Appendix D

Appendix D

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TEXAS DEPARTMENT OF TRANSPORTATION

SOUTH ORIENT REHABILITATION – SULPHUR JUNCTION TO FORT STOCKTON

TIGER DISCRETIONARY GRANTS PROGRAM

ECONOMIC ANALYSIS SUPPLEMENTARY DOCUMENTATION

JUNE 3, 2013

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1. Executive Summary

The South Orient rail line (SORR) rehabilitation project from Sulphur Junction to Fort Stockton, Texas, is a "shovel-ready" rural freight rail project that will have a significant impact on the region as well as the nation.

The entire SORR is a 391 mile state-owned facility that extends from San Angelo Junction (near Coleman, Texas) through several towns in west Texas, to Presidio at the Texas/Mexico border. The proposed project will upgrade the SORR from Sulphur Junction (MP 869.4) to Fort Stockton (MP 883.0) to FRA Class 2 (25 mph) status. The city of Fort Stockton is located 12.52 miles west of Sulphur Junction. This section of the line is currently FRA Class 1 and requires a significant rehabilitation due to substandard rail, defective ties, and track alignment deficiencies. If not rehabilitated, the recent and projected increase in traffic will cause rapid deterioration of the line, resulting in a reclassification to Excepted Status[1] becoming inoperable within 5 to 10 years. The rehabilitation is necessary in order to prevent this degradation of the track structure, continue and improve operations, and provide safe and efficient rail service to existing customers. Termination of rail service to the region threatens future transportation network efficiency, freight mobility, and economic growth in an Economically Distressed Area.

The project will provide significant benefits to the region, state, and nation through:

1) improving freight rail efficiency and capacity
2) avoiding the diversion of existing freight from rail to truck,
3) avoiding truck miles traveled,
4) avoiding highway maintenance costs
5) avoiding increased transportation costs
6) avoiding increased congestion costs
7) avoiding increased transportation costs,
8) avoiding accident costs (fatalities and injuries), and
9) job creation.

This is the only rail line providing service to the cities and businesses in the region, which includes agricultural interests, steel manufacturers, mining businesses, energy resources, and other miscellaneous customers. The project area encompasses a large oil and gas development region that includes the Cline Shale, the Wolfcamp Shale, and the West Texas (Ouachita) Overthrust Resource Play. The SORR is essential in the transportation of frac-sand to Fort Stockton for use in mining the shale formations and the Resource Play.

The TIGER funding being requested is required to complete the funding package and enable the project to proceed. If this funding does not materialize, this section of the line is expected to become inoperable within 5 to 10 years, threatening future transportation network efficiency, freight mobility, and economic growth in an economically distressed area.

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[1] FRA Excepted Status track class limits train speeds to 10 mph, hazardous material cars to 5 cars per train, and prohibits occupied passenger cars.

A table summarizing the changes expected from the project (and the associated benefits) is provided below.

Table ES-1: Summary of Infrastructure Improvements and Associated Benefits

Current Status or Baseline & Problems to be Addressed	Changes to Baseline / Alternative	Type of Impacts	Population Affected by Impacts	Benefits	Summary of Results ($2012, 7% Discounted)
SORR from Sulphur Junction (MP 869.4) to Fort Stockton (MP 883.0) currently FRA Class 1 and requires significant rehabilitation due to substandard rail, defective ties, and track alignment deficiencies. This section of the line is expected to become inoperable within 5 to 10 years.	Replace crossties, tie plates, track spikes, weld joints, install compromise joint bars between the continuously welded rail (CWR) and the project ends, and replace track bolts, rail anchors, and ballast. The track shall be constructed to 56.5" gage. Four (4) at-grade highway-rail crossings in the project limits will also be reconstructed (2 with timber surfaces and 2 with precast concrete panel). The railway will be completely rehabilitated and upgraded to FRA Class 2 standards; and maintained at this level in perpetuity.	Reduced Highway Maintenance Costs from truck diversion to rail.	Federal and State (Texas) Governments	Monetized Maintenance Savings.	$19,981,020.01
		Reduced Transportation Costs from truck diversion to rail.	Shippers and Receivers	Monetized Shipping Savings.	$10,233,769.58
		Short-Term Economic Impacts from construction/planning expenditure.	Regional Citizens and Businesses	Job years, income.	*See page reference*
		Change in Inventory Costs from truck diversion to rail.	Shippers and Receivers	Monetized Increased Inventory Costs.	-$47,417.53
		Reduction in Highway Congestion from truck diversion to rail	On Road Motorists Between Fort Stockton and Fort Worth Texas.	Monetized Reduced Congestion Savings.	$10,074,382.77
		Reduced Emissions from truck diversion to rail.	Texas	Monetized Reduced Pollution.	$3,958,102.60
		Reduced Accident Costs from truck diversion to rail.	Motorists/ Railway Travelers Between Fort Stockton and Fort Worth Texas.	Monetized Increased injuries and fatalities.	$14,932,873.76

* Short-Term Economic Impacts from construction/planning expenditure are not included in the benefit-cost analysis and are only included for informational purposes in the Economic Impact Analysis.

The period of analysis used in the estimation of benefits and costs corresponds to 22 years, including 2 years of construction and 20 years of operation. The total project costs are $13,569,963 million dollars and are expected to be financed by Federal (TIGER), State (TxDOT), local (Fort Stockton Economic Development Corp.) and private (TXPF) funds according to the distribution shown in Table ES-2.

Table ES-2: Summary of Project Costs and Anticipated Funding Sources, 2012$

Funding Source	Capital/Construction	Percent of Total Capital Cost Financed by Source
Federal (TIGER)	$6,400,000	47.1%
State (TxDOT)	$170,000	1.3%
Local (Fort Stockton Economic Development Corp.)	$200,000	1.5%
Private (TXPF)	$6,800,000	50.1%
TOTAL	**$13,570,000**	**100.0%**

**Numbers rounded to nearest 10th dollar.*

A summary of the capital costs and operation and maintenance (O&M) cost changes by year are shown in Table ES-3 below.

Table ES-3: Cost Summary Table

Calendar Year	Capital Cost (2012$, Undiscounted)	Operations & Maintenance Cost Change* (2012$, Undiscounted)	Total
2014	$12,629,800	$0	$12,629,800
2015	$940,163	$0	$940,163
2016		-$24,831	-$24,831
2017		-$24,831	-$24,831
2018		-$24,831	-$24,831
2019		-$24,831	-$24,831
2020		$68,000	$68,000
2021		$68,000	$68,000
2022		$68,000	$68,000
2023		$68,000	$68,000
2024		$68,000	$68,000
2025		$68,000	$68,000
2026		$68,000	$68,000
2027		$68,000	$68,000
2028		$68,000	$68,000
2029		$68,000	$68,000
2030		$68,000	$68,000
2031		$68,000	$68,000
2032		$68,000	$68,000
2033		$68,000	$68,000
2034		$68,000	$68,000
2035		$68,000	$68,000
TOTAL	**$13,569,963**	**$988,676**	$14,558,639

* Note: This is the incremental O&M between the Build Case and No-Build Case of the rail line. In 2014 and 2015 O&M costs remain at the base case level as the project is not yet in operation, thus there is no change in O&M costs. In 2016 the project becomes operational; in years 2016 to 2019, operation and maintenance of the track is less expensive in the Build Case, and thus there is a negative incremental cost; or a reduced O&M amount. In 2020 onwards the No-Build case track becomes inoperable, thus bringing O&M to zero in the No-Build case. The incremental O&M then becomes only the O&M costs of the build scenario as the no-build O&M is zero; i.e. there is an increased O&M amount.

A summary of the relevant data as well as the annual net benefits used in the Benefit Cost calculations shown in Table ES-4 (in dollars of 2012). Based on the Benefit Cost Analysis presented in the rest of this document, the project is expected to generate $66,448,099 in discounted benefits and $12,979,303 in discounted costs, using a 7 percent real discount rate. Therefore, the project is expected to generate a Net Present Value of $53 million and a Benefit/Cost Ratio of 5.12 to 1 (See Table 20).

Table ES-4: Summary of Pertinent Data, Quantifiable Benefits and Costs

Calendar Year	Project Year	Reduced Truck Vehicle Miles Travelled (Diverted to Rail)*	Total Benefits ($2012), Undiscounted	Total Costs ($2012), Undiscounted	Undiscounted Net Benefits ($2012)	Discounted Net Benefits at 7%	Discounted Net Benefits at 3%
2013	1	0	$0	$0	$0	$0	$0
2014	2	0	$0	$12,629,800	-$12,629,800	-$11,803,551	-$12,261,942
2015	3	0	$0	$940,163	-$940,163	-$821,175	-$886,194
2016 (opening)	4	266,120	$211,586	-$24,831	$236,417	$192,987	$216,355
2017	5	540,223	$423,968	-$24,831	$448,799	$342,386	$398,752
2018	6	822,549	$638,954	-$24,831	$663,785	$473,269	$572,586
2019	7	9,984,001	$7,700,490	-$24,831	$7,725,321	$5,147,708	$6,469,835
2020	8	10,283,521	$7,892,051	$68,000	$7,824,051	$4,872,426	$6,361,669
2021	9	10,592,027	$8,092,495	$68,000	$8,024,495	$4,670,329	$6,334,610
2022	10	10,909,788	$8,331,867	$68,000	$8,263,867	$4,494,996	$6,333,566
2023	11	11,237,082	$8,571,082	$68,000	$8,503,082	$4,322,536	$6,327,092
2024	12	11,574,194	$8,847,926	$68,000	$8,779,926	$4,171,280	$6,342,805
2025	13	11,921,420	$9,121,919	$68,000	$9,053,919	$4,020,048	$6,350,237
2026	14	12,279,062	$9,409,948	$68,000	$9,341,948	$3,876,576	$6,361,412
2027	15	12,647,434	$9,714,203	$68,000	$9,646,203	$3,740,964	$6,377,276
2028	16	13,026,857	$10,032,028	$68,000	$9,964,028	$3,611,422	$6,395,531
2029	17	13,417,663	$10,395,790	$68,000	$10,327,790	$3,498,380	$6,435,937
2030	18	13,820,193	$10,752,875	$68,000	$10,684,875	$3,382,558	$6,464,525
2031	19	14,234,799	$11,095,737	$68,000	$11,027,737	$3,262,710	$6,477,633
2032	20	14,661,843	$11,481,266	$68,000	$11,413,266	$3,155,863	$6,508,826
2033	21	15,101,698	$11,879,810	$68,000	$11,811,810	$3,052,396	$6,539,913
2034	22	15,554,749	$12,298,748	$68,000	$12,230,748	$2,953,886	$6,574,630
2035	23	16,021,391	$12,698,205	$68,000	$12,630,205	$2,850,804	$6,591,609
Total		**218,896,615**	**$169,590,947**	**$14,558,639**	**$155,032,308**	**$53,468,796**	**$97,286,664**

*Calculation: First calculate the number of diverted trucks. Diverted Trucks = (# Build Case Train Carloads *less* # of No-Build Case train carloads)* number of trucks per carload. Then calculate the number of reduced truck vehicle miles. Reduced Truck Vehicle Miles = Truck Route Miles * Number of Diverted Trucks. For full demand calculation assumptions see Section 6 Tables 3 and 4; for annual demand numbers see section 10.2 Annual Demand Projections.

A summary of the monetized benefits of the SORR rehabilitation project are included below in Table ES-5.

Table ES-5: Benefit Estimates by Long-Term Outcome over the study period, 2012 $

Long-Term Outcomes	Benefit Categories	7% Discount Rate	3% Discount Rate
State of Good Repair	Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail	$28,544,314	$47,622,232
Economic Competitiveness*	Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail	$7,309,835	$12,195,447
	Change in Inventory Costs from Displacing Heavy Truck Travel to Rail	-$67,739	-$113,014
Livability	Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail.	$10,074,383	$16,807,711
Environmental Sustainability	Emission Savings from Diverting Heavy Truck Travel to Rail	$5,654,432	$9,637,334
Safety	Reduced Accident Costs from Diverting Heavy Truck Travel to Rail	$14,932,874	$24,913,430
Total Benefit Estimates		**$66,448,099**	**$111,063,140**

Note: * Excluding the short-term employment impacts of the project.

In addition to the monetized benefits presented in Table ES-5, the project would generate benefits that are difficult to quantify, and thus are not included in the analysis. A brief description of those benefits is provided below.

<u>Safety</u>

- *Hazardous materials movement*: Rail is the safest way to transport hazardous materials. The value of rail as a safer form of hazardous materials has not been monetized. In particular it is expected a major oil and natural gas distributor will be shipping between 15 and 40 carloads of crude oil outbound per day and receiving 15 carloads of sand inbound per day. The SORR rehabilitation is essential in order to support these developments and to prevent this freight from being diverted to trucks. The rehabilitation of the SORR would allow the transportation of these materials by the safest method available.
- *Derailments:* The project area includes 4 roadway/rail at-grade crossings which are in “fair” or “poor” condition. These crossings have substandard rail with deteriorated ties, subgrade and drainage. This causes the track to pump under load, resulting in the possibility of derailments and vehicular accidents. This also causes most drivers to cross the tracks at extremely low speed, which can contribute to vehicular-train accidents.

2. Introduction

This document provides detailed technical information on the economic analyses conducted in support of the Grant Application for the South Orient Rehabilitation – Sulphur Junction to Fort Stockton project.

Section 3, Methodological Framework, introduces the conceptual framework used in the Benefit-Cost Analysis (BCA). Section 4, Project Overview, provides an overview of the project, including a brief description of existing conditions and proposed alternatives; a summary of cost estimates and schedule; and a description of the types of effects that the South Orient Rehabilitation project is expected to generate. Section 5, General Assumptions, discusses the general assumptions used in the estimation of project costs and benefits, while estimates of travel demand and traffic growth can be found in Section 6, Demand Projections. Specific data elements and assumptions pertaining to the long-term outcome selection criteria are presented in Section 7, Benefits Measurement, Data and Assumptions, along with associated benefit estimates. Estimates of the project's Net Present Value (NPV), its Benefit/Cost ratio (BCR) and other project evaluation metrics are introduced in Section 8, Summary of Findings and BCA Outcomes. Next, Section 9, BCA Sensitivity/Alternative Analysis, provides the outcomes of the sensitivity/alternatives analysis. Additional data tables are provided in Section 10, Supplementary Data Tables, including annual estimates of benefits and costs, as well as intermediate values to assist DOT in its review of the application.[2]

3. Methodological Framework

Benefit-Cost Analysis (BCA) is a conceptual framework that quantifies in monetary terms as many of the costs and benefits of a project as possible. Benefits are broadly defined. They represent the extent to which people impacted by the project are made better-off, as measured by their own willingness-to-pay. In other words, central to BCA is the idea that people are best able to judge what is "good" for them, what improves their well-being or welfare.

BCA also adopts the view that a net increase in welfare (as measured by the summation of individual welfare changes) is a good thing, even if some groups within society are made worse-off. A project or proposal would be rated positively if the benefits to some are large enough to compensate the losses of others.

Finally, BCA is typically a forward-looking exercise, seeking to anticipate the welfare impacts of a project or proposal over its entire life-cycle. Future welfare changes are weighted against today's changes through discounting, which is meant to reflect society's general preference for the present, as well as broader inter-generational concerns.

The specific methodology developed for this application was developed using the above BCA principles and is consistent with the TIGER guidelines. In particular, the methodology involves:

[2] While the models and software themselves do not accompany this appendix, greater detail can be provided, including spreadsheets presenting additional interim calculations and discussions on model mechanics and coding, if requested.

- Establishing existing and future conditions under the build and no-build scenarios, [and considering an alternative to the Full Build];
- Assessing benefits with respect to each of the five long-term outcomes identified in the Notice of Funding Availability (NOFA);
- Measuring benefits in dollar terms, whenever possible, and expressing benefits and costs in a common unit of measurement;
- Using DOT guidance for the valuation of travel time savings, safety benefits and reductions in air emissions, while relying on industry best practice for the valuation of other effects;
- Discounting future benefits and costs with the real discount rates recommended by the DOT (7 percent, and 3 percent for sensitivity analysis); and
- Conducting a sensitivity analysis to assess the impacts of changes in key estimating assumptions.

4. Project Overview

The South Orient rail line (SORR) rehabilitation project from Sulphur Junction to Fort Stockton, Texas, is a “shovel-ready” rural freight rail project that will have a significant impact on the region as well as the nation.

The entire SORR is a 391 mile state-owned facility that extends from San Angelo Junction (near Coleman, Texas) through several towns in west Texas, to Presidio at the Texas/Mexico border. The proposed project will upgrade the SORR from Sulphur Junction (MP 869.4) to Fort Stockton (MP 883.0) to FRA Class 2 (25 mph) status. The city of Fort Stockton is located 12.52 miles west of Sulphur Junction. This section of the line is currently FRA Class 1 and requires a significant rehabilitation due to substandard rail, defective ties, and track alignment deficiencies. If not rehabilitated, the recent and projected increase in traffic will cause rapid deterioration of the line, resulting in a reclassification to Excepted Status[3] becoming inoperable within 5 to 10 years. The rehabilitation is necessary in order to prevent this degradation of the track structure, continue and improve operations, and provide safe and efficient rail service to existing customers. Termination of rail service to the region threatens future transportation network efficiency, freight mobility, and economic growth in an Economically Distressed Area.

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7) avoiding increased transportation costs,
8) avoiding accident costs (fatalities and injuries), and
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This is the only rail line providing service to the cities and businesses in the region, which includes agricultural interests, steel manufacturers, mining businesses, energy resources, and other miscellaneous customers. The project area encompasses a large oil and gas development region that includes the Cline Shale, the Wolfcamp Shale, and the West Texas (Ouachita) Overthrust Resource Play. The SORR is essential in the transportation of Frac-sand to Fort Stockton for use in mining the shale formations and the Resource Play.

The TIGER funding being requested is required to complete the funding package and enable the project to proceed. If this funding does not materialize, this section of the line is expected to become inoperable within 5 to 10 years, threatening future transportation network efficiency, freight mobility, and economic growth in an economically distressed area.

4.1 Base Case, Build Case and Alternative

Base Case (No-Build Case): In the base case, the SORR rehabilitation project from Sulphur Junction to Fort Stockton is not undertaken. Given the tracks condition, it becomes inoperable in year 7 (2019) of the study and all traffic/carloads routing this segment cease operation. The carload tonnage is diverted to heavy truck transportation.

Build Case: In the build case the SORR rehabilitation project from Sulphur Junction to Fort Stockton is undertaken. Carload traffic remains on the railroad (rather than being diverted to trucks). The benefits of the build case are attributed to the avoidance of truck use.

Alternative: In the build case vs. no-build case, the shortest on-road route possible (676 miles, round trip) is taken for diverted trucks given the capacity constraints of on route trans-load facilities. In this alternative, *for comparison to the build vs. no-build case*, HDR assumes transloading is expanded in San Angelo, reducing the diverted trucking route to 414 miles (round trip). San Angelo is the closest location where transloading could occur. The results of this alternative including this alternative's NPV, and Benefit Cost Ratio can be found in section 9, BCA Sensitivity/Alternative Analysis; the remainder of the document refers to the Base Case vs. the Build Case.

4.2 Project Cost and Schedule[4]

Table 1: Detailed Cost Schedule by Quarter, 2012$

Major Activity	2014				2015
	Q1	Q2	Q3	Q4	Q1
Engineering & Contingencies	$165,200	$165,200	$165,200	$165,200	$165,200
Mobilization	$944,000				
Tie Replacement	$430,000	$1,290,000	$1,290,000	$1,290,000	
Rail Replacement		$1,980,000	$1,980,000	$1,980,000	$660,000
Turnout Construction				$80,000	
Ballast Delivery		$165,000	$165,000	$165,000	$55,000
Surfacing & Regulating		$15,000	$30,000	$30,000	$15,000
Grade Crossings		$45,000	$45,000	$45,000	$45,000
Total Cost by Year	$12,629,800				$940,200
Total Cost	$13,570,000				

Note: Numbers rounded to nearest dollar.

Table 1 describes the breakdown of the project costs by quarter by year. Construction begins in 2014 Q1 and completes by the end of 2015 Q1. Of the total project cost of $13.57M; $12.63M will be expended in 2014, and $940K in 2015. For analysis purposes construction years are 2014 and 2015. The project impact analysis period is then analyzed for 20 years from 2016 to 2035.

4.3 Effects on Long-Term Outcomes

Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail

An avoidance of heavy trucks on the highway system reduces highway maintenance costs and in particular pavement re-surfacing and maintenance costs. Typically, this benefit is realized in terms of increased cycle times between maintenance work orders. This benefit category captures the reduced maintenance cost associated with diverting goods from rail to truck.

Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail

Rail shipping rates tend to be lower than truck shipping rates on a per ton-mile basis. As such, diversion of intermodal highway freight to rail can generate cost savings to shippers. The SORR rehabilitation allows shippers a greater choice of transportation mode. Furthermore, these

[4] All cost estimates in this section are in millions of 2012 dollars, discounted to 2013 using a 7 percent real discount rate.

improvements increase schedule reliability, one of the key challenges facing a railroad in terms of product delivery. In the absence of such improvements, some shipments would likely be carried by truck at a greater cost to producers.

Transportation cost savings are quantified using the calculation of the volume of truck ton-miles avoided and relative shipping rates.

Change in Inventory Costs from Displacing Heavy Truck Travel to Rail

SORR improvements would give shippers the choice/opportunity of shipping by rail. Generally trucks use the highly developed interstate highway system that provides faster transit times and potentially lower inventory costs. With lower truck shipping times, a modal diversion to rail will increase inventory costs.

Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail

The proposed SORR project will divert freight from road to rail resulting in a reduction in the use of public highways by heavy trucks. This represents time savings to the remaining on-road motorists.

Emission Savings from Diverting Heavy Truck Travel to Rail

Freight carried over the rail network imposes less environmental impacts for the same amount of cargo than those imposed by trucks on the highway network. This benefit category estimates the value of the reduced environmental emissions associated with transporting goods on rail as opposed to by truck. The reduced amounts of Nitrogen Oxide (NOx), Carbon Dioxide (CO_2), Particulate Matter (PM), and Volatile Organic Compounds (VOCs) are calculated and monetized.

Reduced Accident Costs from Diverting Heavy Truck Travel to Rail

Fatality and injury rates per mile of freight carried by truck are greater than the fatality and injury rates for an equal volume of cargo when shipped by rail. This benefit captures the different accident rates per truck-mile and train-mile, and the reduced amounts of injuries and fatalities of truck diversion to rail.

The main benefit categories associated with the project are mapped into the five long-term outcome criteria set forth by the DOT in the table below.

Table 2: Expected Effects on Long-Term Outcomes and Benefit Categories

Long-Term Outcomes	Benefit or Impact Categories	Description	Monetized	Quantified	Qualitative
State of Good Repair	Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail	Maintenance of railroads is less costly per ton-mile than highway maintenance	√		
Economic Competitiveness	Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail	Railway shipping costs per ton-mile are lower than truck shipping costs.	√		
	Short-term economic impacts*	Number of jobs expected to be created by the project, and related income.		√	
	Change in Inventory Costs from Displacing Heavy Truck Travel to Rail	This is a negative impact. Rail shipment time is greater than truck shipment time	√		
Livability	Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail	This represents the time savings of the remaining on-road motorists	√		
Environmental Sustainability	Emission Savings from Diverting Heavy Truck Travel to Rail	Trains emit fewer pollutants than trucks per ton-mile.	√		
Safety	Reduced Accident Costs from Diverting Heavy Truck Travel to Rail	Trains have a lower injury and fatality rate per ton-mile traveled than trucks	√		

*Note: This impact is quantified, but is NOT included in the Benefit-Cost Analysis

5. General Assumptions

The BCA measures benefits against costs throughout a period of analysis beginning at the start of construction in 2014 and including 20 years of operations (2016 to 2035) after Construction completion in 2015.

The monetized benefits and costs are estimated in 2012 dollars with future dollars discounted in compliance with TIGER requirements using a 7 percent real discount rate, and sensitivity testing at 3 percent.

The methodology makes several important assumptions and seeks to avoid overestimation of benefits and underestimation of costs. Specifically:

- Input prices are expressed in 2012 dollars;
- Benefits and costs are discounted to the year 2013;
- The period of analysis begins in 2013 and ends in 2035. It includes project development and construction years (2014 - 2015) and 20 years of operations (2016 - 2035);

- A constant 7 percent real discount rate is assumed throughout the period of analysis. A 3 percent real discount rate is used for sensitivity analysis; and
- Unless specified otherwise, the results shown in this document correspond to the effects of the Full Build alternative (defined in section 4.1 as "Build Case").

6. Demand Projections

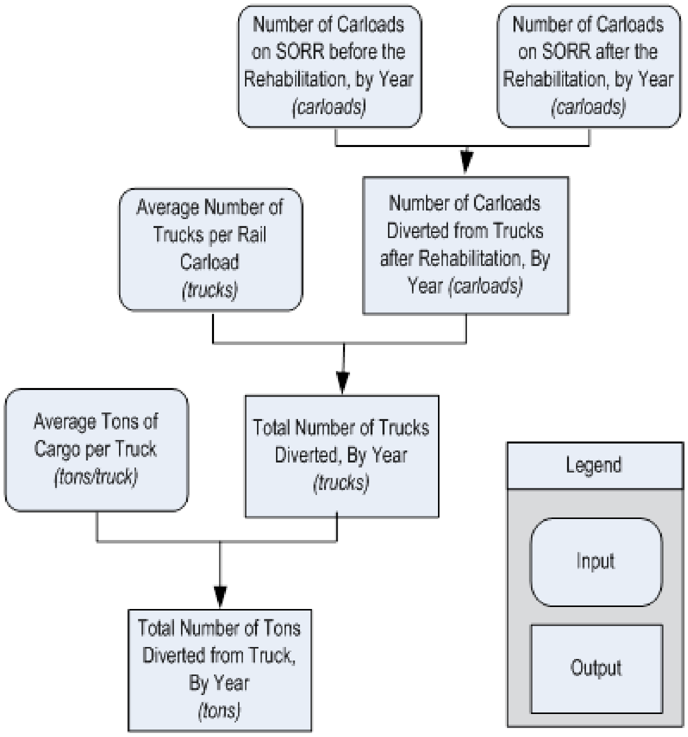
The demand projections are based on the number of carloads that will remain on the rail system in the build scenario. The build case carloads grow at 3% annually based on the 2013 carload value. In the no build case, carloads are equivalent to the build case amount from 2013 to 2015. Carloads then flatten out at the 2015 value from 2016 to 2018. Traffic/carloads routing this track segment drop to 0 from 2019 (year 7) onwards, as the deteriorating track becomes inoperable.

The difference in no-build case carloads and build case carloads is then used to determine the number of diverted (or avoided) on-road trucks. The difference in carloads is multiplied by an average 3.5 trucks/carload to determine the number of avoided trucks. The average number of tons per truck (25 tons/truck) is then multiplied by the number of diverted trucks to determine the number of diverted tons. The number of diverted truck miles is calculated by multiplying the number of trucks by the truck route mileage of 676miles (round trip). The equivalent train miles are calculated by dividing the carload differential by the average carloads per train (50) multiplied by the equivalent train route mileage 873miles (round trip). Truck ton-miles can be calculated by multiplying the truck route (676 miles) by the amount of diverted tons. The equivalent train ton-miles can be calculated by multiplying the train route mileage (873miles) by the amount of diverted tons. Input/assumption sources can be found in Table 3 below. Table 4 shows a summary of the demand projections. Section 10.2 at the back shows an annual breakdown of these projections.

6.1 Methodology

Below in Figure 1 is the structure and logic model of the key demand components on which the studied impacts are based, diverted trucks and diverted tons.

Figure 1: Heavy Truck Diversion to Railroad after Rehabilitation



6.2 Assumptions

Table 2 below lists the key assumptions/inputs used in calculating the: number of train carloads (build case), number of train carloads (no-build case), number of diverted trucks (build case), diverted tons, diverted truck miles, and increased (equivalent) train miles.

Table 3: Assumptions used in the Estimation of Demand

Variable Name	Unit	Value	Source/Comment
Truck Route Mileage	Miles	676	Based on truck route mileage between Fort Stockton and Fort Worth. Round trip. This is the shortest available trucking route, given traffic demand and current trans-load facility capacities.
Train Route Mileage	Miles	814	HDR calculation based on (i) truck route mileage of 676 miles and (ii) truck and rail distance factor of 0.83.

Variable Name	Unit	Value	Source/Comment
Number of Carloads / Train	Carloads	50	TXDOT provided.
Average Tons of Cargo per Truck	Tons/Truck	25	Capacity hauling in pneumatic trucks.
Average Number of Trucks per Rail Carload	Truckloads/ Train carload	3.5	HDR Calculated Average.
Number of Train Carloads (Build Case)	# Carloads/year	3534 carloads in 2013	Conservative TXDOT provided estimate. 3% annual long-term growth based on 2013 value of 3534 carloads. *See section 10.2 for annual projection.*
Number of Train Carloads (No-Build Case)	# Carloads/year	See Comment.	Carloads equivalent to build case from 2013 to 2015. Carloads stay flat at 2015 value from 2016 to 2018. This section of the line is expected to become inoperable within 5 to 10 years. Traffic routing this track segment drops to 0 from 2019 (year 7) onwards. *See section 10.2 for annual projection.*
Number of Diverted Trucks (Build case)	# Trucks/year	See Comment.	Calculated as the differential between **the number of Build Case Train Carloads** *less* **the number of No-Build Case train carloads** *all multiplied by* **the number of trucks per carload.** *See section 10.2 for annual projection.*

Variable Name	Unit	Value	Source/Comment
Diverted Tons	Short Tons/year	See Comment.	Calculated as the number of diverted trucks multiplied by the average tonnage per truck. *See section 10.2 for annual projection.*
Diverted Truck Miles	Truck Miles/year	See Comment.	Number of Diverted Truck Miles multiplied by the Truck Route Mileage. *See section 10.2 for annual projection.*
Increased (equivalent) Train Miles	Train Miles/year	See Comment.	Number of Diverted carloads divided by the Average Carloads per Train multiplied by the Train Route Mileage. *See section 10.2 for annual projection.*

6.3 Demand Projections

The resulting projections for the number of train carloads (build case), number of train carloads (no-build case), number of diverted trucks (build case), diverted tons, diverted truck miles, and increased (equivalent) train miles are presented in the table below. Section 10.2 at the back also shows a year by year breakdown of these projections.

Table 4: Demand Projections

Category	Unit	In Project Opening Year (2016)	2024	2035
Number of Train Carloads (Build Case)	# Carloads/year	3,862	4,892	6,772
Number of Train Carloads (No-Build Case)	# Carloads/year	3,749	0	0
Number of Diverted Trucks (Build case)	# Trucks/year	394	17,122	23,700
Diverted Tons	Short Tons/year	9,842	428,040	592,507
Diverted Truck Miles	Truck Miles/year	266,120	11,574,194	16,021,391
Increased (equivalent) Train Miles	Train Miles/year	1,832	79,685	110,302

7. Benefits Measurement, Data and Assumptions

This section describes the measurement approach used for each benefit or impact category identified in Table 2 (Expected Effects on Long Term Outcomes and Benefit Categories) and provides an overview of the associated methodology, assumptions, and estimates.

7.1 State of Good Repair

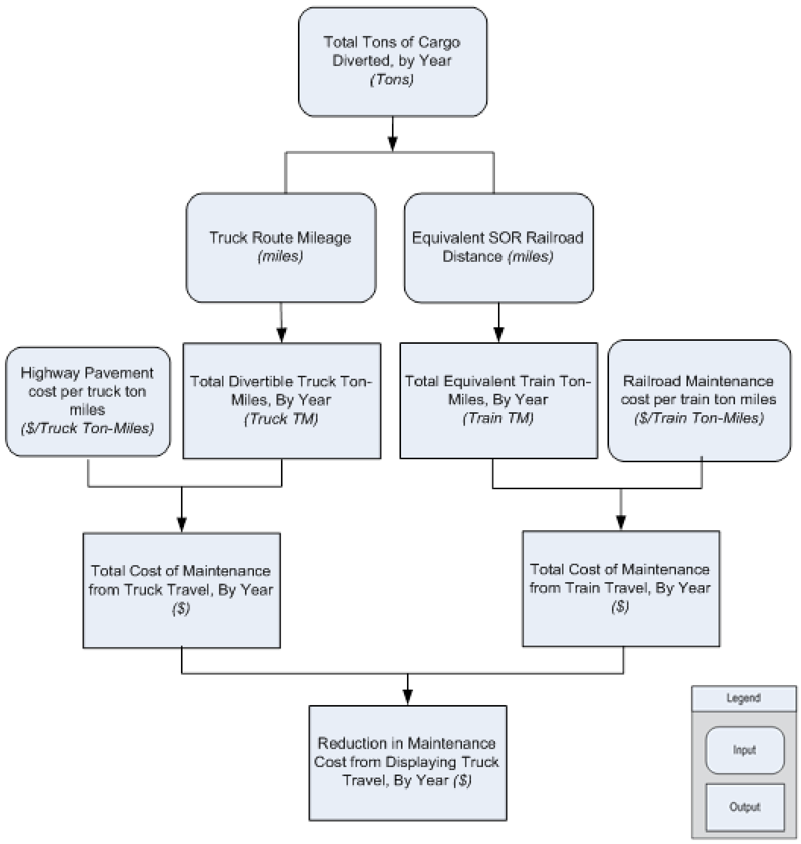
To quantify the benefits associated with maintaining the existing transportation network in a state of good repair, *Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail* is monetized.

7.1.1 Methodology

Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail

An avoidance of heavy trucks on the highway system reduces highway maintenance costs and in particular pavement re-surfacing and maintenance costs. Typically, this benefit is realized in terms of increased cycle times between maintenance work orders. This benefit category captures the reduced maintenance cost associated with diverting goods from truck to rail. The total diverted truck ton-miles are applied to highway maintenance cost per truck ton-mile to calculate highway maintenance costs. Figure 2 below provides the structure and logic (S&L) diagram for the calculation.

Figure 2: Reduction in Highway Maintenance S&L



7.1.2 Assumptions

The assumptions used in the estimation of State-of-Good-Repair benefits are summarized in the table below.

Table 5: Assumptions used in the Estimation of State-of-Good-Repair Benefits

Variable Name	Unit	Value	Source
Pavement maintenance cost per truck ton-mile	2012$/ton-mile	$0.01613	HDR Calculations based on the Addendum to the 1997 Federal Highway Cost Allocation Study, Final Report, U.S. Department of Transportation and Federal Highway Administration, May 2000. Assumes 90 percent rural truck traffic.
Pavement maintenance cost per train ton-mile	2012$/ton-mile	$0.00238	HDR Calculations based on George Avery Grimes, Ph.D., P.E.1; and Christopher P. L. Barkan, Ph.D. "Cost-Effectiveness of Railway Infrastructure Renewal Maintenance".
Truck Route Mileage	Miles	676	Based on truck route mileage between Fort Stockton and Fort Worth. Round trip. This is the shortest available trucking route, given traffic demand and current trans-load facility capacities.
Truck to Rail Distance Factor	Truck Mile per Rail Mile	0.83	National Cooperative Highway Research Program (NCHRP) Report 388, "A Guidebook for Forecasting Freight Transportation Demand", 1997. We assume this figure includes dray distances. This factor is applied to account for relatively longer rail routes for the same origin-destination (O-D) pair.

7.1.3 Benefit Estimates

Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail is roughly $75k in the opening year (2016) and exceeds $28 Million in savings (discounted at 7%) over the study period.

Table 6: Estimates of State-of-Good-Repair Benefits, 2012$

	In Project Opening Year (Discounted 7%)	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail	$72,052	$72,604,257	$28,544,314

7.2 Economic Competitiveness

The proposed project would contribute to enhancing the economic competitiveness of the Nation through improvements in the mobility of goods within and across the study area. In this analysis, two measures of mobility are presented: *Change in Inventory Costs from Displacing Heavy Truck Travel to Rail (Estimation of Inventory Time)* and out-of-pocket *Transportation Cost Savings*.

Generally trucks use the highly developed interstate highway system that provides faster transit times. With faster transit times than rail, a modal shift towards rail increases inventory costs to shippers and receivers of goods. However, rail shipping rates tend to be lower than truck shipping rates on a per ton-mile basis. This generates a transportation cost savings to shippers/receivers.

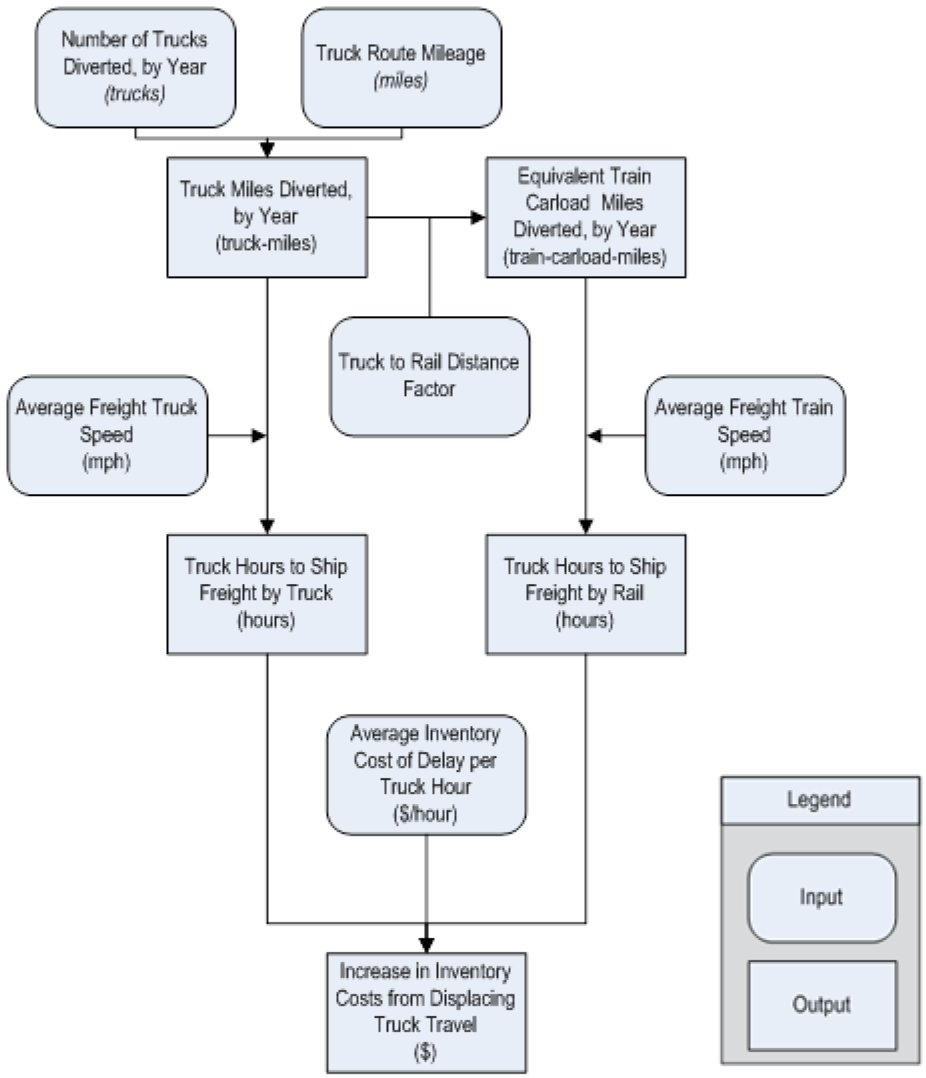
Also presented in this section are estimates of the short-term economic impacts of the project (*7.2.4 Estimation of Short-Term Economic Impacts*), as recommended in the Notice of Funding Availability for TIGER V.

7.2.1 Methodology

Change in Inventory Costs from Displacing Heavy Truck Travel to Rail (Estimation of Inventory Time)

Rail improvements would give shippers the choice/opportunity of shipping by rail. Generally trucks use the highly developed interstate highway system that provides faster transit times and potentially lower inventory costs. With lower truck shipping times, a modal diversion to rail will increase inventory costs. The change in inventory costs due to modal diversion is calculated by applying the time difference in truck and rail shipping to the average inventory cost of transportation time delay per hour. Figure 3 below outlines the model logic used to estimate inventory cost differences.

Figure 3: Change in Inventory Costs S&L

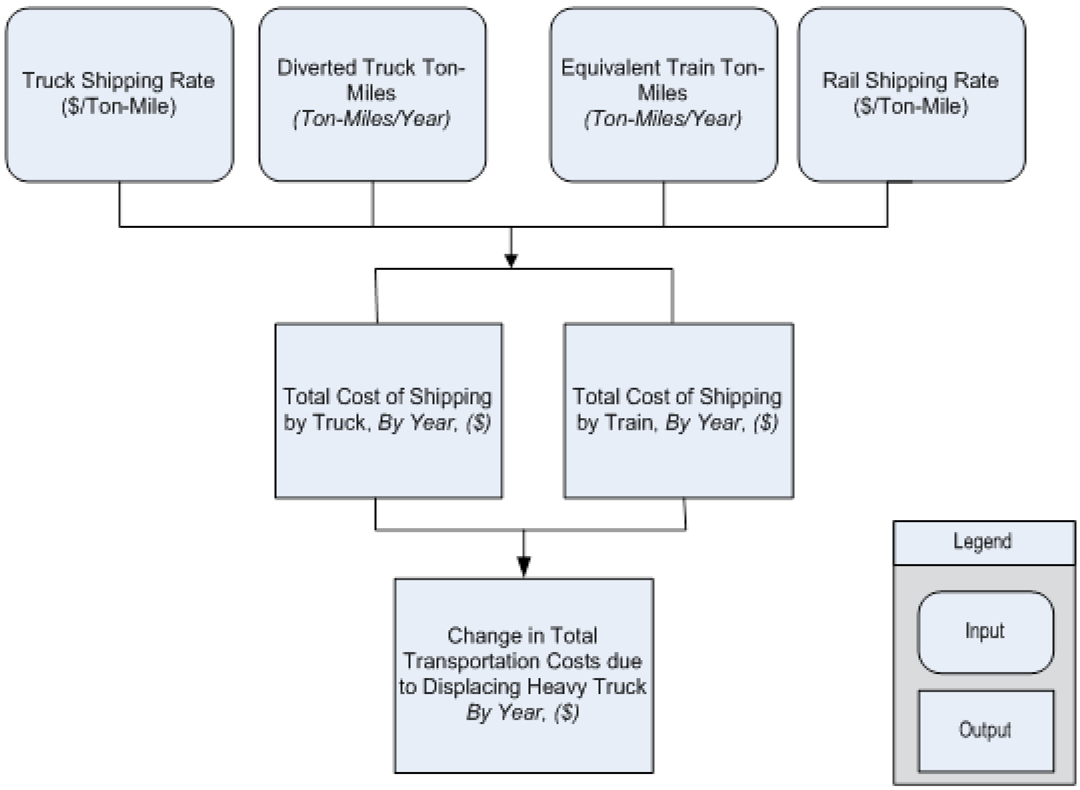


Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail

Rail shipping rates tend to be lower than truck shipping rates on a per ton-mile basis. As such, diversion of intermodal highway freight to rail can generate cost savings to shippers. A rehabilitation of the SORR allows shippers a greater choice of transportation mode. Furthermore, these improvements generally improve schedule reliability, one of the key challenges facing a railroad in terms of product delivery. In the absence of such improvements, some shipments would likely be carried by truck at a greater cost to producers.

Transportation cost savings are quantified using the calculation of the volume of truck ton-miles avoided and relative shipping rates. The benefits in this category are counted as public because the difference in transportation prices between rail intermodal and truckload freight accrue directly to the shipper and receiver lowering the final price consumers pay. Figure 4 below outlines the methodology for quantifying this benefit.[5]

Figure 4: Reduced Transportation Costs S&L



7.2.2 Assumptions

The assumptions used in the estimation of inventory time changes are summarized in the table below.

Table 7: Assumptions used in the Change in Inventory Costs from Displacing Heavy Truck Travel to Rail (Estimation of Inventory Time) Impacts

Variable Name	Unit	Value	Source
Average Freight Truck Speed	mph	50	Average Truck Speeds in Texas. Federal Highway Administration (FHWA). http://ops.fhwa.dot.gov/freight/freight_analysis/nat_freight_stats/docs/11factsfigures/pdfs/fff2011_ch3.pdf. See page 40.
Average Freight	mph	25	Based on the rehabilitation of the track to FRA Class 2.

[5] Only 50% of transportation cost savings are included in the analysis to approximate the consumer surplus under the transportation demand curve due to a price reduction.

Variable Name	Unit	Value	Source
Train Speed			
Average Inventory Cost of Delay per Truck Hour	2012$/hour	$0.03	HDR Calculation based on an hourly discount rate of .00049%, an average commodity value per ton of $230.19, and an average truck tonnage of 17.5 tons.
Truck to Rail Distance Factor	Truck Mile per Rail Mile	0.83	National Cooperative Highway Research Program (NCHRP) Report 388, "A Guidebook for Forecasting Freight Transportation Demand", 1997. We assume this figure includes dray distances. This factor is applied to account for relatively longer rail routes for the same origin-destination (O-D) pair.
Truck Route Mileage	miles	676	Based on truck route mileage between Fort Stockton and Fort Worth. Round trip. This is the shortest available trucking route, given traffic demand and current trans-load facility capacities.

The table below provides the inputs used in calculating transportation cost savings.

Table 8: Assumptions used in the Estimation of Out-of-Pocket Transportation Cost Savings

Variable Name	Unit	Value	Source
Average Shipping Rate per ton-Mile, Truck	2012$/truck ton-mile	$0.052	Accounting for circuitry factor, including factor increase based on industry average rail freight revenue/ton-mile (AAR-https://www.aar.org/StatisticsAndPublications/Documents/AAR-Stats-2013-01-10.pdf).
Average Shipping Rate per ton-Mile, Rail	2012$/rail ton-mile	$0.038	Freight Revenue Per Ton-Mile, Association of American Railroads, https://www.aar.org/StatisticsAndPublications/Documents/AAR-Stats-2013-01-10.pdf.

7.2.3 Benefit Estimates

Change in Inventory Costs from Displacing Heavy Truck Travel to Rail is roughly -$171 in the opening year (2016) and exceeds -$172k (discounted at 7%) over the study period. The numbers are negative, as inventory times are higher for rail. This is a negative impact in the analysis.

Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail is roughly $18k in the opening year (2016) and exceeds $7 Million in savings (discounted at 7%) over the study period.

Table 9: Estimates of Inventory Time and Out-of-Pocket Transportation Cost Savings, 2012$

	In Project Opening Year (2016), Discounted at 7%	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Change in Inventory Costs from Displacing Heavy Truck Travel to Rail	-$171	-$172,299	-$67,739
Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail	$18,452	$18,593,026	$7,309,835

7.2.4 Estimation of Short-Term Economic Impacts

The Minnesota IMPLAN Group's input-output model has been used to estimate the short-term direct, indirect and induced effects of this project in terms of employment, labor income and value added.

Employment effects represent full-time and part-time jobs created for a full year (unless noted otherwise). Labor income consists of total employee compensation (wage and salary payments, as well as health and life insurance benefits, retirement payments and any other non-cash compensation) and proprietary income (payments received by self-employed individuals as income). Value added represents total business sales (output) minus the cost of purchasing intermediate products and is roughly equivalent to gross regional/domestic product.

Estimated spending on project engineering and construction (capital expenditures) between 2014 and 2015 is used to compute short-term economic impacts.

The project is expected to generate 263.7 job-years during the project development phase. It is also expected to create $19.93 million in value added, including $14.27 million in labor income. A breakdown of short-term impacts by type of effect (direct, indirect and induced) is provided in the table below.

Table 10: Project Spending and Economic Impacts (Direct, Indirect and Induced) during Project Development Phase

	Spending (Millions of 2012 Dollars)	Economic Impacts			
		Direct	Indirect	Induced	Total
Employment*	$13.57	119.9	51.1	92.7	263.7
Labor Income**		$6.81	$3.10	$4.36	$14.27
Value Added**		$7.29	$4.91	$7.74	$19.93

*Note: * Employment impacts from IMPLAN reflect total employment (full time plus part time). On average, the ratio of FTE to total employment is estimated at 90 percent. **Millions of 2012 Dollars.*

Another method to estimate job-years from additional spending uses the Council of Economic Advisors' (CEA) methodology as presented in a 2011 analysis[6]. This method assumes that for every $76,923 of government spending, one job-year is created. The following table shows the difference in job-year estimates using the IMPLAN and CEA methodologies.

Note that the estimated employment impacts are lower when using CEA's approach. Specifically, the simplified computation produces a more conservative estimate of 176.4 job-years.

Table 11: Project Spending and Job-Year Estimates with IMPLAN and CEA Methodologies

	Spending (Millions of 2012 Dollars)	Employment Impacts (Job-Years)			
		Direct	Indirect	Induced	Total
IMPLAN *	$13.57	119.9	51.1	92.7	263.7
CEA		112.9		63.5	176.4

*Note: * Employment impacts from IMPLAN should not be interpreted as full-time equivalent (FTE) as they reflect the mix of full and part time jobs that is typical for each sector.*

A breakdown of short-term economic impacts (using IMPLAN estimates) in terms of employment (job-hours), labor income and value added is provided by quarter in the table below.

[6] Executive Office of the President, Council of Economic Advisers, "Estimates of Job Creation from the American Recovery and Reinvestment Act of 2009," Washington, D.C., May 11, 2009; and September 2011 Update.

Table 12: Project Spending and Short-Term Economic Impacts by Quarter

Period	Spending (Millions of 2012 Dollars)*	Economic Impacts			
		Total Job-Hours**	Direct Job-Hours**	Total Labor Income (Millions of 2012 Dollars)	Total Value Added (Millions of 2012 Dollars)
2014 - Q1	$1.54	1,033.3	467.9	$1.63	$2.27
2014 - Q2	$3.66	2,452.7	1,116.8	$3.84	$5.37
2014 - Q3	$3.68	2,462.8	1,121.4	$3.86	$5.39
2014 - Q4	$3.76	2,516.3	1,145.8	$3.94	$5.51
2015 - Q1	$0.94	632.5	284.7	$1.00	$1.39
Total	**$13.57**	**9,097.7**	**4,136.6**	**$14.27**	**$19.93**

*Notes: * includes engineering ($826,000) and construction ($12.74 million); ** assuming average weekly hours of 34.5 (Bureau of Labor Statistics estimate).*

The table below presents the short-term increase in employment and labor income resulting from capital expenditures in key industries employing low-income people. 43.3 cumulative job-years (or 16.4 percent of total job-years) are expected to be created in those industries by the end of 2015, bringing in an additional $1.22 million in labor income.

Table 13: Short-Term Impacts in Key Industries Employing Low-Income People

Sectors	Employment (Job-Years)	Labor Income (Millions of 2012 Dollars)
Retail Industries	18	$0.57
Services to buildings and dwellings	2.9	$0.07
Other business services	2.7	$0.09
Food services and drinking places	10.2	$0.23
Hotel/accommodation services	1.4	$0.05
Personal care and other personal Services	8.1	$0.24
Total	**43.3**	**$1.26**

Note: Low-income sectors are identified in BLS, A Profile of the Working Poor, March 2009; BLS, Characteristics of Minimum Wage Workers, March 2009; and Carsey Institute, Issue Brief No. 2, Summer 2008.

7.3 Livability

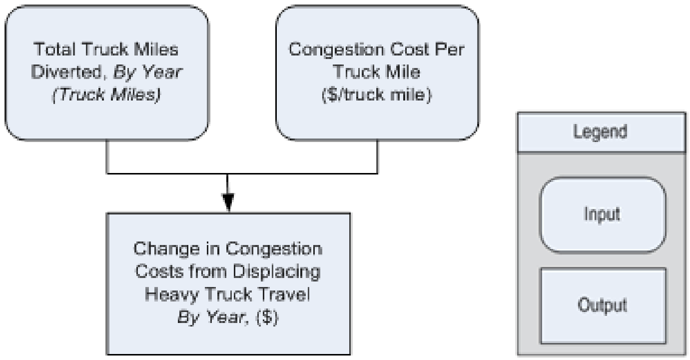
The proposed project would contribute to enhancing livability and quality of life in the study area through the reduction in highway congestion from displacing heavy truck travel to rail. This represents the time savings of the remaining on-road motorists.

7.3.1 Methodology

Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail

The proposed SORR project will divert freight from road to rail resulting in a reduction in the use of public highways by heavy trucks. This benefit category estimates the avoided highway congestion costs by applying the total diverted truck miles to a rate of congestion cost per mile. Figure 5 outlines the structure and logic model of the benefit calculation.

Figure 5: Reduction in Highway Congestion Costs



7.3.2 Assumptions

The assumptions used in the estimation of livability benefits are summarized in the table below.

Table 14: Assumptions used in the Estimation of Livability Benefits

Variable Name	Unit	Value	Source
Congestion Cost per Truck Mile	2012$/mile	$0.1171	HDR Calculations based on the Addendum to the 1997 Federal Highway Cost Allocation Study, Final Report, U.S. Department of Transportation and Federal Highway Administration, May 2000. Quoted in: National Highway Traffic Safety Administration, "Corporate Average Fuel Economy for FY 2011 Passenger Cars and Light Trucks", March 2009, Table VIII-5, page VIII-60

7.3.3 Benefit Estimates

Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail is roughly $25k in the opening year (2016) and exceeds $10 Million in savings (discounted at 7%) over the study period.

Table 15: Estimates of Livability Benefits, 2012$

	In Project Opening Year (2016), Discounted at 7%	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail.	$25,430	$25,624,824	$10,074,383

7.4 Environmental Sustainability

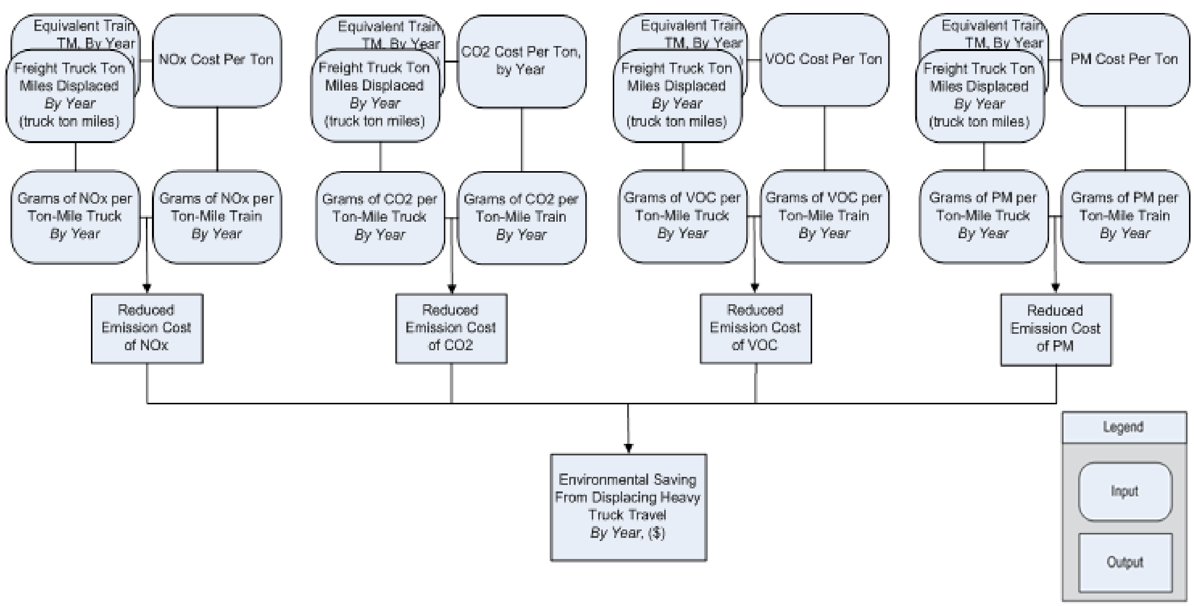
The proposed project would contribute to environmental sustainability through Emission Savings from Diverting Heavy Truck Travel to Rail.

7.4.1 Methodology

Emission Savings from Diverting Heavy Truck Travel to Rail

Freight carried over the rail network imposes less environmental impacts for the same amount of cargo than those imposed by trucks on the highway network. This benefit category estimates the value of the reduced environmental emissions associated with transporting goods on rail as opposed to by truck. The amount of greenhouse gas (GHG) and critical air contaminants (CAC) are calculated on the basis of pollutants generated per ton-mile travelled by truck and train shipping in the base and alternative cases. The monetized value of environmental savings is then calculated by applying the social cost of emissions to the relative difference in truck versus rail emissions. The structure and logic model outlining this calculation is provided in Figure 6.

Figure 6: Emission Savings S&L



7.4.2 Assumptions

The assumptions used in the estimation of sustainability benefits are summarized in the table below.

Table 16: Assumptions used in the Estimation of Environmental Sustainability Benefits

Variable Name	Unit	Value	Source
Grams of NOx per truck ton-mile - 2013	grams/TM	0.472	EPA's MOVES model. Calculated grams/gallon emission factors converted to grams/ton-mile by dividing by an average efficiency of 130 freight ton miles per gallon, per the Rocky Mountain Institute, Transformational Trucking Charette. This calculation assumes a current tractor-trailer combination loaded getting 6.5 mpg. No empty backhaul is assumed. Amount decreases annually due to realized efficiencies. 2035 value = 0.16.
Grams of NOx per train ton-mile - 2013	grams/TM	0.290	United States Environmental Protection Agency, Office of Transportation and Air Quality, "Emission Factors for Locomotives", EPA-420-F-09-025, April 2009. Gram/gallon values are converted to grams/ton-mile by dividing an average efficiency 480 freight ton miles per gallon. (2009 U.S. average data source in “The Economic Impact of America’s Freight Railroads”, Association of American Railroad (AAR), May 2010. Amount decreases annually due to realized efficiencies. 2035 value = 0.08.
Grams of CO2 per truck ton-mile - 2013	grams/TM	102.909	Same source as NOX truck emission rate.
Grams of CO2 per train ton-mile - 2013	grams/TM	21.26666667	Same source as NOX train emission rate. 2035 value = 0.003
Grams of PM per truck ton-mile - 2013	grams/TM	0.0182	Same source as NOX truck emission rate. 2035 value = 0.002
Grams of PM per train ton-mile - 2013	grams/TM	0.0079	Same source as NOX train emission rate. 2035 value = 0.001

Variable Name	Unit	Value	Source
Grams of VOC per truck ton-mile - 2013	grams/TM	0.043	Same source as NOX truck emission rate. 2035 value = 0.029
Grams of VOC per train ton-mile - 2013	grams/TM	0.0143	Same source as NOX train emission rate. 2035 value = 0.003
CO2 cost per ton - 2014	2012$/short ton	$23.41	Tiger V guidelines. Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 (February 2010), page 39, Table A-1 “Annual SCC Values 2010-2050 (in 2007 dollars)”. Varies by year.
PM cost per ton	2012$/short ton	$286,714.29	Tiger V guidelines. Corporate Average Fuel Economy for MY2012-MY2016 Passenger Cars and Light Trucks (March 2010), page 403, Table VIII-8, "Economic Values for Benefits Computations (2007 Dollars)"
VOC cost per ton	2012$/short ton	$1,285.71	Tiger V guidelines. Corporate Average Fuel Economy for MY2012-MY2016 Passenger Cars and Light Trucks (March 2010), page 403, Table VIII-8, "Economic Values for Benefits Computations (2007 Dollars)"

7.4.3 Benefit Estimates

Emission Savings from Diverting Heavy Truck Travel to Rail is roughly $19k in the opening year (2016) and exceeds $5.5 Million in savings (discounted at 7%) over the study period.

Table 17: Estimates of Environmental Sustainability Benefits, 2012$

	In Project Opening Year (Discounted at 7%)	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Emission Savings from Diverting Heavy Truck Travel to Rail	$19,260	$14,958,437	$5,654,432

7.5 Safety

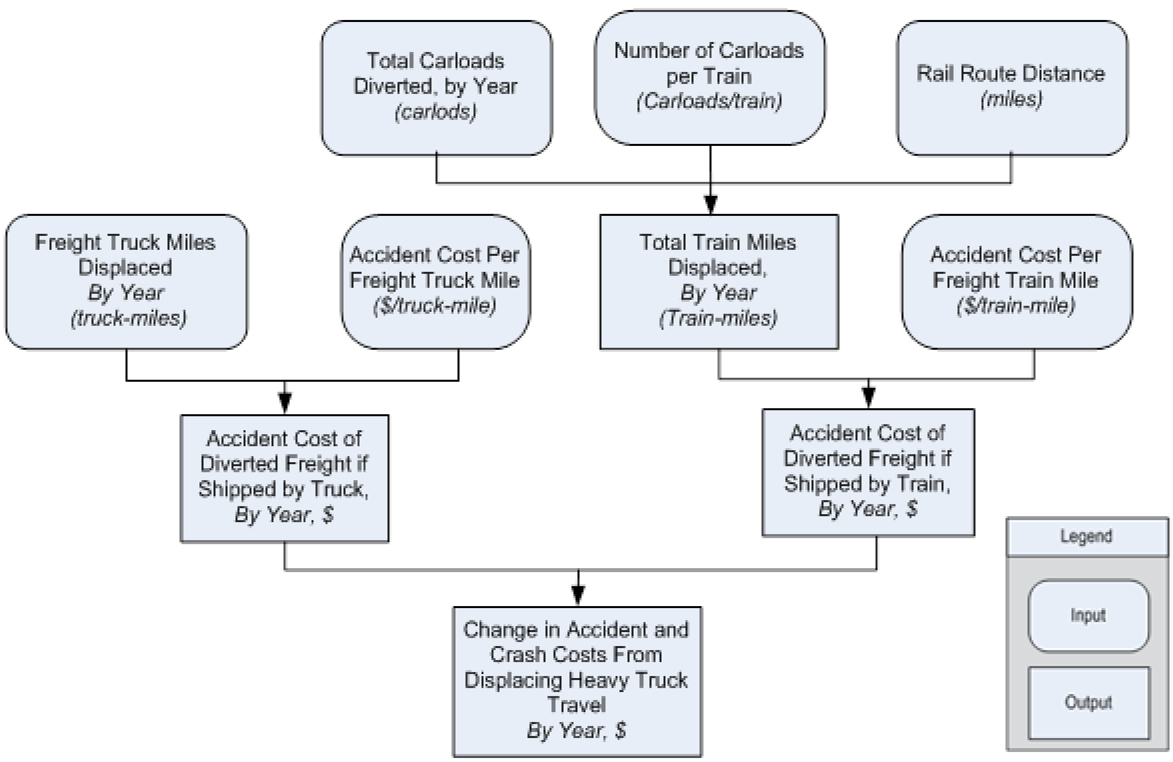
The proposed project would contribute to promoting DOT's safety long-term outcome through a reduction in accident costs (through reduced fatalities and injuries) from diverting heavy truck travel to rail.

7.5.1 Methodology

Reduced Accident Costs from Diverting Heavy Truck Travel to Rail

Fatality and injury rates per mile of freight carried by truck are greater than the fatality and injury rates for an equal volume of cargo when shipped by rail. This benefit captures the different accident rates per truck-mile and train-mile. The accident value used here is recommended by Tiger Guidelines for accident values and based on accident rate data published by the US DOT, Bureau of Transportation Statistics. The logic model outlining this calculation is provided in Figure 7 below.

Figure 7: Reduced Accident Costs S&L



7.5.2 Assumptions

The assumptions used in the estimation of safety benefits are summarized in the table below.

Table 18: Assumptions used in the Estimation of Safety Benefits

Variable Name	Unit	Value	Source
Accident Cost per Truck Mile	2012$/truck miles	$0.22	HDR Calculations based on Tiger Guidelines for Accident Values. US DOT, Bureau of Transportation Statistics for accident data and mileage statistics.
Accident Cost per Train Mile	2012$/train miles	$7.44	HDR Calculations based on Tiger Guidelines for Accident Values. US DOT, Bureau of Transportation Statistics for accident data and mileage statistics.
Average Number of Carloads per Train	carloads/train	50	TXDOT provided.
Train Route Mileage	miles	814	HDR calculation based on (i) truck route mileage of 676 miles and (ii) truck and rail distance factor of 0.83.

7.5.3 Benefit Estimates

Reduced Accident Costs from Diverting Heavy Truck Travel to Rail is roughly $38k in the opening year (2016) and exceeds $14.9 Million in savings (discounted at 7%) over the study period.

Table 19: Estimates of Safety Benefits, 2012$

	In Project Opening Year. Discounted at 7 Percent	Over the Project Lifecycle	
		In Constant Dollars	Discounted at 7 Percent
Reduced Accident Costs from Diverting Heavy Truck Travel to Rail	$37,694	$37,982,703	$14,932,874

8. Summary of Findings and BCA Outcomes

The tables below summarize the BCA findings. Annual costs and benefits are computed over the lifecycle of the project (2013 through 2035). As stated earlier, construction is expected to be completed by the end of 2015. Benefits accrue during the full operation of the project (2016 through 2035).

Table 20: Overall Results of the Benefit Cost Analysis, 2012$*

Project Evaluation Metric	7% Discount Rate	3% Discount Rate
Total Discounted Benefits	$66,448,099	$111,063,140
Total Discounted Costs**	$12,979,303	$13,776,476
Net Present Value	$53,468,796	$97,286,664
Benefit / Cost Ratio	5.12	8.06
Internal Rate of Return (%)	26.0%	
Payback Period (years)	5.0	

** Unless Specified Otherwise*

*** Includes incremental O&M costs and construction/capital costs.*

Considering all monetized benefits and costs, the estimated internal rate of return of the project is 26 percent. With a 7 percent real discount rate, the $12.979 million investment would result in $66.5 million in total benefits and a Benefit/Cost ratio of approximately 5.12 to 1.

With a 3 percent real discount rate, the Net Present Value of the project would increase to $97.3 million, for a Benefit/Cost ratio of 8.06.

Table 21: Benefit Estimates by Long-Term Outcome over the study period, 2012$

Long-Term Outcomes	Benefit Categories	7% Discount Rate	3% Discount Rate
State of Good Repair	Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail	$28,544,314	$47,622,232
Economic Competitiveness*	Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail	$7,309,835	$12,195,447
	Change in Inventory Costs from Displacing Heavy Truck Travel to Rail	-$67,739	-$113,014
Livability	Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail.	$10,074,383	$16,807,711
Environmental Sustainability	Emission Savings from Diverting Heavy Truck Travel to Rail	$5,654,432	$9,637,334
Safety	Reduced Accident Costs from Diverting Heavy Truck Travel to Rail	$14,932,874	$24,913,430
Total Benefit Estimates		**$66,448,100**	**$111,063,140**

* Note: Excluding the short-term employment impacts of the project

9. BCA Sensitivity/Alternative Analysis

The BCA outcomes presented in the previous sections rely on a large number of assumptions and long-term projections; both of which are subject to considerable uncertainty.

The primary purpose of the sensitivity analysis is to help identify the variables and model parameters whose variations have the greatest impact on the BCA outcomes: the "critical variables."

The sensitivity analysis can also be used to:

- Evaluate the impact of changes in individual critical variables – how much the final results would vary with reasonable departures from the "preferred" or most likely value for the variable; and
- Assess the robustness of the BCA and evaluate, in particular, whether the conclusions reached under the "preferred" set of input values are significantly altered by reasonable departures from those values.

The outcomes of the quantitative analysis for the Build Case (as defined in section 4.1) using a 7 percent discount rate are summarized in the table below. The table provides the percentage changes in project NPV associated with variations in variables or parameters (listed in row), as indicated in the column headers.

For example, a 15 percent reduction in Rail and Trucking Shipping Rates leads to a 2.05 percent reduction in the project NPV.

For comparison purposes an alternative to the build case project is included in the first row of the below table. The alternative assumes trans-loading is expanded in San Angelo, reducing the diverted trucking route to 414miles (round trip). San Angelo is the closest location where trans-loading could occur. This assumption reduces the 7% discounted BCR ratio of the project to 3.14; still a positive BCR ratio, supporting the robustness of the projects benefits.

Table 22: Quantitative Assessment of Sensitivity, Summary

Parameters	Change in Parameter Value	New NPV (7% discounted)	Change in NPV	New B/C Ratio (7% discounted)
ALTERNATIVE: Diverted Trucking Route Mileage*	Reduce route to 414 Miles	$27,715,243	-48.17%	3.14
Annual Build Carload Growth (Current Rate: 3%/Year)	1.5% Annual Growth	$41,629,256	-22.14%	4.21
	4.5% Annual Growth	$67,900,393	26.99%	6.23
Rail and Trucking Shipping Rates	Decrease by 15%	$52,372,321	-2.05%	5.04
	Increase by 15%	$54,565,272	2.05%	5.20

*This alternative assumes trans-loading is expanded in San Angelo, reducing the diverted trucking route to 414miles (round trip). San Angelo is the closest location where trans-loading could occur.

10. Supplementary Data Tables

This section breaks down all benefits associated with the five long-term outcome criteria (State of Good Repair, Economic Competiveness, Livability, Sustainability, and Safety) in annual form for the SORR rehabilitation project from Sulphur Junction to Fort Stockton (Build Case). Supplementary data tables are also provided for some specific benefit categories. For example, tables providing estimates of annual emission reductions (in tons) are provided under Environmental Sustainability.

10.1 Annual Estimates of Total Project Benefits and Costs

Calendar Year	Project Year	Total Benefits ($2012), Undiscounted	Total Costs ($2012), Undiscounted	Undiscounted Net Benefits ($2012)	Discounted Net Benefits at 7%	Discounted Net Benefits at 3%
2013	1	$0	$0	$0	$0	$0
2014	2	$0	$12,629,800	-$12,629,800	-$11,803,551	-$12,261,942
2015	3	$0	$940,163	-$940,163	-$821,175	-$886,194
2016 (opening)	4	$211,586	-$24,831	$236,417	$192,987	$216,355
2017	5	$423,968	-$24,831	$448,799	$342,386	$398,752
2018	6	$638,954	-$24,831	$663,785	$473,269	$572,586
2019	7	$7,700,490	-$24,831	$7,725,321	$5,147,708	$6,469,835
2020	8	$7,892,051	$68,000	$7,824,051	$4,872,426	$6,361,669
2021	9	$8,092,495	$68,000	$8,024,495	$4,670,329	$6,334,610
2022	10	$8,331,867	$68,000	$8,263,867	$4,494,996	$6,333,566
2023	11	$8,571,082	$68,000	$8,503,082	$4,322,536	$6,327,092
2024	12	$8,847,926	$68,000	$8,779,926	$4,171,280	$6,342,805
2025	13	$9,121,919	$68,000	$9,053,919	$4,020,048	$6,350,237
2026	14	$9,409,948	$68,000	$9,341,948	$3,876,576	$6,361,412
2027	15	$9,714,203	$68,000	$9,646,203	$3,740,964	$6,377,276
2028	16	$10,032,028	$68,000	$9,964,028	$3,611,422	$6,395,531
2029	17	$10,395,790	$68,000	$10,327,790	$3,498,380	$6,435,937
2030	18	$10,752,875	$68,000	$10,684,875	$3,382,558	$6,464,525
2031	19	$11,095,737	$68,000	$11,027,737	$3,262,710	$6,477,633
2032	20	$11,481,266	$68,000	$11,413,266	$3,155,863	$6,508,826
2033	21	$11,879,810	$68,000	$11,811,810	$3,052,396	$6,539,913
2034	22	$12,298,748	$68,000	$12,230,748	$2,953,886	$6,574,630
2035	23	$12,698,205	$68,000	$12,630,205	$2,850,804	$6,591,609
Total		**$169,590,947**	**$14,558,639**	**$155,032,308**	**$53,468,796**	**$97,286,664**

10.2 Annual Demand Projections

Calendar Year	Project Year	Train Carloads (Build Case)	Train carloads (No-Build Case)	Diverted Trucks (to rail in build case)*	Diverted Tons (to rail in build case)**	Diverted Truck Miles***	Equivalent Train Miles****
2016 (opening)	4	3,862	3,749	394	9,842	266,120	1,832
2017	5	3,978	3,749	799	19,979	540,223	3,719
2018	6	4,097	3,749	1,217	30,420	822,549	5,663
2019	7	4,220	0	14,769	369,231	9,984,001	68,737
2020	8	4,346	0	15,212	380,308	10,283,521	70,799
2021	9	4,477	0	15,669	391,717	10,592,027	72,923
2022	10	4,611	0	16,139	403,468	10,909,788	75,110
2023	11	4,749	0	16,623	415,573	11,237,082	77,364
2024	12	4,892	0	17,122	428,040	11,574,194	79,685
2025	13	5,039	0	17,635	440,881	11,921,420	82,075
2026	14	5,190	0	18,164	454,107	12,279,062	84,537
2027	15	5,345	0	18,709	467,731	12,647,434	87,074
2028	16	5,506	0	19,270	481,762	13,026,857	89,686
2029	17	5,671	0	19,849	496,215	13,417,663	92,376
2030	18	5,841	0	20,444	511,102	13,820,193	95,148
2031	19	6,016	0	21,057	526,435	14,234,799	98,002
2032	20	6,197	0	21,689	542,228	14,661,843	100,942
2033	21	6,383	0	22,340	558,495	15,101,698	103,970
2034	22	6,574	0	23,010	575,250	15,554,749	107,089
2035	23	6,772	0	23,700	592,507	16,021,391	110,302

* Diverted Trucks = Difference in Build and No Build Carloads multiplied by the number of trucks per carload (3.5). ** Diverted Tons = Number of Trucks multiplied by the average tonnage per truck. *** Number of Trucks multiplied by the distance travelled. **** Number of trains (carrying equivalent tonnage) multiplied by the rail route distance.

10.3 State of Good Repair: Annual Benefit Estimates

Calendar Year	Project Year	Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail, Undiscounted	Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail, Discounted 7%	Reduction in Maintenance Costs from Displacing Heavy Truck Travel to Rail, Discounted 3%
2016 (opening)	4	$88,267	$72,052	$80,777
2017	5	$179,183	$136,698	$159,202
2018	6	$272,826	$194,521	$235,342
2019	7	$3,311,522	$2,206,607	$2,773,348
2020	8	$3,410,868	$2,124,117	$2,773,348
2021	9	$3,513,194	$2,044,711	$2,773,348
2022	10	$3,618,590	$1,968,273	$2,773,348
2023	11	$3,727,147	$1,894,693	$2,773,348
2024	12	$3,838,962	$1,823,863	$2,773,348
2025	13	$3,954,131	$1,755,681	$2,773,348
2026	14	$4,072,755	$1,690,048	$2,773,348
2027	15	$4,194,937	$1,626,869	$2,773,348
2028	16	$4,320,785	$1,566,051	$2,773,348
2029	17	$4,450,409	$1,507,507	$2,773,348
2030	18	$4,583,921	$1,451,152	$2,773,348
2031	19	$4,721,439	$1,396,903	$2,773,348
2032	20	$4,863,082	$1,344,683	$2,773,348
2033	21	$5,008,974	$1,294,414	$2,773,348
2034	22	$5,159,244	$1,246,025	$2,773,348
2035	23	$5,314,021	$1,199,445	$2,773,348
Total		**$72,604,257**	**$28,544,314**	**$47,622,232**

10.4 Economic Competitiveness: Annual Benefit Estimates

Calendar Year	Project Year	Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail, Undiscounted	Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail, Discounted 7%	Reduced Transportation Costs from Diverting Heavy Truck Travel to Rail, Discounted 3%	Change in Inventory Costs from Displacing Heavy Truck Travel to Rail, Undiscounted	Change in Inventory Costs from Displacing Heavy Truck Travel to Rail, Discounted 7%	Change in Inventory Costs from Displacing Heavy Truck Travel to Rail, Discounted 3%
2016 (opening)	4	$22,604	$18,452	$20,686	-$209	-$171	-$192
2017	5	$45,886	$35,007	$40,769	-$425	-$324	-$378
2018	6	$69,867	$49,814	$60,268	-$647	-$462	-$558
2019	7	$848,039	$565,084	$710,219	-$7,859	-$5,237	-$6,582
2020	8	$873,480	$543,959	$710,219	-$8,094	-$5,041	-$6,582
2021	9	$899,684	$523,624	$710,219	-$8,337	-$4,852	-$6,582
2022	10	$926,675	$504,050	$710,219	-$8,587	-$4,671	-$6,582
2023	11	$954,475	$485,207	$710,219	-$8,845	-$4,496	-$6,582
2024	12	$983,109	$467,068	$710,219	-$9,110	-$4,328	-$6,582
2025	13	$1,012,603	$449,608	$710,219	-$9,384	-$4,166	-$6,582
2026	14	$1,042,981	$432,800	$710,219	-$9,665	-$4,011	-$6,582
2027	15	$1,074,270	$416,620	$710,219	-$9,955	-$3,861	-$6,582
2028	16	$1,106,498	$401,046	$710,219	-$10,254	-$3,716	-$6,582
2029	17	$1,139,693	$386,053	$710,219	-$10,561	-$3,578	-$6,582
2030	18	$1,173,884	$371,622	$710,219	-$10,878	-$3,444	-$6,582
2031	19	$1,209,100	$357,729	$710,219	-$11,205	-$3,315	-$6,582
2032	20	$1,245,373	$344,356	$710,219	-$11,541	-$3,191	-$6,582
2033	21	$1,282,735	$331,483	$710,219	-$11,887	-$3,072	-$6,582
2034	22	$1,321,217	$319,091	$710,219	-$12,244	-$2,957	-$6,582
2035	23	$1,360,853	$307,162	$710,219	-$12,611	-$2,846	-$6,582
Total		**$18,593,026**	**$7,309,835**	**$12,195,447**	**-$172,299**	**-$67,739**	**-$113,014**

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10.5 Livability: Annual Benefit Estimates

Calendar Year	Project Year	Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail, Undiscounted	Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail, Discounted 7%	Reduction in Highway Congestion Costs from Displacing Heavy Truck Travel to Rail, Discounted, 3%
2016 (opening)	4	$31,153	$25,430	$28,509
2017	5	$63,240	$48,246	$56,188
2018	6	$96,291	$68,654	$83,061
2019	7	$1,168,763	$778,796	$978,821
2020	8	$1,203,826	$749,682	$978,821
2021	9	$1,239,941	$721,657	$978,821
2022	10	$1,277,139	$694,679	$978,821
2023	11	$1,315,453	$668,710	$978,821
2024	12	$1,354,917	$643,711	$978,821
2025	13	$1,395,564	$619,647	$978,821
2026	14	$1,437,431	$596,483	$978,821
2027	15	$1,480,554	$574,184	$978,821
2028	16	$1,524,971	$552,720	$978,821
2029	17	$1,570,720	$532,057	$978,821
2030	18	$1,617,842	$512,167	$978,821
2031	19	$1,666,377	$493,021	$978,821
2032	20	$1,716,368	$474,590	$978,821
2033	21	$1,767,859	$456,848	$978,821
2034	22	$1,820,894	$439,770	$978,820
2035	23	$1,875,520	$423,330	$978,820
Total		**$25,624,824**	**$10,074,383**	**$16,807,711**

10.6 Environmental Sustainability: Annual Benefit Estimates

Calendar Year	Project Year	Emission Savings from Diverting Heavy Truck Travel to Rail, Undiscounted	Emission Savings from Diverting Heavy Truck Travel to Rail, Discounted 7%	Emission Savings from Diverting Heavy Truck Travel to Rail, Discounted 3%
2016 (opening)	4	$23,594	$19,260	$21,592
2017	5	$42,344	$32,304	$37,622
2018	6	$57,890	$41,275	$49,936
2019	7	$647,612	$431,531	$542,365
2020	8	$627,586	$390,829	$510,285
2021	9	$610,096	$355,081	$481,615
2022	10	$624,997	$339,957	$479,008
2023	11	$633,005	$321,788	$471,015
2024	12	$671,707	$319,123	$485,255
2025	13	$700,414	$310,992	$491,256
2026	14	$735,797	$305,330	$501,042
2027	15	$779,827	$302,430	$515,558
2028	16	$829,622	$300,693	$532,503
2029	17	$917,311	$310,725	$571,638
2030	18	$990,042	$313,422	$598,991
2031	19	$1,040,019	$307,704	$610,902
2032	20	$1,123,876	$310,761	$640,931
2033	21	$1,211,698	$313,126	$670,888
2034	22	$1,310,594	$316,526	$704,509
2035	23	$1,380,407	$311,576	$720,424
Total		**$14,958,437**	**$5,654,432**	**$9,637,334**

10.7 Safety: Annual Benefit Estimates

Calendar Year	Project Year	Reduced Accident Costs from Diverting Heavy Truck Travel to Rail, Undiscounted	Reduced Accident Costs from Diverting Heavy Truck Travel to Rail, Discounted 7%	Reduced Accident Costs from Diverting Heavy Truck Travel to Rail, Discounted 3%
2016 (opening)	4	$46,177	$37,694	$42,258
2017	5	$93,739	$71,513	$83,286
2018	6	$142,728	$101,763	$123,118
2019	7	$1,732,413	$1,154,380	$1,450,869
2020	8	$1,784,385	$1,111,226	$1,450,869
2021	9	$1,837,917	$1,069,684	$1,450,869
2022	10	$1,893,055	$1,029,696	$1,450,869
2023	11	$1,949,846	$991,203	$1,450,869
2024	12	$2,008,342	$954,149	$1,450,869
2025	13	$2,068,592	$918,480	$1,450,869
2026	14	$2,130,650	$884,144	$1,450,869
2027	15	$2,194,569	$851,092	$1,450,869
2028	16	$2,260,406	$819,275	$1,450,869
2029	17	$2,328,218	$788,648	$1,450,869
2030	18	$2,398,065	$759,166	$1,450,869
2031	19	$2,470,007	$730,786	$1,450,869
2032	20	$2,544,107	$703,467	$1,450,869
2033	21	$2,620,430	$677,169	$1,450,869
2034	22	$2,699,043	$651,854	$1,450,869
2035	23	$2,780,014	$627,486	$1,450,869
Total		**$37,982,703**	**$14,932,874**	**$24,913,430**