capacity of the elevator to accommodate the larger trucks that farmers are using to deliver their grain.

Table 7 displays 1997-1999 grain shipments of elevators located on shortline railroads serving the study area. Since wheat accounts for the largest share of the grain receipts, it also constitutes the largest share of the shipments. Combined 1997-1999 truck and rail shipments of wheat were 429.2 million bushels or 53.2 percent of total grain shipments, with sorghum

Table 6

Grain Receipts of Elevators Located on Shortline Railroads Serving the Study Area
1997-1999
(Thousands of Bushels)

Year	Wheat	Corn	Sorghum	Soybeans	Total
1997	140,608.9	64,707.0	62,110.9	3739.4	271,166.2
1998	152,238.5	70,627.6	67,121.2	5043.1	295,030.4
1999	144,473.0	73,833.1	68,444.1	6701.7	293,451.9
Total	437,320.4	209,167.7	197,676.2	15,484.2	859,648.5

Table 7

Grain Shipments of Elevators Located on Shortline Railroads Serving the Study Area
1997-1999
(Thousands of Bushels)

Year	Rail Shipments	Percent of Total	Truck Shipments	Percent of Total
		Wheat		
1997	55,345.2	42.8	73,922.0	57.2
1998	71,428.7	46.2	83,299.0	53.8
1999	66,029.7	45.5	79,202.9	54.5
Total	192,803.6	44.9	236,423.9	55.1
		Sorghum		
1997	11,436.1	17.5	53,827.9	82.5
1998	9,558.9	16.6	47,917.0	83.4
1999	10,464.1	15.6	56,499.5	84.4
Total	31,459.1	16.6	158,244.4	83.4
		Corn and Soybeans		
1997	872.1	1.7	51,844.5	98.3
1998	1298.7	2.1	61,368.6	97.9
1999	2278.6	3.1	70,414.0	96.9
Total	4449.4	2.4	183,627.1	97.6
		Total Grain		
1997	67,653.4	27.4	179,594.4	72.6
1998	82,286.3	29.9	192,584.6	70.1
1999	78,772.4	27.7	206,116.4	72.3
Total	228,712.1	28.3	578,295.4	71.7

shipments accounting for 23.5 percent and corn plus soybeans, 23.3 percent of total shipments.

For the 1997-1999 period, about 45 percent of the wheat shipments of these elevators were transported by shortline railroad and the remaining 55 percent by truck. These market shares were relatively stable for each of the years in the 1997-1999 era. During the same period, about 17 percent of the sorghum was shipped by shortline railroad and 83 percent by truck. These market shares were also stable during the late 1990s. The shortline railroad share of combined 1997-1999 corn and soybean shipments was nearly non-existent as shortlines obtained only 2.4 percent of these shipments with 97.6 percent moving by truck. When the shipments of the four crops are aggregated, motor carriers dominate the shipments from elevators located on shortlines. For the 1997-1999 period, shortlines obtained only 28 percent of total grain shipments and motor carriers 72 percent.

Table 8 contains the primary rail and truck destinations of wheat shipments by companies with elevators located on shortline railroads serving the study area. Kansas, and U.S. non-Kansas flour mills were the major destinations for both shortline and truck wheat shipments. Unit train loading locations listed in Table 2 were a major destination for truck wheat shipments. Wichita and Hutchinson were major destinations for both shortline and motor carrier wheat shipments.

Table 9 displays principal rail and truck destinations of sorghum shipments by companies with elevators located on shortline railroads serving the study area. Motor carriers dominate these shipments and the major destinations are feedlots in Kansas, Oklahoma and Texas. Other major destination markets for truck sorghum shipments are unit train loading stations (excluding those located in Wichita, Hutchinson and Salina) and alcohol manufacturing plants. The principal shortline destination for sorghum is Wichita.

Table 8

Primary Rail and Truck Destinations of Wheat Shipments by Companies
With Elevators Located on Shortline Railroads Serving the Study Area

Rail Destinations	Number of Companies That Cited the Destination	Truck Destinations	Number of Companies That Cited the Destination
Kansas Flour Mills	38	Kansas Flour Mills	46
Non-Kansas Flour Mills	18	Unit Train Loading Stations**	35
Wichita*	17	Non-Kansas Flour Mills	17
Texas Gulf and Pacific		Wichita*	17
Northwest Export	14	Hutchinson	16
Kansas City*	12	Salina	10
Hutchinson	12	Nebraska (Omaha, Lincoln, Hastings)	10

*Destinations are a mix of terminal storage and flour mills
**Includes only the facilities listed in Table 2

Table 9

Primary Rail and Truck Destinations of Sorghum Shipments by Companies
With Elevators Located on Shortline Railroads Serving the Study Area

Rail Destinations	Number of Companies That Cited the Destination	Truck Destinations	Number of Companies That Cited the Destination
Wichita	9	Kansas, Oklahoma, and Texas Feedlots	51
California	6	Unit Train Loading Stations*	22
Texas Gulf Export	5	Alcohol Manufacturing Plants	21
Hutchinson	4	Salina	16
Salina	4	Hutchinson	11
Mexico	4	Wichita	7

**Includes only the facilities listed in Table 2

Table 10 contains primary rail and truck destinations of corn shipments by elevators located on shortlines. Corn shipments are almost exclusively by motor carrier with Kansas, Oklahoma and Texas feedlots as the dominant destination markets. Feedlots are also the major market destination of shortline shipments.

Table 11 displays the major rail and truck destinations of soybean shipments by grain elevators located on study area shortlines. Soybean shipments are dominated by motor carriers with the soybean crushing plant in Wichita as the primary destination. Elevator managers also indicated the soybean processing plants at Emporia and Hastings, Nebraska as major destinations of soybean truck shipments. Wichita was the major destination for soybeans shipped by shortline railroad.

2.4 Fertilizer Receipts of Companies with Elevators Located on Shortline Railroads Serving the Study Area

Table 12 displays 1997-1999 shortline and motor carrier fertilizer tonnage delivered to elevators located on study area shortlines. During the 1997-1999 period, motor carriers dominated fertilizer shipments with a 92 percent market share (1.2 million tons), leaving only 8 percent for shortline railroads (104.3 thousand tons). These market shares remained relatively constant for each year of the 1997-1999 interval.

Table 13 contains principal origins of fertilizer receipts by elevators on shortline railroads. The major origins for rail shipments are the primary phosphate fertilizer manufacturing states of Florida and Wyoming. Since truck shipments of fertilizer are much larger than rail shipments, the number of fertilizer origins is much larger. Truck delivered fertilizer originates primarily in a wide variety of Kansas, Oklahoma, and Nebraska locations

Table 10

Principal Rail and Truck Destinations of Corn Shipments by Companies With Elevators Located on Shortline Railroads Serving the Study Area

Rail Destinations	Number of Companies That Cited the Destination	Truck Destinations	Number of Companies That Cited the Destination
Feedlots	11	Kansas, Oklahoma, and	78
Salina	1	Hastings, NE	1
		Salina	1
		Abilene	1
		Wichita	1

Table 11

Principal Rail and Truck Destinations of Soybean Shipments by Companies With Elevators Located on Shortline Railroads Serving the Study Area

Rail Destinations	Number of Companies That Cited the Destination	Truck Destinations	Number of Companies That Cited the Destination
Wichita	6	Wichita	51
Kansas City	1	Emporia	13
St. Louis, MO	1	Hastings, NE	12
		Wright	5
		Salina	5
		Hutchinson	4

Table 12

Fertilizer Receipts by Companies With Elevators Located on Shortline Roilroads Serving the Study Area 1997 – 1999
(Tons)

YEAR	RAIL RECEIPTS	PERCENT OT TOTAL	TRUCK RECEIPTS	PERCENT OF TOTAL
1997	30,141	7.3	380,317	92.7
1998	36,564	8.0	422,353	92.0
1999	37,595	8.2	421,221	91.8
Total	104,300	7.9	1,223,891	92.1

Table 13

Principal Origins of Fertilizer Receipts by Companies
With Elevators Located on Shortline Railroads Serving the Study Area

Rail Origins	Number of Companies That Cited the Origin	Truck Origins	Number of Companies That Cited the Origin
Florida	18	Dodge City	33
Wyoming	11	Enid, OK	27
Enid, OK	5	Catoosa, OK	22
New Mexico	5	Kansas City	10
Catoosa, OK	3	Lawrence	10
Other	2	Conway	9
		Wyoming	7
		Clay Center	4
		Hastings, NE	3
		Beatrice, NE	3
		New Mexico	2
		Other Kansas	11
		Other Nebraska	7
		Other Oklahoma	7
		Other Missouri	3
		Other Texas	3

with Dodge City, and Enid and Catoosa, Oklahoma as the major origins.

2.5 Grain Carloadings of Study Area Shortlines

Each of the four study area shortlines originated carloads of wheat sorghum, corn, and soybeans. The lone exception to this is that one shortline had no originated carloads of corn. Originated carloads are shipments that originate on the shortline and are delivered to another railroad. Only one study area shortline had terminated carloads of wheat, sorghum, corn, and soybeans. Another shortline had terminated carloads of corn. Terminated carloads are shipments that originate on another railroad and delivered by the shortline to a destination on the shortline. Only one shortline had local carloads of wheat, sorghum, corn and soybeans. Local carloads are shipments that originate on the shortline and are delivered to a destination on the shortline. None of the shortlines had any overhead traffic which are shipments that originate on another railroad, and are delivered to the shortline which subsequently delivers the grain to another railroad.

Table 14 contains 1998 and 1999 grain carloadings of study area shortlines. An examination of Table 14 indicates that most of the shortline traffic is originated wheat carloadings. In 1998 and 1999 about 82 percent of the originated traffic was wheat. Sorghum accounted for 12 to 13 percent of the originated carloads; corn, 5 to 6 percent, and soybeans, less than 1 percent of total local carloads. Wheat was 81 percent of the local carloads, sorghum was 18 percent, and the combined local carloads of corn and soybeans were one percent of total carloads. Given the significance of originated carloadings in shortline traffic, the percentages of total carloadings attributable to the various grains were nearly identical to that of the originated carloadings.

Table 14

1998 and 1999 Grain Carloadings of Study Area Shortline Railroads

Originated Carloads*

Commodity	1998	Percent of Total	1999	Percent of Total
Wheat	26,836	81.9	26,092	81.6
Sorghum	4,123	12.6	3,727	11.7
Corn	1,604	4.9	1,854	5.8
Soybeans	211	0.6	292	0.9
Total	32,774	100.0	31,965	100.0

Terminated Carloads**

Commodity	1998	1999
Corn	375	27

Local Carloads***

Commodity	1998	Percent of Total	1999	Percent of Total
Wheat	3,738	81.0	2,547	81.0
Sorghum	831	18.0	566	18.0
Corn	35	0.8	24	0.8
Soybeans	12	0.2	8	0.2
Total	4,616	100.0	3,145	100.0

Total Carloads

Commodity	1998	Percent of Total	1999	Percent of Total
Wheat	30,574	81.0	28,639	81.5
Sorghum	4,954	13.1	4,293	12.2
Corn	2,014	5.3	1,905	5.4
Soybeans	223	0.6	300	0.9
Total	37,765	100.0	35,137	100.0

* Originated carloads are shipments that originate on the shortline and are delivered to another railroad

** Terminated carloads are shipments that originate on another railroad and are delivered to the shortline

*** Local carloads are shipments that originate on the shortline and are delivered to a destination on the shortline

2.6 Summary

Most of the wheat grown in the study area is transported out of Kansas by Class I railroads to U.S. flour mills and export ports. For the 1997-2000 period, Class I railroad wheat carloadings were 79 percent greater than their combined carloadings of sorghum, corn and soybeans. The figures are as follows:

Year	UP & BNSF Wheat Carloadings	UP & BNSF Sorghum, Corn and Soybean Carloadings
1997	72,550	54,164
1998	99,300	53,813
1999	102,180	43,898
2000	73,370	41,979
Total	347,400	193,854

A total of 70 percent of the Class I railroad carloadings in the study area originate at the terminal elevators in Salina, Hutchinson and Wichita, and at the unit train loading locations. The majority of the grain received by the terminals in Salina, Hutchinson and Wichita is delivered by motor carrier, and all of the grain received by the unit train shipping locations on Class I railroads arrives by truck. It is estimated that the dozen unit train locations receive 184,500 truckloads of grain per year or 15,375 truckloads per facility. These are semi-tractor trailer and tandem axle trucks with about one-third of the receipts delivered by farmers and two-thirds from commercial elevators.

The principal destination for the wheat shipments from unit train locations is the Texas Gulf (export). Other primary wheat destinations are Mexico and U.S. flour mills. The two primary destinations for sorghum shipments by unit train facilities on Class I railroads are the Texas Gulf (export) and Mexico.

In the 1997-1999 period, nearly 860 million bushels of grain were received by elevators located on the shortline railroads serving the study area. Nearly 80 percent of this volume was delivered by farmers in semi-tractor trailers and tandem axle trucks. During the same time period, about 45 percent of the wheat shipments of these elevators were transported by shortline railroads and 55 percent by truck. Motor carriers dominated the shipments of sorghum, corn and soybeans from these elevators, accounting for 83 percent of the sorghum shipments and nearly 98 percent of the combined corn and soybean shipments. In total, shortlines accounted for only 28 percent of the grain shipments from the elevators located on their systems.

U.S. flour mills (including those in Kansas), Hutchinson and Wichita were major destinations for both truck and shortline wheat shipments from the elevators located on the shortline railroads serving the study area. Unit train locations on Class I railroads were major destinations for truck wheat shipments. The major destinations for truck shipments of sorghum from these facilities are feedlots in Kansas, Oklahoma and Texas. Other major destinations for sorghum truck shipments were unit train loading locations and alcohol manufacturing plants. The principal destination for sorghum shipped by shortlines from these elevators was Wichita. Motor carriers dominate the corn and soybean shipments from elevators located on shortlines. The major destinations for the corn shipments are Kansas, Oklahoma and Texas feedlots, with Wichita being the dominant destination for truck soybean shipments.

Several trends emerged in the latter part of the 1990s that have resulted in increased trucking of grain in Kansas. Farmers began delivering grain to country elevators and unit train locations on Class I railroads in much larger trucks. The percent of grain delivered by truck to terminals in Salina, Wichita and Hutchinson significantly increased. Unit train locations emerged on Class I railroads and all of the grain received by these facilities was delivered by truck. Shortline railroads serving the study area rely heavily on originated wheat shipments, but slightly more than half of the wheat shipments by elevators located on shortlines are by truck.

CHAPTER 3

REASONS FOR INCREASED GRAIN TRUCKING IN KANSAS

3.1 Reasons for Increased Trucking of Grain by Companies Located on Shortline Railroads Serving the Study Area

The research team conducted interviews of shippers located on shortline railroads serving the study area. Also a questionnaire was distributed to these shippers and 74 companies accounting for 177 grain elevators returned completed questionnaires. Thus the sample accounts for a substantial majority of the shippers located on shortline railroads.

The shippers were asked why they had increased the percent of their grain that they ship by truck. The questionnaire listed the following potential reasons.

1. Truck service is more frequent and dependable than rail service
2. Railcar shortages
3. Truck rates are lower than rail rates
4. Uncompetitive rail rates
5. Construction of rapid loadout facilities on Class I railroads
6. Other

The shippers were asked to indicate all the above reasons that apply to their particular situation.

With respect to wheat, 14 companies indicated that they had not increased the percent of wheat that they ship by truck. Among the other companies, the most frequently cited reason for increased truck shipments was that truck service is more frequent and dependable than rail service (41 citations). The next most frequently cited factor was that truck rates are lower than rail rates (35 citations). A total of 33 shippers cited both railcar shortages and uncompetitive rail rates. Only 23 companies mentioned construction of rapid loadout facilities on Class I railroads.

A wide variety of other reasons were cited for increased trucking of wheat with no more than three shippers mentioning any given reason. A total of 15 firms cited one of the following reasons.

1. Truck-served markets are more profitable
2. Abandoned rail line
3. Wider availability of markets using trucks
4. OSHA fall protection regulation (has the effect of increasing the cost of rail shipment)
5. Inability of the shortline to provide equipment on a timely basis
6. Deteriorating shortline tracks
7. High railroad demurrage costs (costs assessed to the shipper for exceeding the allowed time to load railcars)
8. Poor quality wheat in the area that can't be sold to flour mills
9. Have own truck fleet
10. Low truck backhaul prices

The most frequently cited reasons for increased trucking of sorghum were that truck service is more frequent and dependable than rail service, and truck rates are lower than rail rates (32 citations each). The third most cited factor (28 citations) was one of the Other category reasons—the best sorghum markets are not rail-served. Uncompetitive rail rates was mentioned by 23 shippers while railcar shortages and construction of rapid loadout facilities on Class I railroads were cited by 17 and 16 shippers respectively. The reasons for increased trucking of sorghum in the Other category were:

1. Abandoned rail line
2. Low truck backhaul prices
3. Loss of co-loading opportunity
4. OSHA fall protection regulation
5. High railroad demurrage costs
6. No certified scale for weighing rail shipments
7. All sorghum is used in company feed mill

None of the above other reasons was mentioned by more than three shippers, and 10 firms cited one of the above other reasons.

For corn, the most cited reason for increased trucking was one of the reasons from the Other category—the best corn markets are not rail-served (34 citations). The next most mentioned factor was that truck service is more frequent and dependable than rail service (24 citations). The third most important reason for increased trucking of corn was uncompetitive rail rates (20 citations). Truck rates are lower than rail rates was cited as a reason by 16 shippers, while railcar shortages was mentioned by a dozen firms. Only seven shippers cited construction of rapid loadout facilities on Class I railroads. This is expected since unit train shippers specialize in transporting wheat and sorghum. The following were reasons in the Other category and none of these were mentioned by more than three firms. A total of eight firms cited one of the following reasons:

1. Abandoned rail line
2. OSHA fall protection regulation
3. Corn grading standards for rail shipments
4. No certified scale for weighing rail shipments
5. All corn is used in company feed mill

The most frequently cited reason for increased trucking of soybeans is that truck service is more frequent and dependable than rail service (24 citations). The second and third most important reasons were that truck rates are lower than rail rates (19 citations), and uncompetitive rail rates (18 citations). A total of 14 shippers said they increased their truck shipments of soybeans because the best soybean markets are not rail-served. Only eight shippers cited railcar shortages as a reason, and seven mentioned construction of rapid loadout facilities on Class I railroads. The latter result is expected since unit train facilities specialize in shipping wheat and sorghum. The following reasons were in the Other category and none was mentioned by more than three shippers.

1. Abandoned rail line
2. Low soybean production in the area which makes rail shipment uneconomical
3. OSHA fall protection regulation
4. Low truck backhaul prices

When the reasons for increased trucking of grain are aggregated for wheat, sorghum, corn and soybeans the following results are obtained.

Reason for Increased Grain Trucking	Number of Shipper Citations
1. Truck service is more frequent and dependable than rail service	121
2. Truck rates are lower than rail rates	102
3. Uncompetitive rail rates	94
4. Best markets are not rail-served	76
5. Railcar shortages	70
6. Construction of rapid loadout facilities on Class I railroads	53

The above results indicate that shippers on shortlines have increased the percent of grain they ship by truck primarily because they view truck service and prices as superior to that of railroads. However, the results of the shipper survey should be interpreted with caution since the various reasons for increased trucking are interrelated. For example, relatively lower truck rates are the second most important factor for increased grain trucking, with nearly twice as many citations as construction of rapid loadout facilities on Class I railroads. However, the relatively low rail rates for long haul shipment of unit trains allows unit train shippers to offer high grain prices that attract grain shipments from a 70 mile radius around the facility. Trucks have lower rates than railroads for these short hauls.

The above survey results indicate that shippers on shortline railroads are shipping a greater percent of grain shipments by truck because truck service is more frequent and dependable than rail service and that truck rates are lower than rail rates. These results closely correlate with other results obtained from the survey of shippers located on shortline railroads. On the questionnaire the shippers were given a list of eight carrier choice determinants that could influence their selection of one type of transportation over another, i.e., rail or truck. The shippers were asked to rank these determinants from the most important to the least important, with the most important determinant having rank of 1.0 and the least important having a rank of

8.0. The responses were averaged across all shippers responding to the questionnaire, and the results are as follows:

Carrier Choice Determinant	Average Rank
1. The transportation rate	1.58
2. Ability to ship to many markets	2.67
3. Amount of time required to ship my freight to destination	3.99
4. Predictability of the time it takes to ship my freight to destination	4.23
5. Amount of weekly service provided by the carrier	4.29
6. Billing procedures	6.04
7. Shipment tracing capability	6.46
8. Lost or damaged goods	6.78

Thus shippers located on shortlines emphasize the transportation rate and the ability to ship to many markets as the primary factors that they consider when choosing a mode of transportation. Therefore, they are shipping more grain by truck because the shippers as a group can obtain a lower transportation rate by selecting motor carriers. The shippers also emphasize the ability to ship to many markets in selecting a carrier. Thus the shippers as a group are shipping more by truck because the best sorghum, corn and soybean markets are better served by motor carrier than by railroad.

3.2 The Increase in the Number of Farmer-Owned Semi-Tractor Trailer Trucks

As noted previously in this report, about 80 percent of the grain delivered by farmers to country grain elevators on shortlines is shipped in tandem axle and semi-tractor trailer trucks. Also about one-third of the receipts at unit train shipping locations are delivered by farmers in semi-tractor trailer trucks. Had farmers not increased their ownership of large trucks, some of this grain may have been shipped from country elevators by shortline railroad. Interviews of shippers located on shortlines indicate that farmer ownership of large trucks has been increasing since the early 1990s for a variety of cost and technology reasons.

Farm size has been increasing and the larger grain production can be transported at a lower cost per bushel in a larger truck. It is less costly for farmers to load semi-tractor trailers to 80 thousand pounds and make one trip than to make two tandem axle truck trips or four single axle truck trips. Also, shrinking rail service has caused farmers to deliver grain to more distant locations. Larger trucks are less costly per bushel as shipment distances increase.

Labor shortages during harvests can be offset by using semi-tractor trailer trucks to deliver grain. One person can deliver the grain volume that would have required two or three people using smaller trucks.

Technological improvements in grain harvesting equipment have increased the speed of the harvest. These improvements coupled with increased grain production requires the use of larger trucks since a large volume of grain has to be transported from the farmer's field to the elevator in a short time. Smaller trucks won't be able to deliver grain to the elevator at the rate at which it is being harvested, so the efficiency of improved grain harvesting technology would be lost without the use of large trucks.

Larger trucks also give farmers greater flexibility in terms of markets and timing of sale, provided the farmer has adequate on-farm storage. If this is the case, the grain producer can store some of his grain on-farm, and then later transport the grain a greater distance to a more profitable market (possibly a unit train shipping facility) at a time of the farmer's choosing.

3.3 Reasons for Increased Trucking of Grain According to Class I Railroad Personnel

The Vice-Presidents of Agricultural Products at Class I railroads were asked for their opinions regarding the reasons for increased grain trucking in Kansas. The questionnaire listed the following potential reasons.

1. Railcar shortages
2. Uncompetitive rail rates
3. Truck rates are lower than rail rates
4. Truck service is more frequent and timely than rail service
5. Other

Both vice presidents said that truck rates are lower than rail rates. However, one of them said that this is the case for some shippers because they choose not to use guaranteed car supply systems available from both Class I railroads. Instead these shippers buy transportation in the spot market where truck prices are less than rail prices. One of the vice presidents noted that railcar shortages periodically contribute to increased trucking of grain, and the other noted that truck service is more frequent and timely than rail service for short hauls.

One vice president said that construction of unit train loading facilities on Class I railroads has promoted increased length of haul of truck delivered grain due to the large geographic catchment areas of these facilities. However, the vice president noted that wear and tear of the highways probably increased more due to larger truck sizes and weights which, in the vice president's opinion, likely would have occurred with or without construction of unit train facilities. The other vice president said that grain has always moved on trucks from farms to elevators.

The vice presidents pointed out other reasons for increased trucking of grain such as the growing demand for truck transport of feed grains to the feedlots of southwest Kansas, Oklahoma, and the Texas panhandle. One vice president said that highway construction projects in Kansas contribute to increased trucking of grain due to improved coordination of truck movements by motor carrier brokers. Trucks deliver rock and gravel to the construction site and backhaul grain to central Kansas grain terminals and Kansas City.

3.4 Reasons for Increased Trucking of Grain According to Shortline Railroad Executives

Executives of the four shortline railroads serving the study area were asked their opinions concerning the causes of increased trucking of grain. On the questionnaire, the executives were given the following potential reasons and were asked to check all those that apply to their particular situation.

1. Truck rates are lower than rail rates
2. Construction of rapid loadout facilities on Class I railroads
3. Truck service is more frequent and dependable than rail service
4. Uncompetitive Class I rail rates
5. Other

There was a substantial difference of opinion between the executives of shortlines and the shippers located on these lines concerning the significance of construction of rapid loadout facilities on Class I railroads as a reason for increased grain trucking. As noted above, the shippers ranked five other reasons as more important. However, three of the four executives of the shortlines designated construction of rapid loadout facilities as a significant cause of increased grain trucking.

The importance of the other potential reasons for increased trucking of grain can be summarized as follows:

Reason for Increased Grain Trucking	Number of Shortline Executives That Said the Reason is Significant
1. Truck rates are lower than rail rates	2
2. Uncompetitive Class I rail rates	2
3. Truck service is more frequent and dependable than rail service	1
4. Other	2

In the Other category, one executive mentioned higher weight limits for trucks. Another executive suggested that increased farmer use of semi-tractor trailer trucks coupled with more on-farm storage of grain has contributed to higher grain trucking. This factor has enabled farmers to deliver grain directly to unit train facilities on Class I railroads.

3.5 Summary

Shippers located on shortline railroads, Vice-Presidents of Agricultural Products of Class I railroads, and executives of shortline railroads serving the study area were surveyed to assess the causes of increased trucking of grain in Kansas.

The two most frequently cited reasons for increased trucking by shippers located on shortlines were the same for wheat, sorghum and soybeans, which were (1) truck service is more frequent and dependable than rail service, and (2) truck rates are lower than rail rates. For corn, the two most frequently cited reasons for increased grain trucking are (1) the best corn markets are not rail-served, and (2) truck service is more frequent and dependable than rail service. When the reasons for increased trucking of grain are aggregated for wheat, sorghum, corn and soybeans the following results are obtained.

Reason for Increased Grain Trucking	Number of Shipper Citations
1. Truck service is more frequent and dependable than rail service	121
2. Truck rates are lower than rail rates	102
3. Uncompetitive rail rates	94
4. Best markets are not rail-served	76
5. Railcar shortages	70
6. Construction of rapid loadout facilities on Class I railroads	53

These results indicate that shippers on shortlines have increased their trucking of grain primarily because they view motor carrier service and prices as superior to that of railroads. This result closely correlates with the results of a carrier choice analysis which indicated that shippers emphasize the transportation rate and ability to ship to many markets as the primary factors that they consider when choosing a mode of transportation. Therefore, they are shipping more grain by truck because the shippers (as a group) can obtain a lower transportation rate by selecting motor carriers, and because the best sorghum, corn and soybean markets are better served by motor carrier than by railroad.

About one-third of the total grain receipts of unit train shipping locations are delivered by farmers in semi-tractor trailer trucks. Increased ownership and use of large trucks gives farmers greater flexibility in terms of markets and timing of sale if the farmer has sufficient on-farm storage. If this is the case, the producer can store some of his grain on farm, and then later transport the grain a greater distance to a more profitable market (i.e., a unit train shipping facility) at a time of the farmer's choosing. Thus increased farmer ownership of large trucks has contributed to increased trucking of grain.

In addition to greater marketing flexibility, other factors have contributed to increased farmer ownership and use of large trucks. These include increased farm size and grain production per farm, labor shortages during harvest, shrinking rail service, and technological improvements in grain harvesting that have increased the speed of the harvest.

Both Vice Presidents of Agricultural Products of Class I railroads said that low truck rates relative to rail rates was a cause of increased grain trucking, but that this was due to many shippers buying their transportation on the spot market (as opposed to a guaranteed car supply system) where truck prices are less than rail prices. Other factors mentioned by the vice presidents as causes of increased grain trucking included increased demand for truck transport to move feed grains to the feedlots of Kansas, Oklahoma and Texas; and Kansas highway construction projects. The latter is due to improved coordination of truck movements by motor carrier brokers. Trucks deliver rock and gravel to the construction site and backhaul grain to central Kansas grain terminals and Kansas City.

There was a substantial difference of opinion between the executives of shortlines and the shippers located on these railroads concerning significance of construction of rapid loadout facilities on Class I railroads as a reason for increased grain trucking. The shippers ranked several other causes as more important, but three of the four executives of the shortlines designated this factor as a significant cause of increased grain trucking. No other reason was mentioned by more than two executives as indicated below.

Reason for Increased Grain Trucking	Number of Shortline Executives That Said the Reason is Significant
1. Truck rates are lower than rail rates	2
2. Uncompetitive Class I rail rates	2
3. Truck service is more frequent and dependable than rail service	1
4. Other	2

The reasons in the Other category were higher weight limits for trucks, and increased farmer ownership and use of large trucks.

CHAPTER 4

IMPACTS OF INCREASED GRAIN TRUCKING ON STUDY AREA SHORTLINE RAILROADS

4.1 Impacts of Increased Grain Trucking on Shortline Grain Traffic and Profits

Executives of shortline railroads in the study area were asked to estimate the impact of increased grain trucking in recent years on their grain traffic and profits. With regard to the impact on grain traffic there was considerable variation among the four railroads. One shortline executive responded that increased trucking of grain had reduced his railroad's grain traffic by 21 to 30 percent. Alternatively, the corresponding figure for one of the other shortlines was only a 6 to 10 percent reduction in grain traffic. Both of the other two shortline executives estimated that increased grain trucking had reduced the grain traffic on their respective railroads by 11 to 20 percent.

Assuming the above reductions in grain traffic estimated by the shortline executives are the reductions that actually happened, it is possible to estimate what grain carloadings would have been if increased grain trucking had not occurred. This can be done by multiplying each railroad's grain carloadings by 1.0 plus the midpoint of the range of estimated percentage reduction of grain traffic divided by 100. Thus for the railroad with the estimated grain traffic reduction of 21 to 30 percent, the railroad's grain carloadings for a given year would be multiplied by 1.0 plus [(21+30)/2 ÷ 100)] or 1.255. According to Table 14, total grain carloadings for the four shortline railroads were 37,765 in 1998 and 35,137 in 1999. Applying the above described procedure to each of the four shortlines results in total grain carloadings for the group of 44,466 in 1998 or 17.7 percent greater than actual 1998 carloadings. For 1999, estimated total grain carloadings for the group of four railroads were 40,930, 16.5 percent greater than actual 1999 carloadings. Combined 1998 and 1999 actual total carloadings of grain for the four railroads were 72,902 compared to 85,396 (about 17 percent greater) that would if occurred if increased grain trucking had not occurred.

The shortline executives also estimated the impact on their railroad's profits of increased grain trucking. In contrast to the wide variation in estimates of impacts on grain traffic, all the shortline executives estimated the same negative effect on profits—an 11 to 20 percent decrease.

As noted previously, grain is the principal commodity of each of the four shortlines serving the study area. Thus as grain trucking has increased, shortlines have lost market share in their most important commodity, which has eroded shortline profits. The significance of this finding is reinforced by other information obtained from the survey of shortline railroad executives.

The questionnaire asked the shortline executives to rank several potential factors that could influence shortline railroad success (profits). The list of determinants includes the following:

1. Strong shipper support
2. Adequate track quality
3. Reasonable purchase price
4. Adequate traffic levels
5. Ship many different commodities
6. Access to more than one connecting carrier
7. State financial assistance
8. Ability to compete with motor carriers
9. Experienced management
10. Reliance on equity financing
11. Access to own equipment
12. Cooperation from connecting railroads on joint rates and revenue splits

From the above list the shortline executives were asked to select the three most important determinants of success by giving the most important factor a rank of 1, the second most important determinant a rank of 2, and the third most important a rank of 3. The results of the executives' rankings were tabulated by giving a success determinant three points for a first place selection, two points for second place, and one point for third place. The results are as follows:

Shortline Success Determinant	Ranking Points
1. Adequate traffic levels	6
2. Access to more than one connection carrier	4
3. Strong shipper support	3
4. Cooperation from connecting railroads on joint rates and revenue splits	3
5. Reasonable purchase price	3

Thus executives of study area shortlines ranked adequate traffic levels as the most important determinant of shortline success (profits). The closely related determinant "strong shipper support" tied for third most important factor. Thus grain is the most important commodity of these shortlines and traffic volume is the most important determinant of shortline profitability. As more grain has been shipped by truck, shortline traffic and profits have been negatively affected, perhaps threatening the long run viability of these railroads.

4.2 The Jumbo Covered Hopper Car and Kansas Grain Transportation

Previously, the covered hopper railcars employed to transport grain weighed 263,000 pounds and could haul 100 tons of grain. These cars are gradually being phased out of the grain car fleet in favor of the 286,000 pound car which can haul 111 tons of grain. These cars are sometimes referred to as heavy axle load (HAL) cars. If shortlines are unable to handle the HAL cars, more grain will be moved by truck resulting in higher road damage costs.

The introduction of these cars raises several questions for Kansas shortline railroads such as:

1. What will it cost to upgrade the railroad's tracks and bridges to handle the HAL cars?

2. What will it cost to maintain the railroad's tracks and bridges after the 286,000 pound car becomes the rail industry standard for grain transportation?
3. What is the source of capital to finance upgrading and maintenance costs?
4. If the necessary capital is not obtained, what is the implication for the economic viability of the railroad?

The executives of study area shortlines were asked if the introduction of the HAL car would increase or decrease their grain traffic, and what strategy does the railroad have for adapting to the larger car. One of the executives said that the expansion in the use of the 286,000 pound railcar would reduce grain traffic on shortlines. The executive said his shortline's strategy was to support government assistance programs to upgrade tracks. The executive of another shortline said that his railroad would be out of business in 10 years unless government grants enable the railroad to improve track quality. The executive of another shortline stated that his railroad can only handle the larger railcar on its tracks in the terminal locations of Wichita and Salina. Fully loaded HAL cars are prohibited on the rest of the shortline. This executive said that it would cost $84 million to upgrade the entire railroad to handle HAL cars. This railroad annually spends about $3.3 million on track maintenance, indicating an enormous gap between needs and resources. One of the shortline executives was optimistic that the tracks of his railroad could be upgraded to handle the larger cars without government assistance. However, the railroad faces a large expense in upgrading many wooden bridges to handle the HAL cars.

4.3 Class I Railroad Executives' Opinions of the Impact of 286,000 Pound Railcars on Kansas Grain Transportation

The Vice Presidents of Agricultural Products of the two major Class I railroads serving Kansas were asked their opinions concerning the impacts of HAL cars on Kansas grain transportation. In 2001, approximately 40 percent of the combined grain car fleet of the two railroads was 286,000 pound cars, with 60 percent of the combined fleet composed of 263,000 pound cars. The executives were asked what percent of their grain car fleets would be 286,000 pound cars by the year 2010. One of the executives estimated that 75 percent of the grain cars would be 286,000 pound cars by 2010. The other executive said that as 263,000 pound cars wear out, they would be replaced with 286,000 pound cars.

The executives were asked their opinions regarding the impact of the jumbo covered hopper car on Kansas shortline grain traffic. One executive said that shortlines have time to make the transition to handling HAL cars since the Class I railroads have a sizeable fleet of smaller cars with large remaining use life. The executive stated that shortlines that are not able to handle the larger cars will lose grain traffic if they are competing directly with a unit train shipping facility located on a rail line that is capable of handling HAL cars. This executive said that shortline survival is in the economic interest of Class I railroads since they receive significant traffic from them. The other Class I railroad executive stated that whether or not the shortline railroad is able to handle the larger car, the larger potential negative effect on shortline grain traffic is that it is usually cheaper to gather grain for unit train shipping by truck than it is by rail.

The executives were asked if they thought the share of grain transported by truck would rise if shortlines are unable to handle HAL cars. One executive said that more grain will be trucked to rail lines capable of handling the larger cars. The other stated that perhaps the truck share will increase, but the time pattern of the impact will be determined by the pace at which the Class I railroads and other railcar suppliers replace smaller cars with 286,000 pound cars.

4.4 Summary

According to shortline executives the impact of increased grain trucking on shortline grain traffic was estimated to range from a low of 6 to 10 percent on one railroad to a high of 21 to 30 percent on another. Based on these estimates, the combined 1998 and 1999 grain carloadings for the four shortlines would have been 17 percent greater if increased grain trucking had not occurred.

The shortline railroad executives estimated the impact of increased grain trucking on their railroad's profits, and all agreed that profits were reduced by 11 to 20 percent.

Executives of study area shortlines ranked adequate traffic levels as the most important determinant of shortline railroad success (profits). The closely related determinant "strong shipper support" tied for the third most important factor. Thus grain is the most important commodity of study area shortlines and traffic volume is the most important determinant of shortline profitability. As more grain has been shipped by truck, shortline traffic and profits have been negatively affected, perhaps threatening the long run viability of these railroads.

Another challenge facing Kansas shortlines is the increasing use of 286,000 pound covered hopper cars to transport Kansas grain. All the study area shortlines would have to upgrade their tracks and bridges to handle the larger cars and would face increased costs to maintain their tracks and bridges as more HAL cars move on their lines. The majority of the shortline executives stated that their tracks can't handle the larger car and they would need government assistance to sufficiently improve track quality.

An executive of a Class I railroad serving Kansas stated that shortlines have time to make the investments in tracks and bridges that would enable them to handle the HAL cars since there will be an ample supply of smaller grain cars for several years into the future. However, this executive said that shortlines that are unable to handle the larger cars will lose grain traffic if they are competing with a unit train shipping facility located on a rail line that is capable of handling 286,000 pound cars. Both Class I railroad executives stated that if shortlines are unable to handle HAL cars, then the share of grain transported by truck would continue to increase.

CHAPTER 5

DOES SHORTLINE RAILROAD TRANSPORTATION HAVE A FUTURE IN KANSAS?

5.1 The Views of Grain Shippers Located on Study Area Shortline Railroads

For the reasons discussed in Chapter 3 the percent of Kansas grain shipped by truck has been increasing. As noted in the previous chapter these factors have reduced shortline railroad grain traffic and have harmed profitability. Thus we asked grain shippers and railroad executives to address the question, "Does shortline railroad transportation have a future in Kansas?" Perhaps no group is more qualified to address this question than the grain shippers located on study area shortlines. This question was the last one on the questionnaire distributed to the shippers and the question had three possible responses which were yes, no, and maybe. The questionnaire also asked the shippers to explain their answer. Not every shipper explained the reason for their opinion, but the great majority of shippers did explain their response.

For the grain shippers that answered "yes" to the question, the following are their explanations in their own words.

"Shortline railroads provide access to flour mill wheat markets. Flour mills have a specific need for wheat of a particular grade to obtain the flour quality that they are marketing. Each rail car has a specific origin grade compared to destination truck grades that tend to fluctuate. In addition, the turn-around time of money and logistics costs involving loading rail cars vs. trucks, favors rail.
Advantages of rail sorghum shipping include consistency of grades, turn-around time of money, and logistics costs involving loading rail cars vs. trucks.
Southwest Kansas feedlots tend to be the dominant market for corn, and this probably won't change.
For facilities capable of handling dry fertilizer by rail, the net cost of fertilizer received by rail is substantially less than fertilizer purchases received by trucks."

"Wheat is the most important commodity that we handle and the best market is rail-served. If we are unable to reach these markets by rail and were forced to use trucks to ship wheat, it would take 30 to 50 more trucks per day to handle our volume.

“We need them! The most profitable wheat markets are rail-served. This is sometimes the case for milo as well. Shortlines will have a future as long as wheat is a major Kansas crop. Trucks will be less competitive in the future as fuel costs rise in the long term.”

“Shortlines can cost effectively assemble multi-car shipments from remote areas off Class I rail lines that the Class I’s don’t want to service. So shortlines will survive if enough volume exists to sustain profitability.”

“The shortline that serves my facility is a class operation that is very customer service oriented. They seem to take care of their equipment and tracks. I hope that we will be able to ship more by rail, but at this point it is uneconomical. As the price of fuel rises in the future, we will see fewer trucks available to move grain. Thus we will have to ship by rail.”

“The shortline that serves my facility provides excellent service and the communication is great. The shortline serving my operation is getting the volume it needs to be profitable. The increasing cost of diesel fuel will eventually shift more traffic from truck to rail.”

“My shortline has a future because it provides excellent service and is investing in its line. Also there are plans to construct a unit train loading facility on the shortline.”

“The shortline serving my facility is maintaining its track well. The area is a feed deficit region that keeps the need for rail service alive. We are building a 54 car terminal on the shortline based on our confidence in rail service.”

“I am not sure if my shortline has a future in Kansas, but I hope it does. Without the railroad we would lose some of our flexibility. We lose the ability to serve some markets that we would not be able to serve by truck. We also need competition to keep truck prices in check.”

“We need rail service to access flour mill markets for wheat.”

“The shortline that serves my facility has worked with the shippers on the line in several different ways the past three years and our rail shipments have been increasing.”

“The shortline I am located on serves the most productive wheat country in the state, so this branchline has been profitable.”

“I would hate to be without rail service. We have used the shortline to ship our better quality, higher protein wheat. This competitive advantage has allowed us to treat our customers better.”

“I think shortlines will have a future in my area by serving end users such as feedmills or shipping corn to feedlots.”

“Railroad service is necessary for us to be competitive in national and international markets.”

“We need shortline service to ship wheat out and to import corn from other states.”

“We have markets on both ends of our shortline.”

“If the rate is competitive I prefer to ship railcars because I can ship more volume in a shorter time.”

“Shortlines have a future because there are times when export markets are important and rail is the only practical cost effective mode for reaching these markets.”

“We need to keep shortlines in operation because of the shipping economies and the access to additional markets. The farmer would receive less for grain if we were totally reliant on trucks. It would be hard for us to survive without the shortline.”

“The shortline serving my location does a good job and I don’t want to be totally dependent on trucks.”

“The Class I railroads can’t serve all locations and trucks provide a limited range of market options.”

“We need shortlines to maintain rate competitiveness relative to trucks. We also need railroads to ship sunflower products.”

“Rail has advantages such as the ability to move a lot of grain in a short time, and get paid 90 percent of the value of the shipment at the time of the shipment. Also our shortline has provided exceptional service.”

“The Class I railroads don’t want to serve the branchlines. Shortline railroad transportation is a great asset to isolated rural communities. Also rail service is necessary to have access to the export market.”

“I am getting good twice a week service from my shortline, and I don’t have car supply problems.”

“Some areas are located where shortlines would have good utilization such as areas with high protein wheat demanded by flour mills.”

“Shortline railroads can cost effectively assemble multi-car shipments from remote areas not served by Class I railroads.”

“At our remote location, we will always need shortline railroads.”

“My facility is getting better service from the shortline than we ever got from the previous Class I railroad.”

“We want to ship more grain by rail, but the shortline needs to provide railcars in a more timely manner.”

“Wheat and sorghum markets are more profitable by rail most of the time. We would ship 60 percent of our grain receipts by rail if rail cars were available when we need them.”

“The shortline serving this area provides us with a quick, competitive way to ship wheat to flour mills in Wichita.”

“Shortline transportation is very important in moving grain quickly to terminal markets and storage facilities. It is a much more efficient mode than truck for shipping grain long distances.”

“Shortlines will survive if they get better support from Class I railroads such as improved interlining to reach more markets.”

“We get good service from our shortline.”

Some of the grain shippers responded “no” to the question for the following reasons.

“The shortline serving my elevator won’t survive since its rates are non-competitive, and its markets are very limited.”

“Several changes will need to occur for shortlines to exist five years from now. These are more competitive rates, co-loading of grain, improved service, and better car supply.”

“Unit train loading stations are the wave of the future in grain transportation. Shortlines will thus continue to lose business to trucks.”

“We don’t use the shortline since we are only 20 miles from a terminal market. Also the unit train facilities on Class I railroads will eventually run the shortlines out of business.”

“The shortline serving my elevator doesn’t have enough traffic to be profitable in the long run.”

“The rail market emphasizes rapid, high volume loading. We would have to make major investments to upgrade our loadout capacity and expand our rail siding.”

“The shortline that serves my facility is very deteriorated and the attitude of the railroad’s management is poor. Many farmers in my area truck their grain to terminals.”

“The shortline serving my facility doesn’t provide any markets that can’t be served more cheaply by truck. I believe the shortline will abandon the line serving my elevator.”

“I believe the shortline serving my facility will eventually abandon the line. The shortline will have to improve its service to survive. I want the railroad to survive to provide competition for trucks.”

“In our area the location of our markets for feed grains run north and south whereas the rail service here is for east-west markets.”

Several of the grain shippers located on study area shortlines were not sure if shortlines have a future in the Kansas grain transportation system. The following are quotes from grain shippers who responded "maybe" to the question.

"Shortlines will survive only if they are able to obtain the capital to maintain their lines."

"Shortline survival depends on rates and service. My shortline provides good service, but the connecting Class I railroad has uncompetitive rates."

"Shortlines may be profitable by serving the flour mill market."

"For the shortline system to survive the following has to occur (a) superior management and high employee productivity (b) sufficient volume (c) adequate capital to maintain the tracks."

"The shortline will need more than just grain traffic to remain profitable."

"Shortline survival depends on their ability to provide service at competitive rates and the willingness of Class I railroads to work with shortlines on switching and car availability."

"As long as grain is produced in western Kansas it has to be moved. With increased grain production and the need to move grain quickly to the best markets, rail can do it faster than trucks if railcars are available. If the best market is only 70 or fewer miles distant, trucks will be used to move grain."

"Since we are located close to a terminal market, trucks have a competitive advantage over shortlines. Also many farmers in the area have bought semi-tractor trailer trucks to deliver grain directly to the terminal. However, shortlines have an advantage in more remote areas."

"Shortlines will survive if they can reduce their costs by operating efficiently."

"Their survival depends on construction of rapid loadout facilities and the shortline's freight rates."

"To have a future, shortlines need to provide more dependable service and be more rate competitive."

"The shortline serving my facility needs to increase the frequency of service and establish rates that are competitive with trucks or our rail shipments will continue to decrease."

"Shortlines will survive if they are able to improve their service."

"Shortlines will survive if they can offer competitive rates and provide dependable service."

"The shortline serving my facility would survive if they did a better job of working with grain shippers, and improve the condition of the track."

"Shortlines will survive only if they can supply more cars and upgrade their tracks to provide faster, more timely service, and to handle larger rail cars."

"Shortlines will not be able to survive without government assistance."

"Some shortlines won't survive because of poor service. Others will have a future because shippers will invest in facilities on a railroad that performs well. This will increase the shortline's business."

"We only receive about 500,000 bushels of wheat per year so we don't have a large demand for rail service."

"Most wheat shipments move a long distance and thus moves by rail. Shortlines benefit somewhat from this. Also in some years the best markets for sorghum are rail markets in California and Mexico."

"The shortlines will have a future if they can provide on-time service, and exploit their efficiency in long haul grain shipment."

"In order for shortlines to survive, their freight rates need to be more competitive."

"In order for the shortline to survive, it needs lower rates and higher quality tracks."

"Shortlines need to develop more lenient loading times for the smaller elevators they serve, and to look for backhauls of products to the grain loading points as opposed to running empty most of the time when they pick up or deliver rail cars."

Summarizing all the grain shipper responses, including those that chose not to explain their opinion, about half (49.4 percent) said that shortlines have a future in Kansas. A little over one-third (36.4 percent) of the shippers stated that shortlines may have a future under certain conditions, and only 14.2 percent said that shortlines have no future in the Kansas grain transportation system.

For the grain shippers which agreed that shortlines have a role to play in the Kansas grain transportation system, the most frequently mentioned reason was that shortlines provide better service than their previous Class I railroad. Another frequently mentioned reason was that wheat and sorghum markets are better served by rail. The explanations for the belief that shortlines have a future in Kansas are summarized below from the most frequently mentioned reasons to the least frequently mentioned.

1. Shortlines provide better service than the previous Class I railroad.
2. Wheat and sorghum markets are better served by rail.
3. Railroads are more efficient than trucks for long haul shipment.
4. Shortlines are a quick, competitive way to ship wheat to flour mills.
5. Increasing fuel costs will make shortlines more competitive with trucks.
6. Shortlines can move a lot of grain to market in a short time.
7. Rail transport is needed to access the export market.
8. Shortlines have invested in maintaining their tracks.
9. Shortlines will benefit from planned construction of multi-car shipping facilities on their lines.
10. Shortlines are needed to provide price competition with trucks.
11. More grain would be shipped on shortlines if railcars are provided in a timely manner.
12. Shortlines will survive if they get better support from Class I railroads such as improved interlining to reach more markets.
13. Railroads are the cheapest way to access dry fertilizer markets.
14. Shortlines are a cost effective method of assembling multi-car shipments from remote areas.
15. High wheat production provides a market for shortlines.

The explanations for the belief that shortlines do not have a future in Kansas grain transportation are summarized below.

1. Shortlines do not serve the best feed grain markets.
2. Unit train shipping facilities on Class I railroads have reduced shortline grain traffic.
3. Shortlines have non-competitive rates.
4. Shortlines have inadequate traffic to survive in the long run.
5. Elimination of co-loading (pooling the shipments of several elevators) has reduced shortline grain traffic.
6. Shortlines provide poor service.
7. Shortlines have not supplied grain cars in a timely manner.
8. Shortlines have deteriorated track which has contributed to slow service.
9. Shortline have poor management.
10. Increased farmer ownership of semi-tractor trailer trucks has reduced shortline grain traffic.
11. Rail can’t compete with truck on short-haul trips to terminals.

For the grain shippers who said that shortlines may have a future in Kansas grain transportation, the most frequently mentioned factor was more competitive rates. These shippers also emphasized that shortlines must raise the capital necessary to maintain their tracks to provide faster service and to handle larger rail cars. The reasons why shortlines may have a future are summarized below from the most frequently mentioned reasons to the least frequently cited.

Shortlines may survive if:

1. They charge more competitive rates.
2. They are able to raise the capital necessary to maintain their tracks to provide faster service and to handle larger railcars.
3. They can provide dependable service.
4. They become more customer oriented.
5. Class I railroads cooperate with shortlines on switching, railcar availability, and competitive rates.
6. They can supply more railcars.
7. They can reduce their costs.
8. They receive government assistance.
9. They provide more frequent service.
10. They can obtain sufficient traffic.
11. They have non-grain traffic.
12. Unit train facilities are built on their lines.
13. They explore potential backhaul markets.
14. They exploit their efficiency for long haul grain shipment.

5.2 The Views of Unit Train Shippers Located on Class I Railroads

Unit train grain shippers were also asked for their opinions regarding the question, "Does shortline railroad transportation have a future in Kansas?" Managers of 9 of the 12 facilities listed in Table 2 responded to this question. Managers of four companies responded "yes" to the question, three responded "no", and two checked the "maybe" alternative.

With regard to the managers that believe shortlines have a future in Kansas grain transportation, three of them emphasized significance of large wheat production in Kansas. They said that in areas of Kansas where wheat is still the primary grain, the shortline's function is to move wheat from these areas to domestic flour mills. The flour mills provide a stable demand for shortline transport throughout the year, and usually will be the best market at some time during the year. The other manager in this group stated that shortlines that are efficient and willing to work with Class I railroads will prosper.

One of the unit train facility managers who stated that shortlines do not have a future in Kansas grain transportation said that elevators on shortlines will ship grain by truck to unit train facilities on Class I railroads who will be the rail shippers. The basis of this opinion is that unit train loading facilities have cost advantages due to economies of scale in computerized rapid loadout facilities and unit train transportation. Another manager of a facility in this group said that poor service of some of the shortline railroads won't allow them to survive in the long term. The third manager expressing a lack of confidence in shortlines gave no reason for the negative response to the question.

Two of the managers of unit train loading facilities stated that shortlines may have a future in the Kansas grain transportation system, but only one gave an explanation for his view. He said that shortlines will survive if they provide railcars when they are needed and the flexibility to load more cars at one time. Shortlines also need to offer more market choices and lower freight rates. Ultimately shortline survival depends on whether they can generate sufficient traffic on the line to be profitable and be able to maintain their tracks.

5.3 The Views of Study Area Shortline Railroad Executives

Executives of study area shortlines are more qualified than anyone to answer the question, "Does shortline railroad transportation have a future in Kansas?" Two of the executives answered "yes" to this question, and two responded "maybe".

One of the two executives responding in the affirmative to the question said that shortlines have a future, especially if a "level playing field" is established between railroads and trucks. Motor carriers operate on highways maintained by the public and federal government studies have concluded that heavy trucks do not pay all their cost responsibility for damage to these roads. According to this executive, shortlines maintain their own lines and provide a public benefit by keeping some trucks off the public highway system, making the highways safer and lowering highway maintenance costs. The other executive in this group noted that railroads have cost advantages relative to trucks for long haul grain shipments.

One of the executives expressing a “maybe” opinion on the future of shortlines in Kansas said that shuttle trains on Class I railroads are geared to serve the export market. Shortlines are needed to serve the domestic flour mill market. The other executive with a “maybe” opinion said that he believes the construction of 110 car grain loading facilities has peaked, and the main issue will be how Kansas helps shortlines overcome the heavy axle railcar problem.

5.4 Summary

The last question on the questionnaire distributed to grain shippers and executives of study area shortline railroads was “Does shortline railroad transportation have a future in Kansas?” The question had three possible responses which were yes, no, and maybe.

With respect to the grain shippers located on study area shortlines, about half (49.4 percent) said that shortlines have a future in Kansas. A little over one-third (36.4 percent) stated that shortlines may have a future under certain conditions, and only 14.2 percent said that shortline railroads do not have a future in the Kansas grain transportation system.

For the grain shippers located on shortlines which agreed that shortlines have a role to play in the Kansas grain transportation system, the most frequently mentioned reason was that shortlines provide better service than their previous Class I railroad. Another frequently mentioned reason was that wheat and sorghum markets are better served by rail transport.

Concerning the grain shippers located on study area shortlines that believe shortlines do not have a future in Kansas grain transportation, the principal reasons were "shortlines don't serve the best feed grain markets," and "unit train shipping facilities on Class I railroads have reduced shortline grain traffic."

For the grain shippers who said that shortlines may have a future in Kansas grain transportation, the most frequently mentioned factor was the need for more competitive rates. These shippers also emphasized that shortlines must obtain the capital necessary to maintain their tracks to provide faster service and handle larger railcars.

Unit train grain shippers were also asked for their opinions concerning the question, "Does shortline railroad transportation have a future in Kansas?" Managers of 9 of the 12 facilities listed in Table 2 responded to the question. Managers of four companies responded "yes" to the question, three responded "no," and two checked the "maybe" alternative.

With regard to the unit train facility managers that believe shortlines have a future in Kansas grain transportation, three of them emphasized the significance of large wheat production in Kansas. The shortline's function is to move wheat from areas with large wheat production to domestic flour mills. The flour mills provide a stable demand for shortline transport throughout the year.

One of the unit train facility managers who stated that shortlines do not have a future in Kansas said that elevators on shortlines will ship grain by truck to unit train facilities on Class I railroads who will be the rail shippers. Another manager said that the poor service of some shortlines won't allow them to survive in the long run.

Executives of the four study area shortline railroads were asked if "shortline railroad transportation has a future in Kansas." Two of the executives responded "yes" to the question and two responded "maybe". One of the two executives responding in the affirmative to the question said that shortlines have a future, especially if a "level playing field" is established between railroads and trucks. The other executive in this group noted that railroads have cost advantages relative to trucks for long haul grain shipments.

One of the executives expressing a "maybe" opinion on the future of shortlines in Kansas said that shortlines are needed to serve the domestic flour mill market. The other executive in this group said that the main shortline survival issue will be how (if) Kansas helps shortlines overcome the heavy axle railcar problem.

CHAPTER 6

PAVEMENT DAMAGE ANALYSIS

6.1 Increased Grain Trucking and Road Damage Cost

As noted previously in this report, during the 1997-1999 time period, about 45 percent of the wheat shipments of elevators located on study area shortlines were transported by shortline railroad and 55 percent by motor carrier. Trucks dominated the shipments of sorghum, corn, and soybeans, accounting for 83 percent of the sorghum shipments and nearly 98 percent of the combined corn and soybean shipments. In total, shortlines accounted for only 28 percent of the grain shipments from the elevators located on their systems.

Several trends emerged in the latter part of the 1990s that have resulted in increased trucking of grain in Kansas. Farmers began delivering grain to country elevators and unit train locations on Class I railroads in much larger trucks. The percent of grain delivered by truck to terminals in Salina, Wichita and Hutchinson significantly increased. Unit train locations emerged on Class I railroads and all of the grain received by these facilities was delivered by truck. According to surveys of shippers located on study area shortlines, the reasons they are shipping more grain by truck are primarily because they (as a group) can obtain a lower transportation rate by selecting trucks, and because the best sorghum, corn, and soybean markets are not rail-served.

Increased trucking of grain has negatively affected study area shortline grain traffic and profits. According to surveys of executives of study area shortlines, the combined 1998 and 1999 grain carloadings for the four shortlines would have been 17 percent greater if increased grain trucking had not occurred. The executives also estimated that increased grain trucking had reduced their profits by 11 to 20 percent.

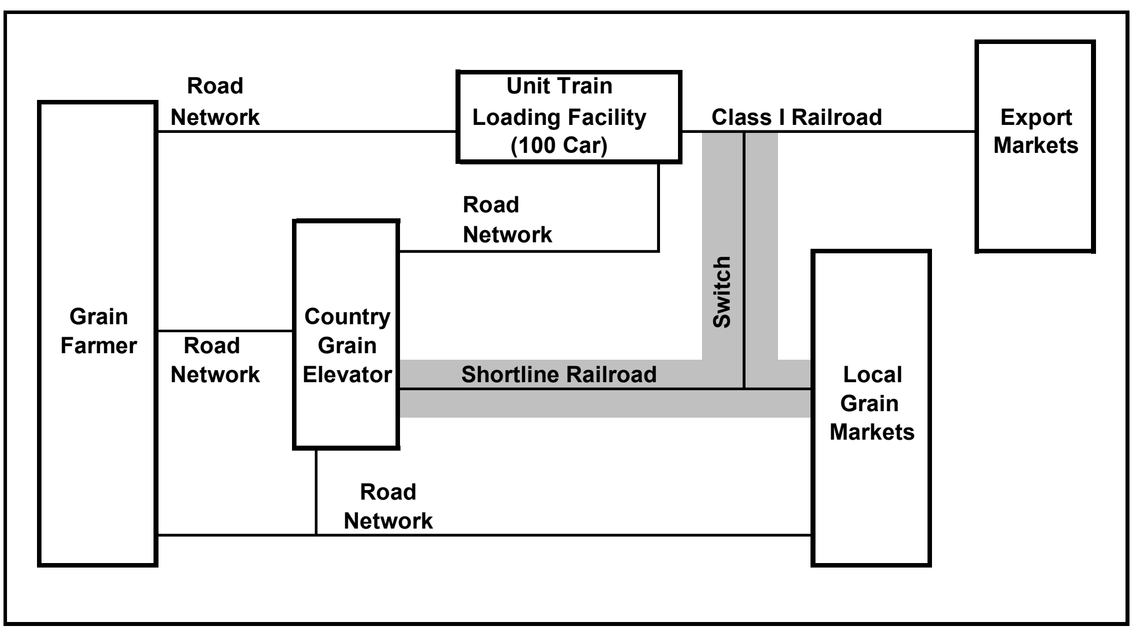
Executives of study area shortlines ranked adequate traffic levels as the most important determinant of shortline success (profitability). The closely related determinant "strong shipper support" was ranked as the third most important factor. Thus grain is the most important commodity of study area shortlines and traffic volume is the most important determinant of shortline profitability. As more grain has been shipped by truck, shortline traffic and profits have been negatively affected, perhaps threatening the long run viability of these railroads. Should this happen, several consequences could occur. One of the most important impacts would be increased road damage as the grain the shortlines would have transported is diverted to motor carriers.

Consistent with Objective C, this chapter will focus on quantifying the costs associated with pavement deterioration due to the incremental grain truck traffic resulting from hypothesized shortline abandonment. In particular, a pavement damage estimate will be made given the most recent conditions as quantified through the primary data gathered in the study. Current grain transport practices, as ascertained through the interview and survey process documented previously, as well as the volume of grain shipped in 1999 from elevators located on study area shortlines, will be used to determine the annual benefit that each of the four shortline railroads in the study area provides to Kansas in terms of pavement damage prevention. Origin-destination information obtained from grain shippers along with the actual 1999 grain carloads originated by shortlines by location are used in the analysis. Standard engineering models modified to provide impact estimates are used to quantify the costs associated with the pavement damage expected from shortline abandonment given current pavement conditions as documented by the Kansas Department of Transportation.

6.2 Specification of the Kansas Grain Transportation System With and Without Shortlines

The passage of grain from farm to market is best modeled as a network flow problem with farms serving as the supply nodes, grain elevators and unit train loading facilities serving as transshipment nodes and both domestic and export markets serving as the terminal demand nodes in the system. The county and state road networks, shortline railroads, and Class I railroads serve as the arcs which connect the nodes in the system. Grain originates at the farms and makes its way through either a country grain elevator or unit train loading facility on its way to either a domestic or export market destination either by truck or by rail. Figure 2 provides a flow diagram for the Kansas grain transport system in its current state, inclusive of shortline rail service.

Figure 2
Current Grain Transportation System With Shortlines



Harvested grain leaves the farm on trucks that travel over the county and state road network. About 80 percent of the grain-filled trucks leaving the farm are either semi or tandem axle trucks with the number of semis growing rapidly every year. A farmer has three options. First, he can truck his grain to a local market that is almost always limited to 250 miles from the farm because of the high proportion of variable costs involved with trucking. Also, the farmer has neither the expertise nor the economies of scale to profitably ship his grain over distances greater than 250 miles. Second, he can truck his grain to a nearby country elevator, where it is consolidated with other grain from the local area and marketed over much greater distances given the economies of scale involved in rail transport. Third, the farmer can truck his grain to a unit train loading facility. Since there are relatively few of these facilities state-wide, farmers drive anywhere from 11 to 70 miles to deliver grain to be loaded on a 100-car train. The motivation to travel greater distances is the greater grain price paid by unit train shippers due to low transport costs generated by economies of scale that the Class I railroads experience by shipping 100-car trains.

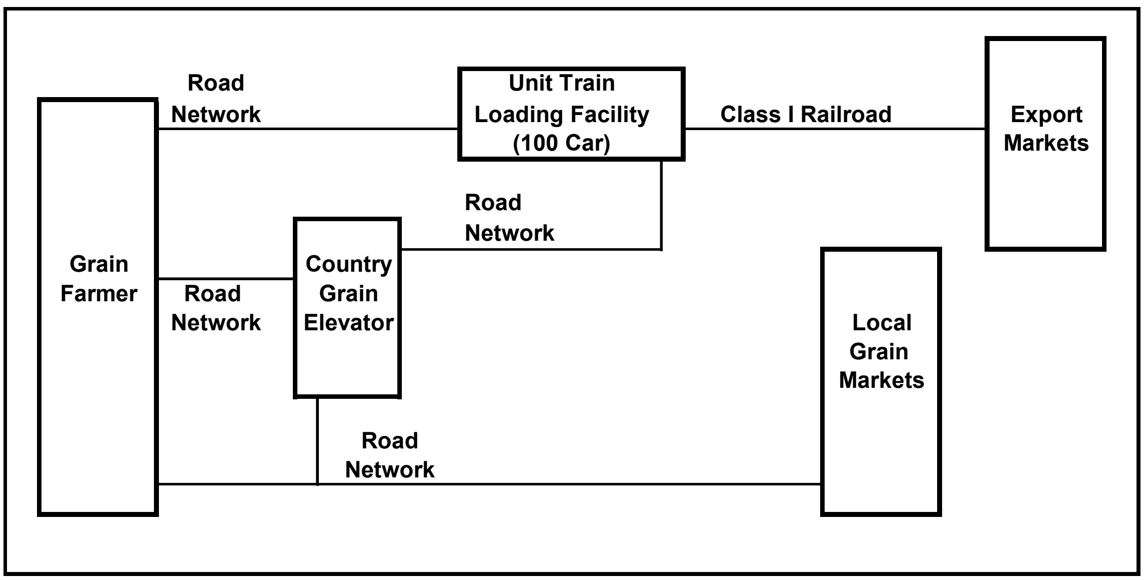
The country grain elevator has three options in the system portrayed in Figure 2. First, grain can be shipped by truck to a local market. This option is prevalent in the sorghum, corn and soybean markets, as these markets are not well served by rail. Second, the grain elevator can ship grain by shortline that will either switch into a Class I rail line in order to proceed to the more distant domestic and export markets, or the elevator can originate and terminate grain on the shortline to serve regional domestic markets. And, finally, the country grain elevator has the option to truck grain to a unit train loading facility to serve distant domestic or export markets.

Unit train loading facilities, of course, seldom truck any grain. Their recent prominence and profitability in the grain industry has been gained through their computerized loading of grain and economies of scale in shipping 100 cars of grain at a time to distant domestic and export market terminals.

Undoubtedly, market prices impact transport choices. However, as in most logistic systems, cost is best analyzed as the chief factor in modal selection in the Kansas grain transport system. All other things equal, sound business strategy still demands firms routinely minimize costs in order to maximize profits. In the grain industry, that means getting grain to market in a timely manner at the least possible cost. With this in mind, the traditional least cost flow of grain from farm to market travels by truck to a country grain elevator where it is loaded on a shortline for delivery either to a regional market or to a switching point with a Class I railroad for delivery to distant domestic or export markets. The country grain elevator may also ship grain by truck to a local grain market. Traditionally, this is how grain has moved in Kansas. The recent infusion of unit train loading facilities into the grain logistics system has altered the traditional system quite significantly. The sharp decline in shortline grain transport market share and corresponding decline in profits makes the exercise of simulating their absence in the Kansas grain logistics system a pertinent endeavor at this point in time.

As seen in Figure 3, abandonment of shortline track leaves country grain elevators only one modal choice. Country grain elevators can ship grain by truck to either local grain markets, or to a unit train loading facility to service distant domestic or export markets. The resulting system yields a new typical least cost product flow. The farmer still ships his grain from the farm to the nearest country elevator to minimize his trip times during harvest, while the country elevator must now ship by truck to a local grain market or to the nearest unit train shipping location for shipment to distant markets. As noted previously, motor carriers dominate the shipment of corn, sorghum, and soybeans in Kansas. Thus, the abandonment of shortlines will primarily affect the transportation of Kansas wheat. Grain shippers, whether farmer, elevator, or unit train loading facility all seek least cost transportation, that is increasingly becoming the system with less shortline participation and more trucking.

Figure 3
Grain Transportation System Without Shortlines

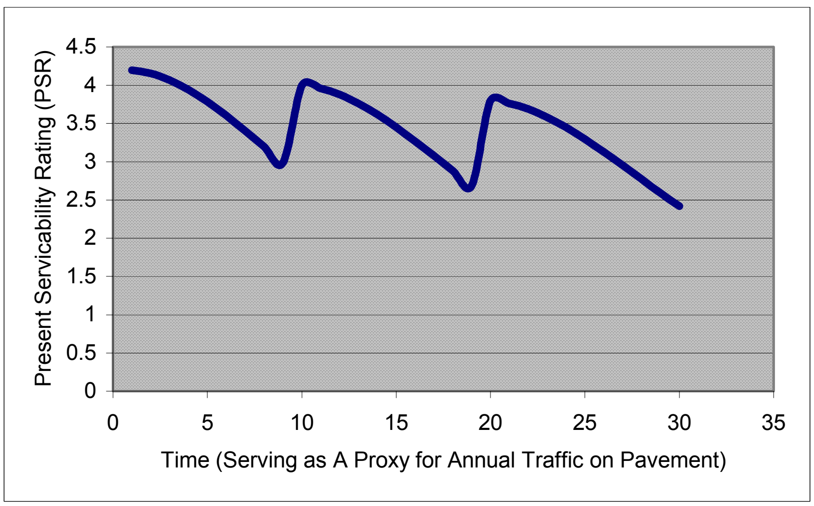


6.3 Overview of Road Damage Cost Model

The model described above is the point of departure for estimating anticipated damage caused by potential shortline abandonment. It is safe to assume that when shortline track is abandoned that the grain shippers will shift to the next lowest cost transportation to replace shortline service. Ignoring random spikes and dips in grain prices, the least cost transport path for grain follows from the farmer to the country elevator, and then from the grain elevator to the unit train loading facility for low cost shipment to distant markets. It is also reasonable to assume that local markets are already saturated and would not be able to handle the volume of grain moved out of the region by shortlines via switch to a Class I railroad. Thus, the incremental increase in truck traffic is anticipated to originate at country elevators and terminate at the nearest unit train loading facility at the levels necessary to haul the volume of grain historically transported by the shortline. Furthermore, holding to the least cost practice assumptions, the routing for those trucks can also be predicted by identifying the least cost route which would be assessed in terms of distance, time, and wear and tear on the equipment. Considering these factors, an assumption is made that trucks will utilize the better maintained state highway network whenever possible to avoid the 30 mile per hour road conditions and the excessive wear and tear caused by gravel county roads.

Before exploring the pavement damage model, it is necessary to consider the pavement management process. To begin, the performance of a pavement is measured by its present serviceability rating (PSR). PSR is an objective rating criterion developed by the American Association of State Highway and Transportation Officials (AASHTO) in an empirical study where a panel of test drivers made quality assessments on their ability to safely operate their test vehicles on test pavements that were in varied states of decay. The PSR rating is a quality index with 5 being the best possible pavement conditions and 0 being the worst. Kansas Department of Transportation policy is to design and build asphalt pavements to an initial PSR of 4.2, and requires a mandatory reconstruction of an asphalt pavement when its PSR reaches a 2.5 or lower. Roads are initially designed to accommodate forecasted traffic volumes, and the PSR of a road is expected to decline over time with a progressive number of cumulative vehicle passes. Thus, a pavement begins with an initial PSR of 4.2 and steadily declines with time and vehicle passes until it reaches the terminal PSR of 2.5 when the entire road must be reconstructed. KDOT further extends the lives of its asphalt pavements by conducting substantial maintenance in the interim to raise the PSR of the pavement prior to it reaching its terminal PSR. In fact, current KDOT practice, albeit subject to variances caused by budget fluctuations and political pressures, is to perform substantial maintenance on a pavement, on average, at the 10 and 20 year point in a pavement lifecycle which thereby extends the maximum feasible life of asphalt pavements to 30 years on the state highway network. Thus, as depicted in Figure 4 asphalt pavements are constructed with an initial PSR of 4.2. When their PSR declines to the KDOT trigger PSR of 3.25 or on a planned schedule of approximately 10 years, they are re-paved and then are used for approximately 10 more years before they must be reconstructed to begin the cycle again.

Figure 4
Pavement Life Cycle



Although the pavement management process above is subject to frequent under-budgeting and rapid shift in priorities caused by political processes, this study proceeds with a best practices assumption which was derived from input provided by the staff at KDOT Bureau of Materials and Research, Materials and Research Center. Pavement management and cost data were derived from the model previously discussed and depicted in Figure 4. Given that a reconstruction operation and two substantial maintenance operations are necessary to extend the life of a pavement to 30 years, consisting of three 10 year pavement performance periods, the life cycle cost of a pavement is simply the sum of those three activities. The average costs of these rehabilitative operations were obtained using 1999 KDOT budget data which funded 200 miles of reconstruction at a cost of $250 million, and 1400 miles of substantial maintenance at a cost of $150 million. The average cost in 1999 for reconstruction projects was $1,250,000 per mile and for substantial maintenance projects was $107,142.90 per mile. An asphalt pavement then costs $1,464,285.80 per mile with a maximum feasible life of 30 years, inclusive of 10 year typical pavement performance periods involving two resurfacings.

Taking stock of the information gathered thus far in the discussion leads to a greater appreciation of the methodology designed by Denver Tolliver of North Dakota State University and documented in the study funded by the Washington State Department of Transportation entitled *Benefits of Rail Freight Transportation in Washington* which was published in 2000. From the least cost grain transport model, origin-destination and routing information of expected incremental truck traffic was obtained. KDOT provided data from their CANSYS system that contains the engineering specifications of the pavements along those least cost routes. All four shortline railroads in the study area provided their 1999 grain and fertilizer carloadings by station yielding actual grain volumes by location. Thus, with the pavements on the least cost routes, their corresponding engineering characteristics, and the volumes of incremental traffic expected on those pavements, a full explanation of the Tolliver method can proceed.

The Tolliver methodology has four main steps and utilizes the damage functions estimated from the previously mentioned AASHTO studies. First, the load characteristics of a standard grain truck are converted to an equivalent single axle load (ESAL) measurement which indicates the damage that the standard loaded grain truck will inflict upon a specific pavement segment as compared to that caused by a pass of the standard 18,000 pound tandem axle utilized in AASHTO studies. Thus a 1.2 ESAL axle pass will cause 1.2 times the damage as a standard 18,000 pound axle. Pavement damage is evaluated in terms of loss in PSR and is dependent upon the structural number (SN) of a pavement segment, as well upon the weight and load configurations of a standard grain truck. The structural number is simply a measure of the thickness of the pavement that has been adjusted in terms of its strength based upon the materials comprising the pavement design. The structural number gives an indication of how a pavement will bear an ESAL pass and gives an indication of the design life of a pavement in terms of the total number of ESAL passes it will bear before its terminal serviceability is reached. The weight and load configurations of a standard grain truck were assumed to be 10/35/35, or a semi truck with a single front axle loaded to 10,000 pounds with the two tandem trailer axles weighing 35,000 pounds each. This configuration was the recommendation of the staffs at both the KDOT Bureau of Materials and Research, Materials and Research Center and the KDOT Planning Traffic and Field Operations Division. They decided upon 10,000 pounds for the front axle based upon the ability to steer the vehicle and that many of these vehicles have a hydraulic 5th wheel that allows them to adjust the position to achieve this weight. The 35,000 pound rear tandem axles would bring the total truck weight to the legal limit, and although some trucks may be operating above that limit, they felt the legal weight limit was a reasonable estimate for calculating ESALs of loaded grain-hauling vehicles. KDOT historical truck weighing data was unreliable in this matter as the data available made no indication of whether the vehicles being weighed were loaded or empty.

The second step in the Tolliver method is to determine the design life of a pavement segment as defined in terms of the total number of ESAL passes it can sustain before its serviceability declines below its terminal PSR. The ESAL life equations are designed from the same AASHTO equations used to determine the ESAL factors calculated in step one. This calculation provides the total traffic life of a pavement section and is the chief input to step three of the process.

Step three is to determine and apply the cost per ESAL to the impacted pavement segments. In short, from the pavement life cycle cost data, we know the total life cycle cost of a pavement segment. From our ESAL calculation in step 2, we know how many ESAL passes comprise the pavement's feasible life, or ESAL life of the pavement. By dividing the total life cycle pavement cost by the ESAL life of the pavement segment, the cost per ESAL mile is determined for a pavement segment. Thus by multiplying the cost per ESAL mile by the length of the pavement segment and by the total number of ESAL passes expected upon the impacted pavement, the total pavement damage cost for a pavement segment is estimated.

Step four of the Tolliver method involves adjusting the total damage for a pavement segment so that it does not include the pavement deterioration that occurs naturally over the 30 year life of a pavement. As Tolliver himself notes "[t]hermal cracking, differential heaving due to swelling subgrade or frost penetration, disintegration of surface materials due to freeze-thaw cycles, and other climatic/aging effects of materials are largely a function of the environmental zone, and will result in a loss of pavement serviceability" (Denver Tolliver and Associates and HDR Engineering Inc. 2000, p. 98). The environmental damage function is modeled as a negative exponential function and predicts large environmental deterioration in the early life of a pavement which deteriorates at a decreasing rate as the pavement ages. Tolliver's method determines a decay rate by determining the deterioration rate that would be necessary to erode the serviceability of a pavement segment from the initial PSR of a road to its terminal PSR over the maximum feasible life of the pavement section, which in Kansas involves the decay of a pavement in the absence of traffic from a PSR of 4.2 to 2.5 over the 30 year feasible life of the pavement section. This decay rate is then applied to the typical pavement performance period to determine PSR expected to be lost to the environment. The PSR lost to the environment is translated into the percentage of total PSR decline by dividing the PSR lost to the environment by the PSR difference between initial and terminal PSR. For instance, if the environment is expected to deteriorate an impacted pavement by .85 PSR points and the difference between initial and terminal PSR is 1.7, then environmental damage would be estimated to be 50 percent of the total pavement damage. The total pavement damage cost estimate is reduced by this percentage estimate to yield the damage caused by incremental truck traffic.

Tolliver's method can be applied to both asphalt and concrete pavements, but was only used to estimate damages to state and county asphalt roads. The only rigid or concrete pavements that corresponded with the incremental truck routings were located in urban areas and had large variances in engineering characteristics over the course of a few hundred feet. Urban area road data was omitted, and the characteristics of the adjacent rural area roads were assumed to be present through town to avoid unnecessarily overstating estimated pavement damage costs. Median pavement characteristics were used if outliers were evident; otherwise, average PSR and SN values were utilized for damage calculations. In the case where no pavement characteristic data was available, as in those county paved roads that were impacted, state highways in the neighboring region were used to approximate their PSR and SN. Only 110 miles of pavement, or 4 percent of the impacted pavement was analyzed in this fashion.

Tolliver's method makes no provisions for calculating damages to unpaved roads, and although paved roads were given preference in routing based on least cost considerations, 23 miles of impacted roads were unpaved (1 percent of the total impacted pavement). The 1993 AASHTO Guide for Design of Pavement Structures contains estimates for the loss of aggregate, or gravel surface, of unpaved roads given truck traffic levels. Cost data for an average county in terms of annual gravel road maintenance was used to estimate the cost of replacing the loss of aggregate predicted by the AASHTO functions. The estimated cost per truck mile was developed from the following information. First, the county engineer interviewed reported that he purchased crushed limestone aggregate from an external vendor so his cost of materials would fall somewhere in the middle of the costs of the counties located in the study area. He reported that he spends $7,000 a year to maintain one mile of a standard 24 foot gravel road. This maintenance cost was the equivalent of the materials, labor, and equipment costs for two separate applications involving 2 inches of aggregate per application per year. Thus it costs approximately $7000 per year to apply 4 inches of gravel to a one mile segment of unpaved road. Thus, it follows that the total cost of replacing lost aggregate is $1750 per inch/mile ($7000 / 4). This cost per inch/mile was applied to the aggregate loss estimated from the AASHTO function to arrive at the total damage to the gravel road.

6.4 Specification and Implementation of Road Damage Cost Model

Road damage estimates were obtained using the following 12 step process:

1. The incremental increase in truck traffic was determined given the simulated removal of shortline rail service.
2. The least cost route (origin-destination) was determined for the incremental truck traffic.
3. Pavement characteristics along the truck routes were ascertained.
4. Axle load equivalency factors for a standard grain truck were calculated given truck and road characteristics.
5. The maximum tolerable decline in pavement serviceability (PSR) was quantified given KDOT design and pavement management policies.
6. The maximum feasible life of the pavement in the study area in the absence of traffic

was estimated.

7. The total number of standardized truck passes until pavement failure (ESAL life) for each impacted pavement segment was calculated.
8. The expected percentage of loss in pavement serviceability (PSR) as a result of temporal-environmental decay was estimated.
9. The adjusted unit cost per mile per truck pass (ESAL) was calculated for each impacted pavement segment by separating estimated non-traffic costs.
10. The total cost of the incremental increase in traffic was determined for each shortline's grain traffic.
11. The pavement characteristics for county paved roads were estimated using the pavement characteristics of nearby state highways with similar traffic patterns and steps 3 through 9 were used to estimate damage using the approximated road characteristics.
12. Damage to county roads was estimated by determining an average cost to apply aggregate (gravel) and multiplying that cost by the amount of aggregate expected to be lost due to incremental grain truck traffic.

1. All of the shortline railroads in the study area provided the total carloads of grain and fertilizer that originated or terminated (by location) on their lines in 1999. Railcar grain shipments (200,000 pounds) were converted to truckloads (about 50,000 pounds) at an estimated four truckloads necessary to transport the grain carried by one railcar. Origin location and grain quantities were obtained through primary data collection, and shipment destinations were predicted to be the nearest unit train loading station. Routing for the grain freight network absent the shortline railroads was accomplished using least distant passage from origin to destination making maximum use of the state highway system.
2. In the absence of shortline rail access, grain previously shipped by shortline will move by least cost method to market. From the trends in grain traffic previously outlined in Chapter 2, it is assumed that grain stored in country elevators will be shipped by truck to the nearest unit train loading station (Table 2) to facilitate the least cost movement for either export or non-Kansas U.S. domestic flour mill markets. Grain shippers also use shortlines to deliver grain to Kansas flour mills and the grain terminals in Hutchinson, Salina, and Wichita. If shortlines were abandoned, these shipments would move by truck.

However, we did not include these destinations in the analysis since our survey data did not indicate how much of the wheat was shipped by shortline to each of these destinations by shippers located on study area shortlines. Maximum use of the state highway system is expected, given the extra truck maintenance cost that would be incurred by utilizing county roads which have poorer service characteristics and are seldom paved. Routing assumptions were corroborated by surveys and interviews of managers of elevators located on shortlines, nearly all of whom responded that the nearest unit train loading station was one of their outbound truck shipment destinations.

3. Pavement characteristics along routes in the grain freight network absent shortlines were obtained from KDOT (CANSYS database query). Pavement damage was calculated for complete segments of the network roads utilizing the median segment characteristics to estimate damage to the entire segment. Since most of the pavement analyzed involved rural highways, urban pavement data was not included in the damage calculations. Instead, the average characteristic of the rural roadway on either side of the city or town was taken to represent urban road.
4. AASHTO damage calculations are estimated in ESALs. An ESAL is a formal measure relating the damage expected from a truck axle pass on a pavement segment to the damage that was empirically observed during the AASHTO experiments by a standardized 18,000 pound axle (18 kip) on a standardized pavement segment. Thus, in order to utilize the AASHTO functions, the load characteristics for a typical grain truck had to first be converted into18 kip equivalents. Axle load equivalency factors were calculated for the standard grain tractor-trailer configuration. The typical grain semi has one single-axle load and two tandem axle loads. Standard loaded grain truck weight was estimated to be

80,000 pounds configured with 10,000 pounds on the front single axle and 35,000 pounds on both the second and third tandem axles.

(i) First, the pavement deterioration caused by the front single-axle load was calculated in comparison to the damage expected from a standardized single 18,000 pound axle on the pavement impacted by the increase in grain truck traffic using the following AASHTO damage function:

(1) $\log_{10}(ESAL) = 4.79 \log_{10}([L + 1] / [18 + 1]) + (G / B_{18}) - (G / B)$

using

$L = 10$ (10,000 lbs)

(2) $B_{18} = 0.4 + [1{,}094 / (SN + 1)^{5.19}]$

where

B_{18} = rate of deterioration resulting from a single 18-kip axle

SN = structural number of flexible pavement section

and

(3) $$B = 0.4 + \frac{0.081\ (L + 1)^{3.23}}{(SN + 1)^{5.19}}$$

where

B = rate of deterioration for a given axle

and

(4) $G = \log10([P_I - P_T] / [P_I - 1.5])$

where

P_I = initial pavement serviceability rating

P_T = terminal pavement serviceability rating

Then, the actual ESAL factor for the front axle is determined.

(5) $n1 = 10^{\log10\ (ESAL)}$

where n1 = ESAL factor for single front axle

(ii) Second, the deterioration caused by the tandem-axle loads in comparison to a standard 18,000 pound axle load was similarly estimated using the following relationship:

(6) $\log_{10}(ESAL) = 4.79 \log_{10}([L + 2] / [18 + 1]) - 4.33 \log_{10}(2) + (G / B_{18}) - (G / B)$

using

$L = 37$ (37,000 lbs)

(7) $B_{18} = 0.4 + [1{,}094 / (SN + 1)^{5.19}]$

where

B_{18} = rate of deterioration for a single 18-kip axle

SN = structural number of flexible pavement section

and

(8) $$B = 0.4 + \frac{0.081\ (L + 2)^{3.23}}{(SN + 1)^{5.19}\ 2^{3.23}}$$

where

B = rate of deterioration for a given axle

and

(9) $G = \log10([P_I - P_T] / [P_I – 1.5])$

where

P_I = initial pavement serviceability rating

P_T = terminal pavement serviceability rating

Then, the actual ESAL factor for the loaded rear tandem axles was determined.

(10) $n2 = 10^{\log10\ (ESAL)}$

where

n2 = n3 = ESAL factor for loaded rear tandem axles

(iii) Third, the ESAL, or pavement damage factor, for an individual grain semi on each impacted pavement segment was determined by summing the ESAL factors for each of the axles.

(11) ESALtruck = n1 + n2 +n3

5. The maximum life of an impacted pavement is defined in terms of tolerable decline in its serviceability rating (PSR). KDOT has set a terminal serviceability rating of 2.5 for flexible pavements, below which reconstruction of the pavement segment is required. The maximum life of an impacted pavement is determined by taking initial serviceability rating and subtracting minimum allowable, or terminal serviceability rating. Flexible pavements in Kansas are designed to have an initial PSR of 4.2. Thus, the maximum tolerable decline in PSR is calculated as:

(12) MaxPSRDecline $= P_I - P_T$
$= 4.2 - 2.5$
$= 1.7$

6. The maximum feasible life of an impacted pavement is defined in terms of years by estimating how long it will take a pavement to decline to the minimum allowable PSR in the absence of truck traffic. The typical pavement performance period for an asphalt pavement section is around 10 years. However, by performing substantial maintenance, usually in the form of an asphalt overlay, the life of a flexible pavement can be dramatically extended. Thus, in practice, by performing substantial maintenance at 10 and 20 years, the maximum feasible life for asphalt pavement is extended to 30 years.
7. The life of a pavement is defined in terms of traffic. ESAL life of each segment is the number of axle passes that would cause the pavement to decline to its terminal serviceability rating. Highway Pavement Management System (HERS) functions developed by the Federal Highway Administration are used to compute the ESAL lives of impacted pavement segments as follows:

(13) LGE = XA + (XG / XB)

Where

LGE = logarithmic representation of ESALlife
XA = theoretical life of a newly constructed pavement
XB = the rate at which a pavement life is consumed with the accumulation of ESALs
XG = expresses pavement serviceability loss in terms of maximum tolerable decline in PSR

And

(14) $XA = 9.36 \log_{10} (SNA) - 0.2$
(15) $SNA = SN + (6 / SN)^{0.5}$
SN = structural number of impacted pavement

And

(16) $XB = 0.4 + (1094 / SNA)^{5.19}$

And

(17) $$XG = \log_{10}([P_I - P_T] / 3.5)$$

Thus

(18) $$ESALlife = 10^{LGE}$$

8. A time decay function is used to estimate how much loss in PSR would occur independent of truck traffic due to materials breakdown and environmental forces.

(19) $$P_E = P_I \times e^{(-t\delta)}$$

where

(20) $$\delta = (-\ln[P_T / P_I]) / (L)$$

P_E = PSR lost to the environment
δ = decay rate due to environmental losses
P_T = terminal PSR
P_I = initial PSR
L = 30 = maximum feasible life of pavement section
t = 10 = typical pavement performance period

The percentage of PSR decline due to environment relative to total tolerable decline in PSR is calculated as follows:

(21) $$EnvDamage = P_E / (P_I - P_T)$$

9. The unit costs per ESAL per mile for each road segment are then computed by multiplying the average pavement life cycle cost per mile, which includes the cost of complete reconstruction along with two substantial maintenance treatments, by the percent of PSR loss that can be attributed to the incremental truck traffic independent of environmental deterioration (ie. 1- EnvDamage) and dividing by the ESAL lives of the roadway segments.

(22) ESALcost / Mile = [(Repair Cost per Mile) x (1- EnvDamage)] / [ESALlife]

Where

Repair Cost per Mile = sum of one reconstruction and two substantial maintenance treatments

And

For substantial maintenance*:
$150,000,000 / 1400 miles = $107,142.90 per mile
For reconstruction*:
$25,000,000 / 200 miles = $1,250,000 per mile

*estimated from KDOT FY2000 expenditure data

10. Estimated pavement damage costs are then obtained by multiplying unit costs per ESAL per mile by the length (miles) of the impacted pavement segment, and then multiplying the result by the number of incremental ESAL passes generated on a road segment.

    (i.) The total incremental number of ESALs impacting a pavement section is equal to the number of ESALs per grain truck on that particular section of pavement (represented by ESALtruck in equation (10)) multiplied by the total number of incremental grain trucks anticipated to be traveling upon that segment of pavement following the simulated shortline abandonment.

(23) IncrESALs = ESALtruck * Incremental Truckloads

    (ii.) The total damage to a pavement section was calculated by multiplying the cost per ESAL per mile by the incremental increase in ESALs by the total length (miles) of the pavement segment.

(24) Total Cost = (ESALcost / mile) x (length of pavement) x (Incremental ESALs)

    (iii) Finally, shortline pavement damage impacts as a whole were calculated by summing the Total Cost of the increased traffic per pavement segment for each segment anticipated to be impacted by the hypothetical abandonment of the shortline track.

11. Pavement characteristics for paved county roads were approximated from nearby state highways with similar traffic patterns, and equations (1 – 24) were applied to the approximations to obtain damage estimates for the 110 miles of paved county roads expected to be impacted by shortline abandonment.

12. The total amount of aggregate (gravel) expected to be lost on impacted county gravel roads was estimated using the following AASHTO damage function:

(25) $$GL = 0.12 + 0.1223\ (LT)$$

Where
GL = total aggregate lost in inches
LT = number of loaded trucks in thousands

Next, the total damage cost to the impacted road was determined by multiplying $1750 cost per inch mile of aggregate by the loss of aggregate from equation (25), and then multiplying the result by the total miles of gravel road impacted as follows:

(26) $$\text{Total Cost} = \$1750 \times GL \times \text{Length of Gravel Road}$$

Lastly the average cost per truck mile was calculated for county road impacts using the following equation:

(27) $$\text{Cost Per Truck Mile} = \frac{\text{Total Cost}}{(\text{incremental trucks} \times \text{length of road})}$$

6.5 Results and Analysis

Calculations for impacted road segments are provided by shortline railroad in Tables 15-18. Each row of Tables 15-18 contains the data necessary to estimate damage for a single pavement segment upon which incremental grain truck traffic was routed. The “Truck” column provides the total number of incremental grain trucks expected to travel over a pavement. The “Mile” column represents the total length of the impacted pavement segment. The “SN” column is the median structural number of the pavement segment, and the “PSR” column is the present serviceability rating of the impacted pavement segment. Columns (1) through (24) provide the results for the equations described in the previous section, and the total estimated pavement damage cost is provided at the bottom of each table to give the total estimated benefit in avoided flexible pavement damage cost that each particular railroad provides the study area. The damage cost estimated for gravel roads is provided in Table 19. Pavement segment locational data has been omitted to protect proprietary business data.

Given KDOT policy for initial PSR of 4.2 and terminal PSR of 2.5, it is significant to note that the exponential time decay function prescribed by the Tolliver method estimates that 52 percent of damage sustained by flexible pavements in Kansas is caused by environmental deterioration. Thus the total ESAL costs in the study were adjusted by 52 percent to isolate damage attributable solely to incremental truck traffic. There is no consensus in the pavement engineering community concerning the optimal model for environmental decay.

Table 15
Pavement Damage Calculations
Central Kansas Railroad

Truck	Mile	SN	PSR	{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}	{9}	{10}	{11}	{12}	{13}	{14}	{15}	{16}	{17}	{18}	{19}	{20}	{21}	{22}	{23}	{24}
320	9	3.4	3.6	-0.9	0.9	0.5	-0.2	0.1	-0.1	0.9	40.8	-0.2	0.7	1.6	1.7	6.1	6.1	4.7	1.9E+12	-0.3	1.3E+06	0.89	0.05	0.52	0.54	234.4	1134.49
52	14	2.2	3.7	-1.0	3.0	0.8	-0.2	0.1	0.0	3.0	211.4	-0.2	1.0	2.2	1.7	5.3	5.3	3.9	5.4E+12	-0.3	1.9E+05	0.89	0.05	0.52	3.67	54.1	2779.08
348	3	1.7	3.3	-1.0	6.7	1.5	-0.2	0.1	0.1	6.7	510.1	-0.2	1.1	2.4	1.7	5.0	5.0	3.6	7.9E+12	-0.3	9.6E+04	0.89	0.05	0.52	7.30	393.6	8614.85
788	9	1.9	4.0	-1.0	4.8	1.1	-0.2	0.1	0.0	4.8	352.2	-0.2	1.1	2.3	1.7	5.1	5.1	3.7	6.9E+12	-0.3	1.2E+05	0.89	0.05	0.52	5.66	866.7	44152.00
1740	24	2.3	3.0	-1.0	2.6	0.8	-0.2	0.1	0.0	2.6	180.3	-0.2	1.0	2.1	1.7	5.3	5.3	3.9	5.0E+12	-0.3	2.2E+05	0.89	0.05	0.52	3.15	1771.0	133728.81
5040	10	4.2	3.8	-1.0	0.6	0.4	-0.2	0.1	-0.2	0.6	17.4	-0.2	0.6	1.3	1.7	6.7	6.7	5.4	9.4E+11	-0.3	4.5E+06	0.89	0.05	0.52	0.16	6370.6	9965.33
2152	12	1.7	3.3	-1.0	6.7	1.5	-0.2	0.1	0.1	6.7	510.1	-0.2	1.1	2.4	1.7	5.0	5.0	3.6	7.9E+12	-0.3	9.6E+04	0.89	0.05	0.52	7.30	5068.1	443725.33
4388	8	4.6	3.6	-1.0	0.5	0.4	-0.2	0.1	-0.3	0.5	12.0	-0.2	0.5	1.2	1.7	6.9	6.9	5.7	6.8E+11	-0.3	8.0E+06	0.89	0.05	0.52	0.09	5118.3	3574.77
4708	2	4.6	3.6	-1.0	0.5	0.4	-0.2	0.1	-0.3	0.5	12.0	-0.2	0.5	1.2	1.7	6.9	6.9	5.7	6.8E+11	-0.3	8.0E+06	0.89	0.05	0.52	0.09	5491.5	958.87
120	12	3.2	4.0	-0.9	1.0	0.5	-0.2	0.1	-0.1	1.0	51.9	-0.2	0.8	1.7	1.7	6.0	6.0	4.6	2.2E+12	-0.3	9.5E+05	0.89	0.05	0.52	0.74	201.6	1792.04
536	7	2.7	4.1	-0.9	1.6	0.6	-0.2	0.1	0.0	1.6	99.7	-0.2	0.9	1.9	1.7	5.6	5.6	4.2	3.5E+12	-0.3	4.2E+05	0.89	0.05	0.52	1.66	1044.5	12170.86
1352	6	2.7	4.1	-0.9	1.6	0.6	-0.2	0.1	0.0	1.6	99.7	-0.2	0.9	1.9	1.7	5.6	5.6	4.2	3.5E+12	-0.3	4.2E+05	0.89	0.05	0.52	1.66	2634.7	26313.96
52	11	2.3	3.6	-1.0	2.6	0.8	-0.2	0.1	0.0	2.6	180.3	-0.2	1.0	2.1	1.7	5.3	5.3	3.9	5.0E+12	-0.3	2.2E+05	0.89	0.05	0.52	3.15	111.6	3862.52
184	1	1.3	4.0	-1.1	14.9	2.9	-0.2	0.1	0.1	14.9	1171.9	-0.2	1.2	2.4	1.7	4.8	4.8	3.4	9.6E+12	-0.3	6.8E+04	0.89	0.05	0.52	10.32	447.3	4618.71
4948	10	1.7	3.3	-1.0	6.7	1.5	-0.2	0.1	0.1	6.7	510.1	-0.2	1.1	2.4	1.7	5.0	5.0	3.6	7.9E+12	-0.3	9.6E+04	0.89	0.05	0.52	7.30	11652.9	850198.63
5040	17	1.5	3.2	-1.1	9.8	2.0	-0.2	0.1	0.1	9.8	760.4	-0.2	1.2	2.4	1.7	4.9	4.9	3.5	8.9E+12	-0.3	7.8E+04	0.89	0.05	0.52	8.98	12089.4	1846287.77
3596	8	1.7	3.5	-1.0	6.7	1.5	-0.2	0.1	0.1	6.7	510.1	-0.2	1.1	2.4	1.7	5.0	5.0	3.6	7.9E+12	-0.3	9.6E+04	0.89	0.05	0.52	7.30	8468.9	494311.12
3944	8	1.7	3.5	-1.0	6.7	1.5	-0.2	0.1	0.1	6.7	510.1	-0.2	1.1	2.4	1.7	5.0	5.0	3.6	7.9E+12	-0.3	9.6E+04	0.89	0.05	0.52	7.30	9288.4	542147.68
3596	9	1.3	3.8	-1.1	14.9	2.9	-0.2	0.1	0.1	14.9	1171.9	-0.2	1.2	2.4	1.7	4.8	4.8	3.4	9.6E+12	-0.3	6.8E+04	0.89	0.05	0.52	10.32	8742.5	812391.01
2236	13	1.6	3.7	-1.0	8.1	1.7	-0.2	0.1	0.1	8.1	620.4	-0.2	1.1	2.4	1.7	4.9	4.9	3.5	8.4E+12	-0.3	8.6E+04	0.89	0.05	0.52	8.15	5318.1	563611.57
628	9	2.9	3.8	-0.9	1.3	0.6	-0.2	0.1	-0.1	1.3	76.0	-0.2	0.9	1.8	1.7	5.8	5.8	4.3	2.9E+12	-0.3	5.8E+05	0.89	0.05	0.52	1.20	1156.1	12524.97
2988	32	1.7	4.0	-1.0	6.7	1.5	-0.2	0.1	0.1	6.7	510.1	-0.2	1.1	2.4	1.7	5.0	5.0	3.6	7.9E+12	-0.3	9.6E+04	0.89	0.05	0.52	7.30	7037.0	1642938.41
2200	40	1.9	3.3	-1.0	4.8	1.1	-0.2	0.1	0.0	4.8	352.2	-0.2	1.1	2.3	1.7	5.1	5.1	3.7	6.9E+12	-0.3	1.2E+05	0.89	0.05	0.52	5.66	5057.4	1145088.05
92	1	1.7	3.3	-1.0	6.7	1.5	-0.2	0.1	0.1	6.7	510.1	-0.2	1.1	2.4	1.7	5.0	5.0	3.6	7.9E+12	-0.3	9.6E+04	0.89	0.05	0.52	7.30	216.7	1580.81
6400	29	1.5	3.3	-1.1	9.8	2.0	-0.2	0.1	0.1	9.8	760.4	-0.2	1.2	2.4	1.7	4.9	4.9	3.5	8.9E+12	-0.3	7.8E+04	0.89	0.05	0.52	8.98	15351.6	3999428.23
768	6	2.6	4.0	-0.9	1.8	0.6	-0.2	0.1	0.0	1.8	114.9	-0.2	0.9	2.0	1.7	5.6	5.6	4.1	3.8E+12	-0.3	3.6E+05	0.89	0.05	0.52	1.96	1536.8	18036.14
768	7	3.4	3.5	-0.9	0.9	0.5	-0.2	0.1	-0.1	0.9	40.8	-0.2	0.7	1.6	1.7	6.1	6.1	4.7	1.9E+12	-0.3	1.3E+06	0.89	0.05	0.52	0.54	1212.1	4562.57
1604	8	3.1	3.5	-0.9	1.1	0.5	-0.2	0.1	-0.1	1.1	58.7	-0.2	0.8	1.7	1.7	5.9	5.9	4.5	2.4E+12	-0.3	8.1E+05	0.89	0.05	0.52	0.87	2779.4	19356.93
1788	8	2.8	3.7	-0.9	1.5	0.6	-0.2	0.1	-0.1	1.5	86.9	-0.2	0.9	1.9	1.7	5.7	5.7	4.3	3.2E+12	-0.3	5.0E+05	0.89	0.05	0.52	1.42	3388.6	38377.95
2152	9	2.6	4.2	-0.9	1.8	0.6	-0.2	0.1	0.0	1.8	114.9	-0.2	0.9	2.0	1.7	5.6	5.6	4.1	3.8E+12	-0.3	3.6E+05	0.89	0.05	0.52	1.96	4306.3	75808.13
1256	10	2.2	3.7	-1.0	3.0	0.8	-0.2	0.1	0.0	3.0	211.4	-0.2	1.0	2.2	1.7	5.3	5.3	3.9	5.4E+12	-0.3	1.9E+05	0.89	0.05	0.52	3.67	2749.7	100870.98
1256	14	2.4	3.5	-0.9	2.3	0.7	-0.2	0.1	0.0	2.3	154.5	-0.2	1.0	2.1	1.7	5.4	5.4	4.0	4.6E+12	-0.3	2.6E+05	0.89	0.05	0.52	2.69	2637.9	99368.43
884	10	2.0	3.1	-1.0	4.1	1.0	-0.2	0.1	0.0	4.1	295.4	-0.2	1.1	2.3	1.7	5.2	5.2	3.7	6.4E+12	-0.3	1.4E+05	0.89	0.05	0.52	4.93	2002.8	98659.78
568	9	1.1	3.3	-1.1	23.7	4.4	-0.2	0.1	0.1	23.7	1878.8	-0.2	1.2	2.5	1.7	4.8	4.8	3.4	9.8E+12	-0.3	6.6E+04	0.89	0.05	0.52	10.69	1394.1	134152.13
120	6	2.4	3.8	-0.9	2.3	0.7	-0.2	0.1	0.0	2.3	154.5	-0.2	1.0	2.1	1.7	5.4	5.4	4.0	4.6E+12	-0.3	2.6E+05	0.89	0.05	0.52	2.69	252.0	4068.77

Table 15 continued page 2
Pavement Damage Calculations
Central Kansas Railroad

Truck	Mile	SN	PSR	{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}	{9}	{10}	{11}	{12}	{13}	{14}	{15}	{16}	{17}	{18}	{19}	{20}	{21}	{22}	{23}	{24}
484	9	1.8	4.1	-1.0	5.6	1.3	-0.2	0.1	0.0	5.6	422.4	-0.2	1.1	2.3	1.7	5.0	5.0	3.6	7.4E+12	-0.3	1.1E+05	0.89	0.05	0.52	6.46	1127.0	65486.48
1044	8	1.3	4.0	-1.1	14.9	2.9	-0.2	0.1	0.1	14.9	1171.9	-0.2	1.2	2.4	1.7	4.8	4.8	3.4	9.6E+12	-0.3	6.8E+04	0.89	0.05	0.52	10.32	2538.1	209649.29
1172	8	1.3	4.1	-1.1	14.9	2.9	-0.2	0.1	0.1	14.9	1171.9	-0.2	1.2	2.4	1.7	4.8	4.8	3.4	9.6E+12	-0.3	6.8E+04	0.89	0.05	0.52	10.32	2849.3	235353.42
1172	5	1.2	4.0	-1.1	18.7	3.5	-0.2	0.1	0.1	18.7	1475.9	-0.2	1.2	2.4	1.7	4.8	4.8	3.4	9.8E+12	-0.3	6.6E+04	0.89	0.05	0.52	10.68	2864.2	152880.57
1172	26	1.2	4.0	-1.1	18.7	3.5	-0.2	0.1	0.1	18.7	1475.9	-0.2	1.2	2.4	1.7	4.8	4.8	3.4	9.8E+12	-0.3	6.6E+04	0.89	0.05	0.52	10.68	2864.2	794978.99
1172	12	2.6	3.8	-0.9	1.8	0.6	-0.2	0.1	0.0	1.8	114.9	-0.2	0.9	2.0	1.7	5.6	5.6	4.1	3.8E+12	-0.3	3.6E+05	0.89	0.05	0.52	1.96	2345.3	55047.79
732	9	1.8	4.1	-1.0	5.6	1.3	-0.2	0.1	0.0	5.6	422.4	-0.2	1.1	2.3	1.7	5.0	5.0	3.6	7.4E+12	-0.3	1.1E+05	0.89	0.05	0.52	6.46	1704.5	99041.54
1700	7	2.1	3.9	-1.0	3.5	0.9	-0.2	0.1	0.0	3.5	249.2	-0.2	1.1	2.2	1.7	5.2	5.2	3.8	5.9E+12	-0.3	1.6E+05	0.89	0.05	0.52	4.26	3789.5	113033.22
544	7	2.0	4.1	-1.0	4.1	1.0	-0.2	0.1	0.0	4.1	295.4	-0.2	1.1	2.3	1.7	5.2	5.2	3.7	6.4E+12	-0.3	1.4E+05	0.89	0.05	0.52	4.93	1232.5	42499.60
1028	10	2.6	3.8	-0.9	1.8	0.6	-0.2	0.1	0.0	1.8	114.9	-0.2	0.9	2.0	1.7	5.6	5.6	4.1	3.8E+12	-0.3	3.6E+05	0.89	0.05	0.52	1.96	2057.1	40236.87
2080	4	2.1	3.9	-1.0	3.5	0.9	-0.2	0.1	0.0	3.5	249.2	-0.2	1.1	2.2	1.7	5.2	5.2	3.8	5.9E+12	-0.3	1.6E+05	0.89	0.05	0.52	4.26	4636.5	79028.27
1060	6	2.6	3.8	-0.9	1.8	0.6	-0.2	0.1	0.0	1.8	114.9	-0.2	0.9	2.0	1.7	5.6	5.6	4.1	3.8E+12	-0.3	3.6E+05	0.89	0.05	0.52	1.96	2121.2	24893.62
1724	11	2.6	3.4	-0.9	1.8	0.6	-0.2	0.1	0.0	1.8	114.9	-0.2	0.9	2.0	1.7	5.6	5.6	4.1	3.8E+12	-0.3	3.6E+05	0.89	0.05	0.52	1.96	3449.9	74226.84
1592	8	2.6	3.2	-0.9	1.8	0.6	-0.2	0.1	0.0	1.8	114.9	-0.2	0.9	2.0	1.7	5.6	5.6	4.1	3.8E+12	-0.3	3.6E+05	0.89	0.05	0.52	1.96	3185.7	49849.88
1332	6	3.9	3.6	-1.0	0.7	0.4	-0.2	0.1	-0.2	0.7	23.5	-0.2	0.6	1.4	1.7	6.5	6.5	5.1	1.2E+12	-0.3	2.9E+06	0.89	0.05	0.52	0.25	1815.0	2679.62
1024	7	3.8	3.6	-1.0	0.7	0.5	-0.2	0.1	-0.2	0.7	26.1	-0.2	0.6	1.4	1.7	6.4	6.4	5.1	1.3E+12	-0.3	2.4E+06	0.89	0.05	0.52	0.29	1434.3	2881.31
2164	3	2.1	3.5	-1.0	3.5	0.9	-0.2	0.1	0.0	3.5	249.2	-0.2	1.1	2.2	1.7	5.2	5.2	3.8	5.9E+12	-0.3	1.6E+05	0.89	0.05	0.52	4.26	4823.8	61664.84
560	8	3.1	3.8	-0.9	1.1	0.5	-0.2	0.1	-0.1	1.1	58.7	-0.2	0.8	1.7	1.7	5.9	5.9	4.5	2.4E+12	-0.3	8.1E+05	0.89	0.05	0.52	0.87	970.4	6758.03
164	9	3.1	3.8	-0.9	1.1	0.5	-0.2	0.1	-0.1	1.1	58.7	-0.2	0.8	1.7	1.7	5.9	5.9	4.5	2.4E+12	-0.3	8.1E+05	0.89	0.05	0.52	0.87	284.2	2226.53
3808	4	1.9	3.7	-1.0	4.8	1.1	-0.2	0.1	0.0	4.8	352.2	-0.2	1.1	2.3	1.7	5.1	5.1	3.7	6.9E+12	-0.3	1.2E+05	0.89	0.05	0.52	5.66	8753.9	198204.33
3808	8	1.9	3.7	-1.0	4.8	1.1	-0.2	0.1	0.0	4.8	352.2	-0.2	1.1	2.3	1.7	5.1	5.1	3.7	6.9E+12	-0.3	1.2E+05	0.89	0.05	0.52	5.66	8753.9	396408.66
3100	11	1.9	3.7	-1.0	4.8	1.1	-0.2	0.1	0.0	4.8	352.2	-0.2	1.1	2.3	1.7	5.1	5.1	3.7	6.9E+12	-0.3	1.2E+05	0.89	0.05	0.52	5.66	7126.3	443721.62
5344	10	3.4	3.6	-0.9	0.9	0.5	-0.2	0.1	-0.1	0.9	40.8	-0.2	0.7	1.6	1.7	6.1	6.1	4.7	1.9E+12	-0.3	1.3E+06	0.89	0.05	0.52	0.54	8434.1	45354.09
3092	7	1.9	3.7	-1.0	4.8	1.1	-0.2	0.1	0.0	4.8	352.2	-0.2	1.1	2.3	1.7	5.1	5.1	3.7	6.9E+12	-0.3	1.2E+05	0.89	0.05	0.52	5.66	7107.9	281639.61
3772	10	1.9	3.7	-1.0	4.8	1.1	-0.2	0.1	0.0	4.8	352.2	-0.2	1.1	2.3	1.7	5.1	5.1	3.7	6.9E+12	-0.3	1.2E+05	0.89	0.05	0.52	5.66	8671.1	490826.38
5344	13	4.0	3.5	-1.0	0.7	0.4	-0.2	0.1	-0.2	0.7	21.2	-0.2	0.6	1.3	1.7	6.5	6.5	5.2	1.1E+12	-0.3	3.3E+06	0.89	0.05	0.52	0.21	7092.5	19479.42
1568	10	3.1	3.5	-0.9	1.1	0.5	-0.2	0.1	-0.1	1.1	58.7	-0.2	0.8	1.7	1.7	5.9	5.9	4.5	2.4E+12	-0.3	8.1E+05	0.89	0.05	0.52	0.87	2717.0	23653.10
1504	6	3.3	3.8	-0.9	1.0	0.5	-0.2	0.1	-0.1	1.0	45.9	-0.2	0.8	1.6	1.7	6.0	6.0	4.6	2.0E+12	-0.3	1.1E+06	0.89	0.05	0.52	0.63	2448.8	9269.60
1700	3	2.1	3.9	-1.0	3.5	0.9	-0.2	0.1	0.0	3.5	249.2	-0.2	1.1	2.2	1.7	5.2	5.2	3.8	5.9E+12	-0.3	1.6E+05	0.89	0.05	0.52	4.26	3789.5	48442.81
1036	8	2.4	4.0	-0.9	2.3	0.7	-0.2	0.1	0.0	2.3	154.5	-0.2	1.0	2.1	1.7	5.4	5.4	4.0	4.6E+12	-0.3	2.6E+05	0.89	0.05	0.52	2.69	2175.9	46836.08
1632	4	2.1	3.9	-1.0	3.5	0.9	-0.2	0.1	0.0	3.5	249.2	-0.2	1.1	2.2	1.7	5.2	5.2	3.8	5.9E+12	-0.3	1.6E+05	0.89	0.05	0.52	4.26	3637.9	62006.79
80	12	1.9	3.5	-1.0	4.8	1.1	-0.2	0.1	0.0	4.8	352.2	-0.2	1.1	2.3	1.7	5.1	5.1	3.7	6.9E+12	-0.3	1.2E+05	0.89	0.05	0.52	5.66	183.9	12491.87
156	24	2.3	3.5	-1.0	2.6	0.8	-0.2	0.1	0.0	2.6	180.3	-0.2	1.0	2.1	1.7	5.3	5.3	3.9	5.0E+12	-0.3	2.2E+05	0.89	0.05	0.52	3.15	334.8	25281.93
284	11	3.3	4.1	-0.9	1.0	0.5	-0.2	0.1	-0.1	1.0	45.9	-0.2	0.8	1.6	1.7	6.0	6.0	4.6	2.0E+12	-0.3	1.1E+06	0.89	0.05	0.52	0.63	462.4	3209.02
3648	13	3.9	4.0	-1.0	0.7	0.4	-0.2	0.1	-0.2	0.7	23.5	-0.2	0.6	1.4	1.7	6.5	6.5	5.1	1.2E+12	-0.3	2.9E+06	0.89	0.05	0.52	0.25	4970.9	15900.66

Table 15 continued page 3
Pavement Damage Calculations
Central Kansas Railroad

Truck	Mile	SN	PSR	{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}	{9}	{10}	{11}	{12}	{13}	{14}	{15}	{16}	{17}	{18}	{19}	{20}	{21}	{22}	{23}	{24}
4924	25	2.4	3.4	-0.9	2.3	0.7	-0.2	0.1	0.0	2.3	154.5	-0.2	1.0	2.1	1.7	5.4	5.4	4.0	4.6E+12	-0.3	2.6E+05	0.89	0.05	0.52	2.69	10341.7	695646.85
468	20	3.4	4.0	-0.9	0.9	0.5	-0.2	0.1	-0.1	0.9	40.8	-0.2	0.7	1.6	1.7	6.1	6.1	4.7	1.9E+12	-0.3	1.3E+06	0.89	0.05	0.52	0.54	738.6	7943.75
908	20	9.0	3.5	-1.1	0.4	0.4	-0.2	0.1	-0.2	0.4	1.0	-0.2	0.6	1.3	1.7	9.1	9.1	9.8	4.2E+10	-0.3	1.2E+09	0.89	0.05	0.52	0.00	1203.9	13.89
468	11	5.0	4.1	-1.1	0.5	0.4	-0.2	0.1	-0.3	0.5	8.5	-0.2	0.5	1.1	1.7	7.1	7.1	6.1	5.0E+11	-0.3	1.4E+07	0.89	0.05	0.52	0.05	515.5	283.07
684	7	5.0	4.1	-1.1	0.5	0.4	-0.2	0.1	-0.3	0.5	8.5	-0.2	0.5	1.1	1.7	7.1	7.1	6.1	5.0E+11	-0.3	1.4E+07	0.89	0.05	0.52	0.05	753.4	263.28
812	9	3.8	4.2	-1.0	0.7	0.5	-0.2	0.1	-0.2	0.7	26.1	-0.2	0.6	1.4	1.7	6.4	6.4	5.1	1.3E+12	-0.3	2.4E+06	0.89	0.05	0.52	0.29	1137.4	2937.58
812	10	6.3	4.3	-1.1	0.4	0.4	-0.2	0.1	-0.3	0.4	3.3	-0.2	0.5	1.0	1.7	7.9	7.9	7.3	2.0E+11	-0.3	7.4E+07	0.89	0.05	0.52	0.01	846.5	80.59
812	11	9.0	3.8	-1.1	0.4	0.4	-0.2	0.1	-0.2	0.4	1.0	-0.2	0.6	1.3	1.7	9.1	9.1	9.8	4.2E+10	-0.3	1.2E+09	0.89	0.05	0.52	0.00	1076.7	6.83
812	8	5.5	3.8	-1.1	0.5	0.4	-0.2	0.1	-0.3	0.5	5.7	-0.2	0.5	1.1	1.7	7.4	7.4	6.5	3.5E+11	-0.3	2.7E+07	0.89	0.05	0.52	0.03	857.4	176.05
812	7	9.0	3.3	-1.1	0.4	0.4	-0.2	0.1	-0.2	0.4	1.0	-0.2	0.6	1.3	1.7	9.1	9.1	9.8	4.2E+10	-0.3	1.2E+09	0.89	0.05	0.52	0.00	1076.7	4.35
156	22	3.6	3.7	-1.0	0.8	0.5	-0.2	0.1	-0.2	0.8	32.5	-0.2	0.7	1.5	1.7	6.3	6.3	4.9	1.6E+12	-0.3	1.8E+06	0.89	0.05	0.52	0.39	231.6	1996.81
1740	20	9.0	3.8	-1.1	0.4	0.4	-0.2	0.1	-0.2	0.4	1.0	-0.2	0.6	1.3	1.7	9.1	9.1	9.8	4.2E+10	-0.3	1.2E+09	0.89	0.05	0.52	0.00	2307.1	26.63
16	5	3.5	3.9	-1.0	0.8	0.5	-0.2	0.1	-0.1	0.8	36.4	-0.2	0.7	1.5	1.7	6.2	6.2	4.8	1.7E+12	-0.3	1.5E+06	0.89	0.05	0.52	0.46	24.5	56.17
92	10	3.2	3.9	-0.9	1.0	0.5	-0.2	0.1	-0.1	1.0	51.9	-0.2	0.8	1.7	1.7	6.0	6.0	4.6	2.2E+12	-0.3	9.5E+05	0.89	0.05	0.52	0.74	154.5	1144.91
664	6	5.7	4.1	-1.1	0.5	0.4	-0.2	0.1	-0.3	0.5	5.0	-0.2	0.5	1.0	1.7	7.5	7.5	6.7	3.0E+11	-0.3	3.5E+07	0.89	0.05	0.52	0.02	694.9	82.84
1704	6	6.0	4.3	-1.1	0.4	0.4	-0.2	0.1	-0.3	0.4	4.0	-0.2	0.5	1.0	1.7	7.7	7.7	7.0	2.4E+11	-0.3	5.1E+07	0.89	0.05	0.52	0.01	1772.8	145.42
1704	14	4.3	3.3	-1.0	0.6	0.4	-0.2	0.1	-0.2	0.6	15.8	-0.2	0.6	1.2	1.7	6.7	6.7	5.5	8.7E+11	-0.3	5.2E+06	0.89	0.05	0.52	0.13	2106.4	3978.17
2236	8	3.3	3.0	-0.9	1.0	0.5	-0.2	0.1	-0.1	1.0	45.9	-0.2	0.8	1.6	1.7	6.0	6.0	4.6	2.0E+12	-0.3	1.1E+06	0.89	0.05	0.52	0.63	3640.6	18374.84
9160	38	3.5	3.8	-1.0	0.8	0.5	-0.2	0.1	-0.1	0.8	36.4	-0.2	0.7	1.5	1.7	6.2	6.2	4.8	1.7E+12	-0.3	1.5E+06	0.89	0.05	0.52	0.46	14017.7	244393.69
TOTAL																											18413860.09

Table 16
Pavement Damage Calculations
Kyle Railroad

Truck	Mile	SN	PSR	{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}	{9}	{10}	{11}	{12}	{13}	{14}	{15}	{16}	{17}	{18}	{19}	{20}	{21}	{22}	{23}	{24}
1532	8	8.0	2.7	-1.1	0.4	0.4	-0.2	0.1	-0.3	0.4	1.4	-0.2	0.6	1.2	1.7	8.7	8.7	8.9	7.1E+10	-0.314	4.7E+08	0.89	0.05	0.52	0.00	1801.1	21.57
2196	8	8.0	2.8	-1.1	0.4	0.4	-0.2	0.1	-0.3	0.4	1.4	-0.2	0.6	1.2	1.7	8.7	8.7	8.9	7.1E+10	-0.314	4.7E+08	0.89	0.05	0.52	0.00	2581.8	30.92
1396	2	1.2	2.4	-1.1	18.7	3.5	-0.2	0.1	0.1	18.7	1475.9	-0.2	1.2	2.4	1.7	4.8	4.8	3.4	9.8E+12	-0.314	6.6E+04	0.89	0.05	0.52	10.68	3411.6	72840.03
96	10	1.5	4.1	-1.1	9.8	2.0	-0.2	0.1	0.1	9.8	760.4	-0.2	1.2	2.4	1.7	4.9	4.9	3.5	8.9E+12	-0.314	7.8E+04	0.89	0.05	0.52	8.98	230.3	20686.70
1236	11	3.0	3.7	-0.9	1.2	0.5	-0.2	0.1	-0.1	1.2	66.7	-0.2	0.8	1.8	1.7	5.8	5.8	4.4	2.7E+12	-0.314	6.9E+05	0.89	0.05	0.52	1.02	2208.3	24862.90
812	11	3.2	3.9	-0.9	1.0	0.5	-0.2	0.1	-0.1	1.0	51.9	-0.2	0.8	1.7	1.7	6.0	6.0	4.6	2.2E+12	-0.314	9.5E+05	0.89	0.05	0.52	0.74	1364.0	11115.62
540	9	3.2	4.1	-0.9	1.0	0.5	-0.2	0.1	-0.1	1.0	51.9	-0.2	0.8	1.7	1.7	6.0	6.0	4.6	2.2E+12	-0.314	9.5E+05	0.89	0.05	0.52	0.74	907.1	6048.13
80	8	2.9	3.6	-0.9	1.3	0.6	-0.2	0.1	-0.1	1.3	76.0	-0.2	0.9	1.8	1.7	5.8	5.8	4.3	2.9E+12	-0.314	5.8E+05	0.89	0.05	0.52	1.20	147.3	1418.26
2120	4	3.0	3.7	-0.9	1.2	0.5	-0.2	0.1	-0.1	1.2	66.7	-0.2	0.8	1.8	1.7	5.8	5.8	4.4	2.7E+12	-0.314	6.9E+05	0.89	0.05	0.52	1.02	3787.7	15507.31
60	9	1.6	4.0	-1.0	8.1	1.7	-0.2	0.1	0.1	8.1	620.4	-0.2	1.1	2.4	1.7	4.9	4.9	3.5	8.4E+12	-0.314	8.6E+05	0.89	0.05	0.52	8.15	142.7	10470.29
1492	12	2.5	4.0	-0.9	2.0	0.7	-0.2	0.1	0.0	2.0	133.0	-0.2	1.0	2.1	1.7	5.5	5.5	4.0	4.2E+12	-0.314	3.1E+05	0.89	0.05	0.52	2.30	3061.2	84339.65
4448	7	3.3	3.7	-0.9	1.0	0.5	-0.2	0.1	-0.1	1.0	45.9	-0.2	0.8	1.6	1.7	6.0	6.0	4.6	2.0E+12	-0.314	1.1E+06	0.89	0.05	0.52	0.63	7242.1	31983.40
6392	21	3.3	3.5	-0.9	1.0	0.5	-0.2	0.1	-0.1	1.0	45.9	-0.2	0.8	1.6	1.7	6.0	6.0	4.6	2.0E+12	-0.314	1.1E+06	0.89	0.05	0.52	0.63	10407.2	137885.28
8208	9	3.5	3.5	-1.0	0.8	0.5	-0.2	0.1	-0.1	0.8	36.4	-0.2	0.7	1.5	1.7	6.2	6.2	4.8	1.7E+12	-0.314	1.5E+06	0.89	0.05	0.52	0.46	12560.8	51866.96
9732	17	0.9	3.1	-1.1	39.5	7.1	-0.2	0.1	0.1	39.5	3158.1	-0.2	1.2	2.5	1.7	4.9	4.9	3.5	9.1E+12	-0.314	7.4E+04	0.89	0.05	0.52	9.43	24041.0	3853198.82
9780	15	1.5	3.5	-1.1	9.8	2.0	-0.2	0.1	0.1	9.8	760.4	-0.2	1.2	2.4	1.7	4.9	4.9	3.5	8.9E+12	-0.314	7.8E+04	0.89	0.05	0.52	8.98	23459.1	3161186.00
372	6	2.6	3.8	-0.9	1.8	0.6	-0.2	0.1	0.0	1.8	114.9	-0.2	0.9	2.0	1.7	5.6	5.6	4.1	3.8E+12	-0.314	3.6E+04	0.89	0.05	0.52	1.96	744.4	8736.25
372	3	3.8	3.8	-1.0	0.7	0.5	-0.2	0.1	-0.2	0.7	26.1	-0.2	0.6	1.4	1.7	6.4	6.4	5.1	1.3E+12	-0.314	2.4E+04	0.89	0.05	0.52	0.29	521.1	448.60
372	4	1.4	3.7	-1.1	12.0	2.4	-0.2	0.1	0.1	12.0	939.7	-0.2	1.2	2.4	1.7	4.9	4.9	3.5	9.3E+12	-0.314	7.2E+04	0.89	0.05	0.52	9.73	898.8	34990.16
352	5	2.8	3.7	-0.9	1.5	0.6	-0.2	0.1	-0.1	1.5	86.9	-0.2	0.9	1.9	1.7	5.7	5.7	4.3	3.2E+12	-0.314	5.0E+05	0.89	0.05	0.52	1.42	667.1	4722.12
352	6	2.8	3.4	-0.9	1.5	0.6	-0.2	0.1	-0.1	1.5	86.9	-0.2	0.9	1.9	1.7	5.7	5.7	4.3	3.2E+12	-0.314	5.0E+05	0.89	0.05	0.52	1.42	667.1	5666.54
256	6	2.8	3.5	-0.9	1.5	0.6	-0.2	0.1	-0.1	1.5	86.9	-0.2	0.9	1.9	1.7	5.7	5.7	4.3	3.2E+12	-0.314	5.0E+05	0.89	0.05	0.52	1.42	485.2	4121.12
160	10	1.4	3.5	-1.1	12.0	2.4	-0.2	0.1	0.1	12.0	939.7	-0.2	1.2	2.4	1.7	4.9	4.9	3.5	9.3E+12	-0.314	7.2E+04	0.89	0.05	0.52	9.73	386.6	37623.83
1416	3	1.1	3.5	-1.1	23.7	4.4	-0.2	0.1	0.1	23.7	1878.8	-0.2	1.2	2.5	1.7	4.8	4.8	3.4	9.8E+12	-0.314	6.6E+04	0.89	0.05	0.52	10.69	3475.4	120768.41
1720	8	1.1	3.3	-1.1	23.7	4.4	-0.2	0.1	0.1	23.7	1878.8	-0.2	1.2	2.5	1.7	4.8	4.8	3.4	9.8E+12	-0.314	6.6E+04	0.89	0.05	0.52	10.69	4221.6	371795.61
1044	9	1.3	3.5	-1.1	14.9	2.9	-0.2	0.1	0.1	14.9	1171.9	-0.2	1.2	2.4	1.7	4.8	4.8	3.4	9.6E+12	-0.314	6.8E+04	0.89	0.05	0.52	10.32	2538.1	235855.45
452	7	1.6	3.3	-1.0	8.1	1.7	-0.2	0.1	0.1	8.1	620.4	-0.2	1.1	2.4	1.7	4.9	4.9	3.5	8.4E+12	-0.314	8.6E+04	0.89	0.05	0.52	8.15	1075.0	61348.11
452	10	1.6	3.5	-1.0	8.1	1.7	-0.2	0.1	0.1	8.1	620.4	-0.2	1.1	2.4	1.7	4.9	4.9	3.5	8.4E+12	-0.314	8.6E+04	0.89	0.05	0.52	8.15	1075.0	87640.16
1896	7	3.5	3.8	-1.0	0.8	0.5	-0.2	0.1	-0.1	0.8	36.4	-0.2	0.7	1.5	1.7	6.2	6.2	4.8	1.7E+12	-0.314	1.5E+06	0.89	0.05	0.52	0.46	2901.5	9318.53
5164	6	3.3	3.5	-0.9	1.0	0.5	-0.2	0.1	-0.1	1.0	45.9	-0.2	0.8	1.6	1.7	6.0	6.0	4.6	2.0E+12	-0.314	1.1E+06	0.89	0.05	0.52	0.63	8407.9	31827.27
13940	27	1.8	3.8	-1.0	5.6	1.3	-0.2	0.1	0.0	5.6	422.4	-0.2	1.1	2.3	1.7	5.0	5.0	3.6	7.4E+12	-0.314	1.1E+05	0.89	0.05	0.52	6.46	32460.7	5658356.79
3596	12	2.2	3.9	-1.0	3.0	0.8	-0.2	0.1	0.0	3.0	211.4	-0.2	1.0	2.2	1.7	5.3	5.3	3.9	5.4E+12	-0.314	1.9E+05	0.89	0.05	0.52	3.67	7872.5	346559.27
2540	10	2.2	3.5	-1.0	3.0	0.8	-0.2	0.1	0.0	3.0	211.4	-0.2	1.0	2.2	1.7	5.3	5.3	3.9	5.4E+12	-0.314	1.9E+05	0.89	0.05	0.52	3.67	5560.6	203990.67
5584	21	2.1	2.3	-1.0	3.5	0.9	-0.2	0.1	0.0	3.5	249.2	-0.2	1.1	2.2	1.7	5.2	5.2	3.8	5.9E+12	-0.314	1.6E+05	0.89	0.05	0.52	4.26	12447.3	1113842.61
668	11	3.8	3.8	-1.0	3.5	0.9	-0.2	0.1	0.0	3.5	249.2	-0.2	1.1	2.2	1.7	5.2	5.2	3.8	5.9E+12	-0.314	1.6E+05	0.89	0.05	0.52	4.26	1489.0	69795.64

Table 16 continued page 2
Pavement Damage Calculations
Kyle Railroad

Trucks	Mile	SN	PSR	{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}	{9}	{10}	{11}	{12}	{13}	{14}	{15}	{16}	{17}	{18}	{19}	{20}	{21}	{22}	{23}	{24}
8064	10	3.8	3.8	-0.9	1.3	0.6	-0.2	0.1	-0.1	1.3	76.0	-0.2	0.9	1.8	1.7	5.8	5.8	4.3	2.9E+12	-0.314	5.8E+05	0.89	0.05	0.52	1.20	14845.6	178700.15
8820	8	3.9	3.9	-1.0	3.5	0.9	-0.2	0.1	0.0	3.5	249.2	-0.2	1.1	2.2	1.7	5.2	5.2	3.8	5.9E+12	-0.314	1.6E+05	0.89	0.05	0.52	4.26	19660.7	670220.48
2120	9	3.3	3.3	-1.0	0.8	0.5	-0.2	0.1	-0.1	0.8	36.4	-0.2	0.7	1.5	1.7	6.2	6.2	4.8	1.7E+12	-0.314	1.5E+06	0.89	0.05	0.52	0.46	3244.3	13396.44
2120	8	3.9	3.9	-0.9	1.8	0.6	-0.2	0.1	0.0	1.8	114.9	-0.2	0.9	2.0	1.7	5.6	5.6	4.1	3.8E+12	-0.314	3.6E+05	0.89	0.05	0.52	1.96	4242.3	66383.00
572	17	3.9	2.9	-0.9	2.0	0.7	-0.2	0.1	0.0	2.0	133.0	-0.2	1.0	2.1	1.7	5.5	5.5	4.0	4.2E+12	-0.314	3.1E+05	0.89	0.05	0.52	2.30	1173.6	45806.45
572	19	3.6	3.6	-1.0	3.0	0.8	-0.2	0.1	0.0	3.0	211.4	-0.2	1.0	2.2	1.7	5.3	5.3	3.9	5.4E+12	-0.314	1.9E+05	0.89	0.05	0.52	3.67	1252.2	87282.31
14512	25	3.5	3.5	-0.9	1.5	0.6	-0.2	0.1	-0.1	1.5	86.9	-0.2	0.9	1.9	1.7	5.7	5.7	4.3	3.2E+12	-0.314	5.0E+05	0.89	0.05	0.52	1.42	27502.6	973400.54
132	6	3.1	3.1	-0.9	1.3	0.6	-0.2	0.1	-0.1	1.3	76.0	-0.2	0.9	1.8	1.7	5.8	5.8	4.3	2.9E+12	-0.314	5.8E+05	0.89	0.05	0.52	1.20	243.0	1755.09
292	9	3.0	3.0	-1.0	3.0	0.8	-0.2	0.1	0.0	3.0	211.4	-0.2	1.0	2.2	1.7	5.3	5.3	3.9	5.4E+12	-0.314	1.9E+05	0.89	0.05	0.52	3.67	639.3	21105.81
5264	7	2.9	2.9	-0.9	1.5	0.6	-0.2	0.1	-0.1	1.5	86.9	-0.2	0.9	1.9	1.7	5.7	5.7	4.3	3.2E+12	-0.314	5.0E+05	0.89	0.05	0.52	1.42	9976.1	98864.01
4724	5	2.9	2.9	-0.9	1.2	0.5	-0.2	0.1	-0.1	1.2	66.7	-0.2	0.8	1.8	1.7	5.8	5.8	4.4	2.7E+12	-0.314	6.9E+05	0.89	0.05	0.52	1.02	8440.2	43193.71
4152	6	2.4	2.4	-0.9	1.5	0.6	-0.2	0.1	-0.1	1.5	86.9	-0.2	0.9	1.9	1.7	5.7	5.7	4.3	3.2E+12	-0.314	5.0E+05	0.89	0.05	0.52	1.42	7868.7	66839.45
3132	6	3.6	3.6	-0.9	1.2	0.5	-0.2	0.1	-0.1	1.2	66.7	-0.2	0.8	1.8	1.7	5.8	5.8	4.4	2.7E+12	-0.314	6.9E+05	0.89	0.05	0.52	1.02	5595.9	34364.78
2296	7	3.7	3.7	-0.9	1.2	0.5	-0.2	0.1	-0.1	1.2	66.7	-0.2	0.8	1.8	1.7	5.8	5.8	4.4	2.7E+12	-0.314	6.9E+05	0.89	0.05	0.52	1.02	4102.2	29390.74
1396	7	3.7	3.7	-0.9	1.3	0.6	-0.2	0.1	-0.1	1.3	76.0	-0.2	0.9	1.8	1.7	5.8	5.8	4.3	2.9E+12	-0.314	5.8E+05	0.89	0.05	0.52	1.20	2570.0	21654.98
832	8	4.0	4.0	-0.9	0.9	0.5	-0.2	0.1	-0.1	0.9	40.8	-0.2	0.7	1.6	1.7	6.1	6.1	4.7	1.9E+12	-0.314	1.3E+06	0.89	0.05	0.52	0.54	1313.1	5648.89
832	11	3.9	3.9	-1.0	0.8	0.5	-0.2	0.1	-0.1	0.8	36.4	-0.2	0.7	1.5	1.7	6.2	6.2	4.8	1.7E+12	-0.314	1.5E+06	0.89	0.05	0.52	0.46	1273.2	6425.80
1304	8	4.0	4.0	-1.0	0.7	0.4	-0.2	0.1	-0.2	0.7	23.5	-0.2	0.6	1.4	1.7	6.5	6.5	5.1	1.2E+12	-0.314	2.9E+06	0.89	0.05	0.52	0.25	1776.9	3497.72
1304	6	3.8	3.8	-1.0	0.7	0.4	-0.2	0.1	-0.2	0.7	23.5	-0.2	0.6	1.4	1.7	6.5	6.5	5.1	1.2E+12	-0.314	2.9E+06	0.89	0.05	0.52	0.25	1776.9	2623.29
1304	7	40.0	4.0	-1.0	0.6	0.4	-0.2	0.1	-0.2	0.6	19.2	-0.2	0.6	1.3	1.7	6.6	6.6	5.3	1.0E+12	-0.314	3.9E+06	0.89	0.05	0.52	0.18	1687.8	2146.22
7728	7	4.1	4.1	-1.0	0.7	0.4	-0.2	0.1	-0.2	0.7	23.5	-0.2	0.6	1.4	1.7	6.5	6.5	5.1	1.2E+12	-0.314	2.9E+06	0.89	0.05	0.52	0.25	10530.5	18137.70
7728	8	3.9	3.9	-0.9	1.0	0.5	-0.2	0.1	-0.1	1.0	51.9	-0.2	0.8	1.7	1.7	6.0	6.0	4.6	2.2E+12	-0.314	9.5E+05	0.89	0.05	0.52	0.74	12981.6	76938.22
60	11	3.5	3.5	-0.9	1.0	0.5	-0.2	0.1	-0.1	1.0	45.9	-0.2	0.8	1.6	1.7	6.0	6.0	4.6	2.0E+12	-0.314	1.1E+06	0.89	0.05	0.52	0.63	97.7	677.96
428	15	3.8	3.8	-1.1	0.4	0.4	-0.2	0.1	-0.2	0.4	1.2	-0.2	0.6	1.2	1.7	8.8	8.8	9.2	5.7E+12	-0.314	6.9E+08	0.89	0.05	0.52	0.00	526.8	7.99
12016	19	3.6	3.6	-1.0	0.5	0.4	-0.2	0.1	-0.3	0.5	10.0	-0.2	0.5	1.1	1.7	7.0	7.0	5.9	5.8E+12	-0.314	1.1E+07	0.89	0.05	0.52	0.07	13582.1	16984.92
512	25	3.7	3.7	-1.1	0.4	0.4	-0.2	0.1	-0.3	0.4	1.3	-0.2	0.6	1.2	1.7	8.7	8.7	9.0	6.8E+12	-0.314	5.2E+08	0.89	0.05	0.52	0.00	608.6	20.62
1788	14	3.7	3.7	-0.9	2.0	0.7	-0.2	0.1	0.0	2.0	133.0	-0.2	1.0	2.1	1.7	5.5	5.5	4.0	4.2E+12	-0.314	3.1E+05	0.89	0.05	0.52	2.30	3668.6	117917.23
TOTAL																											18495306.00

Table 17
Pavement Damage Calculations
Cimarron Valley Railroad

Trucks	Mile	SN	PSR	{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}	{9}	{10}	{11}	{12}	{13}	{14}	{15}	{16}	{17}	{18}	{19}	{20}	{21}	{22}	{23}	{24}
8064	10	3.8	3.8	-0.9	1.3	0.6	-0.2	0.1	-0.1	1.3	76.0	-0.2	0.9	1.8	1.7	5.8	5.8	4.3	2.9E+12	-0.314	5.8E+05	0.89	0.05	0.52	1.20	14845.6	178700.15
8820	8	3.9	3.9	-1.0	3.5	0.9	-0.2	0.1	0.0	3.5	249.2	-0.2	1.1	2.2	1.7	5.2	5.2	3.8	5.9E+12	-0.314	1.6E+05	0.89	0.05	0.52	4.26	19660.7	670220.48
2120	9	3.3	3.3	-1.0	0.8	0.5	-0.2	0.1	-0.1	0.8	36.4	-0.2	0.7	1.5	1.7	6.2	6.2	4.8	1.7E+12	-0.314	1.5E+06	0.89	0.05	0.52	0.46	3244.3	13396.44
2120	8	3.9	3.9	-0.9	1.8	0.6	-0.2	0.1	0.0	1.8	114.9	-0.2	0.9	2.0	1.7	5.6	5.6	4.1	3.8E+12	-0.314	3.6E+05	0.89	0.05	0.52	1.96	4242.3	66383.00
572	17	3.9	2.9	-0.9	2.0	0.7	-0.2	0.1	0.0	2.0	133.0	-0.2	1.0	2.1	1.7	5.5	5.5	4.0	4.2E+12	-0.314	3.1E+05	0.89	0.05	0.52	2.30	1173.6	45806.45
572	19	3.6	3.6	-1.0	3.0	0.8	-0.2	0.1	0.0	3.0	211.4	-0.2	1.0	2.2	1.7	5.3	5.3	3.9	5.4E+12	-0.314	1.9E+05	0.89	0.05	0.52	3.67	1252.2	87282.31
14512	25	3.5	3.5	-0.9	1.5	0.6	-0.2	0.1	-0.1	1.5	86.9	-0.2	0.9	1.9	1.7	5.7	5.7	4.3	3.2E+12	-0.314	5.0E+05	0.89	0.05	0.52	1.42	27502.6	973400.54
132	6	3.1	3.1	-0.9	1.3	0.6	-0.2	0.1	-0.1	1.3	76.0	-0.2	0.9	1.8	1.7	5.8	5.8	4.3	2.9E+12	-0.314	5.8E+05	0.89	0.05	0.52	1.20	243.0	1755.09
292	9	3.0	3.0	-1.0	3.0	0.8	-0.2	0.1	0.0	3.0	211.4	-0.2	1.0	2.2	1.7	5.3	5.3	3.9	5.4E+12	-0.314	1.9E+05	0.89	0.05	0.52	3.67	639.3	21105.81
5264	7	2.9	2.9	-0.9	1.5	0.6	-0.2	0.1	-0.1	1.5	86.9	-0.2	0.9	1.9	1.7	5.7	5.7	4.3	3.2E+12	-0.314	5.0E+05	0.89	0.05	0.52	1.42	9976.1	98864.01
4724	5	2.9	2.9	-0.9	1.2	0.5	-0.2	0.1	-0.1	1.2	66.7	-0.2	0.8	1.8	1.7	5.8	5.8	4.4	2.7E+12	-0.314	6.9E+05	0.89	0.05	0.52	1.02	8440.2	43193.71
4152	6	2.4	2.4	-0.9	1.5	0.6	-0.2	0.1	-0.1	1.5	86.9	-0.2	0.9	1.9	1.7	5.7	5.7	4.3	3.2E+12	-0.314	5.0E+05	0.89	0.05	0.52	1.42	7868.7	66839.45
3132	6	3.6	3.6	-0.9	1.2	0.5	-0.2	0.1	-0.1	1.2	66.7	-0.2	0.8	1.8	1.7	5.8	5.8	4.4	2.7E+12	-0.314	6.9E+05	0.89	0.05	0.52	1.02	5595.9	34364.78
2296	7	3.7	3.7	-0.9	1.2	0.5	-0.2	0.1	-0.1	1.2	66.7	-0.2	0.8	1.8	1.7	5.8	5.8	4.4	2.7E+12	-0.314	6.9E+05	0.89	0.05	0.52	1.02	4102.2	29390.74
1396	7	3.7	3.7	-0.9	1.3	0.6	-0.2	0.1	-0.1	1.3	76.0	-0.2	0.9	1.8	1.7	5.8	5.8	4.3	2.9E+12	-0.314	5.8E+05	0.89	0.05	0.52	1.20	2570.0	21654.98
832	8	4.0	4.0	-0.9	0.9	0.5	-0.2	0.1	-0.1	0.9	40.8	-0.2	0.7	1.6	1.7	6.1	6.1	4.7	1.9E+12	-0.314	1.3E+06	0.89	0.05	0.52	0.54	1313.1	5648.89
832	11	3.9	3.9	-1.0	0.8	0.5	-0.2	0.1	-0.1	0.8	36.4	-0.2	0.7	1.5	1.7	6.2	6.2	4.8	1.7E+12	-0.314	1.5E+06	0.89	0.05	0.52	0.46	1273.2	6425.80
1304	8	4.0	4.0	-1.0	0.7	0.4	-0.2	0.1	-0.2	0.7	23.5	-0.2	0.6	1.4	1.7	6.5	6.5	5.1	1.2E+12	-0.314	2.9E+06	0.89	0.05	0.52	0.25	1776.9	3497.72
1304	6	3.8	3.8	-1.0	0.7	0.4	-0.2	0.1	-0.2	0.7	23.5	-0.2	0.6	1.4	1.7	6.5	6.5	5.1	1.2E+12	-0.314	2.9E+06	0.89	0.05	0.52	0.25	1776.9	2623.29
1304	7	40.0	4.0	-1.0	0.6	0.4	-0.2	0.1	-0.2	0.6	19.2	-0.2	0.6	1.3	1.7	6.6	6.6	5.3	1.0E+12	-0.314	3.9E+06	0.89	0.05	0.52	0.18	1687.8	2146.22
7728	7	4.1	4.1	-1.0	0.7	0.4	-0.2	0.1	-0.2	0.7	23.5	-0.2	0.6	1.4	1.7	6.5	6.5	5.1	1.2E+12	-0.314	2.9E+06	0.89	0.05	0.52	0.25	10530.5	18137.70
7728	8	3.9	3.9	-0.9	1.0	0.5	-0.2	0.1	-0.1	1.0	51.9	-0.2	0.8	1.7	1.7	6.0	6.0	4.6	2.2E+12	-0.314	9.5E+05	0.89	0.05	0.52	0.74	12981.6	76938.22
60	11	3.5	3.5	-0.9	1.0	0.5	-0.2	0.1	-0.1	1.0	45.9	-0.2	0.8	1.6	1.7	6.0	6.0	4.6	2.0E+12	-0.314	1.1E+06	0.89	0.05	0.52	0.63	97.7	677.96
428	15	3.8	3.8	-1.1	0.4	0.4	-0.2	0.1	-0.2	0.4	1.2	-0.2	0.6	1.2	1.7	8.8	8.8	9.2	5.7E+12	-0.314	6.9E+08	0.89	0.05	0.52	0.00	526.8	7.99
12016	19	3.6	3.6	-1.0	0.5	0.4	-0.2	0.1	-0.3	0.5	10.0	-0.2	0.5	1.1	1.7	7.0	7.0	5.9	5.8E+12	-0.314	1.1E+07	0.89	0.05	0.52	0.07	13582.1	16984.92
512	25	3.7	3.7	-1.1	0.4	0.4	-0.2	0.1	-0.3	0.4	1.3	-0.2	0.6	1.2	1.7	8.7	8.7	9.0	6.8E+12	-0.314	5.2E+08	0.89	0.05	0.52	0.00	608.6	20.62
1788	14	3.7	3.7	-0.9	2.0	0.7	-0.2	0.1	0.0	2.0	133.0	-0.2	1.0	2.1	1.7	5.5	5.5	4.0	4.2E+12	-0.314	3.1E+05	0.89	0.05	0.52	2.30	3668.6	117917.23
TOTAL																											18495306.00

Table 18
Pavement Damage Calculations
Nebraska, Kansas and Colorado Railnet

Trucks	Miles	SN	PSR	{1}	{2}	{3}	{4}	{5}	{6}	{7}	{8}	{9}	{10}	{11}	{12}	{13}	{14}	{15}	{16}	{17}	{18}	{19}	{20}	{21}	{22}	{23}	{24}
240	11	3.1	3.8	-0.93	1.12	0.52	-0.20	0.12	-0.09	1.12	59	-0.2	0.8	1.7	1.7	5.9	5.9	4.5	2.4E+12	-0.31	8.1E+05	0.89	0.05	0.52	0.9	415.9	3982.41
364	10	0.8	2.9	-1.12	52.18	9.26	-0.20	0.08	0.08	52.18	4181	-0.2	1.2	2.5	1.7	4.9	4.9	3.5	8.4E+12	-0.31	8.7E+04	0.89	0.05	0.52	8.1	901.3	73065.65
60	8	0.8	2.9	-1.12	52.18	9.26	-0.20	0.08	0.08	52.18	4181	-0.2	1.2	2.5	1.7	4.9	4.9	3.5	8.4E+12	-0.31	8.7E+04	0.89	0.05	0.52	8.1	148.6	9635.03
696	10	3.3	3.9	-0.94	0.96	0.50	-0.20	0.11	-0.12	0.96	46	-0.2	0.8	1.6	1.7	6.0	6.0	4.6	2.0E+12	-0.31	1.1E+06	0.89	0.05	0.52	0.6	1133.2	7149.42
3176	9	3.9	3.7	-0.98	0.69	0.45	-0.20	0.10	-0.20	0.69	24	-0.2	0.6	1.4	1.7	6.5	6.5	5.1	1.2E+12	-0.31	2.9E+06	0.89	0.05	0.52	0.2	4327.8	9583.85
4180	8	3.3	3.3	-0.94	0.96	0.50	-0.20	0.11	-0.12	0.96	46	-0.2	0.8	1.6	1.7	6.0	6.0	4.6	2.0E+12	-0.31	1.1E+06	0.89	0.05	0.52	0.6	6805.7	34350.11
5980	11	3.3	3.3	-0.94	0.96	0.50	-0.20	0.11	-0.12	0.96	46	-0.2	0.8	1.6	1.7	6.0	6.0	4.6	2.0E+12	-0.31	1.1E+06	0.89	0.05	0.52	0.6	9736.4	67570.28
892	5	4.1	3.6	-1.00	0.63	0.44	-0.20	0.10	-0.22	0.63	19	-0.2	0.6	1.3	1.7	6.6	6.6	5.3	1.0E+12	-0.31	3.9E+06	0.89	0.05	0.52	0.2	1154.5	1048.66
604	17	2.2	3.7	-0.97	3.01	0.85	-0.20	0.11	0.02	3.01	211	-0.2	1.0	2.2	1.7	5.3	5.3	3.9	5.4E+12	-0.31	1.9E+05	0.89	0.05	0.52	3.7	1322.3	82463.63
240	7	2.5	3.7	-0.94	2.04	0.68	-0.20	0.11	-0.01	2.04	133	-0.2	1.0	2.1	1.7	5.5	5.5	4.0	4.2E+12	-0.31	3.1E+05	0.89	0.05	0.52	2.3	492.4	7913.91
240	5	3.0	3.6	-0.93	1.22	0.54	-0.20	0.12	-0.08	1.22	67	-0.2	0.8	1.8	1.7	5.8	5.8	4.4	2.7E+12	-0.31	6.9E+05	0.89	0.05	0.52	1.0	428.8	2194.43
7372	28	2.3	3.6	-0.96	2.63	0.78	-0.20	0.11	0.01	2.63	180	-0.2	1.0	2.1	1.7	5.3	5.3	3.9	5.0E+12	-0.31	2.2E+05	0.89	0.05	0.52	3.1	15821.8	1393855.40
1316	8	2.6	3.6	-0.93	1.82	0.64	-0.20	0.12	-0.03	1.82	115	-0.2	0.9	2.0	1.7	5.6	5.6	4.1	3.8E+12	-0.31	3.6E+05	0.89	0.05	0.52	2.0	2633.4	41207.56
644	11	3.0	4.0	-0.93	1.22	0.54	-0.20	0.12	-0.08	1.22	67	-0.2	0.8	1.8	1.7	5.8	5.8	4.4	2.7E+12	-0.31	6.9E+05	0.89	0.05	0.52	1.0	1150.6	12954.46
508	5	2.7	3.9	-0.93	1.63	0.61	-0.20	0.12	-0.04	1.63	100	-0.2	0.9	1.9	1.7	5.6	5.6	4.2	3.5E+12	-0.31	4.2E+05	0.89	0.05	0.52	1.7	989.9	8239.33
3268	22	3.0	3.8	-0.93	1.22	0.54	-0.20	0.12	-0.08	1.22	67	-0.2	0.8	1.8	1.7	5.8	5.8	4.4	2.7E+12	-0.31	6.9E+05	0.89	0.05	0.52	1.0	5838.8	131475.65
1320	6	2.6	3.1	-0.93	1.82	0.64	-0.20	0.12	-0.03	1.82	115	-0.2	0.9	2.0	1.7	5.6	5.6	4.1	3.8E+12	-0.31	3.6E+05	0.89	0.05	0.52	2.0	2641.4	30999.61
1320	33	3.0	3.5	-0.93	1.22	0.54	-0.20	0.12	-0.08	1.22	67	-0.2	0.8	1.8	1.7	5.8	5.8	4.4	2.7E+12	-0.31	6.9E+05	0.89	0.05	0.52	1.0	2358.4	79657.83
4588	24	3.0	3.7	-0.93	1.22	0.54	-0.20	0.12	-0.08	1.22	67	-0.2	0.8	1.8	1.7	5.8	5.8	4.4	2.7E+12	-0.31	6.9E+05	0.89	0.05	0.52	1.0	8197.2	201360.95
4588	10	3.5	3.2	-0.95	0.85	0.48	-0.20	0.11	-0.15	0.85	36	-0.2	0.7	1.5	1.7	6.2	6.2	4.8	1.7E+12	-0.31	1.5E+06	0.89	0.05	0.52	0.5	7021.1	32213.23
TOTAL																											2230921.40

Table 19

County Gravel Road Damage Cost Calculations

Railroad	Miles	Truckloads	{25} GL	{26} Total Cost	{27} Cost per Truck Mile
Railroad 1	2	672	0.2021856	$ 707.65	$ 0.53
Railroad 1	3	288	0.1552224	$ 814.92	$ 0.94
Railroad 2	8	396	0.1684308	$2,358.03	$ 0.74
Railroad 2	5	592	0.1924016	$1,683.51	$ 0.57
Totals	18	1948	0.838485	$5,564.11	
Avg Cost/Truck Mile					$ 0.16

The results of calculations to estimate damage on county gravel roads are summarized in Table 19. A total of 18 miles of county gravel roads were impacted statewide by an estimated 1948 truckloads of grain causing $5,564.11 worth of total damage. The average cost is estimated to be $0.16 per truck mile for grain traffic traveling on county gravel roads [$5,564.11 / (18 x 1948)].

Table 20
Miles of Road Impacted and Total Truck Miles of Incremental Grain Traffic Resulting From Abandonment of Shortlines

Railroad	Track Miles	State Highway	Miles Impacted County Paved	County Gravel	Total Miles	Total Truck Miles
CKR	1079	1095	101	13	1209	108,161,976
Kyle	480	735	9	5	749	138,530,680
CV	182	300	0	0	300	30,099,600
NKC	122	269	0	0	269	13,680,262
Study Area Total	1863	2399	110	18	2527	290,472,518

Table 20 summarizes the total miles of Kansas roadway impacted by the absence of shortline rail service by individual railroad and for the four shortlines as a group. On average, the traffic on 1.0 mile of shortline track would impact 1.29 miles of Kansas state highways if the track were abandoned. In its entirety, the study area shortline rail system saves 290,472,518 truck miles on the Kansas road system.

Table 21
Pavement Characteristics and Damage Cost Statistics

Railroad	Pavement Characteristics			Total Pavement Damage Cost	Average Cost/Mile Abandoned	Average Cost/ Truck Mile
	SN	PSR	Average ESAL/truck			
CKR	3.1	3.7	1.81	$ 18,417,902	$ 17,069.42	0.17
Kyle	3.1	3.5	1.83	$ 18,495,306	$ 38,531.89	0.13
CV	2.4	3.4	2.01	$ 10,306,211	$ 56,627.54	0.34
NKC	3.1	3.6	1.83	$ 2,232,444	$ 18,298.72	0.16
Study Area Total	2.9	3.6	1.9	$ 49,451,863	$ 26,544.21	0.17

In Table 21, the average pavement characteristics and damage cost estimates are provided both by individual railroad and for the four railroads as a group. It is estimated that the shortline rail system in the study area saves the state of Kansa $ 49,451,863 in pavement damage cost annually with the average cost per truck mile of incremental traffic costing approximately $0.17. This is apportioned with 37 percent of the savings being provided by the CKR, 37 percent by the Kyle, 21 percent by the CV, and 5 percent by the NKC. The CV provides a disproportionate amount of positive benefit due to the poorer pavement conditions in its area of operation. The CV's average cost per mile of abandoned track as well as its average cost per incremental truck mile are about double that of the other shortlines in the study area. In summation, the CKR and Kyle railroads each prevent over $18 million in pavement damage per year, the CV prevents over $10 million, and the NKC prevents a little under $2.5 million annually.

6.6 Summary

Abandonment of shortline track leaves country grain elevators only one modal choice. Country grain elevators can ship grain by truck to either local grain markets, or to a unit train loading facility to service distant domestic or export markets. The system without shortlines yields a new least cost grain flow. The farmer still ships his grain from the farm to the nearest country elevator to minimize his trip times during harvest, while the country elevator must now ship by truck to a local grain market or to the nearest unit train loading location for shipment to distant markets. Since trucks dominate the shipment of sorghum, corn, and soybeans, the impact of shortline abandonment will be primarily on the transport of wheat.

Road damage cost estimates were obtained using the following 12 step process:

1. The incremental increase in truck traffic was determined given the simulated removal of short-line rail service.
2. The least cost route (origin-destination) was determined for the incremental truck traffic.
3. Pavement characteristics along the new truck routes were ascertained.
4. Axle load equivalency factors for a standard grain truck were calculated given truck and road characteristics.
5. The maximum tolerable decline in pavement serviceability (PSR) was quantified given KDOT design and pavement management policies.
6. The maximum feasible life of the pavement in the study area in the absence of truck traffic was estimated.
7. The total number of standardized truck passes until pavement failure (ESAL life) for each impacted pavement segment was calculated.
8. The expected percentage of loss in pavement serviceability (PSR) as a result of temporal-environmental decay was estimated.
9. The adjusted unit cost per mile per truck pass (ESAL) was calculated for each impacted pavement segment by separating estimated non-traffic costs.
10. The total cost of the incremental increase in truck traffic was determined for each shortline's grain traffic.
11. The pavement characteristics for county paved roads were estimated using the pavement characteristics of nearby state highways with similar traffic patterns and steps 3 through 9 were used to estimate damage using the approximated road characteristics.
12. Damage to county roads was estimated by determining an average cost to apply aggregate (gravel) and multiplying that by the amount of aggregate expected to be lost to incremental grain truck traffic.

In conclusion, it is estimated that the shortline rail system in the study area saves the state of Kansas $ 49,451,863 in pavement damage cost annually with the average cost of incremental traffic costing approximately $0.17 per truck mile. The total pavement damage savings for the study area is apportioned with 37 percent of the savings being provided by the CKR, 37 percent by the Kyle, 21 percent by the CV, and 5 percent by the NKC. The CV provides a disproportionate amount of positive benefit due to the poorer pavement conditions in its area of operation. The CV's average cost per mile of abandoned track and its average cost per incremental truck mile are approximately double that of the other shortlines. In summation, the CKR and Kyle railroads each prevent over $18 million in pavement damage per year, the CV prevents over $10 million, and the NKC prevents a little under $2.5 million annually.

CHAPTER 7

CONCLUSIONS AND POLICY RECOMMENDATIONS

7.1 Conclusions

7.1.1 Trends in Kansas Grain Traffic

Most of the wheat grown in the study area is transported out of Kansas by Class I railroads to U.S. flour mills and export ports. For the 1997-2000 period, Class I railroad (Union Pacific System plus Burlington Northern Santa Fe) wheat carloadings in Kansas were 347,400. During the same period their combined Kansas carloadings of sorghum, corn, and soybeans were 193,854.

A total of 70 percent of the Class I railroad carloadings in the study area originate at the terminal elevators in Salina, Hutchinson and Wichita, and at the unit train loading locations identified in Table 2. The majority of the grain received by the terminals in Salina, Hutchinson and Wichita is delivered by truck, and all of the grain received by the unit train shipping locations on Class I railroads arrives by motor carrier. It is estimated that the dozen unit train locations in the study area receive 184,500 truckloads per year or 15,375 truckloads per facility. These are semi-tractor trailer and tandem axle trucks with about one-third of the receipts delivered by farmers and two-thirds from commercial elevators.

The principal destination for the wheat shipments from unit train locations is the Texas Gulf (export). Other primary wheat destinations are Mexico and U.S. flour mills. The two primary destinations for sorghum shipments from these facilities are the Texas Gulf (export) and Mexico.

In the 1997-1999 period, nearly 860 million bushels of grain were received by elevators located on the shortline railroads serving the study area. Nearly 80 percent of this volume was delivered by farmers in semi-tractor trailers and tandem axle trucks. During the same time period, about 45 percent of the wheat shipments of these elevators were transported by shortline railroads and 55 percent by motor carrier. Trucks dominated the shipments of sorghum, corn and soybeans from these elevators, accounting for 83 percent of the sorghum shipments and nearly 98 percent of the combined corn and soybean shipments. In total, shortlines accounted for only 28 percent of the grain shipments from the elevators located on their systems.

U.S. flour mills (including those in Kansas), Hutchinson and Wichita were major destinations for both truck and shortline wheat shipments from the elevators located on the shortline railroads serving the study area. Unit train locations on Class I railroads were major destinations for truck wheat shipments. The major destinations for truck shipments of sorghum from these facilities are feedlots in Kansas, Oklahoma and Texas. Other major destinations for sorghum truck shipments were unit train loading locations and alcohol manufacturing plants. The principal destination for sorghum shipped by shortlines from these elevators was Wichita. Motor carriers dominate the corn and soybean shipments from elevators located on shortlines. The major destinations for the corn shipments are Kansas, Oklahoma and Texas feedlots, with Wichita being the dominant destination for truck soybean shipments.

7.1.2 Reasons for Increased Grain Trucking in Kansas

The two most frequently cited reasons for increased grain trucking by shippers located on shortlines serving the study area were the same for wheat, sorghum and soybeans, which are (1) truck service is more frequent and dependable than rail service, and (2) truck rates are lower than rail rates. For corn, the two most frequently cited reasons for increased grain trucking are (1) the best corn markets are not rail-served, and (2) truck service is more frequent and dependable than rail service. When the reasons for increased trucking of grain are aggregated for wheat, sorghum, corn and soybeans the following results are obtained.

Reasons for Increased Grain Trucking	Number of Shippers Citing the Reason
1. Truck service is more frequent and dependable than rail service	121
2. Truck rates are lower than rail rates	102
3. Uncompetitive rail rates	94
4. Best markets are not rail-served	76
5. Railcar shortages	70
6. Construction of rapid loadout facilities on Class I railroads	53

These results indicate that shippers on study area shortlines have increased their trucking of grain primarily because they view motor carrier service and prices as superior to that of railroads. This result closely correlates with the results of a carrier choice analysis which indicated that shippers emphasize the transportation rate and ability to ship to many markets as the primary factors that they consider when choosing a transportation mode. Therefore, they are shipping more grain by truck because the shippers (as a group) can obtain a lower transportation rate by selecting motor carriers, and because the best sorghum, corn and soybean markets are better served by motor carrier than by railroad.

Increased ownership and use of large trucks gives farmers greater flexibility in terms of markets and timing of sale if the farmer has sufficient on-farm storage. If this is the case, the producer can store some of his grain on farm, and then later transport the grain a greater distance to a more profitable market (i.e., a unit train shipping facility) at a time of the farmer's choosing. Thus increased farmer ownership of large trucks has contributed to increased trucking of grain.

The Vice Presidents of Agricultural Products of UP and BNSF said that low truck rates relative to rail rates was a cause of increased grain trucking, but that this was due to many shippers buying their transportation on the spot market (as opposed to a guaranteed car supply system) where truck prices are less than rail prices. Other factors mentioned by the vice presidents as causes of increased grain trucking included increased demand for truck transport to move feed grains to the feedlots of Kansas, Oklahoma and Texas; and Kansas highway construction projects (front haul of construction materials and grain backhaul).

There was a substantial difference of opinion between the executives of study area shortlines and the shippers located on these railroads concerning the significance of construction of rapid loadout facilities on Class I railroads as a reason for increased grain trucking. The shippers ranked several other causes as more important, but three of the four executives of the shortlines designated this factor as a significant cause of increased grain trucking.

7.1.3 Impacts of Increased Grain Trucking on Study Area Shortlines

According to executives of study area shortlines the impact of increased grain trucking on shortline grain traffic was estimated to range from a low of 6 to 10 percent on one railroad to a high of 21 to 30 percent on another. Based on these estimates, the combined 1998 and 1999 grain carloadings of the four shortlines would have been 17 percent greater if increased grain trucking had not occurred.

The shortline railroad executives estimated the impact of increased grain trucking on their railroad's profits, and all agreed that profits were reduced by 11 to 20 percent.

Executives of study area shortlines ranked adequate traffic levels as the most important determinant of shortline railroad success (profits). The closely related determinant "strong shipper support" tied for the third most important factor. Thus grain is the most important commodity of study area shortlines and traffic volume is the most important determinant of shortline profitability. As more grain has been shipped by truck, shortline traffic and profits have been negatively affected, perhaps threatening the long run viability of these railroads.

7.1.4 Kansas Shortlines and the 286,000 Pound Covered Hopper Car

Another challenge facing Kansas shortlines is the increasing use of 286,000 pound covered hopper cars to transport Kansas grain. All the study area shortlines would have to upgrade their tracks and bridges to handle the larger cars and would face increased costs to maintain their tracks and bridges as more heavy axle load (HAL) cars move on their lines. The majority of the shortline executives stated that their tracks can't handle the larger car and they would need government assistance to sufficiently improve track quality.

An executive of a Class I railroad serving Kansas stated that shortlines have time to make the investments in tracks and bridges that would enable them to handle the HAL cars since there will be an ample supply of smaller grain cars for several years into the future. However, this executive said that shortlines that are unable to handle the larger cars will lose grain traffic if they are competing with a unit train shipping facility located on a rail line that is capable of handling 286,000 pound cars. Both Class I railroad executives that participated in this study stated that if shortlines are unable to handle HAL cars, then the share of grain transported by truck would continue to increase.

7.1.5 Shortline Abandonment and Road Damage Cost

If the structural changes in the Kansas grain transportation system continue, the long run viability of Kansas shortlines could be threatened. Should this happen, several consequences could occur. One of the most important impacts would be increased road damage as the grain the shortlines would have transported is diverted to motor carriers.

It is estimated that the study area shortline rail system saves the state of Kansas $49.5 million in pavement damage costs annually, with the average damage cost of incremental truck traffic costing approximately $0.17 per truck mile. The total pavement damage cost savings for the study area is apportioned with 37 percent of the savings being provided by the Central Kansas Railroad (CKR), 37 percent by the Kyle, 21 percent by the Cimarron Valley Railroad (CV), and 5 percent by the Nebraska, Kansas and Colorado Railnet (NKC). The CV provides a disproportionate amount of positive benefit (in terms of average road damage cost per mile of abandoned track) due to the poorer pavement conditions in the CV's area of operation. The CV's average road damage cost per mile of abandoned track as well as its average road damage per incremental truck mile are about double that of the other study area shortlines. The CKR and Kyle railroads each prevent a little over $18 million in pavement damage cost per year, the CV prevents over $10 million, and the NKC prevents about $2.5 million annually.

7.1.6 The Future of Shortline Grain Transportation in Kansas

Increased grain trucking in Kansas has reduced shortline railroad grain traffic and harmed profitability. Thus we asked grain shippers and railroad executives to address the question, "Does shortline railroad transportation have a future in Kansas?" The question had three possible responses which were yes, no, and maybe.

With respect to the grain shippers located on study area shortlines, about half (49.4 percent) said that shortlines have a future in Kansas. A little over one-third (36.4 percent) stated that shortlines may have a future under certain conditions, and only 14.2 percent said that shortline railroads do not have a future in the Kansas grain transportation system.

For the grain shippers located on shortlines which agreed that shortlines have a role to play in the Kansas grain transportation system, the most frequently mentioned reason was that shortlines provide better service than their previous Class I railroad. Another frequently mentioned reason was that wheat and sorghum markets are better served by rail transport.

Concerning the grain shippers located on study area shortlines that believe shortlines do not have a future in Kansas grain transportation, the principal reasons were “shortlines don’t serve the best feed grain markets,” and “unit train shipping facilities on Class I railroads have reduced shortline grain traffic.”

For the grain shippers on study area shortlines who said that shortlines may have a future in Kansas grain transportation, the most frequently mentioned factor was the need for more competitive rates. These shippers also emphasized that shortlines must obtain the capital necessary to maintain their tracks to provide faster service and handle larger railcars.

Managers of 9 of the 12 unit train shipping facilities listed in Table 2 responded to the question. Managers of four companies responded “yes” to the question. Managers of three companies responded “no,” and two selected the “maybe” alternative.

With regard to the unit train facility managers that believe shortlines have a future in Kansas grain transportation, three of them emphasized the significance of large wheat production in Kansas. According to these managers, the shortline’s function is to move wheat from areas with large wheat production to domestic flour mills. The flour mills provide a stable demand for shortline transport throughout the year.

One of the unit train facility managers who stated that shortlines do not have a future in Kansas said that elevators on shortlines will ship grain by truck to unit train facilities on Class I railroads who will be the rail shippers. Another manager said that the poor service of some shortlines won't allow them to survive in the long run.

Executives of the four study area shortline railroads were asked if shortline railroad transportation has a future in Kansas. Two of the executives responded "yes" to the question and two responded "maybe". One of the two executives responding in the affirmative to the question said that shortlines have a future, especially if a "level playing field" is established between railroads and trucks. The other executive in this group noted that railroads have cost advantages relative to trucks for long haul grain shipments.

One of the executives expressing a "maybe" opinion on the future of shortlines in Kansas said that shortlines are needed to serve the domestic flour mill market. The other shortline executive in this group said that the main shortline survival issue will be how (if) Kansas helps shortlines overcome the heavy axle railcar problem.

In summary, while the study area shortlines face significant challenges, the majority of the participants in the Kansas grain logistics system believe that they have a viable role to play in the marketing of Kansas grain.

7.2 Policy Recommendations

Since the study area shortline railroads annually save the state of Kansas nearly $50 million in avoided road damage cost, the state has an economic interest in the preservation of shortline rail service.

Kansas has two shortline railroad assistance plans which are the Federal Local Rail Freight Assistance to States (LRFA) and the State Rail Service Improvement Funds (SRSIF). In 1989, the Kansas legislature granted KDOT the authority to loan Federal Railroad Administration (FRA) funds to shortline railroads through the LRFA program, which provides low interest revolving loans below the prime rate to shortlines. The SRSIF was established in 1999 to provide shortline railroads operating in Kansas with low interest, 10 year revolving loans to be used primarily for track rehabilitation. For SRSIF projects the shortline must pay 30 percent of the cost of the project and the state provides a combination of grants (30 percent) and loans (40 percent) for the remaining 70 percent. The interest rate on the loan portion is 3 percent.

In order for Kansas shortline railroads to be able to safely and efficiently handle HAL cars and provide better service, the funds in the SRSIF program need to be greatly increased. In order to reduce the impact of SRSIF on debt burdens of shortlines, the state's 70 percent share of track rehabilitation projects should be increased to 90 percent with the grant portion at 60 percent and the loan portion at 30 percent, if SRSIF funds are increased.

The federal government needs to change the Railroad Rehabilitation and Improvement Financing (RRIF) program which has not been used at all in Kansas. The program provides for up to one billion dollars in direct loans and loan guarantees for projects benefitting freight railroads other than Class I carriers (i.e., shortline railroads). Eligible projects include (1) acquisition, improvement or rehabilitation of intermodal or rail equipment or facilities (including tracks, components of tracks, bridges, yards, buildings, and shops); (2) refinancing of outstanding debt incurred for these purposes; or (3) development or establishment of new intermodal or railroad facilities. The maximum repayment period is 25 years and the current interest rate is about 6 percent. One unique feature of the RRIF program is the payment of a credit risk premium prior to an appropriation of funds. The credit risk premium is a cash payment to be provided by the loan applicant or a non-Federal infrastructure partner on behalf of the loan applicant.

The RRIF program could provide a source of loans for Kansas shortline railroads to improve their system infrastructure to accommodate HAL cars and attract more traffic. Currently there are no RRIF loan applicants in Kansas. The federal government needs to modify the provisions of RRIF in order to make it attractive to shortlines. The maximum repayment period could be extended to 30 years and the interest rate reduced to 3 percent to conform to the interest rate available on LRFA and SRSIF loans. The credit risk premium should be modified to be more user friendly since, as noted above, there are currently no RRIF loan applicants in Kansas.

It is recommended that Port Authorities, as an economic development goal, purchase covered hopper cars, new or used, and lease them to shortline railroads for use in Kansas. Given periodic car shortages and railroad congestion, the Class I railroads can not always supply shortline railroads with covered hopper cars in a timely manner. Having an adequate covered hopper car supply to move Kansas grain to market is paramount to the continued success of shortline railroads operating in the state.

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APPENDIX A

KANSAS GRAIN TRANSPORTATION STUDY, GRAIN SHIPPERS LOCATED ON SHORTLINES

APPENDIX A
KANSAS GRAIN TRANSPORTATION STUDY
GRAIN SHIPPERS LOCATED ON SHORTLINES

Respondent's Name ________________________________

Company Name ___________________________________

PART A: GRAIN RECEIPTS

1. Please provide Grain Receipts from farmers for the three year period 1997-1999. If there is more than one elevator station in the company, simply provide grain receipts for all of the elevators in the company as a single total. If possible, provide grain receipts on a calendar basis. If not possible, please specify your fiscal year.

Grain Receipts
(Bushels)

Year	Wheat	Corn	Sorghum	Soybeans
1997	______________	______________	______________	______________
1998	______________	______________	______________	______________
1999	______________	______________	______________	______________

2. In the past 12 months, what percent of your total grain receipts were delivered to your elevator(s) in the following types of trucking equipment. Sum of percents must add to 100.

	Percent
(a) gravity flow wagons	____________
(b) single axle truck	____________
(c) tandem axle truck	____________
(d) semi-tractor trailer	____________
(e) other (please specify)	____________

PART B: GRAIN SHIPMENTS AND FERTILIZER RECEIPTS

Please provide rail and truck outbound grain shipments and inbound fertilizer receipts for the 1997-1999 period. If there is more than one elevator station in the company, simply provide grain shipments for all the elevators in the company as a single total. If possible, provide grain shipments on a calendar year basis. If not possible, please specify your fiscal year.

3. Outbound Wheat-Bushels

Year	Rail	Truck
1997	______________	______________
1998	______________	______________
1999	______________	______________

4. Outbound Sorgum-Bushels

Year	Rail	Truck
1997	______________	______________
1998	______________	______________
1999	______________	______________

5. Outbound Corn-Bushels

Year	Rail	Truck
1997	______________	______________
1998	______________	______________
1999	______________	______________

6. Outbound Soybeans-Bushels

Year	Rail	Truck
1997	______________	______________
1998	______________	______________
1999	______________	______________

7. Inbound Fertilizer-Tons

Year	Rail	Truck
1997	______________	______________
1998	______________	______________
1999	______________	______________

PART C: CURRENT GRAIN DESTINATIONS AND FERTILIZER ORIGINS

Please list the most important destinations (markets) for your outbound grain shipments during the last 12 months. Also estimate the percent shipped by rail and truck to each destination market. List the most important origins for fertilizer and the percent delivered by rail and truck. If there is more than one elevator station in the company, please provide the requested data for all the elevators in the company as a group.

8. Outbound Wheat
Current Markets (Previous 12 months)

Market Name	Percent Shipped by Rail	Percent Shipped by Truck
1.	________________	________________
2.	________________	________________
3.	________________	________________
4.	________________	________________
5.	________________	________________

9. Outbound Sorghum
Current Markets (Previous 12 months)

Market Name	Percent Shipped by Rail	Percent Shipped by Truck
1.	________________	________________
2.	________________	________________
3.	________________	________________
4.	________________	________________
5.	________________	________________

10. Outbound Corn
Current Markets (Previous 12 Months)

Market Name	Percent Shipped by Rail	Percent Shipped by Truck
1.	________________	________________
2.	________________	________________
3.	________________	________________
4.	________________	________________
5.	________________	________________

11. Outbound Soybeans
Current Markets (Previous 12 months)

Market Name	Percent Shipped by Rail	Percent Shipped by Truck
1.	____________________	_____________________
2.	____________________	_____________________
3.	____________________	_____________________
4.	____________________	_____________________
5.	____________________	_____________________

12. Inbound Fertilizer
Current Origins (Previous 12 months)

Origin Name	Percent Received by Rail	Percent Received by Truck
1.	____________________	_____________________
2.	____________________	_____________________
3.	____________________	_____________________
4.	____________________	_____________________
5.	____________________	_____________________

PART D: CARRIER CHOICE QUESTIONS

Below is a list of transportation carrier characteristics that may influence your selection of one type of transport carrier over another (i.e., rail or truck). Please rank these characteristics from the most important to the least important. The most important is Number 1 and the least important is Number 8. **Only one characteristic can be ranked Number 1, and only one characteristic can be ranked Number 2, etc. Be sure to give all eight characteristics a ranking number.**

13.

Transportation Characteristic	Importance Rank
The Transportation Rate	______________
Ability to Ship to Many Markets	______________
Amount of Time Required to Deliver My Freight from Origin to Destination	______________
Predictability of the Time it Takes to Ship My Freight to Destination	______________

The Amount of Weekly Service Provided by the Carrier ______________

Shipment Tracing Capability ______________

Lost or Damaged Goods ______________

Billing Procedures ______________

14. If you have increased the percent of total <u>wheat</u> shipments that you ship by truck, which of the following are reasons for shipping more by truck? Check all that apply.

(a) railcar shortages _______________

(b) uncompetitive rail rates _______________

(c) construction of rapid loadout facilities on Class I railroads _______________

(d) truck rates are lower than rail rates _______________

(e) truck service is more frequent and dependable than rail service _______________

(f) other (please describe) _______________

15. If you have increased the percent of total <u>sorghum</u> shipments that you ship by truck, which of the following are reasons for shipping more by truck? Check all that apply.

(a) truck service is more frequent and dependable than rail service _______________

(b) truck rates are lower than rail rates _______________

(c) construction of rapid loadout facilities on Class I railroads _______________

(d) uncompetitive rail rates _______________

(e) railcar shortages _______________

(f) other (please specify) _______________

16. If you have increased the percent of total <u>corn</u> shipments that you ship by truck, which of the following are reasons for shipping more by truck? Check all that apply.

(a) uncompetitive rail rates ______________

(b) railcar shortages ______________

(c) truck service is more frequent and dependable than rail service ______________

(d) truck rates are lower than rail rates ______________

(e) construction of rapid loadout facilities on Class I railroads ______________

(f) other (please specify) ______________

17. If you have increased the percent of total <u>soybean</u> shipments that you ship by truck, which of the following are reasons for shipping more by truck? Check all that apply.

(a) construction of rapid loadout facilities on Class I railroads ______________

(b) uncompetitive rail rates ______________

(c) railcar shortages ______________

(d) truck service is more frequent and dependable than rail service ______________

(e) truck rates are lower than rail rates ______________

(f) other (please specify) ______________

PART E: SUMMARY

18. In your opinion does shortline railroad grain transportation have a future in Kansas?

(a) yes _____

(b) no _____

(c) maybe _____

19. Explain your answer to the previous question.

APPENDIX B

KANSAS GRAIN TRANSPORTATION STUDY, SHORTLINE RAILROAD EXECUTIVES SURVEY

APPENDIX B
KANSAS GRAIN TRANSPORTATION STUDY
SHORTLINE RAILROAD EXECUTIVES SURVEY

Company Name ________________________________

Respondent's Name _____________________________

PART A: GENERAL QUESTIONS

1. When did your company buy, lease, or begin operating the shortline?

2. How many people are employed full time by the shortline?

3. Does your company own, lease, or operate the shortline?

4. What is the current number of route miles of your shortline? Have there been any changes in the last five years in the number of route miles you operate? If so, please describe the changes.

5. List all the railroads that your shortline has connections with. Also list the junction location for each connection.

PART B: GRAIN TRAFFIC

In answering the following questions regarding traffic on your shortline, please use the following traffic definitions.

Originated - Traffic that originates on your railroad and terminates on another railroad

Terminated - Traffic that originates on another railroad and terminates on your railroad

Local - Traffic that originates and terminates on your railroad

Overhead - Traffic handled by your railroad but which originates and terminates on other railroads

6. Which of the following grains are originated on your shortline in Kansas? Check all that apply.

(a) wheat _____
(b) sorghum _____
(c) corn _____
(d) soybeans _____

7. For the grains checked in the previous question, please provide the number of originated carloads for each grain for the 1997, 1998, 1999, and 2000 calendar years.

Originated Carloads

Grain:	1997 Carloads	1998 Carloads	1999 Carloads	2000 Carloads
Wheat	___________	___________	___________	___________
Sorghum	___________	___________	___________	___________
Corn	___________	___________	___________	___________
Soybeans	___________	___________	___________	___________

8. Which of the following grains are terminated on your shortline in Kansas. Check all that apply.

(a) wheat _____
(b) sorghum _____
(c) corn _____
(d) soybeans _____

9. For the grains checked in the previous question, please provide the number of terminated carloads for each grain for the 1997, 1998, 1999, and 2000 calendar years.

Terminated Carloads

Grain:	1997 Carloads	1998 Carloads	1999 Carloads	2000 Carloads
Wheat	___________	___________	___________	___________
Sorghum	___________	___________	___________	___________
Corn	___________	___________	___________	___________
Soybeans	___________	___________	___________	___________

10. For which of the following grains do you have local traffic in Kansas? Check all that apply.

(a) wheat _____
(b) sorghum _____
(c) corn _____
(d) soybeans _____

11. For the grains checked in the previous question, please provide the number of local carloads for each grain for the 1997, 1998, 1999, and 2000 calendar years.

Local Carloads

Grain:	1997 Carloads	1998 Carloads	1999 Carloads	2000 Carloads
Wheat	___________	___________	___________	___________
Sorghum	___________	___________	___________	___________
Corn	___________	___________	___________	___________
Soybeans	___________	___________	___________	___________

12. For which of the following grains do you have overhead traffic in Kansas? Check all that apply.

(a) wheat _____
(b) sorghum _____
(c) corn _____
(d) soybeans _____

13. For the grains checked in the previous question, please provide the number of overhead carloads for each grain for the 1997, 1998, 1999, and 2000 calendar years.

Overhead Carloads

Grain:	1997 Carloads	1998 Carloads	1999 Carloads	2000 Carloads
Wheat	___________	___________	___________	___________
Sorghum	___________	___________	___________	___________
Corn	___________	___________	___________	___________
Soybeans	___________	___________	___________	___________

PART C: SHORTLINE SUCCESS PROFILE

14. Below are listed several potential ingredients for a profitable shortline railroad. From the choices given, select what you feel to be the three most important determinants of success (profits). Put the number 1 next to the most important determinant, the number 2 next to the second most important determinant, and the number 3 next to the third most important.

Strong Shipper Support	____________
Adequate Track Quality	____________
Reasonable Purchase Price	____________
Adequate Traffic Levels	____________
Ship Many Different Commodities	____________
Access to More than One Connecting Carrier	____________
State Financial Assistance	____________
Ability to Compete with Motor Carriers	____________
Experienced Management	____________
Reliance on Equity Financing	____________
Access to Own Equipment	____________
Cooperation from Connecting Railroads on Joint Rates and Revenue Splits	____________

15. If the above list of determinants omits something that you feel is important to shortline profitability, please explain in detail.

PART D: IMPACT OF TRUCKING ON SHORTLINES

The share of Kansas grain transported by truck has increased substantially in recent years. The implication is that shortline grain traffic has correspondingly decreased. The following questions address this hypothesis.

16. Select the response that best describes your shortline's situation. Increased trucking of grain in Kansas has affected my railroad's grain traffic as follows:

(a) not at all ______________
(b) caused a reduction of 1 to 5% ______________
(c) caused a reduction of 6 to 10% ______________
(d) caused a reduction of 11 to 20% ______________
(e) caused a reduction of 21 to 30% ______________
(f) caused a reduction of more than 30% ______________

17. Select the response that best describes your shortline's situation. Increased trucking of grain in Kansas has affected my railroad's profits as follows:

(a) not at all ______________
(b) caused a reduction of 1 to 5% ______________
(c) caused a reduction of 6 to 10% ______________
(d) caused a reduction of 11 to 20% ______________
(e) caused a reduction of 21 to 30% ______________
(f) caused a reduction of more than 30% ______________

18. In your opinion which of the following is a significant cause of increased trucking of grain in Kansas in recent years? Check all that apply.

(a) truck rates are lower than rail rates ______________
(b) construction of rapid loadout facilities on Class I railroads ______________
(c) truck service is more frequent and dependable than rail service ______________
(d) uncompetitive Class I rail rates ______________
(e) other (please specify) ______________

PART E: SUMMARY

19. In your opinion what changes, especially government policies, would enable Kansas shortlines to increase their share of the Kansas grain transportation market.

20. Will the introduction of the jumbo covered hopper car increase or decrease your grain traffic? What strategy does your railroad have for adapting to the larger car?

21. In your opinion what changes will occur in the Kansas grain logistics system in the next 10 years? How will these expected changes affect Kansas shortline grain traffic and profits?

22. Does shortline transportation of grain in Kansas have a future?

(a) yes ______
(b) no ______
(c) maybe ______

23. Explain your answer to the previous question.

APPENDIX C

KANSAS GRAIN TRANSPORTATION STUDY
CLASS I RAILROADS

APPENDIX C
KANSAS GRAIN TRANSPORTATION SURVEY
CLASS I RAILROADS

Railroad ____

Respondent's Name ____________________________________

PART A: GRAIN SHIPMENTS FROM COUNTRY ELEVATORS

1. Please provide the number of wheat carloads originated from country elevators as a group on your railroad in Kansas by month for calendar years 1997, 1998, 1999, and 2000.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1997	___	___	___	___	___	___	___	___	___	___	___	___
1998	___	___	___	___	___	___	___	___	___	___	___	___
1999	___	___	___	___	___	___	___	___	___	___	___	___
2000	___	___	___	___	___	___	___	___	___	___	___	___

2. Please provide the number of corn carloads originated from country elevators as a group on your railroad in Kansas by month for calendar years 1997, 1998, 1999, and 2000.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1997	___	___	___	___	___	___	___	___	___	___	___	___
1998	___	___	___	___	___	___	___	___	___	___	___	___
1999	___	___	___	___	___	___	___	___	___	___	___	___
2000	___	___	___	___	___	___	___	___	___	___	___	___

3. Please provide the number of sorghum carloads originated from country elevators as a group on your railroad in Kansas by month for calendar years 1997, 1998, 1999, and 2000.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1997	___	___	___	___	___	___	___	___	___	___	___	___
1998	___	___	___	___	___	___	___	___	___	___	___	___
1999	___	___	___	___	___	___	___	___	___	___	___	___
2000	___	___	___	___	___	___	___	___	___	___	___	___

4. Please provide the number of soybean carloads originated from country elevators as a group on your railroad in Kansas by month for the calendar years 1997, 1998, 1999, and 2000.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1997	___	___	___	___	___	___	___	___	___	___	___	___
1998	___	___	___	___	___	___	___	___	___	___	___	___
1999	___	___	___	___	___	___	___	___	___	___	___	___
2000	___	___	___	___	___	___	___	___	___	___	___	___

PART B: SUBTERMINALS (RAPID LOADOUT FACILITIES)

5. What are the locations of subterminals (rapid loadout facilities) on your railroad in Kansas? Exclude facilities in Salina, Hutchinson, Topeka, and Kansas City.

6. For the subterminals as a group that you named in the previous question, what is the number of wheat carloads originated on your railroad by month for the calendar years 1997, 1998, 1999, and 2000?

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1997	___	___	___	___	___	___	___	___	___	___	___	___
1998	___	___	___	___	___	___	___	___	___	___	___	___
1999	___	___	___	___	___	___	___	___	___	___	___	___
2000	___	___	___	___	___	___	___	___	___	___	___	___

7. For the subterminals as a group that you named in question 5, what is the number of corn carloads originated on your railroad by month for the calendar years 1997, 1998, 1999, and 2000?

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1997	___	___	___	___	___	___	___	___	___	___	___	___
1998	___	___	___	___	___	___	___	___	___	___	___	___
1999	___	___	___	___	___	___	___	___	___	___	___	___
2000	___	___	___	___	___	___	___	___	___	___	___	___

8. For the subterminals as a group that you named in question 5, what is the number of sorghum carloads originated on your railroad by month for the calendar years 1997, 1998, 1999, and 2000?

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1997	___	___	___	___	___	___	___	___	___	___	___	___
1998	___	___	___	___	___	___	___	___	___	___	___	___
1999	___	___	___	___	___	___	___	___	___	___	___	___
2000	___	___	___	___	___	___	___	___	___	___	___	___

9. For the subterminals as a group that you named in question 5, what is the number of soybean carloads originated on your railroad by month for the calendar years 1997, 1998, 1999, and 2000?

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1997	___	___	___	___	___	___	___	___	___	___	___	___
1998	___	___	___	___	___	___	___	___	___	___	___	___
1999	___	___	___	___	___	___	___	___	___	___	___	___
2000	___	___	___	___	___	___	___	___	___	___	___	___

10. In your opinion, has the construction of subterminals (rapid loadout facilities) on Class I railroads in Kansas had a negative impact on Kansas shortline grain traffic? Please Explain.

11. In your opinion has the construction of subterminals (rapid loadout facilities) on Class I railroads in Kansas contributed to the increased trucking of grain in Kansas? Please Explain.

PART C: JUMBO COVERED HOPPER CARS (286,000 POUNDS)

12. How many jumbo covered hopper cars (286,000 pounds) are currently in service on your railroad in Kansas?

Number of Cars ________________

Percent of Total Grain Cars Serving Kansas ________________

13. By the year 2010, how many jumbo covered hopper cars (286,000 pounds) do you expect will be in service on your railroad in Kansas?

Number of Cars ________________

Percent of Total Grain Cars Serving Kansas ________________

14. In your opinion what impact will the jumbo covered hopper car (286,000 pounds) have on Kansas shortline railroad grain traffic. In other words, can Kansas shortlines handle these cars with their current systems? Please explain.

15. In your opinion what impact will the jumbo covered hopper car (286,000 pounds) have on the railroad share of the Kansas grain transportation market? In other words, if the Kansas shortlines can't handle these cars, will this cause even more Kansas grain to be shipped by truck? Please explain.

PART D: MARKET SHARES

16. In recent years trucks have increased their share of the grain transportation market in Kansas. In your opinion which of the following have contributed to this trend? Check all that apply.

(a) railcar shortages __________
(b) uncompetitive rail rates __________
(c) truck rates are cheaper than rail rates __________
(d) truck service is more frequent and timely than rail __________
(e) other (please specify) __________

17. What changes do you think will occur in the Kansas grain transportation system in the next 10 years? Will these changes increase or decrease the railroad share of the market? Please explain.

APPENDIX D

KANSAS GRAIN TRANSPORTATION STUDY,
UNIT TRAIN GRAIN SHIPPERS LOCATED ON CLASS I RAILROADS

APPENDIX D
KANSAS GRAIN TRANSPORTATION STUDY
UNIT TRAIN GRAIN SHIPPERS LOCATED ON CLASS I RAILROADS

Company Name ____________________________________

Respondent's Name _________________________________

PART A: GRAIN RECEIPTS

1. Please provide Grain Receipts for the four year period 1997-2000. If there is more than one unit train elevator station in the company, simply provide grain receipts for all of the elevators in the company as a single total. If possible, provide grain receipts on a calendar basis. If not possible, please specify your fiscal year.

Grain Receipts
(Bushels)

Year	Wheat	Corn	Sorghum	Soybeans
1997	______________	______________	______________	______________
1998	______________	______________	______________	______________
1999	______________	______________	______________	______________
2000	______________	______________	______________	______________

2. In the past 12 months, which of the following types of trucking equipment is the major type used to deliver grain to your elevator(s). Check the one that applies.

(a) gravity flow wagons ____________
(b) single axle truck ____________
(c) tandem axle truck ____________
(d) semi-tractor trailer ____________
(e) other (please specify) ____________

3. In the last 12 months what percentage of your wheat receipts have been obtained from farmers (farmer-owned vehicles) and country grain elevators?

From:	Percent of Total Wheat Receipts
Farmers	___________________
Country Grain Elevators	___________________
Other (please specify)	___________________

4. In the last 12 months what percentage of your sorghum receipts have been obtained from farmers (farmer-owned vehicles) and country grain elevators?

From:	Percent of Total Sorghum Receipts
Farmers	____________________
Country Grain Elevators	____________________
Other (please specify)	____________________

5. In the last 12 months what percentage of your corn receipts have been obtained from farmers (farmer-owned vehicles) and country grain elevators?

From:	Percent of Total Corn Receipts
Farmers	____________________
Country Grain Elevators	____________________
Other (please specify)	____________________

6. In the last 12 months what percentage of your soybean receipts have been obtained from farmers (farmer-owned vehicles) and country grain elevators?

From:	Percent of Total Soybean Receipts
Farmers	____________________
Country Grain Elevators	____________________
Other (please specify)	____________________

7. Please estimate the percent of your total grain receipts that originate at the following distances from your facility.

(a) 0-10 miles _____________
(b) 11-25 miles _____________
(c) 26-50 miles _____________
(d) 51-70 miles _____________
(e) over 70 miles _____________

PART B: GRAIN SHIPMENTS

Please provide rail outbound grain shipments for the 1997-2000 period. If there is more than one unit train elevator in the company, simply provide grain shipments for all the elevators in the company as a single total. If possible, provide grain shipments on a calendar year basis. If not possible, please specify your fiscal year.

8. Outbound Wheat-Bushels

Year	Rail
1997	___________________
1998	___________________
1999	___________________
2000	___________________

9. Outbound Sorghum-Bushels

Year	Rail
1997	___________________
1998	___________________
1999	___________________
2000	___________________

10. Outbound Corn-Bushels

Year	Rail
1997	___________________
1998	___________________
1999	___________________
2000	___________________

11. Outbound Soybeans-Bushels

Year	Rail
1997	___________________
1998	___________________
1999	___________________
2000	___________________

12. What percent of the rail cars shipped from your unit train facility(s) are 286,000 pound covered hopper cars?

Percent __________

13. What percent of the following outbound types of grain shipped from your unit train facility(s) is shipped on shuttle trains? In this study, a shuttle train is defined as 100-110 car train from one origin to one destination.

Wheat Percent __________
Sorghum Percent __________
Corn Percent __________
Soybean Percent __________

14. What percent of the following outbound types of grain shipped from your unit train facility(s) is shipped on unit trains? In this study, a unit train is defined as a 50-99 car train from one origin to one destination.

Wheat Percent __________
Sorghum Percent __________
Corn Percent __________
Soybean Percent __________

PART C: CURRENT GRAIN DESTINATIONS

Please list the most important destinations (markets) for your outbound grain shipments during the last 12 months. List the most important market first, the next most important market second, etc. If there is more than one unit train elevator station in the company, please provide the requested data for all the elevators in the company as a group.

15. Outbound Wheat
Current Markets (Previous 12 months)

Market Name

1.
2.
3.
4.
5.

16. Outbound Sorghum

Current Markets (Previous 12 months)

Market Name

1.
2.
3.
4.
5.

17. Outbound Corn

Current Markets (Previous 12 Months)

Market Name

1.
2.
3.
4.
5.

18. Outbound Soybeans

Current Markets (Previous 12 months)

Market Name

1
2.
3.
4.
5.

PART D: SUMMARY

19. In recent years, for a variety of reasons, an increasing percent of grain is being shipped by truck from Kansas country grain elevators. Less grain is being shipped by shortline railroad. In your opinion does <u>shortline</u> railroad grain transportation have a future in Kansas?

(a) yes _____

(b) no _____

(c) maybe _____

20. Explain your answer to the previous question.

K-TRAN

KANSAS TRANSPORTATION RESEARCH
AND
NEW – DEVELOPMENTS PROGRAM

A COOPERATIVE TRANSPORTATION RESEARCH PROGRAM BEWTEEN:

KANSAS DEPARTMENT OF TRANSPORTATION

KANSAS STATE UNIVERSITY

THE UNIVERSITY OF KANSAS