HDR

ONE COMPANY | *Many Solutions*®

Cost-Benefit Analysis in Support of TIGER II Application

Texas Department of Transportation
North East Texas Rural Rail Transportation District - Rail Line Rehabilitation Project

HDR | Decision Economics

August 18, 2010

HDR Corporation
Decision Economics

Risk Analysis · Investment and Finance
Economics and Policy

Cost-Benefit Analysis in Support of TIGER II Application

Texas Department of Transportation
North East Texas Rural Rail Transportation District - Line Rehabilitation Project

HDR | Decision Economics

August 18, 2010

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY OF ECONOMIC BENEFITS AND COST-BENEFIT ANALYSIS RESULTS

The Northeast Texas Rural Rail Transportation District rail line (NETEX), approximately 65.6 miles in length, is a state-owned facility that extends from railroad Milepost (MP) 489.4 at the Franklin/Titus County line (near Winfield, Texas) to MP 555 (just west of Greenville, Texas) in Hunt county.

The project area encompasses a large, rural, and agricultural region that has seen some industrial development in the past few years. In 2009, there were 19 customers located on the line, and 2,315 carloads. These customers depend on rail transportation and some could cease operations if rail service was no longer provided. Operational impacts from track condition and speed limitations have limited the capacity on the line and made the line uncompetitive with other modes of transportation for the movement of some goods. It is important that the NETEX line is rehabilitated in order to support its continued operation and foster economic development opportunities.

This analysis compares the project's costs to the economic benefits of replacing main line crossties, siding/spur track crossties, switch ties, and installing and regulating ballast. It also quantifies the benefits that are expected to accrue to freight and passenger train customers and to the broader society in terms of avoided environmental costs.

Completing the NETEX Rail Line Rehabilitation Project will yield significant economic benefits of between $4.1 and $6.5 million[1]. The societal benefit-cost ratio is between 0.32 to 1 and 0.47 to 1.

By far the most valuable of the project's benefits is the reduction in transportation costs due to avoidance of future rail diversion to a longer route. Existing rail traffic will have to be diverted to trucks without the rehabilitation project. In total, the transportation benefits account for 84% of total benefits. Also very valuable are the benefits of safety saving from diverting trucks to rail, which comprises about 14% of the $4.1 million total benefits, discounted at a 7% rate.

[1] Net present value of cash flows in 2010 dollars over 20 years at a 7 percent and 3 percent real discount rate.

1: PROJECT DESCRIPTION FOR COST BENEFIT ANALYSIS

1.1 TIGER II Discretionary Grants

This cost-benefit analysis is prepared under the guidelines of the Transportation, Housing and Urban Development, and Related Agencies Appropriations Act for 2010, for grants to be awarded by the Department of Transportation ("DOT") for National Infrastructure Investments. The guidelines are similar, but not identical to the appropriation for the Transportation Investment Generating Economic Recovery, or TIGER Discretionary Grant, program authorized and implemented pursuant to the American Recovery and Reinvestment Act of 2009. Because of the similarity in program structure, grants for National Infrastructure Investments under the FY 2010 Appropriations Act are referred to as TIGER II Discretionary Grants.

1.2 Project Description

The project limits begin near Winfield, Texas (MP 489.4) and end at the west side of Greenville (MP 555). The NETEX line is constructed predominantly of 112# jointed rail on ties that date from the 1940's to the 1980's. Most of the ties have exceeded their expected service life and have severely deteriorated. This causes the alignment and profile of the track to be substandard and does not provide adequate support of the rail. These tie, alignment, and profile conditions cause the NETEX line to be classified as "Excepted Track" according to Federal Railroad Administration (FRA) regulations, which limits Blacklands Railroad (BLR)'s operating speed to 10 mph, restricts the movement of hazardous materials to no more than five (5) hazardous cars per train, and prohibits the movement of occupied passenger cars. The Excepted Track status affects the efficiency and capacity of the NETEX/BLR line and operations, and may lead to the eventual cessation of service if the track continues to deteriorate. The line is in need of rehabilitation to address tie, alignment, and profile deficiencies and to achieve and maintain FRA Class 2 (25 mph) status. The project will consist of:

1. Replace 85,800 main line crossties (40%)
2. Replace 3,499 siding/spur track crossties
3. Replace 350 switch ties
4. Install and regulate 39,600 tons of ballast
5. Surface and align 69.6 miles of track (including siding/spurs)
6. Repairs to 51 bridges
7. Vegetation removal and controls

1.3 No-Build and Build Cases

The cost benefit analysis assesses the net benefits to society of the project to improve the rail line relative to the NETEX rail line being inoperable and closing. It is forecasted that undertaking the project will maintain existing rail freight traffic, while if the rail line is inoperable, the freight is carried by truck.

1.4 Economic Benefits Quantification

The public benefits of the project are derived from the diversion of freight from truck to rail. Six benefits (and dis-benefits) are estimated over a 20 year time period:

- The reduction is transportation or shipping costs to shippers;
- The change in inventory costs for shippers;
- The highway congestion relief benefits;
- The highway maintenance cost savings;
- Safety benefits; and,
- Emission savings.

1.5 Economic Costs

The total cost of the project is $14.4 Million. For the cost benefit analysis quantification, these costs have been spread equally through 2011 and 2012.

Table 1: Project Costs

Cost Categories	$
Project cost	$14,303,813
Administration cost	$100,000
Total Cost	$14,403,813
Year 2011	$7,201,907
Year 2012	$7,201,907

1.6 Report Structure

The balance of the report is structured as follows. Section 2 provides a summary of the results of the cost benefit analysis. Section 3 provides the logic and input data assumptions for the calculation of benefits for each of the six benefit categories. Section 4 provides a sensitivity analysis that illustrates how the project's Net Present Value varies with alternative variable input assumptions.

2: ECONOMIC BENEFITS RESULTS AND DISCUSSION

The NETEX project has gross economic benefits of $4.1 M using a 7 percent real discount rate[2].

Table 2: Summary of Project Economic Indicators

Economic Indicators	7%	3%
Total Costs	$13,021,178	$13,780,630
Total Benefits	$4,109,108	$6,472,880
NPV	-$8,912,070	-$7,307,750
ROI	-68%	-53%
B/C	0.32	0.47

Table 3: Summary of Benefits

Benefit Category	Ben #	PV Over 20 Years	
		7%	3%
Transportation cost saving from diverting trucks to rail	1	$2,803,315.3	$4,406,294.1
Increased inventory cost from diverting trucks to rail	2	-$31,009.0	-$48,740.5
Congestion cost saving from diverting trucks to rail	3	$137,331.3	$215,859.4
Maintenance cost saving from diverting trucks to rail	4	$557,397.1	$876,125.4
Safety saving from diverting trucks to rail	5	$562,983.4	$884,906.0
Emission saving from diverting trucks to rail	6	$79,090	$138,436
Total		**$4,109,108**	**$6,472,880**

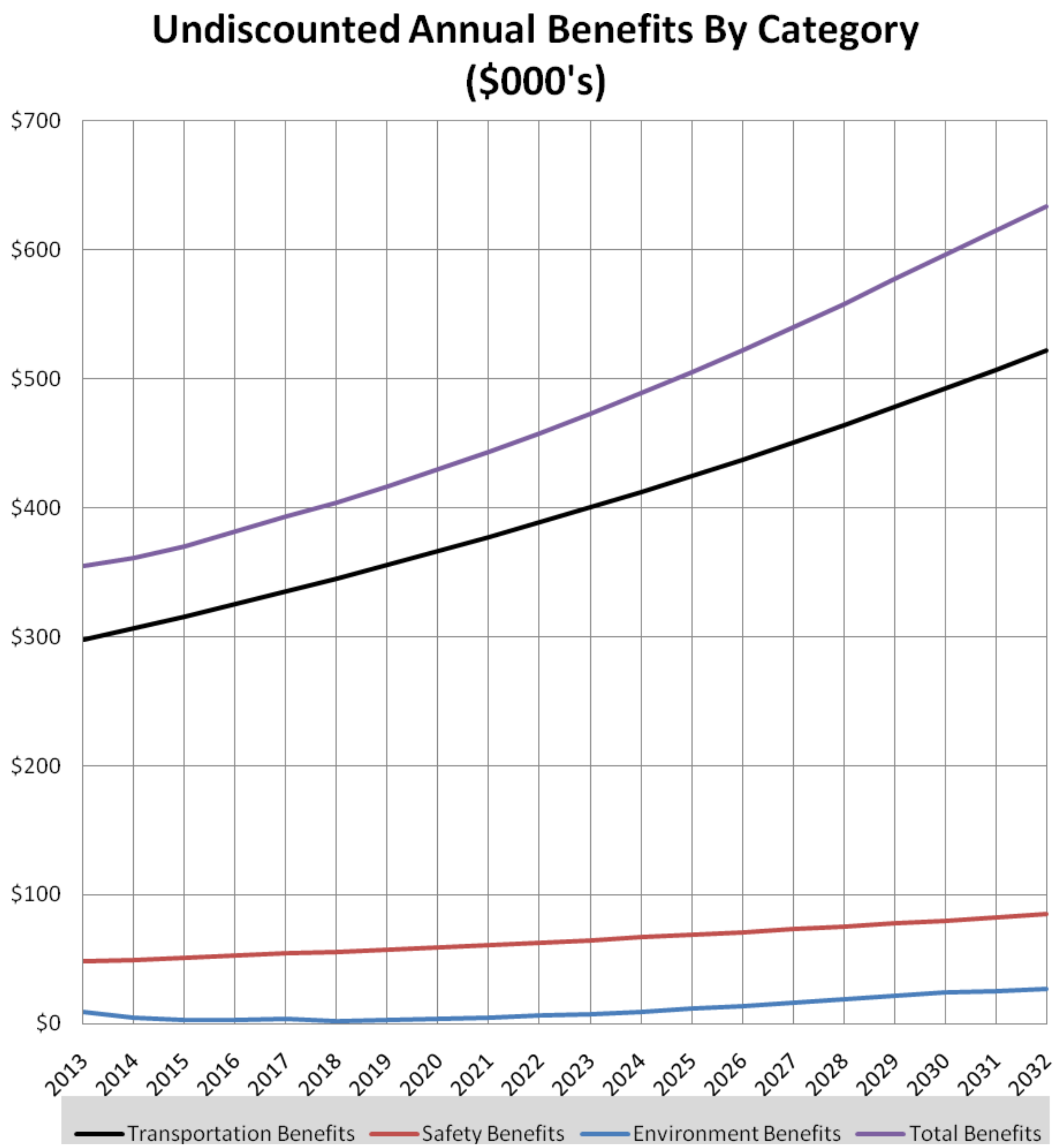
The economic benefits are mainly weighted on "Transportation cost saving from diverting trucks to rail", which accounts for about two-thirds of the benefits, followed by "safety saving from diverting trucks to rail" and "Maintenance cost saving from diverting trucks to rail" (14% each).

As shown in Figure 1and Table 4, annual economic benefits start at $355 thousand in 2013, and grow to $422 thousand in 2032.

[2] At a 3% discount rate, the benefits are $6.7 M.

Texas Department of Transportation

Figure 1: Undiscounted Annual Benefits by Category ($000's)



The project benefits are determined by the increase in the number of carloads on the NETEX after the rehabilitation of the rail line (the build or alternative case), relative to the no build or base case. The carloads are shown in Figure 2 below:

Figure 2: Number of Carloads on SORR – Base and Alternative Cases

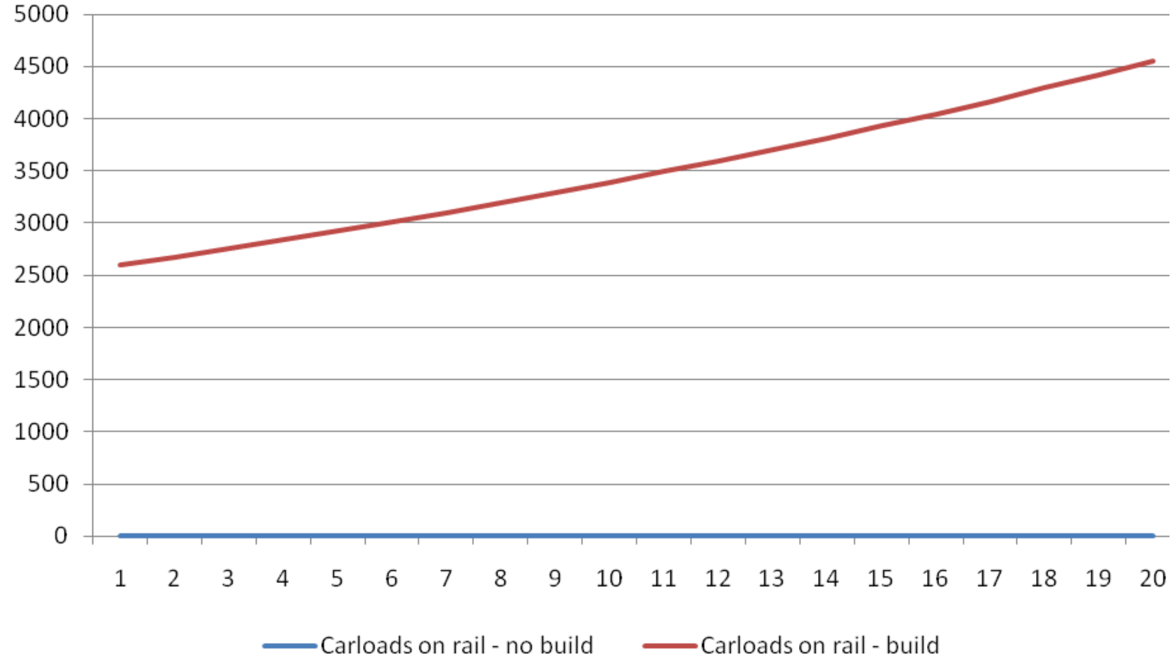


Table 4: Undiscounted Benefits of NETEX Rail Line Rehabilitation Project, by Year

Benefit Category	Ben #	S&L #	Sum	Years																			
				2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Transportation cost saving from diverting trucks to rail	T1	T1	**$6,468,876.8**	$240,744	$247,966	$255,405	$263,067	$270,959	$279,088	$287,461	$296,085	$304,967	$314,116	$323,540	$333,246	$343,243	$353,540	$364,147	$375,071	$386,323	$397,913	$409,850	$422,146
Increased inventory cost from diverting trucks to rail	T2	T2	**-$71,555.9**	-$2,663	-$2,743	-$2,825	-$2,910	-$2,997	-$3,087	-$3,180	-$3,275	-$3,373	-$3,475	-$3,579	-$3,686	-$3,797	-$3,911	-$4,028	-$4,149	-$4,273	-$4,402	-$4,534	-$4,670
Congestion cost saving from diverting trucks to rail	T3	T3	**$316,903.1**	$11,794	$12,148	$12,512	$12,887	$13,274	$13,672	$14,082	$14,505	$14,940	$15,388	$15,850	$16,325	$16,815	$17,320	$17,839	$18,374	$18,926	$19,493	$20,078	$20,680
Maintenance cost saving from diverting trucks to rail	T4	T4	**$1,286,239.0**	$47,868	$49,304	$50,783	$52,307	$53,876	$55,492	$57,157	$58,872	$60,638	$62,457	$64,331	$66,261	$68,249	$70,296	$72,405	$74,577	$76,815	$79,119	$81,493	$83,937
Safety saving from diverting trucks to rail	S1	S1	**$1,299,129.8**	$48,348	$49,798	$51,292	$52,831	$54,416	$56,049	$57,730	$59,462	$61,246	$63,083	$64,976	$66,925	$68,933	$71,001	$73,131	$75,325	$77,584	$79,912	$82,309	$84,779
Emission saving from diverting trucks to rail	E1	E1	**$221,042.1**	$8,971	$4,812	$2,836	$3,370	$3,801	$2,402	$3,255	$3,993	$5,089	$6,390	$7,607	$9,631	$11,870	$13,920	$16,029	$18,624	$21,559	$24,304	$25,604	$26,974
Total			**$9,520,635**	**$355,061**	**$361,286**	**$370,004**	**$381,553**	**$393,329**	**$403,617**	**$416,506**	**$429,641**	**$443,507**	**$457,960**	**$472,724**	**$488,702**	**$505,313**	**$522,166**	**$539,522**	**$557,823**	**$576,934**	**$596,340**	**$614,801**	**$633,846**

Table 5: Discounted Benefits of NETEX Rail Line Rehabilitation Project, by Year, 7 Percent Discount Rate

Benefit Category	Ben #	S&L #	Present Value	Years																			
				2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Transportation cost saving from diverting trucks to rail	T1	T1	**$2,803,315.3**	$196,519	$189,172	$182,100	$175,293	$168,740	$162,432	$156,360	$150,514	$144,888	$139,471	$134,257	$129,238	$124,407	$119,756	$115,280	$110,970	$106,822	$102,828	$98,984	$95,284
Increased inventory cost from diverting trucks to rail	T2	T2	**-$31,009.0**	-$2,174	-$2,093	-$2,014	-$1,939	-$1,867	-$1,797	-$1,730	-$1,665	-$1,603	-$1,543	-$1,485	-$1,430	-$1,376	-$1,325	-$1,275	-$1,228	-$1,182	-$1,137	-$1,095	-$1,054
Congestion cost saving from diverting trucks to rail	T3	T3	**$137,331.3**	$9,627	$9,267	$8,921	$8,587	$8,266	$7,957	$7,660	$7,374	$7,098	$6,833	$6,577	$6,331	$6,095	$5,867	$5,647	$5,436	$5,233	$5,037	$4,849	$4,668
Maintenance cost saving from diverting trucks to rail	T4	T4	**$557,397.1**	$39,075	$37,614	$36,208	$34,854	$33,551	$32,297	$31,090	$29,928	$28,809	$27,732	$26,695	$25,697	$24,736	$23,812	$22,922	$22,065	$21,240	$20,446	$19,682	$18,946
Safety saving from diverting trucks to rail	S1	S1	**$562,983.4**	$39,466	$37,991	$36,571	$35,204	$33,888	$32,621	$31,401	$30,227	$29,097	$28,010	$26,963	$25,955	$24,984	$24,050	$23,151	$22,286	$21,453	$20,651	$19,879	$19,136
Emission saving from diverting trucks to rail	E1	E1	**$79,090.0**	$7,323	$3,671	$2,022	$2,246	$2,367	$1,398	$1,770	$2,030	$2,418	$2,837	$3,157	$3,735	$4,302	$4,715	$5,074	$5,510	$5,961	$6,281	$6,184	$6,088
Total			**$4,109,108**	**$289,836**	**$275,623**	**$263,808**	**$254,245**	**$244,946**	**$234,908**	**$226,551**	**$218,408**	**$210,707**	**$203,340**	**$196,164**	**$189,527**	**$183,149**	**$176,876**	**$170,799**	**$165,040**	**$159,527**	**$154,106**	**$148,483**	**$143,067**

Table 6: Discounted Benefits of NETEX Rail Line Rehabilitation Project, by Year, 3 Percent Discount Rate

Benefit Category	Ben #	S&L #	Present Value	Years																			
				2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Transportation cost saving from diverting trucks to rail	T1	T1	**$4,406,294.1**	$220,315	$220,315	$220,315	$220,315	$220,315	$220,315	$220,315	$220,315	$220,315	$220,315	$220,315	$220,315	$220,315	$220,315	$220,315	$220,315	$220,315	$220,315	$220,315	$220,315
Increased inventory cost from diverting trucks to rail	T2	T2	**-$48,740.5**	-$2,437	-$2,437	-$2,437	-$2,437	-$2,437	-$2,437	-$2,437	-$2,437	-$2,437	-$2,437	-$2,437	-$2,437	-$2,437	-$2,437	-$2,437	-$2,437	-$2,437	-$2,437	-$2,437	-$2,437
Congestion cost saving from diverting trucks to rail	T3	T3	**$215,859.4**	$10,793	$10,793	$10,793	$10,793	$10,793	$10,793	$10,793	$10,793	$10,793	$10,793	$10,793	$10,793	$10,793	$10,793	$10,793	$10,793	$10,793	$10,793	$10,793	$10,793
Maintenance cost saving from diverting trucks to rail	T4	T4	**$876,125.4**	$43,806	$43,806	$43,806	$43,806	$43,806	$43,806	$43,806	$43,806	$43,806	$43,806	$43,806	$43,806	$43,806	$43,806	$43,806	$43,806	$43,806	$43,806	$43,806	$43,806
Safety saving from diverting trucks to rail	S1	S1	**$884,906.0**	$44,245	$44,245	$44,245	$44,245	$44,245	$44,245	$44,245	$44,245	$44,245	$44,245	$44,245	$44,245	$44,245	$44,245	$44,245	$44,245	$44,245	$44,245	$44,245	$44,245
Emission saving from diverting trucks to rail	E1	E1	**$138,435.6**	$8,209	$4,276	$2,446	$2,823	$3,090	$1,896	$2,495	$2,971	$3,677	$4,481	$5,180	$6,367	$7,619	$8,674	$9,698	$10,940	$12,295	$13,457	$13,764	$14,077
Total			**$6,472,880**	**$324,932**	**$320,998**	**$319,169**	**$319,545**	**$319,812**	**$318,619**	**$319,217**	**$319,694**	**$320,399**	**$321,204**	**$321,902**	**$323,089**	**$324,341**	**$325,397**	**$326,420**	**$327,662**	**$329,017**	**$330,179**	**$330,486**	**$330,799**

3. MODEL LOGIC DIAGRAMS AND INPUT VARIABLES

3.1 Demand Outlook D1: Heavy Truck Diversion to Rail after Rehabilitation

This structure and logic diagram illustrates how the freight tonnage diverted to rail and the number of resulting diverted truck and truck-miles were calculated. Estimates of annual freight carloads on NETEX upon completion of track upgrades are compared to base figures to establish the increased railcar activity resulting from the project. Using average truck and train capacity values and typical railcar travel distances, this incremental railcar activity is used to determine the subsequent reduction in truck freight and travel. Most of the project's social benefits stem from this diversion of freight from truck to rail.

Figure 3: Calculation #1 – Heavy Truck Diversion to Rail after Rehabilitation

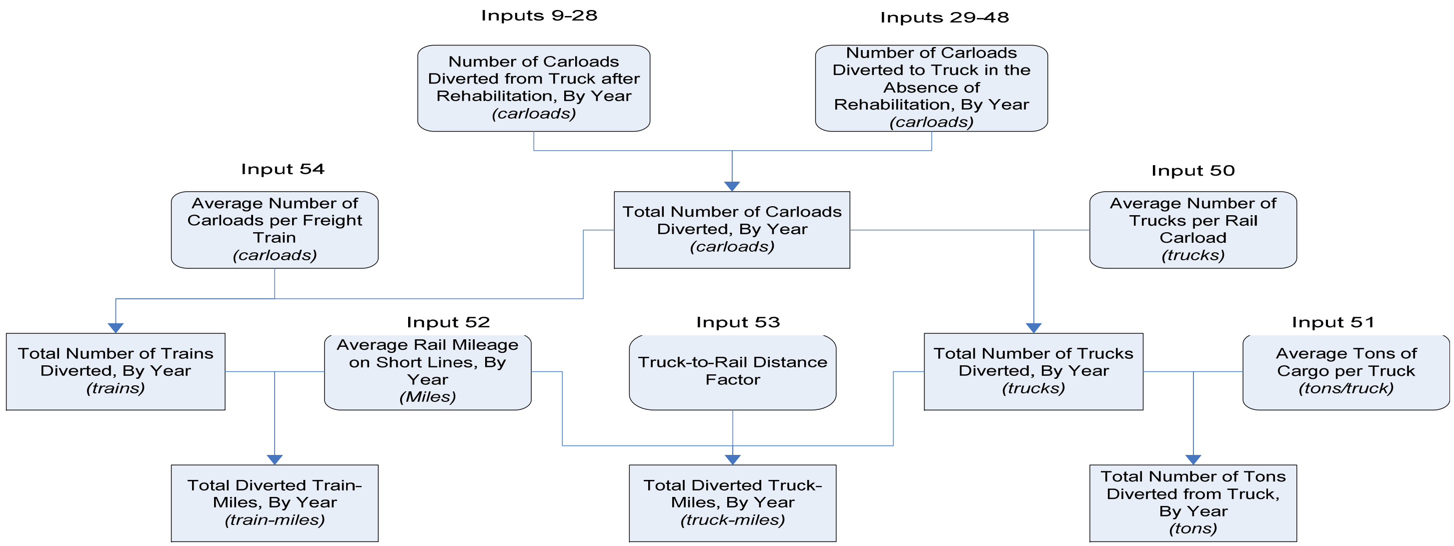


Table 7: Calculation #1. Input Values and Sources

Input #	Input Name	Units	Value	Source/Comment
9	Projected Rail Carloads on NETEX - 2013	carloads	2,599	HDR calculation based on (i)2006 to 2009 average to be 2010 carloads of 2378, (ii) carload growth rate of 3% from 2011 to 2032
10	Projected Rail Carloads on NETEX - 2014	carloads	2,676	
11	Projected Rail Carloads on NETEX - 2015	carloads	2,757	
12	Projected Rail Carloads on NETEX - 2016	carloads	2,839	
13	Projected Rail Carloads on NETEX - 2017	carloads	2,925	
14	Projected Rail Carloads on NETEX - 2018	carloads	3,012	
15	Projected Rail Carloads on NETEX - 2019	carloads	3,103	
16	Projected Rail Carloads on NETEX - 2020	carloads	3,196	
17	Projected Rail Carloads on NETEX - 2021	carloads	3,292	
18	Projected Rail Carloads on NETEX - 2022	carloads	3,390	
19	Projected Rail Carloads on NETEX - 2023	carloads	3,492	
20	Projected Rail Carloads on NETEX - 2024	carloads	3,597	
21	Projected Rail Carloads on NETEX - 2025	carloads	3,705	
22	Projected Rail Carloads on NETEX - 2026	carloads	3,816	
23	Projected Rail Carloads on NETEX - 2027	carloads	3,930	
24	Projected Rail Carloads on NETEX - 2028	carloads	4,048	
25	Projected Rail Carloads on NETEX - 2029	carloads	4,170	
26	Projected Rail Carloads on NETEX - 2030	carloads	4,295	
27	Projected Rail Carloads on NETEX - 2031	carloads	4,424	
28	Projected Rail Carloads on NETEX - 2032	carloads	4,556	
29	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2013	carloads	2,599	Assume all rails will be diverted to trucks under base case
30	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2014	carloads	2,676	
31	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2015	carloads	2,757	
32	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2016	carloads	2,839	
33	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2017	carloads	2,925	
34	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2018	carloads	3,012	
35	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2019	carloads	3,103	
36	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2020	carloads	3,196	

Input #	Input Name	Units	Value	Source/Comment
37	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2021	carloads	3,292	Assume all rails will be diverted to trucks under base case
38	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2022	carloads	3,390	
39	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2023	carloads	3,492	
40	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2024	carloads	3,597	
41	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2025	carloads	3,705	
42	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2026	carloads	3,816	
43	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2027	carloads	3,930	
44	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2028	carloads	4,048	
45	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2029	carloads	4,170	
46	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2030	carloads	4,295	
47	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2031	carloads	4,424	
48	Number of Carloads that would Diverted to Truck in the Absence of Rehabilitation - 2032	carloads	4,556	
49	Percentage of difference between actual carloads on rail in base and alt cases	%	75%	
50	Average Number of Trucks per Rail Carload	trucks	3	NETEX
51	Average Tons of Cargo per Truck	tons/truck	17.5	Highway Economic Requirements (HERS) Model - FHWA
52	NETEX Project Railroad Distance	miles	65.6	NETEX
53	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.
54	Average Carloads per Freight Train	carloads	28	NETEX

On average, there are 4,000 trucks per year diverted as a result of the project (Table 8).

Table 8: Calculation #1 - Total Truck Diversion

Year	Total Truck Diversion	Year	Total Truck Diversion
2013	2599	**2023**	3492
2014	2676	**2024**	3597
2015	2757	**2025**	3705
2016	2839	**2026**	3816
2017	2925	**2027**	3930
2018	3012	**2028**	4048
2019	3103	**2029**	4170
2020	3196	**2030**	4295
2021	3292	**2031**	4424
2022	3390	**2032**	4556

3.2 Benefit 1#: Transportation Cost Saving from Diverting Trucks to Rail

This benefit category captures the cost savings experienced by businesses as they ship by rail instead of truck. A given amount of cargo is typically more expensive to ship by truck than by rail. The increased rail capacity stemming from the project allows cargo to be diverted from truck to rail freight, and thus shipped at a lower cost.

Figure 4: Benefit #1 – Structure and Logic Diagram

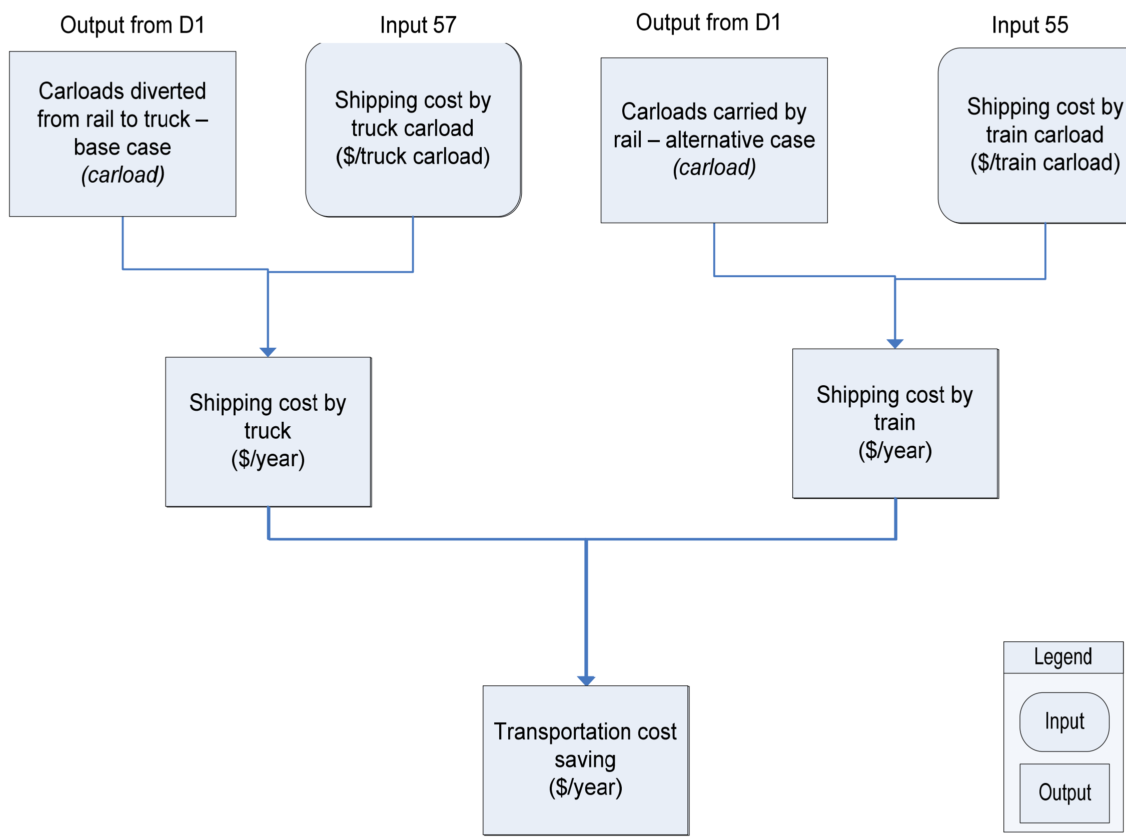


Table 9: Benefit #1 – Input values and Sources

Input #	Input Name	Units	Value	Source/Comment
55	Average Shipping Rate per carload for Domestic Container, Rail	$/train-carload	$525.00	NETEX
56	Transportation cost savings from rail relative to truck	%	15%	HDR calculation based on haul rates
57	Average Shipping Rate per carload for a Domestic Container, Truck	$/truck-carload	$617.65	Assume Rail's shipping rate is 15% cheaper than Truck's

Table 10: Benefit #1 – Present Values of Benefits

Benefit Category	PV Over 20 Years	
	7%	3%
Transportation cost saving from diverting trucks to rail	$2,803,315.3	$4,406,294.1

3.3 Benefit T2: Increased Inventory Cost from Diverting Trucks to Rail

This benefit category captures the change in shipping time and resulting inventory cost that arises from the diversion of freight from truck to rail. The less time the cargo spends in transit, the quicker it is put to productive use. In this case, the benefit is calculated as a net cost in Table 11, with longer trip and lower speed.

Figure 5: Benefit #2 – Structure and Logic Diagram

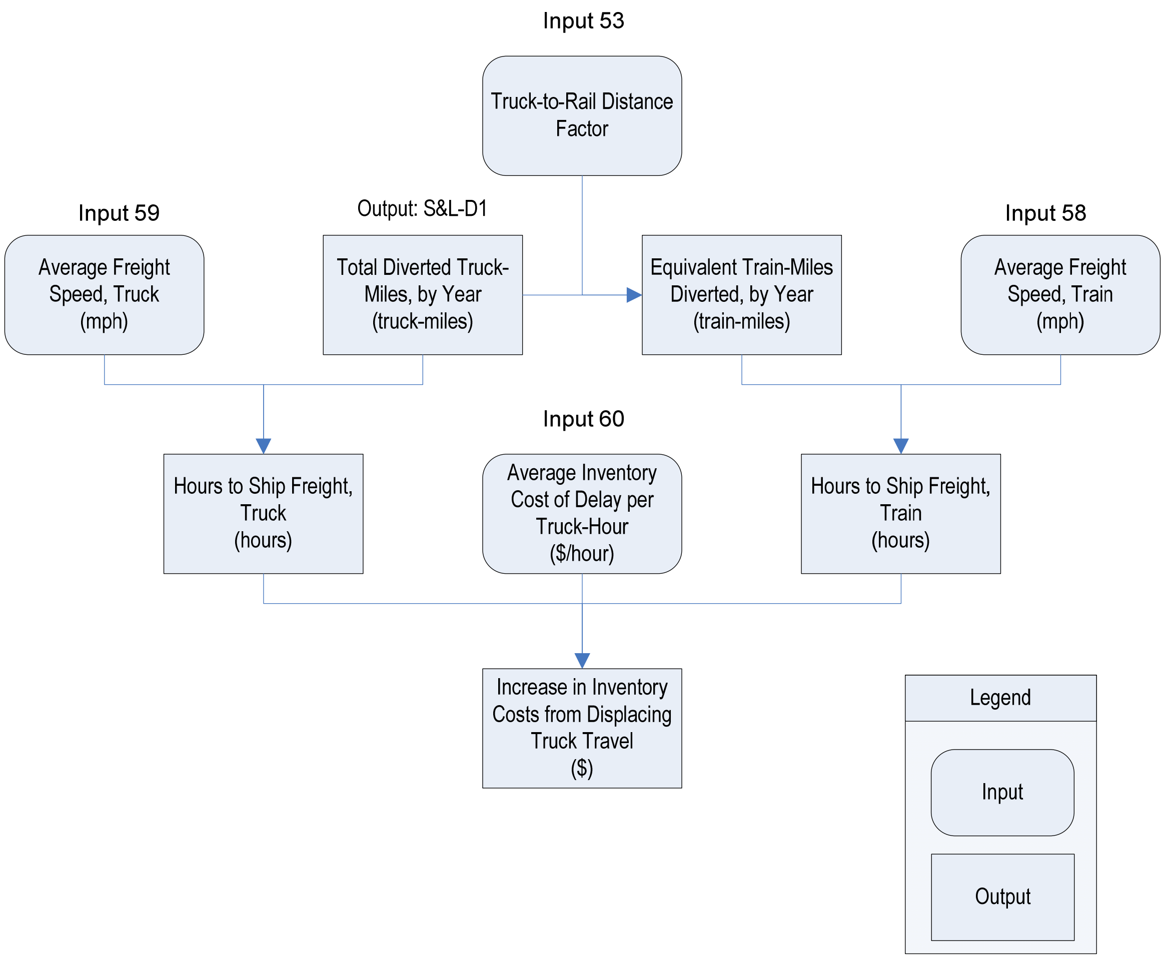


Table 11: Benefit #2. Input Values and Sources

Input #	Input Name	Units	Value	Source/Comment
58	Average Freight Truck Speed	mph	30	Federal Highway Administration (FHWA)
59	Average Freight Train Speed	mph	18	Surface Transportation Board (STB) - 2007
60	Average Inventory Cost of Delay per Truck Hour	$/hour	$0.18	HDR Calculation based on a 4.25% Discount Rate
53	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.

Table 12: Benefit #2 – Present Values of Benefits

Benefit Category	PV Over 20 Years	
	7%	3%
Increased inventory cost from diverting trucks to rail	-$31,009.0	-$48,740.5

3.4 Benefit #3: Congestion Cost Saving from Diverting Trucks to Rail

As freight is diverted from truck to rail transit because of the project, truck travel will decrease in the region, *ceteris paribus*. A truck takes up more physical space on the road than a car, and reducing the amount of truck travel will lead to a decrease in highway congestion and an increase in time savings for the regional population. The structure and logic of the decreased congestion benefit is presented below.

Figure 6: Benefit #3 – Structure and Logic Diagram

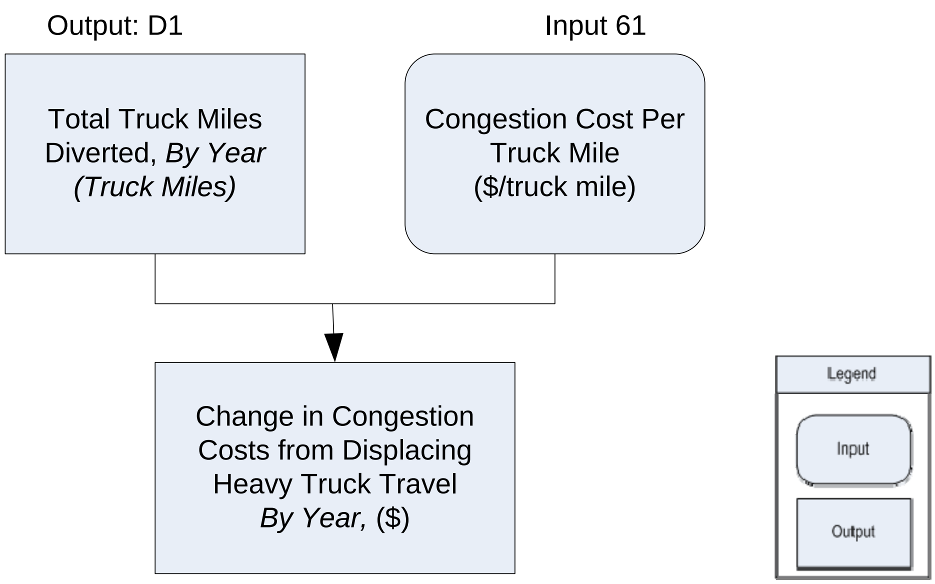


Table 13: Benefit #3 – Input Values and Sources

Input #	Input Name	Units	Value	Source/Comment
61	Congestion Cost per Truck Mile	$/mile	$0.027786	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.

Table 14: Benefit #3 – Present Values of Benefits

Benefit Category	PV Over 20 Years	
	7%	3%
Congestion cost saving from diverting trucks to rail	$137,331.3	$215,859.4

3.5 Benefit #4: Maintenance Cost Saving from Diverting Trucks to Rail

Heavy trucks put a great deal of physical wear and tear on roads, and the roads must be maintained at the taxpayer's expense. Diverting freight from truck to rail and reducing the amount of truck travel will lead to less required highway maintenance and associated costs. This cost reduction benefit is quantified by taking the difference between the highway maintenance costs avoided if freight is diverted from truck to rail and the expected incremental railroad maintenance costs associated with the increased rail activity.

Figure 7: Benefit #4 – Structure and Logic Diagram

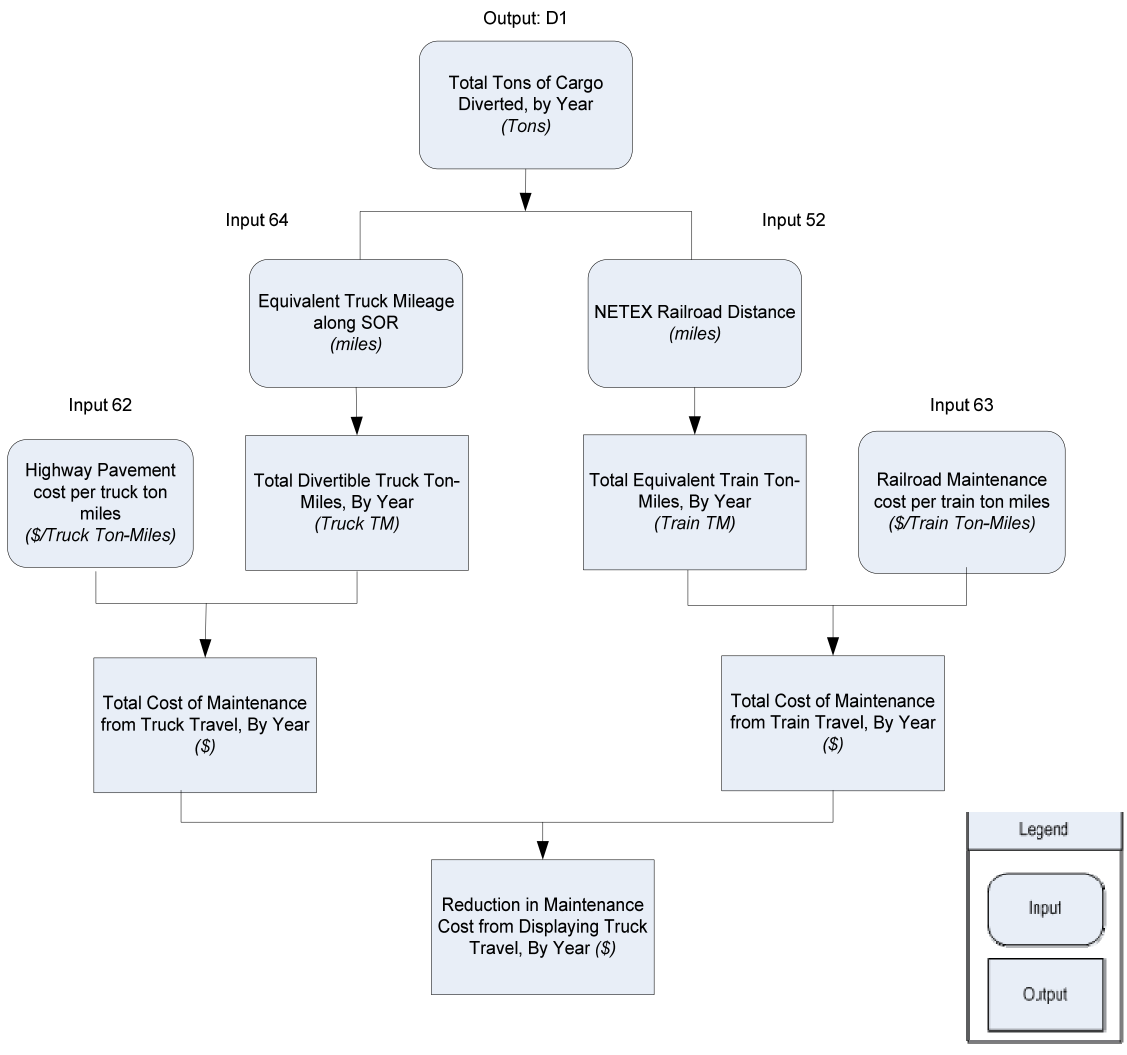


Table 15: Benefit #4 – Input Values and Sources

Input #	Input Name	Units	Value	Source/Comment
62	Pavement maintenance cost per truck ton-mile	2010$/ ton-mile	0.009166	HDR Calculations based on the Addendum to the 1997 Federal Highway Cost Allocation Study, Final Report, U.S. Department of Transportation and Federal Highway Administration, May 2000. Assumes 90 percent rural truck traffic.
63	Pavement maintenance cost per train ton-mile	2010$/ ton-mile	$0.0022589	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".
64	Truck Mileage along NETEX	miles	54.45	HDR calculation based on truck and railroad distance factor of 0.83
52	NETEX Railroad Distance	miles	65.60	NETEX

Table 16: Benefit #4 – Present Values of Benefits

Benefit Category	PV Over 20 Years	
	7%	3%
Maintenance cost saving from diverting trucks to rail	$557,397.1	$876,125.4

3.6 Benefit #5: Safety Saving from Diverting Trucks to Rail

Regardless of the mode of transportation utilized, accidents will occur while shipping cargo. Although highway accidents should diminish as freight is diverted from trucks to railcars, rail accidents should increase in turn. Rail and truck travel have their own respective accident frequency and associated cost levels, and thus the change in safety resulting from the project is monetized according to the diagram below.

Figure 8: Benefit #5 – Structure and Logic Diagram

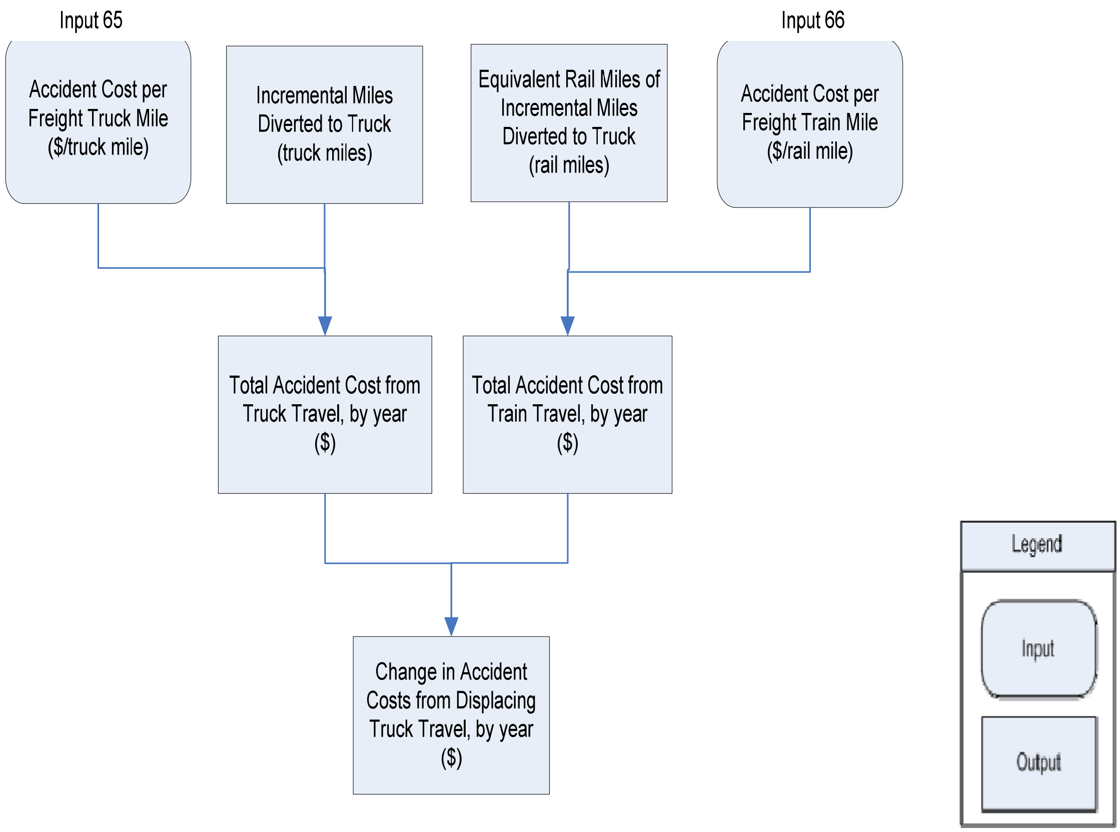


Table 17: Benefit #5 – Input Values and Sources

Input #	Input Name	Units	Value	Source/Comment
65	Accident Cost per Truck Mile	$/truck mile	$0.3111	HDR Calculations based on Tiger II Guidelines for Accident Values, National Highway Traffic Safety Administration (NHTSA) for accident data and mileage statistics.
66	Accident Cost per Train Mile	$/train mile	$13.5028	HDR Calculations based on Tiger II Guidelines for Accident Values, National Highway Traffic Safety Administration (NHTSA) for accident data, and U.S. Department of Transportation, Bureau of Transportation Statistics for mileage statistics.

Table 18: Benefit #5 – Present Values of Benefits

Benefit Category	PV Over 20 Years	
	7%	3%
Safety Saving from Diverting Trucks to Rail	$562,983.4	$884,906.0

3.7 Benefit #6: Emission Saving from Diverting Trucks to Rail

This benefit category captures the emissions quantities that result from the diversion of truck freight to rail. Standard U.S. EPA and TIGER II guidance inputs were used.

Figure 9: Benefit #6 – Structure and Logic Diagram

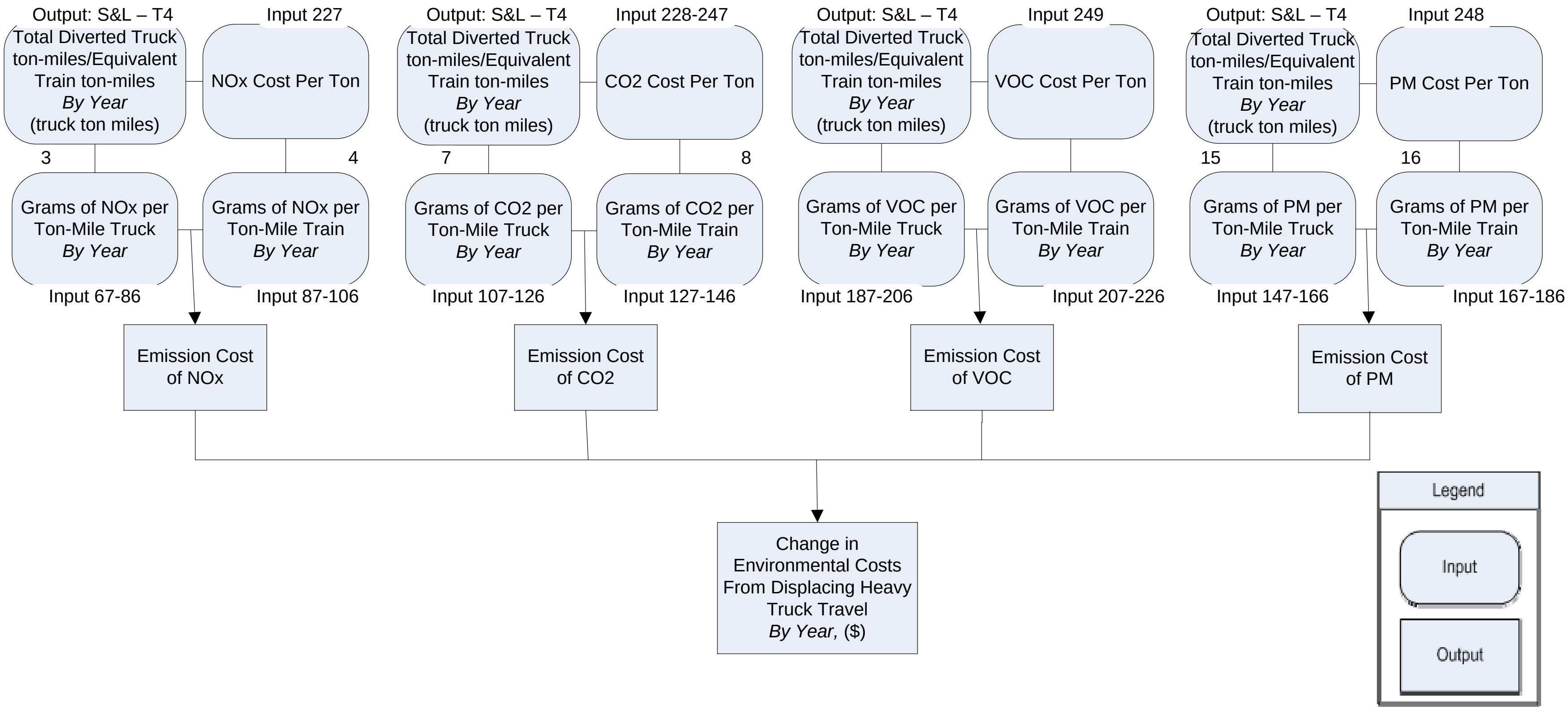


Table 19: Benefit #6 – Input Values and Sources

Input #	Input Name	Units	Value	Source/Comment
67	Grams of NOx per truck ton-mile - 2013	grams/TM	0.47	Mobile 6.2. 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 to the legal 80,000-lb.-GVW limit and getting 6.5 mpg.No empty backhaul is assumed.
68	Grams of NOx per truck ton-mile - 2014	grams/TM	0.40	
69	Grams of NOx per truck ton-mile - 2015	grams/TM	0.34	
70	Grams of NOx per truck ton-mile - 2016	grams/TM	0.31	
71	Grams of NOx per truck ton-mile - 2017	grams/TM	0.26	
72	Grams of NOx per truck ton-mile - 2018	grams/TM	0.22	
73	Grams of NOx per truck ton-mile - 2019	grams/TM	0.19	
74	Grams of NOx per truck ton-mile - 2020	grams/TM	0.17	
75	Grams of NOx per truck ton-mile - 2021	grams/TM	0.15	
76	Grams of NOx per truck ton-mile - 2022	grams/TM	0.13	
77	Grams of NOx per truck ton-mile - 2023	grams/TM	0.11	
78	Grams of NOx per truck ton-mile - 2024	grams/TM	0.10	
79	Grams of NOx per truck ton-mile - 2025	grams/TM	0.09	
80	Grams of NOx per truck ton-mile - 2026	grams/TM	0.08	
81	Grams of NOx per truck ton-mile - 2027	grams/TM	0.07	
82	Grams of NOx per truck ton-mile - 2028	grams/TM	0.06	
83	Grams of NOx per truck ton-mile - 2029	grams/TM	0.06	
84	Grams of NOx per truck ton-mile - 2030	grams/TM	0.06	
85	Grams of NOx per truck ton-mile - 2031	grams/TM	0.06	
86	Grams of NOx per truck ton-mile - 2032	grams/TM	0.06	
87	Grams of NOx per train ton-mile - 2013	grams/TM	0.28	Source for Tables 3-71 and 3-81 is "Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters Per Cylinder" Gram/ton-mile 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.) In addition, a conservative 1% improvement in fuel
88	Grams of NOx per train ton-mile - 2014	grams/TM	0.27	
89	Grams of NOx per train ton-mile - 2015	grams/TM	0.26	
90	Grams of NOx per train ton-mile - 2016	grams/TM	0.24	
91	Grams of NOx per train ton-mile - 2017	grams/TM	0.23	
92	Grams of NOx per train ton-mile - 2018	grams/TM	0.21	
93	Grams of NOx per train ton-mile - 2019	grams/TM	0.20	
94	Grams of NOx per train ton-mile - 2020	grams/TM	0.19	
95	Grams of NOx per train ton-mile - 2021	grams/TM	0.18	
96	Grams of NOx per train ton-mile - 2022	grams/TM	0.17	
97	Grams of NOx per train ton-mile - 2023	grams/TM	0.16	
98	Grams of NOx per train ton-mile - 2024	grams/TM	0.15	
99	Grams of NOx per train ton-mile - 2025	grams/TM	0.14	
100	Grams of NOx per train ton-mile - 2026	grams/TM	0.13	
101	Grams of NOx per train ton-mile - 2027	grams/TM	0.12	
102	Grams of NOx per train ton-mile - 2028	grams/TM	0.11	
103	Grams of NOx per train ton-mile - 2029	grams/TM	0.10	
104	Grams of NOx per train ton-mile - 2030	grams/TM	0.09	

105	Grams of NOx per train ton-mile - 2031	grams/TM	0.09	
106	Grams of NOx per train ton-mile - 2032	grams/TM	0.09	
107	Grams of CO2 per truck ton-mile - 2013	grams/TM	78.57	Mobile 6.2. 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 to the legal 80,000-lb.-GVW limit and getting 6.5 mpg.No empty backhaul is assumed.
108	Grams of CO2 per truck ton-mile - 2014	grams/TM	78.50	
109	Grams of CO2 per truck ton-mile - 2015	grams/TM	78.44	
110	Grams of CO2 per truck ton-mile - 2016	grams/TM	78.40	
111	Grams of CO2 per truck ton-mile - 2017	grams/TM	78.36	
112	Grams of CO2 per truck ton-mile - 2018	grams/TM	78.33	
113	Grams of CO2 per truck ton-mile - 2019	grams/TM	78.30	
114	Grams of CO2 per truck ton-mile - 2020	grams/TM	78.28	
115	Grams of CO2 per truck ton-mile - 2021	grams/TM	78.28	
116	Grams of CO2 per truck ton-mile - 2022	grams/TM	78.28	
117	Grams of CO2 per truck ton-mile - 2023	grams/TM	78.28	
118	Grams of CO2 per truck ton-mile - 2024	grams/TM	78.28	
119	Grams of CO2 per truck ton-mile - 2025	grams/TM	78.28	
120	Grams of CO2 per truck ton-mile - 2026	grams/TM	78.28	
121	Grams of CO2 per truck ton-mile - 2027	grams/TM	78.28	
122	Grams of CO2 per truck ton-mile - 2028	grams/TM	78.28	
123	Grams of CO2 per truck ton-mile - 2029	grams/TM	78.28	
124	Grams of CO2 per truck ton-mile - 2030	grams/TM	78.28	
125	Grams of CO2 per truck ton-mile - 2031	grams/TM	78.28	
126	Grams of CO2 per truck ton-mile - 2032	grams/TM	78.28	
127	Grams of CO2 per train ton-mile - 2013	grams/TM	20.23	Source for Tables 3-71 and 3-81 is "Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters Per Cylinder" Gram/ton-mile 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.) In addition, a conservative 1% improvement in fuel efficiency is assumed per
128	Grams of CO2 per train ton-mile - 2014	grams/TM	20.02	
129	Grams of CO2 per train ton-mile - 2015	grams/TM	19.81	
130	Grams of CO2 per train ton-mile - 2016	grams/TM	19.60	
131	Grams of CO2 per train ton-mile - 2017	grams/TM	19.39	
132	Grams of CO2 per train ton-mile - 2018	grams/TM	19.18	
133	Grams of CO2 per train ton-mile - 2019	grams/TM	18.97	
134	Grams of CO2 per train ton-mile - 2020	grams/TM	18.75	
135	Grams of CO2 per train ton-mile - 2021	grams/TM	18.54	
136	Grams of CO2 per train ton-mile - 2022	grams/TM	18.33	
137	Grams of CO2 per train ton-mile - 2023	grams/TM	18.12	
138	Grams of CO2 per train ton-mile - 2024	grams/TM	17.91	
139	Grams of CO2 per train ton-mile - 2025	grams/TM	17.70	
140	Grams of CO2 per train ton-mile - 2026	grams/TM	17.49	
141	Grams of CO2 per train ton-mile - 2027	grams/TM	7.28	
142	Grams of CO2 per train ton-mile - 2028	grams/TM	17.07	
143	Grams of CO2 per train ton-mile - 2029	grams/TM	16.86	
144	Grams of CO2 per train ton-mile - 2030	grams/TM	16.65	
145	Grams of CO2 per train ton-mile - 2031	grams/TM	16.44	

146	Grams of CO2 per train ton-mile - 2032	grams/TM	16.23	
147	Grams of PM per truck ton-mile - 2013	grams/TM	0.009	Mobile 6.2. 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 to the legal 80,000-lb.-GVW limit and getting 6.5 mpg. No empty backhaul is assumed.
148	Grams of PM per truck ton-mile - 2014	grams/TM	0.007	
149	Grams of PM per truck ton-mile - 2015	grams/TM	0.006	
150	Grams of PM per truck ton-mile - 2016	grams/TM	0.006	
151	Grams of PM per truck ton-mile - 2017	grams/TM	0.006	
152	Grams of PM per truck ton-mile - 2018	grams/TM	0.005	
153	Grams of PM per truck ton-mile - 2019	grams/TM	0.005	
154	Grams of PM per truck ton-mile - 2020	grams/TM	0.005	
155	Grams of PM per truck ton-mile - 2021	grams/TM	0.005	
156	Grams of PM per truck ton-mile - 2022	grams/TM	0.004	
157	Grams of PM per truck ton-mile - 2023	grams/TM	0.004	
158	Grams of PM per truck ton-mile - 2024	grams/TM	0.004	
159	Grams of PM per truck ton-mile - 2025	grams/TM	0.004	
160	Grams of PM per truck ton-mile - 2026	grams/TM	0.004	
161	Grams of PM per truck ton-mile - 2027	grams/TM	0.004	
162	Grams of PM per truck ton-mile - 2028	grams/TM	0.004	
163	Grams of PM per truck ton-mile - 2029	grams/TM	0.004	
164	Grams of PM per truck ton-mile - 2030	grams/TM	0.004	
165	Grams of PM per truck ton-mile - 2031	grams/TM	0.004	
166	Grams of PM per truck ton-mile - 2032	grams/TM	0.004	
167	Grams of PM per train ton-mile - 2013	grams/TM	0.009	Source for Tables 3-71 and 3-81 is "Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters Per Cylinder" Gram/ton-mile 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.) In addition, a conservative 1% improvement in fuel efficiency is assumed per
168	Grams of PM per train ton-mile - 2014	grams/TM	0.009	
169	Grams of PM per train ton-mile - 2015	grams/TM	0.008	
170	Grams of PM per train ton-mile - 2016	grams/TM	0.008	
171	Grams of PM per train ton-mile - 2017	grams/TM	0.007	
172	Grams of PM per train ton-mile - 2018	grams/TM	0.007	
173	Grams of PM per train ton-mile - 2019	grams/TM	0.006	
174	Grams of PM per train ton-mile - 2020	grams/TM	0.006	
175	Grams of PM per train ton-mile - 2021	grams/TM	0.005	
176	Grams of PM per train ton-mile - 2022	grams/TM	0.005	
177	Grams of PM per train ton-mile - 2023	grams/TM	0.005	
178	Grams of PM per train ton-mile - 2024	grams/TM	0.004	
179	Grams of PM per train ton-mile - 2025	grams/TM	0.004	
180	Grams of PM per train ton-mile - 2026	grams/TM	0.004	
181	Grams of PM per train ton-mile - 2027	grams/TM	0.003	
182	Grams of PM per train ton-mile - 2028	grams/TM	0.003	
183	Grams of PM per train ton-mile - 2029	grams/TM	0.003	
184	Grams of PM per train ton-mile - 2030	grams/TM	0.002	
185	Grams of PM per train ton-mile - 2031	grams/TM	0.002	

186	Grams of PM per train ton-mile - 2032	grams/TM	0.002	
187	Grams of VOC per truck ton-mile - 2013	grams/TM	0.013	Mobile 6.2. 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 to the legal 80,000-lb.-GVW limit and getting 6.5 mpg. No empty backhaul is assumed.
188	Grams of VOC per truck ton-mile - 2014	grams/TM	0.013	
189	Grams of VOC per truck ton-mile - 2015	grams/TM	0.012	
190	Grams of VOC per truck ton-mile - 2016	grams/TM	0.011	
191	Grams of VOC per truck ton-mile - 2017	grams/TM	0.011	
192	Grams of VOC per truck ton-mile - 2018	grams/TM	0.011	
193	Grams of VOC per truck ton-mile - 2019	grams/TM	0.011	
194	Grams of VOC per truck ton-mile - 2020	grams/TM	0.010	
195	Grams of VOC per truck ton-mile - 2021	grams/TM	0.010	
196	Grams of VOC per truck ton-mile - 2022	grams/TM	0.010	
197	Grams of VOC per truck ton-mile - 2023	grams/TM	0.010	
198	Grams of VOC per truck ton-mile - 2024	grams/TM	0.010	
199	Grams of VOC per truck ton-mile - 2025	grams/TM	0.010	
200	Grams of VOC per truck ton-mile - 2026	grams/TM	0.010	
201	Grams of VOC per truck ton-mile - 2027	grams/TM	0.010	
202	Grams of VOC per truck ton-mile - 2028	grams/TM	0.009	
203	Grams of VOC per truck ton-mile - 2029	grams/TM	0.009	
204	Grams of VOC per truck ton-mile - 2030	grams/TM	0.009	
205	Grams of VOC per truck ton-mile - 2031	grams/TM	0.009	
206	Grams of VOC per truck ton-mile - 2032	grams/TM	0.009	
207	Grams of VOC per train ton-mile - 2013	grams/TM	0.014	Source for Tables 3-71 and 3-81 is "Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters Per Cylinder" Gram/ton-mile 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.) In addition, a conservative 1% improvement in fuel efficiency is assumed per
208	Grams of VOC per train ton-mile - 2014	grams/TM	0.013	
209	Grams of VOC per train ton-mile - 2015	grams/TM	0.012	
210	Grams of VOC per train ton-mile - 2016	grams/TM	0.010	
211	Grams of VOC per train ton-mile - 2017	grams/TM	0.009	
212	Grams of VOC per train ton-mile - 2018	grams/TM	0.009	
213	Grams of VOC per train ton-mile - 2019	grams/TM	0.008	
214	Grams of VOC per train ton-mile - 2020	grams/TM	0.007	
215	Grams of VOC per train ton-mile - 2021	grams/TM	0.007	
216	Grams of VOC per train ton-mile - 2022	grams/TM	0.006	
217	Grams of VOC per train ton-mile - 2023	grams/TM	0.006	
218	Grams of VOC per train ton-mile - 2024	grams/TM	0.006	
219	Grams of VOC per train ton-mile - 2025	grams/TM	0.005	
220	Grams of VOC per train ton-mile - 2026	grams/TM	0.005	
221	Grams of VOC per train ton-mile - 2027	grams/TM	0.004	
222	Grams of VOC per train ton-mile - 2028	grams/TM	0.004	
223	Grams of VOC per train ton-mile - 2029	grams/TM	0.004	
224	Grams of VOC per train ton-mile - 2030	grams/TM	0.003	
225	Grams of VOC per train ton-mile - 2031	grams/TM	0.003	

226	Grams of VOC per train ton-mile - 2032	grams/TM	0.003	
227	NOx cost per ton	2010$/short ton	$5,590	NHTSA Final Regulatory Impact Analysis (2009)
228	CO2 cost per ton - 2013	2010$/short ton	$21.81	Interagency Working Group on Social Cost of Carbon, US Government for Regulatory Impact Analysis under Executive Order 12866. 2010
229	CO2 cost per ton - 2014	2010$/short ton	$22.27	
230	CO2 cost per ton - 2015	2010$/short ton	$22.74	
231	CO2 cost per ton - 2016	2010$/short ton	$23.21	
232	CO2 cost per ton - 2017	2010$/short ton	$23.70	
233	CO2 cost per ton - 2018	2010$/short ton	$24.20	
234	CO2 cost per ton - 2019	2010$/short ton	$24.71	
235	CO2 cost per ton - 2020	2010$/short ton	$25.22	
236	CO2 cost per ton - 2021	2010$/short ton	$25.78	
237	CO2 cost per ton - 2022	2010$/short ton	$26.35	
238	CO2 cost per ton - 2023	2010$/short ton	$26.93	
239	CO2 cost per ton - 2024	2010$/short ton	$27.52	
240	CO2 cost per ton - 2025	2010$/short ton	$28.12	
241	CO2 cost per ton - 2026	2010$/short ton	$28.74	
242	CO2 cost per ton - 2027	2010$/short ton	$29.38	
243	CO2 cost per ton - 2028	2010$/short ton	$30.02	
244	CO2 cost per ton - 2029	2010$/short ton	$30.68	
245	CO2 cost per ton - 2030	2010$/short ton	$31.36	
246	CO2 cost per ton - 2031	2010$/short ton	$31.92	
247	CO2 cost per ton - 2032	2010$/short ton	$32.50	
248	PM cost per ton	2010$/short ton	$306,092	National Highway Traffic Safety Administration, "Corporate Average Fuel Economy for FY 2011 Passenger Cars and Light Trucks", March 2009
249	VOC cost per ton	2010$/short ton	$1,377	National Highway Traffic Safety Administration, "Corporate Average Fuel Economy for FY 2011 Passenger Cars and Light Trucks", March 2009
250	Grams per Short Ton	grams	907,185	HDR

Table 20: Benefit #6 – Present Values of Benefits

Benefit Category	PV Over 20 Years	
	7%	3%
Emission Saving from Diverting Trucks to Rail	$79,090	$138,436

4 MODEL SENSITIVITIES

The values in the cost-benefit analysis model that have the biggest impact on the economic benefits and Net Present Value results are provided in the table below. The data that is most influential are the number of carloads on the NETEX (the percentage difference between actual carloads on rail in base and alternative cases) and the relative cost of shipping by rail and truck (the percentage rail shipping discount relative to truck). The sensitivity analysis reveals how much these values would have to change for the project Net Present Value to equal zero (and a benefit cost ratio of 1.0). The sensitivity analysis indicates that these key assumptions must be reduced by large amounts in order for the Net Present Value to equal zero at a 7 percent discount rate.

Table 21: Variables in the Model That Can be Modified

Variable	Base Value	Value Required for NPV = 0	% Change Required
Percentage of difference between actual carloads on rail in base and alt cases	100%	326%	226%
Transportation cost savings from rail relative to truck	15%	42%	180%
Trucks per Car	3	14.4	390%

GLOSSARY

Carbon Dioxide (CO_2): Carbon dioxide is a heavy colorless gas that is a by-product of the combustion of hydrocarbon fuels. Carbon dioxide is linked to climate change.

Discounted Value: The discounted value is the present value of a future cash amount. The present value is determined by reducing its future value by the appropriate discount rate for each unit of time between the time when the cash flow is to be valued to the time of the cash flow. To calculate the present value of a single cash flow, it is divided by one plus the interest rate (discount rate) for each period of time that will pass. This is expressed mathematically as raising the divisor to the power of the number of units of time.

Nitrogen Oxides (NO_X): Nitrogen oxides include a number of gases that are composed of oxygen and nitrogen. In the presence of sunlight these substances can transform into acidic air pollutants such as nitrate particles. The nitrogen oxides family of gases can be transported long distances in our atmosphere. Nitrogen oxides play a key role in the formation of smog (ground-level ozone). At elevated levels, NO_X can impair lung function, irritate the respiratory system and, at very high levels, make breathing difficult, especially for people who already suffer form asthma or bronchitis.

Particulate Matter (PM): Particulate matter refers to tiny particles of solid or liquid suspended in a gas. Sources of particulate matter can be man made or natural. Some particulates occur naturally, originating from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. Human activities, such as the burning of fossil fuels in vehicles, power plants and various industrial processes also generate significant amounts of aerosols.

Ton: In the context of this document, is a short ton equivalent to 2,000 lbs.

Train Mile: A train mile is the one mile distance traveled by a train.

Train Ton-Mile: One train ton-mile is equivalent to transporting one ton of materials via train a distance of one mile.

Volatile Organic Compound (VOC): Volatile organic compounds (VOCs) are a large and diverse family of chemicals that contain carbon and hydrogen. They can be emitted into indoor air from a variety of sources including cigarette smoke, household products like air fresheners, furnishings, vehicle exhaust and building materials such as paint, varnish and glues.

HDR

www.hdrinc.com

MISSION

To be a superior
professional firm
known for vision,
value, and service
to our clients,
our communities
and our employees.