



US 377 Relief Route

Appendix C: Benefit Cost Analysis

TIGER FY17 Grant Application

October 2017

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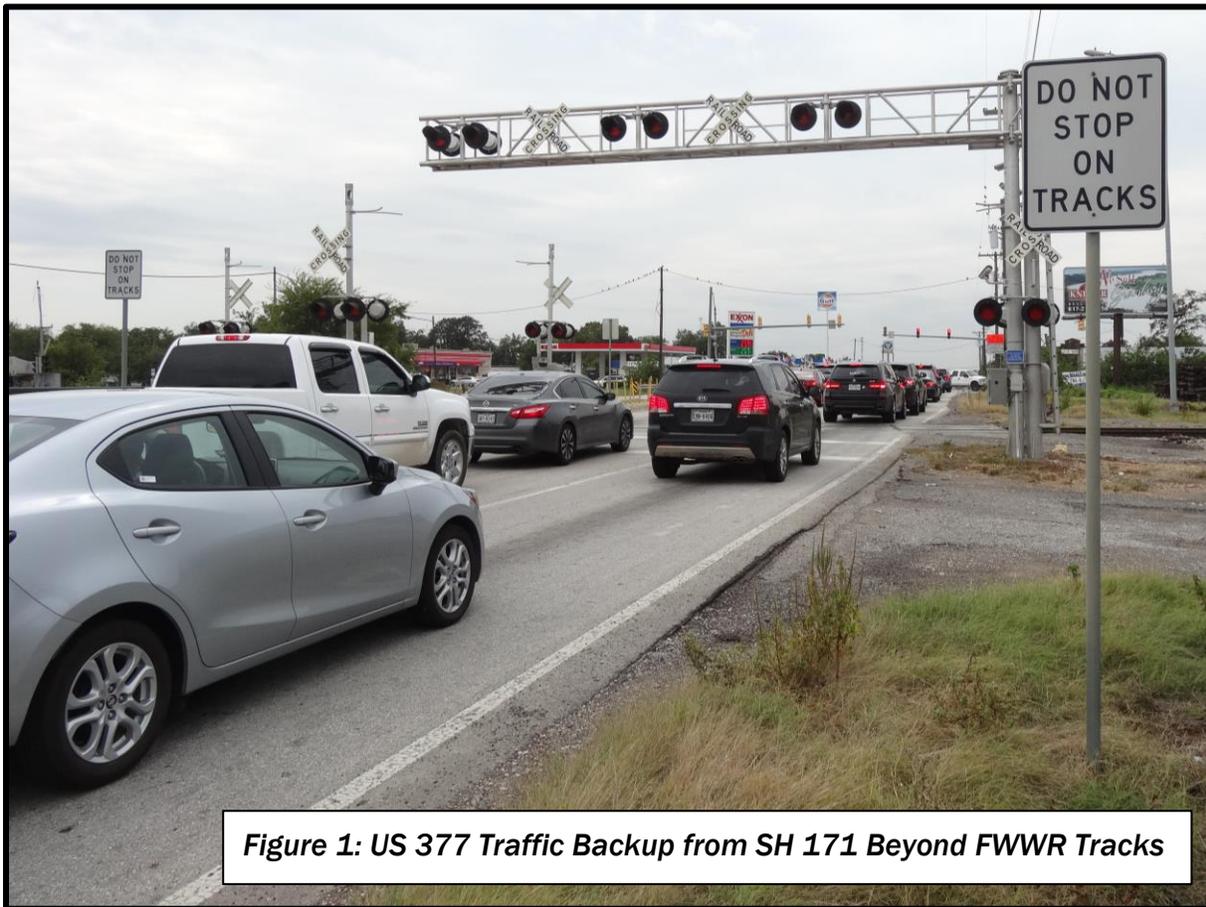
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Appendix: US 377 Relief Route BCA Spreadsheet

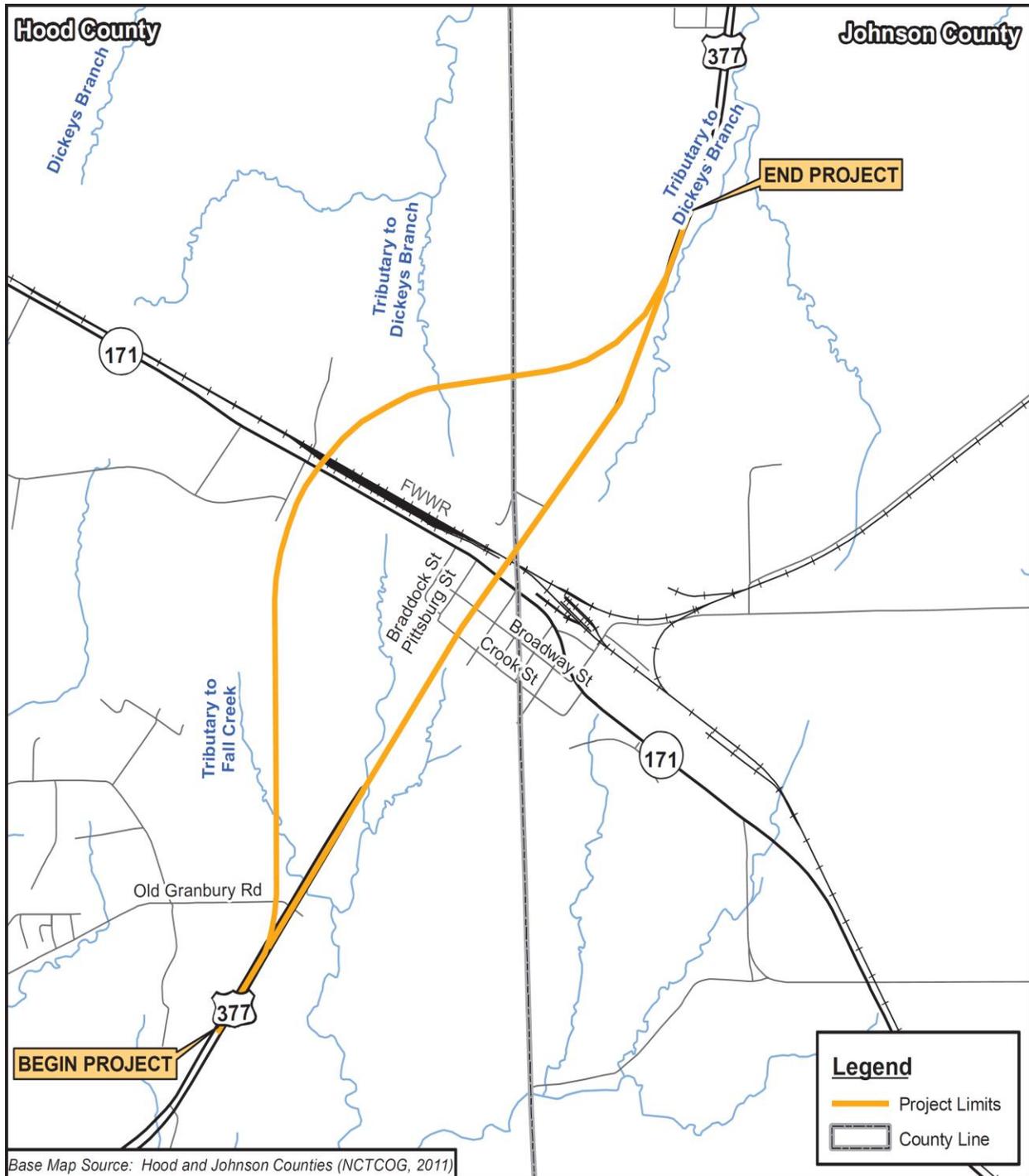


1.0 Executive Summary

The 2.68-mile stretch of US 377 through Cresson, Texas—an undivided, four-lane roadway—creates a bottleneck in the commuter corridor between Granbury and the Dallas-Fort Worth-Arlington, Texas, Metropolitan Statistical Area (the “Metroplex”), largely due to the proximity of an at-grade railroad crossing to the signaled intersection with SH 171. Furthermore, US 377 is part of the Texas Highway Trunk System, but does not meet the Texas Department of Transportation (TxDOT) design criteria which states that Trunk routes should be at least four-lane divided highways with grade-separated railroad crossings. The State has analyzed alternatives for increasing the vehicular capacity in this area and determined that a 3.02-mile, access-controlled highway relief route for US 377 west of Cresson is the most viable option. (See Figure 2.)

The greatest benefit calculated in this analysis is the time savings drivers and passengers of vehicles using the proposed US 377 Relief Route will enjoy. A US 377 Relief Route with a grade separation over SH 171 and Fort Worth & Western Railroad (FWWR) tracks, as well as over Old Granbury Road and under a proposed access road, manifests in reduced traveling and idling time. A second significant benefit is the reduction in accidents. Not only will the relief route experience fewer accidents because it will be a divided, rather than undivided, highway, but it will have no vehicle-train crashes. These benefits are partially

Figure 2: US 377 Relief Route Project Map



offset with additional costs (“disbenefits”) related to a longer—albeit faster—route, such as increased vehicular operating costs and higher emissions due to greater miles traveled. While a US 377 relief route will improve emergency response times when slow-moving trains occupy the FWR at-grade crossing, those benefits and a few others are not readily translated into dollars (“monetized”), so are mentioned, but not directly incorporated in this benefits-cost analysis (BCA).

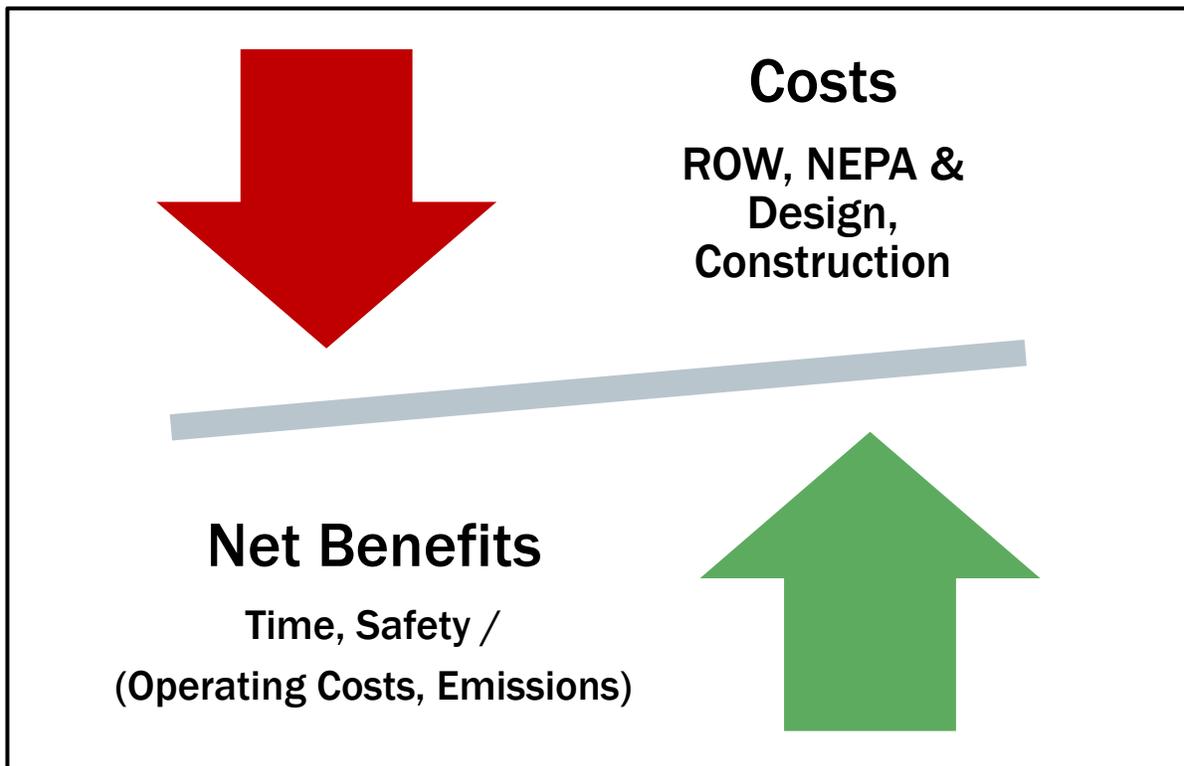


Figure 3: Benefit-Cost Analysis Overview

The costs associated with a US 377 relief route include not only the cost of the infrastructure itself, but also environmental review (already completed), engineering design (in process), and traffic control during construction. Total cost of the project is \$80.1 million.

All monetary values are stated in 2016 dollars, as directed by the U.S. Department of Transportation (USDOT) in its Benefit-Cost Analysis Guidance for TIGER and INFRA Grants. The BCA estimates benefits over a 20-year period beyond the four-year period to complete design and construction of the project. Since the relief route and related structures will have a longer effective life, likely about 75 years, the BCA estimates a residual value as one final benefit at the end of the analysis period. USDOT guidelines for benefit-cost analyses were followed, including guidelines for valuing travelers’ time, injuries, and emissions, for discounting future cash flows, and for categorizing benefits.

The BCA categorizes the project's benefits by the Primary Selection Criteria for TIGER funds, as follows (and references these categories in Tables 1 and 2 under the applicable impacts):

- A) **Safety:** Improving the safety of U.S. transportation facilities and systems.
- B) **State of Good Repair:** Improving the condition of existing transportation facilities and systems, with particular emphasis on projects that minimize lifecycle costs.
- C) **Economic Competitiveness:** Contributing to the economic competitiveness of the United States over the medium- to long-term.
- D) **Environmental Sustainability:** Improving energy efficiency, reducing dependence on oil, reducing greenhouse gas emissions and benefitting the environment.
- E) **Quality of Life:** Improving the quality of living and working environments and the experience for people in communities across the United States.

Table 1: Summary of Analysis Benefits

Current Status/ Baseline & Problem to be Addressed	Change to Baseline/ Alternatives	Type of Impacts	Population Affected by Impacts	Economic Impacts	Summary of Results: Benefit / (Disbenefit)	Page Reference In BCA and Spreadsheet
4-lane undivided highway through Cresson, crossing FWWR tracks and SH 171 at grade	Construct a relief route around Cresson with grade separation over FWWR tracks and SH 171	Roadway and auto-train accidents (A)	Drivers and passengers in using US 377 through Cresson; FWWR	Decreased cost of roadway accidents, Lower costs of auto-train crashes	\$35 million fewer roadway accidents; \$1 million of avoided auto-train crashes	Page 9, Appendix spreadsheet tabs Accidents and Grade Xing Accidents
		Travel time, including delays at FWWR crossing (C)	Drivers and passengers in using US 377 through Cresson	Monetized value of time	\$291 million time saved	Page 12, Appendix spreadsheet tabs Time & Grade Xing Time
		Residual value (B)	TxDOT	Estimated residual value, net of future costs	\$56 million of residual value	Page 19
		Additional qualitative benefits (C, D, E)	Drivers and residents in Hood & Johnson Counties, FWWR	Greater reliability; Reduced emergency response times; Reduced train delays	Not monetized	Page 22

Table 2: Summary of Analysis Disbenefits

Current Status/ Baseline & Problem to be Addressed	Change to Baseline/ Alternatives	Type of Impacts	Population Affected by Impacts	Economic Impacts	Summary of Results: Benefit / (Disbenefit)	Page Reference In BCA and Spreadsheet
<p>4-lane undivided highway through Cresson, crossing FWWR tracks and SH 171 at grade</p>	<p>Construct a relief route around Cresson with grade separation over FWWR tracks and SH 171</p>	<p>Detours and construction delays (C, E)</p>	<p>Drivers and passengers in using US 377 through Cresson</p>	<p>Monetized value of time</p>	<p>(\$1 million) additional time</p>	<p>Page 8</p>
		<p>Maintenance for additional infrastructure (B)</p>	<p>TxDOT, Texas taxpayers</p>	<p>Cost to maintain new route</p>	<p>(\$3 million) more materials and labor</p>	<p>Page 12, Appendix spreadsheet tab Mntc</p>
		<p>Vehicular costs (C)</p>	<p>Drivers and passengers in using US 377 Relief Route</p>	<p>Cost of driving additional miles, but idling less</p>	<p>(\$22 million) more operating costs</p>	<p>Page 15, Appendix spreadsheet tabs VMT-Operating Costs and Idling – Operating Costs</p>
		<p>Emissions (D)</p>	<p>Residents of Hood & Johnson Counties</p>	<p>Monetized values of VOC, NOx, PM₁₀</p>	<p>(\$1 million) of emissions</p>	<p>Page 16, Appendix spreadsheet (3) tabs starting with “Emissions”</p>

The BCA, summarized below in Table 3, suggests that the benefits associated with the proposed relief route for US 377 through Cresson, Texas, exceed the costs.

Table 3: Benefit-Cost Analysis Summary (\$ in Millions)

Description	Estimate (20-Year Benefit Summary)	Discounted (7%)
Net Benefits	\$356	\$125
Costs	\$80	\$72
B-C Ratio	4.44 : 1	1.73 : 1
Net Present Value		\$53

2.0 Purpose

The purpose of this benefit-cost analysis (BCA) is to quantify and compare the net benefits and costs of building and maintaining a relief route for US 377 in Cresson, Texas. The BCA illustrates that the benefits of adding an alternative route around the town justify the costs. Not only commuters working in the Fort Worth metropolitan area and truck drivers traveling through Cresson will enjoy these benefits, but also Cresson residents.

This BCA outlines the benefits and costs identified, benefit calculations, project costs, and the overall benefit-cost ratio and net present value (NPV) for the proposed project. Additionally, the BCA describes other, qualitative benefits of the project that have not been monetized.

3.0 Benefits and Disbenefits

3.1 *Detours and Construction Delay*

Since the proposed US 377 Relief Route itself is a new alignment with no existing traffic, most of its construction will generate no negative impacts; however, traffic on the existing US 377 and SH 171 will detour slightly during construction of connections to the proposed relief route. Planned construction phasing will minimize disbenefits of construction delays.

The project's design team expects detours will entail temporary lane closures at the project termini and at SH 171. Traffic control planning and design would include efforts to maintain existing traffic capacity during peak travel periods to minimize impacts. The BCA calculates detours based on the assumption that they would last one month during the last year of construction and affect all traffic on US 377 and SH 171, delaying traffic an average of five (5) minutes, or 0.083 hours.

The BCA calculates value of time (VOT) for both US 377 and SH 171 and for trucks and passenger vehicles separately. The total VOT is the sum of these individual VOT values. Calculations for the disbenefit of construction delay are as follows:

Average daily trucks = Average daily traffic (ADT for 2021) x Truck percentage

Average daily cars = ADT – Average daily trucks

Occupants = Average daily trucks (cars) x Truck (passenger vehicle) occupancy rates

Delay Hours = # Occupants x Average delay (0.083 hours) x 30 days

VOT = Delay hours x VOT rate (See section 3.4 for discussion of VOT rates)

3.2 Accidents

Accidents were valued using the following values for KABCO levels suggested by USDOT in its Benefit-Cost Analysis Guidance for TIGER and INFRA Applications:

Table 4: Value of Injuries

KABCO Level	Monetized Value
K – Killed	\$9,600,000
A – Incapacitating Injury	\$459,100
B – Non-incapacitating Injury	\$125,000
C – Possible Injury	\$63,900
O – No Injury	\$3,200
U – Injured (Severity Unknown)	\$174,000

3.2.1 Roadway Accidents

Driving on a divided highway, such as the proposed US 377 Relief Route, is safer than driving on an undivided highway like the existing highway through Cresson. Partially offsetting this safety design improvement is the greater length of route. As more highway miles are driven, more opportunities for roadway accidents are presented. Since the proposed US 377 Relief Route, at 3.02 miles, is longer than the existing US 377 route—2.68 miles as measured from the north and south project termini—all diversion of traffic from the existing corridor to the relief route creates an increase to potential roadway accidents. TxDOT reports the number of crashes per 100 million vehicle miles each year, differentiating rural and urban traffic and roadway types. It also maintains statistics for the number of fatalities and injuries (by severity) incurred. This BCA uses three years of these state historical rates as predictive rates on US 377 and on the proposed relief route. Granted, other conditions, such as speed limits, also factor into the number and severity of accidents. This BCA does not consider such other factors.

Table 5: Crash Rates per 100 Million Vehicle Miles Traveled (VMT)

Roadway Type	2014-2016 Texas Average Rate ¹
4 or More Lanes, Undivided	105.79
4 or More Lanes, Divided	62.24

Table 6: Fatality and Injuries (by Severity) per Crash

Incident Type	Incidents per Crash ²
K – Killed	.0154
A – Incapacitating Injury	.0545
B – Non-incapacitating Injury	.1686
C – Possible Injury	.2189
O – No Injury	1.8961
U – Injured (Severity Unknown)	.0825

The BCA estimates future roadway accidents for undivided and divided highways as follows:

$$\begin{aligned} \text{Annual VMT} &= \text{Average Daily Traffic (ADT)} \times \text{Corridor Length} \times 365 \text{ Days/Year} \\ \text{Number of Annual Crashes} &= \text{Annual VMT} \div 100\text{M} \times \text{Crash Rate} \\ \text{Number of Annual Incidents (by KABCO level)} &= \text{Number of Annual Crashes} \times \text{Incident Rate} \\ \text{Cost of Incidents (by KABCO level)} &= \text{Number of Annual Incidents} \times \text{KABCO Level Value} \\ \text{Total Accident Cost} &= \text{Cost of Fatalities} + \text{Cost of Incapacitating Injuries} + \text{Cost of Non-incapacitating Injuries} \\ &\quad + \text{Cost of Possible Injuries} + \text{Cost of No Injuries} + \text{Cost of Injuries, Severity Unknown} \end{aligned}$$

¹ TxDOT, Statewide Traffic Crash Rates, 2014, 2015 and 2016 (average).

<https://www.txdot.gov/government/enforcement/annual-summary.html> , accessed 9 October, 2017.

² TxDOT, Rural and Urban Crashes and Injuries by Severity, calculated using statistics for 2014, 2015 and 2016 (average).

<https://www.txdot.gov/government/enforcement/annual-summary.html> , accessed 9 October, 2017.

For the “Build” scenario, there will be VMT on both undivided and divided highways, so the BCA calculates the number of annual crashes for each. The total number of crashes is the sum of those on the undivided highway and those on the divided highway.

3.2.2 Railroad Crossing Accidents

The US 377 corridor through Cresson has an at-grade railroad crossing (FWWR’s crossing 020871M) that presents risks for auto-train crashes. The Federal Railroad Administration’s (FRA) grade crossing database reports 22 accidents/incidents at crossing 020871M over the last 40 years, resulting in two (2) fatalities and seven (7) injuries, or 9% and 32% as a percent of incidents incurred, respectively. The remaining 59% of incidents had no injuries. The BCA assumes that the historical severity of accidents at this crossing is predictive of future events.

Using the FRA database’s predictive capabilities, currently there is a 4.5225%³ likelihood of a collision at crossing 020871M. The BCA assumes this probability will change ratably with changes in the number of trains and the number of vehicles. One can expect the number of daily trains— currently ten⁴ (10)—to increase as U.S. gross domestic product (GDP) increases. TxDOT estimates GDP annual growth to be 2.5% over the analysis period, a rate slightly greater than the 2.27%⁵ suggested by the Office of Cooperation and Development (OECD). TxDOT expects ADT on US 377 to grow from 24,400 in 2015 to 33,900 in 2035 and to 38,600 in 2045⁶, suggesting growth rates of 1.66% annually between 2015 and 2035 and 1.31% annually between 2035 and 2045.

Based on a TxDOT traffic analysis from March 7, 2016, 69% of the ADT on US 377 would use the US 377 Relief Route. Since the relief route does not have an at-grade crossing, traffic using this route avoids all risk of incurring a vehicle-train collision.

Accident costs at the railroad crossing were valued as follows:

$$\text{Annual Accidents} = 2017 \text{ Probability } (.045225) \div 2017 \text{ \# Trains/day } (10) \times \text{Future Year \# Trains/day} \div 2017 \text{ ADT} \times \text{Future Year ADT}$$

$$\text{Cost of Fatalities} = \# \text{ Accidents} \times \text{Fatality Incident Rate } (9\%) \times \text{KABCO Level K Value}$$

$$\text{Cost of Injuries} = \# \text{ Accidents} \times \text{Injury Incident Rate } (32\%) \times \text{KABCO Level U Value}$$

$$\text{Cost of Non-injury Accidents} = \# \text{ Accidents} \times \text{No Injury Rate } (59\%) \times \text{KABCO Level O Value}$$

$$\text{Total Accident Cost} = \text{Cost of Fatalities} + \text{Cost of Injuries} + \text{Cost of Non-injury Accidents}$$

³ FRA Annual WBAPS 2017, Web Accident Prediction System, accessed 27 September, 2017.

⁴ FRA, USDOT Crossing Inventory Form for 020871M, accessed 26 September, 2017.

⁵ OECD, GDP Long-term Forecast, 2016-2041, <https://data.oecd.org/gdp/gdp-long-term-forecast.htm> , accessed 3 October, 2017.

⁶ TxDOT, Traffic Analysis for Highway Design, January 25, 2012.

3.3 Maintenance

TxDOT estimates annual roadway maintenance for the existing section of US 377 at \$13,000 per lane-mile. In addition to roadway maintenance, the proposed US 377 Relief Route will also have maintenance on the proposed structures, but new structures require little maintenance in the first 20 years. For purposes of the BCA, inspections costing \$2,000 every other year and one joint replacement costing \$15,000 in year 15 comprise estimated structure maintenance.

Maintenance costs were valued as follows:

Annual Roadway Maintenance = Corridor Length (in miles) x 4 Lanes x \$13,000/lane-mile

Annual Structure Maintenance (relief route only) = \$2,000 (inspection) even numbered years + \$15,000 (replace expansion joints) in year 15

Total Maintenance Cost = Annual Roadway Maintenance + Annual Structure Maintenance

3.4 Travel Time

The BCA follows USDOT guidelines for travel time savings to monetize the value of driver/passenger delays. The Benefit-Cost Analysis Guidance for TIGER and INFRA Applications dictates that private vehicle travel for all purposes and commercial truck travel be valued at \$14.10 and \$27.20 per hour, respectively, in 2016 dollars. The BCA augments these rates by 1.2% per year⁷ for productivity increases. The resultant private vehicle and commercial VOT rates range from \$14.44 to \$19.00 and \$27.86 to \$36.65, respectively, for the analysis period, 2018 through 2041.

USDOT recommends using occupancy rates of 1.39 and 1.00 for passenger vehicles and for commercial trucks, respectively.⁸

3.4.1 Time on Existing US 377 (Bus 377)

The posted speed limit on US 377 through Cresson is 45 mph. The BCA assumes that traffic on Bus 377 will travel at an average speed of 30 mph in 2022, for an average travel time through Cresson of 0.089 hours (5.36 minutes), including any wait at the signal for SH 171, and that travel times will change ratably with traffic changes. TxDOT estimates that

⁷ USDOT, Memo re: *Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis*, p.6, 9 July 2014, <https://www.transportation.gov/sites/dot.gov/files/docs/USDOT%20VOT%20Guidance%202014.pdf> accessed 3 October 2017.

⁸ USDOT, *Benefit-Cost Analysis Guidance for TIGER and INFRA Applications*, July 2017, page 31.

69%⁹ of the traffic on US 377 would utilize the relief route, substantially eliminating the congestion. We have assumed that traffic through Cresson would then achieve an average of 40 mph through Cresson, equating to a 0.067-hour (4.02 minutes) travel duration. Speed will not be impaired with growth on Bus 377 during the analysis period because, with the relief route taking the bulk of traffic, traffic volumes on Bus 377 through 2041 will not create congestion.

The BCA calculates VOT for trucks and cars separately and then sums these

values to get total VOT. VOT calculations are as follows:

$$\text{Average Daily Trucks} = \text{ADT} \times \text{Truck percentage (7\%)}$$

$$\text{Average Daily Cars} = \text{ADT} - \text{Average Daily Trucks}$$

$$\text{Occupants} = \text{Average daily trucks (cars)} \times \text{Truck (passenger vehicle) occupancy rates}$$

$$\text{Average Travel Time} = \text{Travel Time in 2022} \div \text{ADT in 2022} \times \text{ADT in future year}$$

(Noted exception is that speeds on Bus 377 will not exceed 40 mph)

$$\text{Annual Travel Time} = \# \text{ Occupants} \times \text{Average Travel Time} \times 365 \text{ days/year}$$

$$\text{VOT} = \text{Annual Travel Time} \times \text{VOT rate}$$

Figure 4: Rush Hour Congestion on US 377



⁹ TxDOT Traffic Analysis for Highway Design, March 7, 2016. Calculated as ADT for proposed alignment divided by ADT for US 377 existing alignment (no build).

3.4.2 Time on US 377 Relief Route

The BCA assumes that traffic on the relief route will achieve an average speed of 60 mph¹⁰ the year it is placed in service and that speeds will decrease (i.e., time to traverse route will increase) slightly to 59 mph¹¹ as volume increases to levels projected for 2035. The BCA interpolated travel times between these dates—a 0.14% annual increase—and assumed a similar rate of increase in travel times beyond 2035. Accordingly, the BCA estimates initial travel time for the 3.02-mile relief route to be .0503 hours (3.02 minutes) and travel time for the final year of the analysis period to be .0517 hours (or 3.10 minutes).

VOT calculations for the proposed US 377 Relief Route are similar to above, but with the following adjustments:

$$\begin{aligned} \text{ADT (relief route)} &= \text{ADT US 377 (no build)} \times \text{Diversion rate (69\%)} \\ \text{Average Travel Time} &= \text{Travel Time in 2022} \times (1 + 0.14\%) \end{aligned}$$

3.4.3 Time Delayed at FWR Crossing

Signals at the FWR railroad crossing force vehicles to stop whenever they activate. In 2014, activation occurred an average of 14 times per day for an average duration of two (2) minutes¹². As the number of activations (14) exceed the number of trains reported to cross the tracks (10), it may be that signals are sometimes activated when trains get close to, but do not actually occupy, the crossing. The BCA assumes the number of activations will increase ratably with the increase of number of trains, or 2.5% per year, equal to an estimate of GDP growth.

While a signal lasts an average of two minutes, some vehicles arrive at the crossing right as the signal starts, experiencing the full duration of delay, while others arrive as the signal is ending, experiencing minimal delay. Accordingly, the average signal delay for a two-minute signal is just one (1) minute. In addition to the time that vehicles are actually stopped for the crossing signal, backed up traffic requires additional time to recover. This analysis has estimated total delay to be three (3) times the delay experienced during the signal itself. Of course, most travelers experience no delay at the tracks because trains only occupy the crossing a small fraction of the day.

¹⁰ Civil Associates, Inc., Technical Memo Re: US 377 Mobility Study Project – Design Schematic Level of Service Analysis and attachment, July 11, 2012.

¹¹ Ibid.

¹² TxDOT Public Hearing Documentation – US 377 Cresson Relief Route, May 8, 2015.

Grade crossing delay calculations are as follows:

$$\begin{aligned}\text{Crossing Occupation (\%)} &= \# \text{ Daily Signals} \times 2 \text{ Minutes/signal} \div 1440 \text{ Min/day} \\ \text{Average Delay Time (hrs)} &= \text{Average Signal Duration (2 minutes)} \div 60 \text{ Min/hr} \div 2 \text{ (half the} \\ &\quad \text{full signal duration)} \times 3 \text{ (recovery period)} \\ \text{Annual Delay Hours} &= \text{Vehicle Occupants} \times \text{Crossing Occupation} \times \text{Average Delay Time} \times \\ &\quad 365 \text{ Days/year} \\ \text{Crossing Delay VOT} &= \text{Annual Delay Hours} \times \text{VOT Rate}\end{aligned}$$

As in other VOT calculations, the BCA calculates passenger vehicle and truck delays separately, applying different vehicle occupancy. Total crossing delay VOT is the sum of truck and passenger vehicle delays.

3.5 Vehicular Operating Costs

USDOT has estimated the cost of operating cars and trucks at \$0.40 and \$0.96 per mile¹³, respectively.

3.5.1 Costs for Vehicle Miles Traveled

Drivers incur costs, such as fuel, maintenance, and depreciation, for every mile traveled. Since the US 377 Relief Route is longer than the existing route through Cresson (3.02 miles versus 2.68 miles), vehicular operating costs will be higher using the new route.

The BCA calculates operating costs for trucks and cars separately and then sums these costs to get total operating cost. Operating cost calculations are as follows:

$$\begin{aligned}\text{Annual Vehicle Miles Traveled (VMT)} &= \text{ADT} \times \text{Route Length (miles)} \times 365 \text{ Days/year} \\ \text{Operating Cost} &= \text{Annual VMT} \times \text{Operating Cost/mi}\end{aligned}$$

3.5.2 Costs for Idling

In addition to incurring costs for every mile traveled, drivers incur additional fuel costs when idling. Since the existing US 377 route entails delays (idling) at both the SH 171 traffic signal and at the FWR grade crossing, additional fuel costs are incurred. Travelers using the proposed US 377 Relief Route avoid idling costs.

A technical memo developed as part of the schematic effort concluded that the traffic signal for US 377 and SH 171 should cycle every 150 seconds in the no-build scenario, but that 90 seconds is appropriate with a relief route¹⁴. Since a traffic light is green half the time, only half of the traffic will experience a red light. Of those hitting a red light, some approach the

¹³ USDOT, Benefit-Cost Analysis Guidance for TIGER and INFRA Applications, July 2017, page 31.

¹⁴ Civil Associates, Inc., July 30, 2010, Technical Memo: US 377 Mobility Study Project – Traffic Operational Analyses of Alternatives, page 5.

intersection just when the light turns red, while others approach when the red light is about to change to green.

Factors used for calculating operating costs while idling include the following:

Table 7: Idling Factors

Description	Cars	Unit	Trucks	Unit
Fuel Consumption	0.16 ¹⁵	Gallon/Hour (Gasoline)	0.44 ¹⁶	Gallon/Hour (Diesel)
Fuel Price	\$2.430 ¹⁷	\$/Gallon	\$2.558 ¹⁸	\$/Gallon

The BCA calculates idling operating (fuel) costs for trucks and cars separately and then sums these to get total operating cost. Calculations for idling operating costs for idling are as follows:

$$\text{Signal Idling Hours} = \text{ADT} \times \text{Signal Length (seconds)} \div 3,600 \text{ Seconds/hour} \div 2 \text{ (half vehicles hit red light)} \div 2 \text{ (portion of red light delayed)} \times 365 \text{ Days/year}$$

$$\text{Grade Crossing Idling Hours} = \text{Delay Man-hours} \div \text{Vehicle Occupancy Rate}$$

$$\text{Total Idling Hours} = \text{Signal Idling Hours} + \text{Grade Crossing Idling Hours}$$

$$\text{Idling Operating Cost} = \text{Total Idling Hours} \times \text{Fuel Consumption Rate} \times \text{Fuel Price}$$

3.6 Emissions

One public cost associated with additional vehicle miles traveled and idling is in the form of impaired air quality due to vehicular emissions.

The USDOT specified values for volatile organic compounds (VOC), nitrogen oxides (NO_x), and particulate matter (PM) in its Benefit-Cost Analysis Guidance for TIGER and INFRA Grants, but not for carbon dioxide (CO₂). The BCA converts each of the values stated in short tons into values per metric ton to ease subsequent calculations.

¹⁵ U.S. Department of Energy, Fact #861 February 23, 2015 Idle Fuel Consumption for Selected Gasoline and Diesel Vehicles, <https://energy.gov/eere/vehicles/fact-861-february-23-2015-idle-fuel-consumption-selected-gasoline-and-diesel-vehicles>, accessed 4 October, 2017.

¹⁶ Ibid.

¹⁷ AAA, Texas Average Gas Prices, <http://gasprices.aaa.com/?state=TX>, accessed 29 September, 2017.

¹⁸ Ibid.

Table 8: Emissions Values

Emission	\$2016 / Short Ton	Conversion	\$2016 / Metric Ton
VOC	\$1872	1.1015	\$2,062
NO_x	\$7,377		\$8,126
PM	\$337,459		\$371,711

3.6.1 Emissions from Vehicle Miles Traveled

The Office of Transportation and Air Quality of the United States' Environmental Protection Agency (EPA) estimated the average number of grams of several types of emissions in its publications Average Annual Emissions and Fuel Consumption for Gasoline-Fueled Passenger Cars and Light Trucks, EPA420-F-08-024, and Average In-Use Emissions from Heavy-Duty Trucks, EPA420-F-08-027, both from October 2008.

Table 9: Emissions Rates

Emission	Grams/Mile Automobile	Grams/Mile Truck
VOC	1.034	0.447
NO_x	0.693	8.613
PM₁₀	0.0044	0.219
CO	9.400	2.311
CO₂	368.4	N/A

The BCA converts vehicle miles traveled (computed previously) to emissions levels and values as follows:

$$\text{Annual Emissions (in grams)} = \text{Annual VMT (auto)} \times \text{Auto Emission Rates} + \text{Annual VMT (truck)} \times \text{Truck Emission Rates}$$

$$\text{Annual Emissions Value} = \text{Annual Emissions (in grams)} \times .000001 \text{ (gram to metric ton conversion)} \times \text{Emission Value}$$

3.6.2 Emissions from Idling

Because vehicles continue to consume fuel while idling at roadway intersections and railroad crossings, they also generate a variety of emissions. The Office of Transportation and Air Quality of the EPA estimated the average number of grams of several types of emissions generated while idling in its publication *Idling Vehicle Emissions for Passenger Cars, Light-Duty Trucks, and Heavy-Duty Trucks*, EPA420-F-08-025, October 2008. The BCA applies emissions from the EPA to the estimated vehicle idling hours at both the traffic signal for US 377 and SH 171 and the FWR grade crossing (calculated previously) to quantify emissions. The factors used include the following:

Table 10: Emissions Rates for Idling Vehicles¹⁹

Emission	Light Duty Gasoline Vehicle Emissions Rate (g/hr)	Heavy Duty Diesel Vehicle Emissions Rate (g/hr)Units
VOC	2.683	3.455
NO _x	3.515	33.763
PM ₁₀	N/A - negligible	1.196

¹⁹ USEPA Office of Transportation and Air Quality, *Idling Vehicle Emissions for Passenger Cars, Light-Duty Trucks, and Heavy-Duty Trucks*, (EPA420-F-08-025), October 2008.

The BCA calculates dollar values of emissions using the values from Table 8 in Section 3.6 above.

$$\text{Annual Emissions (in grams)} = \text{Annual Vehicle-Hours Idling (auto)} \times \text{Auto Emissions Rate} + \text{Annual Vehicle-Hours Idling (truck)} \times \text{Truck Emissions Rate}$$

$$\text{Annual Emissions Value} = \text{Annual Emissions (in grams)} \times .000001 \text{ (gram to metric ton conversion)} \times \text{Emission Value}$$

3.7 Residual Value

A relief route with its grade separations could have a useful life of 75 years, so the traveling public will use it well beyond the 20-year analysis period for benefits. The residual value of the infrastructure investment in the final year of the analysis is estimated at 73.3% (55 years remaining life out of a 75-year life) of the original cost.

The BCA reduced this residual value by the present value (PV) of the anticipated maintenance during the assets' remaining life. The BCA assumes roadway maintenance will continue at \$13,000 per lane-mile per year and estimates structures maintenance to include inspections costing \$2,000 every other year; deck overlays and painting costing \$316,000 in years 25 and 50; replacement of expansion joints costing \$15,000 every 15 years; and \$50,000 of miscellaneous repairs midway through the structures' life.

Table 11: US 377 Relief Route Residual Value

Item Description			Total Value
Residual Value	\$80,104,200 Original Cost	x 55 ÷ 75 Years	\$58,743,080
Less Future:			
Road Maintenance	(\$8,637,200)	PV adjustment	(\$2,189,128)
Structures Maintenance	(\$781,000)	PV adjustment	(\$305,477)
Total Maintenance			(\$2,494,605)
Net Residual Value			\$56,248,475

4.0 Infrastructure Costs

A conceptual design and cost estimate was developed for a US 377 Relief Route, including grade separations over SH 171, FWWR tracks and Old Granbury Road.

Table 12: US 377 Relief Route Cost, 2016 Dollars

Item Description	Total Cost
Land Acquisition	\$3,630,000
Mobilization / Demobilization	\$5,366,000
Earthwork	\$28,841,000
Drainage and SWPPP	\$5,180,000
Roadway and Pavement	\$13,197,000
Structures, including Retaining Walls	\$10,408,000
Utilities	\$4,212,400
Traffic Handling, Signs, Signals	\$2,911,000
NEPA and Engineering Costs	\$4,451,800
Administrative and Legal Costs	\$407,000
Contingency	\$,500,000
Total	\$80,104,200

5.0 Benefit-Cost Comparison

See the Appendix to this BCA for details of the various costs and benefits by year related to the “no build” and “build” scenarios over the 24-year analysis period. The difference in the cash flows (and cash equivalents) between the two scenarios constitute the benefits and costs for the project.

5.1 Net Cash Flows

Table 13: Net Cost and Benefit Cash (or Cash Equivalents) Flows

Monetized Values / Cash Flows (\$ in Thousands)					
Year	Discount Year	Benefits / (Disbenefits)		Costs	
		Net Benefits	Discounted	Costs	Discounted
2018	0	\$0	\$0	\$17,216	\$17,216
2019	1	\$0	\$0	\$17,883	\$16,713
2020	2	\$0	\$0	\$27,762	\$24,248
2021	3	(\$1,439)	(\$1,174)	\$17,243	\$14,075
2022	4	\$7,859	\$5,996	\$0	\$0
2023	5	\$8,405	\$5,993	\$0	\$0
2024	6	\$8,986	\$5,988	\$0	\$0
2025	7	\$9,595	\$5,975	\$0	\$0
2026	8	\$10,242	\$5,961	\$0	\$0
2027	9	\$10,921	\$5,940	\$0	\$0
2028	10	\$11,641	\$5,918	\$0	\$0
2029	11	\$12,396	\$5,889	\$0	\$0
2030	12	\$13,197	\$5,860	\$0	\$0
2031	13	\$14,038	\$5,825	\$0	\$0
2032	14	\$14,928	\$5,789	\$0	\$0
2033	15	\$15,862	\$5,749	\$0	\$0
2034	16	\$16,850	\$5,708	\$0	\$0
2035	17	\$17,888	\$5,663	\$0	\$0
2036	18	\$18,780	\$5,556	\$0	\$0
2037	19	\$19,738	\$5,458	\$0	\$0
2038	20	\$20,728	\$5,356	\$0	\$0
2039	21	\$21,758	\$5,255	\$0	\$0
2040	22	\$22,838	\$5,155	\$0	\$0
2041	23	\$80,211	\$16,920	\$0	\$0
Total		\$355,423	\$124,780	\$80,104	\$72,253

5.2 Benefit-Cost Ratio

The following table summarizes the costs and the net benefits for the project and displays the benefit to cost (B-C) ratio at a discount rate 7%, as has been requested by USDOT for TIGER grant applications.

Table 14: Benefit-Cost Analysis Summary (\$ in Thousands)

Description	Estimate	Discounted (7%)
Net Benefits	\$355,423	\$124,780
Costs	\$80,104	\$72,253
B-C Ratio	4.44 : 1	1.73 : 1
Net Present Value		\$52,527

6.0 Additional Qualitative Benefits and Disbenefits

6.1 Reliability

The State of Texas values an efficient roadway network for the connectivity and reliability it offers to Texas residents and businesses. The US 377 Relief Route eliminates a railroad at-grade crossing and a signaled roadway intersection for traffic on US 377, providing more reliable travel times. Assigning a monetary value to such reliability, however, is nebulous, so is not included in the BCA calculations.

6.2 Emergency Response Delays

The City of Cresson has a volunteer fire department that operates from two stations on either side of the FWWR railroad tracks. As the City has no hospital, ambulance services come from the surrounding cities of Aledo, Weatherford, or Granbury. Hood and Johnson County sheriff's departments handle Law enforcement for the City. Many factors, including trains' occupation of the FWWR crossing, can negatively affect response times. Railroad signal delays can range from less than one minutes to upwards of 53 minutes per occurrence²⁰. While trains occupy the crossing an average of just two minutes, response times for emergencies happening during a longer occupancy could be the difference between life and death. While emergency response delays definitely have value, the timing of unpredictable

²⁰ TxDOT Public Hearing Documentation – US 377 Cresson Relief Route, May 8, 2015.

emergencies with the chance of occupancy of the at-grade crossing is speculative. Accordingly, this BCA does not monetize emergency response delays.

6.3 CO₂ Emissions

The United States Department of Transportation (USDOT) specified values for several types of emissions in its Benefit-Cost Analysis Guidance for TIGER and INFRA Grants, but not for carbon dioxide (CO₂). TxDOT has not yet determined an appropriate value for the cost of CO₂ emissions. Accordingly, the BCA estimates the volume of CO₂ in metric tons, but applies no dollar value.

6.4 Train Delay

While vehicular traffic generally does not delay freight trains, it does disrupt freight rail activity every time there is a train accident at an at-grade crossing. Train delays increase railroads' operating costs, including costs for crew labor, fuel, locomotives and railcars. The duration of delays varies with the severity of the crash. Accidents that derail locomotives or railcars or damage the rail infrastructure can cause extended delays. Furthermore, accidents not only delay the train involved, but also subsequent trains since no train can use the tracks until the railroad clears the accident and, if necessary, repairs the tracks. Due to the wide range of potential delay for accidents, this BCA excludes estimates for train delay costs.

Delayed trains can cause shippers to incur costs associated with late deliveries. Shippers may lose sales or may have to pay penalties to its customers. While these costs are real, this BCA excludes shippers' costs related to train delays since the costs cannot be readily estimated.

Appendix: US 377 Relief Route BCA Spreadsheet

US 377 Relief Route
Build Cash Flows (All Dollar Amounts in Thousands)

Project: US 377 Relief Route

I. Capital Investments / Operating Costs	Up Front 1	Up Front 2	Up Front 3	Up Front 4	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13	Yr 14	Yr 15	Yr 16	Yr 17	Yr 18	Yr 19	20-Year Analysis Period		
																								Yr 20	Totals	
Project cost	\$17,216	\$17,883	\$27,762	\$17,243																						\$80,104
Total Costs	\$17,216	\$17,883	\$27,762	\$17,243	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$80,104
Discounted Investment at Rate of 7.00% (Cost of Capital)	\$17,216	\$16,713	\$24,248	\$14,075	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$72,253
													0.0% inflation rate per year.													
II. (Costs) / Benefits																										
a Detour and construction delays	\$0	\$0	\$0	(\$1,439)	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	(\$1,439)
b Roadway Accidents	(\$6,053)	(\$6,154)	(\$6,256)	(\$6,359)	(\$4,961)	(\$5,044)	(\$5,127)	(\$5,212)	(\$5,299)	(\$5,387)	(\$5,476)	(\$5,567)	(\$5,659)	(\$5,753)	(\$5,848)	(\$5,945)	(\$6,044)	(\$6,144)	(\$6,224)	(\$6,305)	(\$6,388)	(\$6,471)	(\$6,556)	(\$6,641)	(\$6,727)	(\$140,872)
c Accidents at FWWR crossing	(\$43)	(\$45)	(\$47)	(\$49)	(\$16)	(\$17)	(\$17)	(\$18)	(\$19)	(\$19)	(\$20)	(\$21)	(\$22)	(\$23)	(\$24)	(\$25)	(\$26)	(\$27)	(\$28)	(\$29)	(\$30)	(\$31)	(\$33)	(\$34)	(\$34)	(\$665)
d Maintenance	(\$139)	(\$139)	(\$139)	(\$139)	(\$296)	(\$298)	(\$296)	(\$298)	(\$296)	(\$298)	(\$296)	(\$298)	(\$296)	(\$298)	(\$296)	(\$298)	(\$296)	(\$298)	(\$311)	(\$298)	(\$296)	(\$298)	(\$296)	(\$298)	(\$298)	(\$6,520)
e Time on Bus 377 route	(\$16,136)	(\$16,875)	(\$17,648)	(\$18,457)	(\$4,488)	(\$4,617)	(\$4,750)	(\$4,887)	(\$5,027)	(\$5,172)	(\$5,321)	(\$5,474)	(\$5,631)	(\$5,794)	(\$5,960)	(\$6,132)	(\$6,308)	(\$6,490)	(\$6,653)	(\$6,821)	(\$6,993)	(\$7,170)	(\$7,351)	(\$7,536)	(\$7,725)	(\$187,691)
f Time on relief route	\$0	\$0	\$0	\$0	(\$7,504)	(\$7,731)	(\$7,964)	(\$8,205)	(\$8,452)	(\$8,707)	(\$8,970)	(\$9,241)	(\$9,520)	(\$9,807)	(\$10,103)	(\$10,408)	(\$10,722)	(\$11,046)	(\$11,340)	(\$11,642)	(\$11,952)	(\$12,270)	(\$12,597)	(\$12,932)	(\$13,276)	(\$201,116)
g Time at FWWR crossing	(\$192)	(\$203)	(\$214)	(\$225)	(\$74)	(\$78)	(\$82)	(\$86)	(\$91)	(\$96)	(\$101)	(\$107)	(\$113)	(\$119)	(\$125)	(\$132)	(\$139)	(\$147)	(\$154)	(\$162)	(\$170)	(\$179)	(\$188)	(\$198)	(\$198)	(\$3,376)
h Vehicular operating costs VMT	(\$11,013)	(\$11,195)	(\$11,381)	(\$11,570)	(\$12,791)	(\$13,003)	(\$13,219)	(\$13,438)	(\$13,661)	(\$13,887)	(\$14,117)	(\$14,351)	(\$14,589)	(\$14,831)	(\$15,077)	(\$15,327)	(\$15,581)	(\$15,839)	(\$16,046)	(\$16,256)	(\$16,468)	(\$16,684)	(\$16,902)	(\$17,122)	(\$17,348)	(\$344,348)
i Vehicular operating costs idling	(\$92)	(\$94)	(\$96)	(\$98)	(\$31)	(\$32)	(\$33)	(\$34)	(\$34)	(\$35)	(\$36)	(\$37)	(\$38)	(\$38)	(\$39)	(\$40)	(\$41)	(\$42)	(\$43)	(\$44)	(\$45)	(\$46)	(\$47)	(\$48)	(\$48)	(\$1,163)
j Emissions due to VMT	(\$487)	(\$495)	(\$503)	(\$511)	(\$565)	(\$574)	(\$584)	(\$594)	(\$603)	(\$613)	(\$624)	(\$634)	(\$645)	(\$655)	(\$666)	(\$677)	(\$688)	(\$700)	(\$709)	(\$718)	(\$728)	(\$737)	(\$747)	(\$756)	(\$756)	(\$15,213)
k Emissions due to idling	(\$12)	(\$13)	(\$13)	(\$13)	(\$4)	(\$4)	(\$4)	(\$4)	(\$5)	(\$5)	(\$5)	(\$5)	(\$5)	(\$5)	(\$5)	(\$5)	(\$5)	(\$6)	(\$6)	(\$6)	(\$6)	(\$6)	(\$6)	(\$6)	(\$6)	(\$155)
l Residual Value																										\$56,249
Total (Costs) Benefits	(\$34,168)	(\$35,213)	(\$36,297)	(\$38,861)	(\$30,732)	(\$31,398)	(\$32,077)	(\$32,776)	(\$33,488)	(\$34,220)	(\$34,966)	(\$35,735)	(\$36,518)	(\$37,323)	(\$38,145)	(\$38,990)	(\$39,851)	(\$40,738)	(\$41,515)	(\$42,282)	(\$43,077)	(\$43,892)	(\$44,722)	(\$45,576)	(\$46,449)	(\$846,308)
Discounted Benefit at Rate of 7.00% (Cost of Capital)	(\$34,168)	(\$32,909)	(\$31,703)	(\$31,722)	(\$23,445)	(\$22,387)	(\$21,374)	(\$20,411)	(\$19,490)	(\$18,614)	(\$17,775)	(\$16,977)	(\$16,214)	(\$15,488)	(\$14,793)	(\$14,132)	(\$13,499)	(\$12,897)	(\$12,283)	(\$11,691)	(\$11,132)	(\$10,601)	(\$10,094)	(\$9,622)	(\$9,185)	(\$431,548)
III. Cash Flow	(\$51,385)	(\$53,096)	(\$64,059)	(\$56,104)	(\$30,732)	(\$31,398)	(\$32,077)	(\$32,776)	(\$33,488)	(\$34,220)	(\$34,966)	(\$35,735)	(\$36,518)	(\$37,323)	(\$38,145)	(\$38,990)	(\$39,851)	(\$40,738)	(\$41,515)	(\$42,282)	(\$43,077)	(\$43,892)	(\$44,722)	(\$45,576)	(\$46,449)	(\$926,412)
IV. Discounted Cash at Rate of 7.00% (Cost of Capital)	(\$51,385)	(\$49,623)	(\$55,952)	(\$45,798)	(\$23,445)	(\$22,387)	(\$21,374)	(\$20,411)	(\$19,490)	(\$18,614)	(\$17,775)	(\$16,977)	(\$16,214)	(\$15,488)	(\$14,793)	(\$14,132)	(\$13,499)	(\$12,897)	(\$12,283)	(\$11,691)	(\$11,132)	(\$10,601)	(\$10,094)	(\$9,622)	(\$9,185)	(\$503,801)

Detailed Capital Cost Budget					
US 377 Relief Route					
		Estimated Timing			
Cost Category	Cost (2016 \$)	2018	2019	2020	2021
Land Acquisition	\$ 3,630,000	\$ 3,630,000			
Mobilization & Demobilization	\$ 5,366,000	\$ 2,683,000			\$ 2,683,000
Sitework	\$ 24,841,000	\$ 955,423	\$ 11,465,077	\$ 11,465,077	\$ 955,423
Drainage and SWPPP	\$ 5,180,000		\$ 2,486,400	\$ 2,486,400	\$ 207,200
Roadway and Pavement	\$ 13,197,000			\$ 6,598,500	\$ 6,598,500
Structures, including Retaining Walls	\$ 10,408,000		\$ 2,602,000	\$ 5,204,000	\$ 2,602,000
Utilities	\$ 4,212,400	\$ 4,212,400			
Traffic Handling, Signs, Signals	\$ 2,911,000				\$ 2,911,000
NEPA and Engineering Costs	\$ 4,451,800	\$ 4,451,800			
Administrative and Legal Costs	\$ 407,000	\$ 101,750	\$ 101,750	\$ 101,750	\$ 101,750
Contingency	\$ 5,500,000	\$ 1,182,092	\$ 1,227,863	\$ 1,906,146	\$ 1,183,899
	\$ 80,104,200	\$ 17,216,465	\$ 17,883,090	\$ 27,761,873	\$ 17,242,772

# Crashes	# Crashes	Incident & Severity Levels per Crash (Rural)					
105.79	62.24	1.54%	5.45%	16.86%	21.89%	189.61%	8.25%
		\$9,600,000	\$459,100	\$125,000	\$63,900	\$3,200	\$174,000

per 100M VMT, Rural 4-lane undivided	per 100M VMT, Rural 4-lane divided	K	A	B	C	O	U
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Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
25,074,886	25,490,565	25,913,135	26,342,710	26,779,406	27,223,342	27,674,637	28,133,413	28,599,795	29,073,908	29,555,880	30,045,843	30,543,928	31,050,270	31,565,006	32,088,275	32,620,218	33,160,980	33,709,340	34,265,364	34,828,698	35,398,160	35,973,686		
26.53	26.97	27.41	27.87	28.33	28.80	29.28	29.76	30.26	30.76	31.27	31.79	32.31	32.85	33.39	33.95	34.51	35.08	35.54	36.00	36.47	36.95	37.43	37.92	
0.408101	0.414867	0.421744	0.428735	0.435843	0.443068	0.450413	0.457890	0.465470	0.473187	0.481031	0.489005	0.497112	0.505352	0.513730	0.522246	0.530904	0.539705	0.548758	0.558003	0.567445	0.577094	0.586947	0.596914	
1.445480	1.469443	1.493803	1.518566	1.543740	1.569332	1.595347	1.621794	1.648679	1.676010	1.703794	1.732039	1.760752	1.789941	1.819613	1.849778	1.880443	1.911616	1.943298	1.975495	2.008214	2.041463	2.075261	2.109617	
4.473659	4.547821	4.623212	4.699854	4.777765	4.856969	4.937485	5.019336	5.102545	5.187132	5.273122	5.360537	5.449401	5.539739	5.631574	5.724931	5.819836	5.916314	6.014395	6.114118	6.215507	6.318542	6.423261	6.529603	
5.806706	5.902967	6.000823	6.100302	6.201430	6.304294	6.408942	6.515483	6.622985	6.732478	6.844090	6.957853	7.073797	7.190945	7.309395	7.429158	7.550244	7.672679	7.796473	7.921636	8.048178	8.176110	8.305452	8.436215	
50.297751	51.131562	51.979195	52.840880	53.716850	54.607341	55.512594	56.432955	57.368370	58.318894	59.284518	60.266290	61.264161	62.278183	63.308406	64.354981	65.417956	66.497381	67.593317	68.704822	69.832047	70.975144	72.134271	73.309481	
2.187888	2.224158	2.261029	2.298511	2.336614	2.375350	2.414727	2.454757	2.495451	2.536819	2.578873	2.621625	2.665084	2.709265	2.754178	2.799835	2.846249	2.893433	2.941407	2.990191	3.039725	3.090039	3.141153	3.193097	
\$3,917,772	\$3,982,719	\$4,048,743	\$4,115,861	\$4,184,091	\$4,253,453	\$4,323,965	\$4,395,645	\$4,468,514	\$4,542,591	\$4,617,896	\$4,694,449	\$4,772,271	\$4,851,383	\$4,931,807	\$5,013,564	\$5,096,677	\$5,181,167	\$5,267,052	\$5,353,841	\$5,441,544	\$5,530,172	\$5,619,735	\$5,710,244	
\$663,620	\$674,621	\$685,805	\$697,174	\$708,731	\$720,480	\$732,424	\$744,566	\$756,909	\$769,456	\$782,212	\$795,179	\$808,361	\$821,762	\$835,385	\$849,233	\$863,311	\$877,623	\$892,167	\$907,947	\$925,995	\$945,314	\$964,914	\$984,807	
\$559,207	\$568,478	\$577,902	\$587,482	\$597,221	\$607,121	\$617,186	\$627,417	\$637,818	\$648,391	\$659,140	\$670,067	\$681,175	\$692,467	\$703,947	\$715,616	\$727,480	\$739,539	\$751,793	\$764,242	\$776,986	\$789,922	\$803,052	\$816,377	
\$371,049	\$377,200	\$383,453	\$389,809	\$396,271	\$402,841	\$409,519	\$416,307	\$423,209	\$430,225	\$437,357	\$444,607	\$451,977	\$459,470	\$467,087	\$474,830	\$482,701	\$490,703	\$498,835	\$507,089	\$515,466	\$523,967	\$532,504	\$541,177	
\$160,953	\$163,621	\$166,333	\$169,091	\$171,894	\$174,743	\$177,640	\$180,585	\$183,579	\$186,622	\$189,716	\$192,861	\$196,058	\$199,308	\$202,612	\$205,971	\$209,385	\$212,857	\$216,387	\$219,975	\$223,620	\$227,323	\$231,084	\$234,903	
\$380,692	\$387,003	\$393,419	\$399,941	\$406,571	\$413,311	\$420,162	\$427,128	\$434,208	\$441,407	\$448,724	\$456,163	\$463,725	\$471,412	\$479,227	\$487,171	\$495,247	\$503,457	\$511,799	\$521,272	\$529,877	\$538,614	\$547,483	\$556,485	
\$6,053,293	\$6,153,642	\$6,255,654	\$6,359,357	\$6,464,778	\$6,571,949	\$6,680,896	\$6,791,648	\$6,904,237	\$7,018,682	\$7,135,044	\$7,253,325	\$7,373,567	\$7,495,803	\$7,620,064	\$7,746,386	\$7,874,802	\$8,005,346	\$8,138,051	\$8,272,957	\$8,410,104	\$8,549,532	\$8,691,281	\$8,835,381	

NO BUILD

		BUILD															
VMT 4-Lane Undivided	# Crashes	# Fatalities	# Incapacitating Injuries	# Non-Incapacitating Injuries	# Possible Injuries	# Non-Injuries	# Unknown severity injuries	Fatalities Cost	Incapacitating Injuries Cost	Non-Incapacitating Injuries Cost	Possible Injuries Cost	Non-Injuries Cost	Unknown severity injuries Cost	Combined Fatality and Injury Cost			
25,074,886	-	26.53	0.408101	1.445480	4.473659	5.806706	50.297751	2.187888	\$3,917,772	\$663,620	\$559,207	\$371,049	\$160,953	\$380,692	\$6,053,293		
25,490,565	-	26.97	0.414867	1.469443	4.547821	5.902967	51.131562	2.224158	\$3,982,719	\$674,621	\$568,478	\$377,200	\$163,621	\$387,003	\$6,153,642		
25,913,135	-	27.41	0.421744	1.493803	4.623212	6.000823	51.979195	2.261029	\$4,048,743	\$685,805	\$577,902	\$383,453	\$166,333	\$393,419	\$6,255,654		
26,342,710	27.87	0.428735	1.518566	4.699854	6.100302	6.201430	52.840880	2.298511	\$4,115,861	\$697,174	\$587,482	\$389,809	\$169,091	\$399,941	\$6,359,357		
26,779,406	28.33	0.435843	1.543740	4.777765	6.201430	53.716850	54.607341	2.336614	\$4,184,091	\$708,731	\$597,221	\$396,271	\$171,894	\$406,571	\$6,464,778		
27,223,342	28.80	0.443068	1.569332	4.856969	6.304294	54.607341	55.512594	2.375350	\$4,253,453	\$720,480	\$607,121	\$402,841	\$174,743	\$413,311	\$6,571,949		
27,674,637	29.28	0.450413	1.595347	4.937485	6.408942	55.512594	56.432955	2.414727	\$4,323,965	\$732,424	\$617,186	\$409,519	\$177,640	\$420,162	\$6,680,896		
28,133,413	29.76	0.457890	1.621794	5.019336	6.514983	56.432955	57.368370	2.454757	\$4,395,645	\$744,566	\$627,417	\$416,307	\$180,585	\$427,128	\$6,791,648		
28,599,795	30.26	0.465470	1.648679	5.102545	6.622985	57.368370	58.318894	2.495451	\$4,468,514	\$756,909	\$637,818	\$423,209	\$183,579	\$434,208	\$6,904,237		
29,073,908	30.76	0.473187	1.676010	5.187132	6.732478	58.318894	59.284518	2.536819	\$4,542,591	\$769,456	\$648,391	\$430,225	\$186,622	\$441,407	\$7,018,682		
29,555,880	31.27	0.481031	1.703794	5.273122	6.844090	59.284518	60.266290	2.578873	\$4,617,896	\$782,212	\$659,140	\$437,357	\$189,716	\$448,724	\$7,135,044		
30,045,843	31.79	0.489005	1.732039	5.360537	6.957853	60.266290	61.264161	2.621625	\$4,694,449	\$795,179	\$670,067	\$444,607	\$192,861	\$456,163	\$7,253,325		
30,543,928	32.31	0.497112	1.760752	5.449401	7.073797	61.264161	62.278183	2.665084	\$4,772,271	\$808,361	\$681,175	\$451,977	\$196,058	\$463,725	\$7,373,567		
31,050,270	32.85	0.505352	1.789941	5.539739	7.190453	62.278183	63.308406	2.709265	\$4,851,383	\$821,762	\$692,467	\$459,470	\$199,308	\$471,412	\$7,495,803		
31,565,006	33.39	0.513730	1.819613	5.631574	7.309653	63.308406	64.354981	2.754178	\$4,931,807	\$835,385	\$703,947	\$467,087	\$202,612	\$479,227	\$7,620,064		
32,088,275	33.95	0.522246	1.849778	5.724931	7.430829	64.354981	65.417956	2.799835	\$5,013,564	\$849,233	\$715,616	\$474,830	\$205,971	\$487,171	\$7,746,386		
32,620,218	34.51	0.530904	1.880443	5.819836	7.554013	65.417956	66.497381	2.846249	\$5,096,677	\$863,311	\$727,480	\$482,701	\$209,385	\$495,247	\$7,874,802		
33,160,980	35.08	0.539705	1.911616	5.916314	7.679240	66.497381	67.593317	2.893433	\$5,181,167	\$877,623	\$739,539	\$490,703	\$212,857	\$503,457	\$8,005,346		
33,709,340	35.54	0.548758	1.936598	5.993631	7.779595	67.593317	68.704822	2.931246	\$5,248,876	\$889,092	\$749,204	\$497,116	\$215,638	\$510,037	\$8,138,051		
34,265,364	36.00	0.558003	1.961906	6.071968	7.881262	68.704822	69.832047	2.969552	\$5,317,471	\$900,711	\$759,995	\$503,613	\$218,456	\$516,702	\$8,272,957		
34,828,698	36.47	0.567445	1.987545	6.151309	7.984257	69.832047	70.975144	3.008359	\$5,388,961	\$912,482	\$769,914	\$510,194	\$221,311	\$523,455	\$8,410,104		
35,398,160	37.43	0.575904	2.039832	6.231335	8.088598	70.975144	72.134271	3.047674	\$5,457,360	\$924,406	\$778,962	\$516,861	\$224,203	\$530,295	\$8,542,281		
35,973,686	37.92	0.583430	2.066489	6.356537	8.301390	72.134271	73.309481	3.087502	\$5,528,679	\$936,487	\$789,142	\$523,616	\$227,133	\$537,225	\$8,674,471		

\$176,035,998

\$140,871,581

Sources:
 TxDOT_Statewide Traffic Crash Rates, 2014-2016 (See below)
 TxDOT_Rural and Urban Crashes and Injuries by Severity, 2014-2016 (See below)
 NHTSA's Traffic Safety Facts 2015, 2015 National Statistics
 USDOT BCA Guidance for TIGER and INFRA Grants, July 2017

TxDOT_Statewide Traffic Crash Rates, Rural Statistics:	2016	2015	2014	3 Years' Average:
Traffic Crashes per 100 million VMT	62.81	65.31	58.59	62.24
4 or more lanes, divided	111.36	107.42	98.58	105.79

TxDOT_Rural and Urban Crashes and Injuries by Severity, Rural Statistics:	2016	2015	2014	3 Years' Average:	% of Total	KABCO
Fatalities	1,342	1,954	1,966	5,862	1.54%	K
Incapacitating Injuries	6,964	6,750	7,049	20		

Crossing #020871M

NO BUILD			
KABCO Distribution			
	\$9,600,000	\$174,000	\$3,200
2.5% growth	9%	32%	59%

BUILD			
KABCO Distribution			
	\$9,600,000	\$174,000	\$3,200
2.5% growth	9%	32%	59%

Year	Estimated # Accidents	ADT	# Daily Trains	U - Injury, severity			Total Value
				K - Killed	unknown	O - No injury	
2017	.045225	25216	10				
2018	0.04712	25634	10.3	\$40,715	\$2,624	\$89	\$43,428
2019	0.04910	26059	10.5	\$42,425	\$2,734	\$93	\$45,252
2020	0.05116	26491	10.8	\$44,206	\$2,849	\$97	\$47,152
2021	0.05331	26930	11.0	\$46,063	\$2,968	\$101	\$49,132
2022	0.05555	27376	11.3	\$47,997	\$3,093	\$105	\$51,195
2023	0.05788	27830	11.6	\$50,012	\$3,223	\$109	\$53,345
2024	0.06032	28291	11.9	\$52,113	\$3,358	\$114	\$55,585
2025	0.06285	28760	12.2	\$54,301	\$3,499	\$119	\$57,919
2026	0.06549	29237	12.5	\$56,581	\$3,646	\$124	\$60,351
2027	0.06824	29722	12.8	\$58,957	\$3,799	\$129	\$62,885
2028	0.07110	30215	13.1	\$61,433	\$3,959	\$134	\$65,526
2029	0.07409	30715	13.4	\$64,012	\$4,125	\$140	\$68,278
	0.07720	31225	13.8	\$66,700	\$4,298	\$146	\$71,145
2031	0.08044	31742	14.1	\$69,501	\$4,479	\$152	\$74,132
2032	0.08382	32268	14.5	\$72,420	\$4,667	\$158	\$77,245
2033	0.08734	32803	14.8	\$75,461	\$4,863	\$165	\$80,489
2034	0.09101	33347	15.2	\$78,630	\$5,067	\$172	\$83,869
2035	0.09483	33900	15.6	\$81,931	\$5,280	\$179	\$87,391
2036	0.09847	34343	16.0	\$85,077	\$5,483	\$186	\$90,746
2037	0.10225	34792	16.4	\$88,344	\$5,693	\$193	\$94,230
2038	0.10618	35246	16.8	\$91,736	\$5,912	\$200	\$97,848
2039	0.11025	35707	17.2	\$95,258	\$6,139	\$208	\$101,605
2040	0.11449	36174	17.6	\$98,915	\$6,375	\$216	\$105,506
2041	0.11888	36646	18.1	\$102,713	\$6,619	\$224	\$109,557
							\$1,733,810

Year	Estimated # Accidents	ADT	# Daily Trains	U - Injury, severity			Total Value
				K - Killed	unknown	O - No injury	
2017	.045225	25216	10				
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2020	0.05116	26491	10.8	\$44,206	\$2,849	\$97	\$47,152
2021	0.05331	26930	11.0	\$46,063	\$2,968	\$101	\$49,132
2022	0.05555	27376	11.3	\$47,997	\$3,093	\$105	\$51,195
2023	0.05788	27830	11.6	\$50,012	\$3,223	\$109	\$53,345
2024	0.06032	28291	11.9	\$52,113	\$3,358	\$114	\$55,585
2025	0.06285	28760	12.2	\$54,301	\$3,499	\$119	\$57,919
2026	0.06549	29237	12.5	\$56,581	\$3,646	\$124	\$60,351
2027	0.06824	29722	12.8	\$58,957	\$3,799	\$129	\$62,885
2028	0.07110	30215	13.1	\$61,433	\$3,959	\$134	\$65,526
2029	0.07409	30715	13.4	\$64,012	\$4,125	\$140	\$68,278
	0.07720	31225	13.8	\$66,700	\$4,298	\$146	\$71,145
2031	0.08044	31742	14.1	\$69,501	\$4,479	\$152	\$74,132
2032	0.08382	32268	14.5	\$72,420	\$4,667	\$158	\$77,245
2033	0.08734	32803	14.8	\$75,461	\$4,863	\$165	\$80,489
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2038	0.10618	35246	16.8	\$91,736	\$5,912	\$200	\$97,848
2039	0.11025	35707	17.2	\$95,258	\$6,139	\$208	\$101,605
2040	0.11449	36174	17.6	\$98,915	\$6,375	\$216	\$105,506
2041	0.11888	36646	18.1	\$102,713	\$6,619	\$224	\$109,557
							\$665,106

Sources:
 USDOT FRA Crossing Inventory Form for 020871M (run 9/26/17)
 FRA Highway - Rail Grade Crossing Accident/Incident Report (run 9/27/17)
 FRA Accident Prediction Report for Public at-Grade Highway-Rail Crossings (run 9/27/17)
 TxDOT Public Hearing Documentaation: US 377 Cresson Relief Route dated 5/8/15
 USDOT Benefit-Cost Analysis Guidance for TIGER and INFRA Applications, July 2017

Accident History 020871M

Date	Railroad Accident/ Incident No.	# Killed	# Injured
4/20/2017	7022001	0	0
12/7/2010	10120701	0	0
7/20/2009	09072002	0	0
2/19/2009	09021901	0	0
7/27/2008	08072701	0	1
5/9/2008	08050901	0	0
4/25/2008	08042501	0	0
6/11/2007	07061101	0	0
2/5/2007	07020501	0	0
11/5/2004	04110501	0	0
5/27/1994	05	0	0
4/20/1991	040491205	0	1
8/22/1990	260890207	0	0
8/10/1985	220885203	1	0
3/7/1985	220385201	0	1
7/17/1983	220783204	0	1
3/31/1982	220382102	1	0
3/30/1980	220380205	0	1
12/9/1979	22129202	0	1
12/21/1978	22128206	0	0
5/31/1978	22058204	0	0
6/13/1977	22067203	0	1
Count	22	2	7
		9%	32%

Year	Miles Per lane-mi/yr \$13,000	No Build		Build			Total
		US 377 2.68	Bus 377 Reconstructed 0.93	Bus 377 Unimproved 1.75	US 377 Relief Route 3.02	Structures	
Upfront 1		\$139,360	\$48,152	\$91,208	\$0	\$0	\$139,360
Upfront 2		\$139,360	\$48,152	\$91,208	\$0	\$0	\$139,360
Upfront 3		\$139,360	\$48,152	\$91,208	\$0	\$0	\$139,360
Upfront 4		\$139,360	\$48,152	\$91,208	\$0	\$0	\$139,360
1		\$139,360	\$48,152	\$91,208	\$157,040	\$0	\$296,400
2		\$139,360	\$48,152	\$91,208	\$157,040	\$2,000	\$298,400
3		\$139,360	\$48,152	\$91,208	\$157,040	\$0	\$296,400
4		\$139,360	\$48,152	\$91,208	\$157,040	\$2,000	\$298,400
5		\$139,360	\$48,152	\$91,208	\$157,040	\$0	\$296,400
6		\$139,360	\$48,152	\$91,208	\$157,040	\$2,000	\$298,400
7		\$139,360	\$48,152	\$91,208	\$157,040	\$0	\$296,400
8		\$139,360	\$48,152	\$91,208	\$157,040	\$2,000	\$298,400
9		\$139,360	\$48,152	\$91,208	\$157,040	\$0	\$296,400
10		\$139,360	\$48,152	\$91,208	\$157,040	\$2,000	\$298,400
		\$139,360	\$48,152	\$91,208	\$157,040	\$0	\$296,400
12		\$139,360	\$48,152	\$91,208	\$157,040	\$2,000	\$298,400
13		\$139,360	\$48,152	\$91,208	\$157,040	\$0	\$296,400
14		\$139,360	\$48,152	\$91,208	\$157,040	\$2,000	\$298,400
15		\$139,360	\$48,152	\$91,208	\$157,040	\$15,000	\$311,400
16		\$139,360	\$48,152	\$91,208	\$157,040	\$2,000	\$298,400
17		\$139,360	\$48,152	\$91,208	\$157,040	\$0	\$296,400
18		\$139,360	\$48,152	\$91,208	\$157,040	\$2,000	\$298,400
19		\$139,360	\$48,152	\$91,208	\$157,040	\$0	\$296,400
20		\$139,360	\$48,152	\$91,208	\$157,040	\$2,000	\$298,400
Total		\$3,344,640	\$1,155,648	\$2,188,992	\$3,140,800	\$35,000	\$6,520,440

Source:
TxDOT
TranSystems' bridge engineer

			South	Middle	North	Total Structures				
1						\$0				
2	Inspection		\$500	\$1,000	\$500	\$2,000				
3						\$0				
4			\$500	\$1,000	\$500	\$2,000				
5						\$0				
6			\$500	\$1,000	\$500	\$2,000				
7						\$0				
8			\$500	\$1,000	\$500	\$2,000				
9						\$0				
10			\$500	\$1,000	\$500	\$2,000				
11						\$0				
12			\$500	\$1,000	\$500	\$2,000				
13						\$0				
14			\$500	\$1,000	\$500	\$2,000				
15	Expansion joints	400	\$500	\$15,000	\$500	\$15,000				
16			\$500	\$1,000	\$500	\$2,000				
17						\$0				
18			\$500	\$1,000	\$500	\$2,000				
19						\$0				
20			\$500	\$1,000	\$500	\$2,000				
Year 20 PV of below:							\$305,000	Roadway	\$2,189,000	
21	1					\$0	\$0	\$157,040	\$146,766	
22	2		\$500	\$1,000	\$500	\$2,000	\$1,747	\$157,040	\$137,165	
23	3					\$0	\$0	\$157,040	\$128,191	
24	4		\$500	\$1,000	\$500	\$2,000	\$1,526	\$157,040	\$119,805	
25	5 Overlay/SY and	70	\$30,000	\$246,000	\$40,000	\$316,000	\$225,304	\$157,040	\$111,967	
26	6		\$500	\$1,000	\$500	\$2,000	\$1,333	\$157,040	\$104,642	
27	7					\$0	\$0	\$157,040	\$97,797	
28	8		\$500	\$1,000	\$500	\$2,000	\$1,164	\$157,040	\$91,399	
29	9					\$0	\$0	\$157,040	\$85,419	
30	10 Expansion joints		\$500	\$16,000	\$500	\$17,000	\$8,642	\$157,040	\$79,831	
31	11					\$0	\$0	\$157,040	\$74,609	
32	12		\$500	\$1,000	\$500	\$2,000	\$888	\$157,040	\$69,728	
33	13					\$0	\$0	\$157,040	\$65,166	
34	14		\$500	\$1,000	\$500	\$2,000	\$776	\$157,040	\$60,903	
35	15					\$0	\$0	\$157,040	\$56,919	
36	16		\$500	\$1,000	\$500	\$2,000	\$677	\$157,040	\$53,195	
37	17					\$0	\$0	\$157,040	\$49,715	
38	18		\$500	\$1,000	\$500	\$2,000	\$592	\$157,040	\$46,462	
39	19 Miscellaneous		\$500	\$50,000	\$500	\$50,000	\$13,825	\$157,040	\$43,423	
40	20		\$500	\$1,000	\$500	\$2,000	\$517	\$157,040	\$40,582	
41	21					\$0	\$0	\$157,040	\$37,927	
42	22		\$500	\$1,000	\$500	\$2,000	\$451	\$157,040	\$35,446	
43	23					\$0	\$0	\$157,040	\$33,127	
44	24		\$500	\$1,000	\$500	\$2,000	\$394	\$157,040	\$30,960	
45	25 Expansion joints		\$500	\$15,000	\$500	\$15,000	\$2,764	\$157,040	\$28,934	
46	26		\$500	\$1,000	\$500	\$2,000	\$344	\$157,040	\$27,042	
47	27					\$0	\$0	\$157,040	\$25,273	
48	28		\$500	\$1,000	\$500	\$2,000	\$301	\$157,040	\$23,619	
49	29					\$0	\$0	\$157,040	\$22,074	
50	30 Overlay & paint		\$30,500	\$247,000	\$40,500	\$318,000	\$41,775	\$157,040	\$20,630	
51	31					\$0	\$0	\$157,040	\$19,280	
52	32		\$500	\$1,000	\$500	\$2,000	\$229	\$157,040	\$18,019	
53	33					\$0	\$0	\$157,040	\$16,840	
54	34		\$500	\$1,000	\$500	\$2,000	\$200	\$157,040	\$15,738	
55	35					\$0	\$0	\$157,040	\$14,709	
56	36		\$500	\$1,000	\$500	\$2,000	\$175	\$157,040	\$13,747	
57	37					\$0	\$0	\$157,040	\$12,847	
58	38		\$500	\$1,000	\$500	\$2,000	\$153	\$157,040	\$12,007	
59	39					\$0	\$0	\$157,040	\$11,221	
60	40 Expansion joints		\$500	\$16,000	\$500	\$17,000	\$1,135	\$157,040	\$10,487	
61	41					\$0	\$0	\$157,040	\$9,801	
62	42		\$500	\$1,000	\$500	\$2,000	\$117	\$157,040	\$9,160	
63	43					\$0	\$0	\$157,040	\$8,561	
64	44		\$500	\$1,000	\$500	\$2,000	\$102	\$157,040	\$8,001	
65	45					\$0	\$0	\$157,040	\$7,477	
66	46		\$500	\$1,000	\$500	\$2,000	\$89	\$157,040	\$6,988	
67	47					\$0	\$0	\$157,040	\$6,531	
68	48		\$500	\$1,000	\$500	\$2,000	\$78	\$157,040	\$6,104	
69	49					\$0	\$0	\$157,040	\$5,704	
70	50		\$500	\$1,000	\$500	\$2,000	\$68	\$157,040	\$5,331	
71	51					\$0	\$0	\$157,040	\$4,982	
72	52		\$500	\$1,000	\$500	\$2,000	\$59	\$157,040	\$4,656	
73	53					\$0	\$0	\$157,040	\$4,352	
74	54		\$500	\$1,000	\$500	\$2,000	\$52	\$157,040	\$4,067	
75	55					\$0	\$0	\$157,040	\$3,801	
							\$781,000	\$305,477	\$8,637,200	\$2,189,128

TOTAL TIME CALCULATIONS - NO BUILD

Existing US 377															SH 171															
Occupancy		VOT		1.2%		1.66%		7%		Occupants		Annual Man-hours		Value of Time		2.37%														
Private - All Purposes		Commercial		Productivity		ADT on US 377		Growth		Travel Time (hrs)		Cars		Trucks		ADT on SH 171														
1.39	1.00	\$14.10	\$27.20	2015	24400		22692		1708	0.080							10400													
				2016	24804		23068		1736	0.081							10646													
				2017	25216		23451		1765	0.082	978977	53012					10898													
				2018	25634		23839		1794	0.084	1011704	54784	\$14,609,442	\$1,526,103	\$16,135,544		11156													
				2019	26059		24235		1824	0.085	1045525	56615	\$15,279,007	\$1,596,045	\$16,875,052		11420													
				2020	26491		24636		1854	0.086	1080477	58508	\$15,979,258	\$1,669,194	\$17,648,452		11690													
				2021	26930		25045		1885	0.088	1116597	60464	\$16,711,603	\$1,745,694	\$18,457,298		11966													
				2022	27376		25460		1916	0.089	1153925	62485	\$17,477,513	\$1,825,701	\$19,303,214		12249													
				2023	27830		25882		1948	0.091	1192500	64574	\$18,278,524	\$1,909,375	\$20,187,899		12539													
				2024	28291		26311		1980	0.092	1232365	66733	\$19,116,246	\$1,996,883	\$21,113,130		12836													
				2025	28760		26747		2013	0.094	1273563	68964	\$19,992,363	\$2,086,402	\$22,080,765		13139													
				2026	29237		27191		2047	0.095	1316138	71269	\$20,908,632	\$2,184,116	\$23,092,748		13450													
				2027	29722		27641		2081	0.097	1360136	73652	\$21,866,895	\$2,284,216	\$24,151,111		13768													
				2028	30215		28100		2115	0.099	1405605	76114	\$22,869,076	\$2,388,904	\$25,257,980		14094													
				2029	30715		28565		2150	0.100	1452594	78658	\$23,917,188	\$2,498,390	\$26,415,578		14427													
				2030	31225		29039		2186	0.102	1501154	81288	\$25,013,336	\$2,612,893	\$27,626,230		14769													
				2031	31742		29520		2222	0.104	1551338	84005	\$26,159,722	\$2,732,645	\$28,892,367		15118													
				2032	32268		30010		2259	0.105	1603199	86814	\$27,358,647	\$2,857,885	\$30,216,532		15476													
				2033	32803		30507		2296	0.107	1656793	89716	\$28,612,521	\$2,988,864	\$31,601,385		15842													
				2034	33347		31013		2334	0.109	1712179	92715	\$29,923,860	\$3,125,847	\$33,049,707		16216													
				2035	33900	1.31%	31527		2373	0.111	1769417	95814	\$31,295,300	\$3,269,107	\$34,564,407		16600													
				2036	34433		31939		2404	0.112	1815966	98335	\$32,504,026	\$3,395,371	\$35,899,397		16993													
				2037	34972		32356		2435	0.114	1863740	100922	\$33,759,436	\$3,526,511	\$37,285,947		17395													
				2038	35246		32779		2467	0.115	1912770	103577	\$35,063,335	\$3,662,716	\$38,726,051		17806													
				2039	35707		33208		2499	0.117	1963091	106302	\$36,417,594	\$3,804,182	\$40,221,777		18227													
				2040	36174		33642		2532	0.118	2014735	109098	\$37,824,160	\$3,951,112	\$41,775,272		18659													
				2041	36646		34081		2565	0.120	2067737	111968	\$39,285,051	\$4,103,717	\$43,388,768		19100													
				2042	37125																									
				2043	37611																									
				2044	38102																									
				2045	38600																									
															\$673,966,610						\$187,691,413						\$201,115,734		\$388,807,146	

TOTAL TIME CALCULATIONS - BUILD

Business 377															US 377 Relief Route												Bus 377 + Relief Route	
Diversion to Relief Route		ADT		Occupants		Annual Man-hours		Value of Time		ADT		Occupants		0.14%		Annual Man-hours		Value of Time		VOT								

NO BUILD											BUILD											TOTAL						
Existing US 377											US 377 Relief Route											Bus377 + US377 Relief						
Operating Cost/VMT											Bus 377																	
ADT on US 377											ADT											3.02						
2.68											2.68																	
Annual VMT											Annual VMT																	
Operating Cost											Operating Cost																	
Year:	Cars	Trucks	Total	Cars	Trucks	Miles	Car-Miles	Truck-Miles	Cars	Trucks	Total	Cars	Trucks	Miles	Car-Miles	Truck-Miles	Cars	Trucks	Total	Cars	Trucks	Total	US377 + US377 Relief					
2017			25,216	23,451	1,765		22,939,367	1,726,619				23,451	1,765		22,939,367	1,726,619				0	0		\$0	\$0	\$0	\$0		
2018			25,634	23,839	1,794		23,319,644	1,755,242	\$9,327,858	\$1,685,032	\$11,012,890	23,839	1,794		23,319,644	1,755,242	\$9,327,858	\$1,685,032	\$11,012,890	0	0		\$0	\$0	\$0	\$11,012,890		
2019			26,059	24,235	1,824		23,706,225	1,784,340	\$9,482,490	\$1,712,966	\$11,195,456	24,235	1,824		23,706,225	1,784,340	\$9,482,490	\$1,712,966	\$11,195,456	0	0		\$0	\$0	\$0	\$11,195,456		
2020			26,491	24,636	1,854		24,099,215	1,813,919	\$9,639,686	\$1,741,363	\$11,381,049	24,636	1,854		24,099,215	1,813,919	\$9,639,686	\$1,741,363	\$11,381,049	0	0		\$0	\$0	\$0	\$11,381,049		
2021			26,930	25,045	1,885		24,498,720	1,843,990	\$9,799,488	\$1,770,230	\$11,569,718	25,045	1,885		24,498,720	1,843,990	\$9,799,488	\$1,770,230	\$11,569,718	0	0		\$0	\$0	\$0	\$11,569,718		
2022			27,376	25,460	1,916		24,904,848	1,874,558	\$9,961,939	\$1,799,576	\$11,761,515	7,893	594		7,720,503	581,113	\$3,088,201	\$557,869	\$3,646,070	17567	1322		\$19,364,448	\$1,457,539	\$7,745,779	\$1,399,238	\$9,145,017	\$12,791,087
2023			27,830	25,882	1,948		25,317,708	1,905,634	\$10,127,083	\$1,829,409	\$11,956,492	8,023	604		7,848,489	590,747	\$3,139,396	\$567,117	\$3,706,512	17859	1344		\$19,685,462	\$1,481,701	\$7,874,185	\$1,422,433	\$9,296,618	\$13,003,131
2024			28,291	26,311	1,980		25,737,412	1,937,225	\$10,294,965	\$1,859,736	\$12,154,700	8,156	614		7,978,598	600,540	\$3,191,439	\$576,518	\$3,767,957	18155	1366		\$20,011,798	\$1,506,264	\$8,004,719	\$1,446,014	\$9,450,733	\$13,218,690
2025			28,760	26,747	2,013		26,164,074	1,969,339	\$10,465,630	\$1,890,565	\$12,356,195	8,292	624		8,110,863	610,495	\$3,244,345	\$586,075	\$3,830,420	18456	1389		\$20,343,544	\$1,531,234	\$8,137,418	\$1,469,985	\$9,607,403	\$13,437,823
2026			29,237	27,191	2,047		26,597,809	2,001,986	\$10,639,124	\$1,921,906	\$12,561,030	8,429	634		8,245,321	620,616	\$3,298,128	\$595,791	\$3,893,919	18761	1412		\$20,680,789	\$1,556,619	\$8,272,316	\$1,494,354	\$9,766,669	\$13,660,589
2027			29,722	27,641	2,081		27,038,734	2,035,174	\$10,815,494	\$1,953,767	\$12,769,260	8,569	645		8,382,008	630,904	\$3,352,803	\$605,668	\$3,958,471	19073	1436		\$21,023,625	\$1,582,423	\$8,409,450	\$1,519,126	\$9,928,576	\$13,887,047
2028			30,215	28,100	2,115		27,486,969	2,068,912	\$10,994,788	\$1,986,155	\$12,980,943	8,711	656		8,520,960	641,363	\$3,408,384	\$615,708	\$4,024,092	19389	1459		\$21,372,144	\$1,608,656	\$8,548,858	\$1,544,310	\$10,093,167	\$14,117,260
2029			30,715	28,565	2,150		27,942,634	2,103,209	\$11,177,054	\$2,019,081	\$13,196,134	8,855	667		8,662,217	651,995	\$3,464,887	\$625,915	\$4,090,802	19710	1484		\$21,726,441	\$1,635,323	\$8,690,576	\$1,569,911	\$10,260,487	\$14,351,288
2030			31,225	29,039	2,186		28,405,853	2,138,075	\$11,362,341	\$2,052,552	\$13,414,893	9,002	678		8,805,814	662,803	\$3,522,326	\$636,291	\$4,158,617	20037	1508		\$22,086,611	\$1,662,433	\$8,834,644	\$1,595,936	\$10,430,580	\$14,589,197
2031			31,742	29,520	2,222		28,876,751	2,173,519	\$11,550,700	\$2,086,578	\$13,637,279	9,151	689		8,951,793	673,791	\$3,580,717	\$646,839	\$4,227,556	20369	1533		\$22,452,752	\$1,689,992	\$8,981,101	\$1,622,392	\$10,603,493	\$14,831,049
2032			32,268	30,010	2,259		29,355,456	2,209,550	\$11,742,182	\$2,121,168	\$13,863,351	9,303	700		9,100,191	684,961	\$3,640,076	\$657,562	\$4,297,639	20707	1559		\$22,824,962	\$1,718,008	\$9,129,985	\$1,649,288	\$10,779,272	\$15,076,911
2033			32,803	30,507	2,296		29,842,096	2,246,179	\$11,936,838	\$2,156,332	\$14,093,170	9,457	712		9,251,050	696,316	\$3,700,420	\$668,463	\$4,368,883	21050	1584		\$23,203,343	\$1,746,488	\$9,281,337	\$1,676,629	\$10,957,966	\$15,326,849
2034			33,347	31,013	2,334		30,336,803	2,283,415	\$12,134,721	\$2,192,079	\$14,326,800	9,614	724		9,404,409	707,859	\$3,761,764	\$679,544	\$4,441,308	21399	1611		\$23,587,996	\$1,775,441	\$9,435,199	\$1,704,423	\$11,139,621	\$15,580,929
2035			33,900	31,527	2,373		30,839,711	2,321,269	\$12,335,885	\$2,228,418	\$14,564,302	9,773	736		9,560,311	719,593	\$3,824,124	\$690,810	\$4,514,934	21754	1637		\$23,979,026	\$1,804,873	\$9,591,611	\$1,732,678	\$11,324,289	\$15,839,222
2036			34,343	31,939	2,404		31,242,736	2,351,604	\$12,497,095	\$2,257,540	\$14,754,634	9,901	745		9,685,248	728,997	\$3,874,099	\$699,837	\$4,573,937	22038	1659		\$24,292,393	\$1,828,460	\$9,716,957	\$1,755,321	\$11,472,279	\$16,046,215
2037			34,792	32,356	2,435		31,651,028	2,382,335	\$12,660,411	\$2,287,042	\$14,947,453	10,030	755		9,811,819	738,524	\$3,924,728	\$708,983	\$4,633,711	22326	1680		\$24,609,856	\$1,852,355	\$9,843,942	\$1,778,261	\$11,622,203	\$16,255,913
2038			35,246	32,779	2,467		32,064,656	2,413,469	\$12,825,862	\$2,316,930	\$15,142,792	10,162	765		9,940,043	748,175	\$3,976,017	\$718,248	\$4,694,266	22618	1702		\$24,931,467	\$1,876,562	\$9,972,587	\$1,801,500	\$11,774,086	\$16,468,352
2039			35,707	33,208	2,499		32,483,689	2,445,009	\$12,993,476	\$2,347,209	\$15,340,684	10,294	775		10,069,944	757,953	\$4,027,977	\$727,635	\$4,755,612	22913	1725		\$25,257,281	\$1,901,086	\$10,102,912	\$1,825,042	\$11,927,954	\$16,683,567
2040			36,174	33,642	2,532		32,908,199	2,476,961	\$13,163,279	\$2,377,883	\$15,541,162	10,429	785		10,201,542	767,858	\$4,080,617	\$737,144	\$4,817,760	23213	1747		\$25,587,352	\$1,925,930	\$10,234,941	\$1,848,893	\$12,083,833	\$16,901,594
2041			36,646	34,081	2,565		33,338,255	2,509,331	\$13,335,302	\$2,408,958	\$15,744,260	10,565	795		10,334,859	777,893	\$4,133,944	\$746,777	\$4,880,721	23516	1770		\$25,921,738	\$1,951,099	\$10,368,695	\$1,873,055	\$12,241,750	\$17,122,470
										\$320,266,164									\$130,442,299								\$344,348,296	

Sources:
 USDOT BCA Guidance for TIGER and INFRA Grants, July 2017
 TxDOT Final Environmental Assessment US 377 Relief Route, August 2017

NO BUILD

Year:	0.16		0.44		\$2.430		\$2.558		Existing US 377															
	gal/hour	gal/hour	\$/gal	\$/gal	ADT on US 377 / SH 171						Signal US377 / SH171				FWWR Crossing		Total Idling		Fuel Idling					
	Med/Hvy	Truck			US 377	US 377	US 377	SH 171	SH 171	SH 171	Signal	Car Idling	Truck Idling	Car Idling	Truck Idling	Car Idling	Truck Idling	Annual Gas	Annual Diesel	Annual Gas	Annual Diesel	Total Idling		
	Cars (gas)	(diesel)	Gas	Diesel	Total	Cars	Trucks	Total	Cars	Trucks	Length (sec)	Hrs/Yr	Hrs/Yr	Hrs/Yr	Hrs/Yr	Hrs/Yr	Hrs/Yr	Gal	Diesel Gal	\$	Diesel \$	Fuel \$		
2017					25,216	23,451	1,765	10,898	10,135	763	150	127,695	9,611	8322	626									
2018					25,634	23,839	1,794	11,156	10,375	781	150	130,085	9,791	8671	653	138756	10444	\$22,201	\$4,595	\$53,948	\$11,755	\$92,500		
2019					26,059	24,235	1,824	11,420	10,620	799	150	132,520	9,975	9035	680	141556	10655	\$22,649	\$4,688	\$55,037	\$11,992	\$94,366		
2020					26,491	24,636	1,854	11,690	10,871	818	150	135,003	10,162	9415	709	144418	10870	\$23,107	\$4,783	\$56,150	\$12,235	\$96,274		
2021					26,930	25,045	1,885	11,966	11,129	838	150	137,534	10,352	9810	738	147344	11090	\$23,575	\$4,880	\$57,287	\$12,482	\$98,224		
2022					27,376	25,460	1,916	12,249	11,392	857	150	140,113	10,546	10222	769	150335	11316	\$24,054	\$4,979	\$58,450	\$12,736	\$100,219		
2023					27,830	25,882	1,948	12,539	11,661	878	150	142,742	10,744	10651	802	153394	11546	\$24,543	\$5,080	\$59,639	\$12,995	\$102,258		
2024					28,291	26,311	1,980	12,836	11,937	898	150	145,423	10,946	11098	835	156521	11781	\$25,043	\$5,184	\$60,855	\$13,260	\$104,342		
2025					28,760	26,747	2,013	13,139	12,220	920	150	148,155	11,151	11565	870	159719	12022	\$25,555	\$5,290	\$62,099	\$13,531	\$106,474		
2026					29,237	27,191	2,047	13,450	12,509	942	150	150,939	11,361	12050	907	162990	12268	\$26,078	\$5,398	\$63,370	\$13,808	\$108,654		
2027					29,722	27,641	2,081	13,768	12,804	964	150	153,778	11,575	12556	945	166334	12520	\$26,613	\$5,509	\$64,671	\$14,091	\$110,884		
2028					30,215	28,100	2,115	14,094	13,107	987	150	156,672	11,793	13083	985	169755	12777	\$27,161	\$5,622	\$66,001	\$14,381	\$113,165		
2029					30,715	28,565	2,150	14,427	13,417	1,010	150	159,622	12,015	13633	1026	173255	13041	\$27,721	\$5,738	\$67,361	\$14,678	\$115,498		
2030					31,225	29,039	2,186	14,769	13,735	1,034	150	162,629	12,241	14205	1069	176834	13310	\$28,294	\$5,856	\$68,753	\$14,981	\$117,884		
2031					31,742	29,520	2,222	15,118	14,060	1,058	150	165,695	12,472	14802	1114	180497	13586	\$28,879	\$5,978	\$70,177	\$15,291	\$120,325		
2032					32,268	30,010	2,259	15,476	14,392	1,083	150	168,820	12,707	15423	1161	184243	13868	\$29,479	\$6,102	\$71,634	\$15,608	\$122,823		
2033					32,803	30,507	2,296	15,842	14,733	1,109	150	172,006	12,947	16071	1210	188077	14156	\$30,092	\$6,229	\$73,124	\$15,933	\$125,379		
2034					33,347	31,013	2,334	16,216	15,081	1,135	150	175,254	13,191	16746	1260	192000	14452	\$30,720	\$6,359	\$74,649	\$16,266	\$127,994		
2035					33,900	31,527	2,373	16,600	15,438	1,162	150	178,565	13,440	17449	1313	196014	14754	\$31,362	\$6,492	\$76,210	\$16,606	\$130,670		
2036					34,343	31,939	2,404	16,993	15,803	1,189	150	181,520	13,663	18119	1364	199639	15027	\$31,942	\$6,612	\$77,620	\$16,913	\$133,086		
2037					34,792	32,356	2,435	17,395	16,177	1,218	150	184,528	13,889	18815	1416	203343	15305	\$32,535	\$6,734	\$79,060	\$17,226	\$135,555		
2038					35,246	32,779	2,467	17,806	16,560	1,246	150	187,591	14,120	19537	1471	207128	15590	\$33,140	\$6,860	\$80,531	\$17,547	\$138,079		
2039					35,707	33,208	2,499	18,227	16,951	1,276	150	190,709	14,354	20287	1527	210996	15881	\$33,759	\$6,988	\$82,035	\$17,875	\$140,657		
2040					36,174	33,642	2,532	18,659	17,352	1,306	150	193,883	14,593	21066	1586	214949	16179	\$34,392	\$7,119	\$83,572	\$18,210	\$143,293		
2041					36,646	34,081	2,565	19,100	17,763	1,337	150	197,116	14,837	21875	1646	218991	16483	\$35,038	\$7,253	\$85,144	\$18,552	\$145,987		

\$2,824,589

BUILD

Bus 377 (No idling on US 377 relief route)																							
Year:	ADT on US 377 / SH 171				Signal Bus377 / SH171				FWWR Crossing		Total Idling		Fuel Idling										
	US 377	US 377	SH 171	SH 171	Signal	Car Idling	Truck Idling	Car Idling	Truck Idling	Car Idling	Truck Idling	Car Idling	Truck Idling	Annual Gas	Annual Diesel	Annual Gas	Annual Diesel	Total Idling					
	Cars	Trucks	Cars	Trucks	Length (sec)	Hrs/Yr	Hrs/Yr	Hrs/Yr	Hrs/Yr	Hrs/Yr	Hrs/Yr	Hrs/Yr	Hrs/Yr	Gal	Diesel Gal	\$	Diesel \$	Fuel \$					
	Cars	Trucks	Cars	Trucks	(sec)	Hrs/Yr	Hrs/Yr	Hrs/Yr	Hrs/Yr	Hrs/Yr	Hrs/Yr	Hrs/Yr	Hrs/Yr	Gal	Diesel Gal	\$	Diesel \$	Fuel \$					
2017	23,451	1,765	10,135	763	150	127,695	9,611	8322	626														
2018	23,839	1,794	10,375	781	150	130,085	9,791	8671	653	138756	10444	\$22,201	\$4,595	\$53,948	\$11,755	\$92,500							
2019	24,235	1,824	10,620	799	150	132,520	9,975	9035	680	141556	10655	\$22,649	\$4,688	\$55,037	\$11,992	\$94,366							
2020	24,636	1,854	10,871	818	150	135,003	10,162	9415	709	144418	10870	\$23,107	\$4,783	\$56,150	\$12,235	\$96,274							
2021	25,045	1,885	11,129	838	150	137,534	10,352	9810	738	147344	11090	\$23,575	\$4,880	\$57,287	\$12,482	\$98,224							
2022	25,460	1,916	11,392	857	150	140,113	10,546	10222	769	150335	11316	\$24,054	\$4,979	\$58,450	\$12,736	\$100,219							
2023	25,882	1,948	11,661	878	150	142,742	10,744	10651	802	153394	11546	\$24,543	\$5,080	\$59,639	\$12,995	\$102,258							
2024	26,311	1,980	11,937	898	150	145,423	10,946	11098	835	156521	11781	\$25,043	\$5,184	\$60,855	\$13,260	\$104,342							
2025	26,747	2,013	12,220	920	150	148,155	11,151	11565	870	159719	12022	\$25,555	\$5,290	\$62,099	\$13,531	\$106,474							
2026	27,191	2,047	12,509	942	150	150,939	11,361	12050	907	162990	12268	\$26,078	\$5,398	\$63,370	\$13,808	\$108,654							
2027	27,641	2,081	12,804	964	150	153,778	11,575	12556	945	166334	12520	\$26,613	\$5,509	\$64,671	\$14,091	\$110,884							
2028	28,100	2,115	13,107	987	150	156,672	11,793	13083	985	169755	12777	\$27,161	\$5,622	\$66,001	\$14,381	\$113,165							
2029	28,565	2,150	13,417	1,010	150	159,622	12,015	13633	1026	173255	13041	\$27,721	\$5,738	\$67,361	\$14,678	\$115,498							
2030	29,039	2,186	13,735	1,034	150	162,629	12,241	14205	1069	176834	13310	\$28,294	\$5,856	\$68,753	\$14,981	\$117,884							
2031	29,520	2,222	14,060	1,058	150	165,695	12,472	14802	1114	180497	13586	\$28,879	\$5,978	\$70,177	\$15,291	\$120,325							
2032	30,010	2,259	14,392	1,083	150	168,820	12,707	15423	1161	184243	13868	\$29,479	\$6,102	\$71,634	\$15,608	\$122,823							
2033	30,507	2,296	14,733	1,109	150	172,006	12,947	16071	1210	188077	14156	\$30,092	\$6,229	\$73,124	\$15,933	\$125,379							
2034	31,013	2,334	15,081	1,135	150	175,254	13,191	16746	1260	192000	14452	\$30,720	\$6,359	\$74,649	\$16,266	\$127,994							
2035	31,527	2,373	15,438	1,162	150	178,565	13,440	17449	1313	196014	14754	\$31,362	\$6,492	\$76,210	\$16,606	\$130,670							
2036	31,939	2,404	15,803	1,189	150	181,520	13,663	18119	1364	199639	15027	\$31,942	\$6,612	\$77,620	\$16,913	\$133,086							
2037	32,356	2,435	16,177	1,218	150	184,528	13,889	18815	1416	203343	15305	\$32,535	\$6,734	\$79,060	\$17,226	\$135,555							
2038	32,779	2,467	16,560	1,246	150	187,591	14,120	19537	1471	207128	15590	\$33,140	\$6,860	\$80,531	\$17,547	\$138,079							
2039	33,208	2,499	16,951	1,276	150	190,709	14,354	20287	1527	210996	15881	\$33,759	\$6,988	\$82,035	\$17,875	\$140,657							
2040	33,642	2,532	17,352	1,306	150	193,883	14,593	21066	1586	214949	16179	\$34,392	\$7,119	\$83,572	\$18,210	\$143,293							
2041	34,081	2,565	17,763	1,337	150	197,116	14,837	21875	1646	218991	16483	\$35,038	\$7,253	\$85,144	\$18,552	\$145,987							

\$1,162,621

Sources:
 USDOT BCA Guidance for TIGER and INFRA Grants, July 2017
 TxDOT Final Environmental Assessment US 377 Relief Route, August 2017
 TxDOT Technical Memo 7/30/201 re: US 377 Mobility Study Project – Traffic Operational Analyses of Alternatives

U.S. Department of Energy
 Fact #861 February 23, 2015 Idle Fuel Consumption for Selected Gasoline and Diesel Vehicles
<http://energy.gov/eere/vehicles/fact-861-february-23-2015-idle-fuel-consumption-selected-gasoline-and-diesel-vehicles>
 accessed 9/29/17

AAA
<http://gasprices.aaa.com/?state=TX>
 accessed 9/29/17

U.S. Energy Information Administration
 Frequently Asked Questions
 How much carbon dioxide is produced by burning gasoline and diesel fuel?
<http://www.eia.gov/tools/faqs/faq.cfm?id=307&t=1>
 accessed 8/8/16

NO BUILD

				Grams per Year					Metric Tons/Year					Value of Emissions/Year					
														\$1,872	\$7,377	\$337,459	\$0		
														/short ton	/short ton	/short ton			
				g/mi - car	1.034	0.693	0.0044	9.400	368.4						1.1015				
				g/mi - truck	0.447	8.613	0.219	2.311						\$2,062	\$8,126	\$371,711			
														/metric ton	/metric ton	/metric ton			
Annual VMT				VOC	NO _x	PM ₁₀	CO	CO ₂	VOC	NO _x	PM ₁₀	CO	CO ₂	VOC	NO _x	PM ₁₀	CO	Total Non-CO ₂	
Project Year		Car-Miles	Truck-Miles																
Upfront 1	2018	23,319,644	1,755,242	24,897,105	31,278,413	487,004	223,261,017	8,590,956,810	24.89710	31.27841	0.48700	223.26102	8590.95681	\$51,338	\$254,161	\$181,025	\$0	\$486,524	
Upfront 2	2019	23,706,225	1,784,340	25,309,837	31,796,931	495,078	226,962,127	8,733,373,405	25.30984	31.79693	0.49508	226.96213	8733.37340	\$52,189	\$258,374	\$184,026	\$0	\$494,589	
Upfront 3	2020	24,099,215	1,813,919	25,729,411	32,324,044	503,285	230,724,591	8,878,150,910	25.72941	32.32404	0.50328	230.72459	8878.15091	\$53,054	\$262,658	\$187,077	\$0	\$502,788	
Upfront 4	2021	24,498,720	1,843,990	26,155,940	32,859,896	511,628	234,549,429	9,025,328,465	26.15594	32.85990	0.51163	234.54943	9025.32847	\$53,934	\$267,012	\$190,178	\$0	\$511,123	
1	2022	24,904,848	1,874,558	26,589,540	33,404,631	520,110	238,437,672	9,174,945,856	26.58954	33.40463	0.52011	238.43767	9174.94586	\$54,828	\$271,438	\$193,331	\$0	\$519,597	
2	2023	25,317,708	1,905,634	27,030,328	33,958,396	528,732	242,390,373	9,327,043,530	27.03033	33.95840	0.52873	242.39037	9327.04353	\$55,737	\$275,938	\$196,535	\$0	\$528,210	
3	2024	25,737,412	1,937,225	27,478,423	34,521,342	537,497	246,408,599	9,481,662,603	27.47842	34.52134	0.53750	246.40860	9481.66260	\$56,661	\$280,512	\$199,794	\$0	\$536,967	
4	2025	26,164,074	1,969,339	27,933,947	35,093,619	546,407	250,493,438	9,638,844,873	27.93395	35.09362	0.54641	250.49344	9638.84487	\$57,600	\$285,163	\$203,106	\$0	\$545,868	
5	2026	26,597,809	2,001,986	28,397,022	35,675,384	555,465	254,645,993	9,798,632,833	28.39702	35.67538	0.55547	254.64599	9798.63283	\$58,555	\$289,890	\$206,473	\$0	\$554,917	
6	2027	27,038,734	2,035,174	28,867,774	36,266,793	564,673	258,867,388	9,961,069,678	28.86777	36.26679	0.56467	258.86739	9961.06968	\$59,526	\$294,695	\$209,895	\$0	\$564,116	
7	2028	27,486,969	2,068,912	29,346,329	36,868,005	574,034	263,158,762	10,126,199,320	29.34633	36.86801	0.57403	263.15876	10126.19932	\$60,512	\$299,581	\$213,375	\$0	\$573,468	
8	2029	27,942,634	2,103,209	29,832,818	37,479,185	583,550	267,521,276	10,294,066,399	29.83282	37.47918	0.58355	267.52128	10294.06640	\$61,516	\$304,547	\$216,912	\$0	\$582,975	
9	2030	28,405,853	2,138,075	30,327,372	38,100,496	593,224	271,956,111	10,464,716,294	30.32737	38.10050	0.59322	271.95611	10464.71629	\$62,535	\$309,596	\$220,508	\$0	\$592,639	
10	2031	28,876,751	2,173,519	30,830,124	38,732,107	603,058	276,464,463	10,638,195,138	30.83012	38.73211	0.60306	276.46446	10638.19514	\$63,572	\$314,728	\$224,163	\$0	\$602,463	
11	2032	29,355,456	2,209,550	31,341,210	39,374,188	613,056	281,047,553	10,814,549,828	31.34121	39.37419	0.61306	281.04755	10814.54983	\$64,626	\$319,945	\$227,880	\$0	\$612,451	
12	2033	29,842,096	2,246,179	31,860,769	40,026,914	623,218	285,706,619	10,993,828,038	31.86077	40.02691	0.62322	285.70662	10993.82804	\$65,697	\$325,249	\$231,657	\$0	\$622,604	
13	2034	30,336,803	2,283,415	32,388,941	40,690,460	633,550	290,442,921	11,176,078,233	32.38894	40.69046	0.63355	290.44292	11176.07823	\$66,786	\$330,641	\$235,498	\$0	\$632,925	
14	2035	30,839,711	2,321,269	32,925,869	41,365,006	644,053	295,257,739	11,361,349,680	32.92587	41.36501	0.64405	295.25774	11361.34968	\$67,893	\$336,122	\$239,401	\$0	\$643,417	
15	2036	31,242,736	2,351,604	33,356,156	41,905,580	652,469	299,116,279	11,509,824,124	33.35616	41.90558	0.65247	299.11628	11509.82412	\$68,781	\$340,515	\$242,530	\$0	\$651,826	
16	2037	31,651,028	2,382,335	33,792,067	42,453,218	660,996	303,025,245	11,660,238,888	33.79207	42.45322	0.66100	303.02524	11660.23889	\$69,680	\$344,965	\$245,700	\$0	\$660,344	
17	2038	32,064,656	2,413,469	34,233,675	43,008,013	669,634	306,985,294	11,812,619,330	34.23367	43.00801	0.66963	306.98529	11812.61933	\$70,590	\$349,473	\$248,910	\$0	\$668,974	
18	2039	32,483,689	2,445,009	34,681,054	43,570,058	678,385	310,997,095	11,966,991,137	34.68105	43.57006	0.67839	310.99709	11966.99114	\$71,513	\$354,040	\$252,163	\$0	\$677,716	
19	2040	32,908,199	2,476,961	35,134,279	44,139,448	687,251	315,061,323	12,123,380,334	35.13428	44.13945	0.68725	315.06132	12123.38033	\$72,447	\$358,667	\$255,459	\$0	\$686,573	
20	2041	33,338,255	2,509,331	35,593,427	44,716,279	696,232	319,178,665	12,281,813,285	35.59343	44.71628	0.69623	319.17866	12281.81328	\$73,394	\$363,354	\$258,797	\$0	\$695,545	

\$1,492,963 \$7,391,265 \$5,264,392 \$0 \$14,148,619

Sources:

- EPA420-F-08-024 October 2008 Average Annual Emissions and Fuel Consumption for Gasoline-Fueled Passenger Cars and Light Trucks
- EPA420-F-08-027 October 2008 Average In-Use Emissions from Heavy-Duty Trucks
- USDOT Benefit-Cost Analysis Guidance for TIGER and INFRA Applications, July 2017

BUILD

				Grams per Year					Metric Tons/Year					Value of Emissions/Year					
														\$1,872	\$7,377	\$337,459	\$0		
														/short ton	/short ton	/short ton			
				g/mi - car	1.034	0.693	0.0044	9.400	368.4						1.1015				
				g/mi - truck	0.447	8.613	0.219	2.311						\$2,062	\$8,126	\$371,711			
														/metric ton	/metric ton	/metric ton			
				Annual VMT															
Project Year		Car-Miles	Truck-Miles	VOC	NO _x	PM ₁₀	CO	CO ₂	VOC	NO _x	PM ₁₀	CO	CO ₂	VOC	NO _x	PM ₁₀	CO	Total Non-CO ₂	
Upfront 1	2018	23,319,644	1,755,242	24,897,105	31,278,413	487,004	223,261,017	8,590,956,810	24.89710	31.27841	0.48700	223.26102	8590.95681	\$51,338	\$254,161	\$181,025	\$0	\$486,524	
Upfront 2	2019	23,706,225	1,784,340	25,309,837	31,796,931	495,078	226,962,127	8,733,373,405	25.30984	31.79693	0.49508	226.96213	8733.37340	\$52,189	\$258,374	\$184,026	\$0	\$494,589	
Upfront 3	2020	24,099,215	1,813,919	25,729,411	32,324,044	503,285	230,724,591	8,878,150,910	25.72941	32.32404	0.50328	230.72459	8878.15091	\$53,054	\$262,658	\$187,077	\$0	\$502,788	
Upfront 4	2021	24,498,720	1,843,990	26,155,940	32,859,896	511,628	234,549,429	9,025,328,465	26.15594	32.85990	0.51163	234.54943	9025.32847	\$53,934	\$267,012	\$190,178	\$0	\$511,123	
1	2022	27,084,951	2,038,652	28,917,117	36,328,783	565,639	259,309,865	9,978,095,968	28.91712	36.32878	0.56564	259.30987	9978.09597	\$59,627	\$295,199	\$210,254	\$0	\$565,081	
2	2023	27,533,952	2,072,448	29,396,490	36,931,023	575,015	263,608,575	10,143,507,863	29.39649	36.93102	0.57502	263.60857	10143.50786	\$60,616	\$300,093	\$213,740	\$0	\$574,448	
3	2024	27,990,396	2,106,804	29,883,811	37,543,247	584,548	267,978,546	10,311,661,874	29.88381	37.54325	0.58455	267.97855	10311.66187	\$61,621	\$305,068	\$217,283	\$0	\$583,971	
4	2025	28,454,407	2,141,730	30,379,210	38,165,620	594,238	272,420,961	10,482,603,458	30.37921	38.16562	0.59424	272.42096	10482.60346	\$62,642	\$310,125	\$220,885	\$0	\$593,652	
5	2026	28,926,110	2,177,234	30,882,821	38,798,311	604,089	276,937,019	10,656,378,827	30.88282	38.79831	0.60409	276.93702	10656.37883	\$63,681	\$315,266	\$224,547	\$0	\$603,493	
6	2027	29,405,632	2,213,327	31,394,781	39,441,490	614,103	281,527,943	10,833,034,957	31.39478	39.44149	0.61410	281.52794	10833.03496	\$64,736	\$320,492	\$228,269	\$0	\$613,498	
7	2028	29,893,104	2,250,019	31,915,228	40,095,331	624,284	286,194,973	11,012,619,604	31.91523	40.09533	0.62428	286.19497	11012.61960	\$65,809	\$325,805	\$232,053	\$0	\$623,668	
8	2029	30,388,657	2,287,318	32,444,303	40,760,012	634,633	290,939,370	11,195,181,316	32.44430	40.76001	0.63463	290.93937	11195.18132	\$66,900	\$331,206	\$235,900	\$0	\$634,007	
9	2030	30,892,425	2,325,236	32,982,148	41,435,711	645,153	295,762,418	11,380,769,444	32.98215	41.43571	0.64515	295.76242	11380.76944	\$68,009	\$336,697	\$239,811	\$0	\$644,517	
10	2031	31,404,544	2,363,783	33,528,910	42,122,612	655,848	300,665,420	11,569,434,160	33.52891	42.12261	0.65585	300.66542	11569.43416	\$69,137	\$342,278	\$243,786	\$0	\$655,201	
11	2032	31,925,153	2,402,969	34,084,735	42,820,899	666,721	305,649,701	11,761,226,466	34.08474	42.82090	0.66672	305.64970	11761.22647	\$70,283	\$347,953	\$247,828	\$0	\$666,063	
12	2033	32,454,393	2,442,804	34,649,775	43,530,763	677,773	310,716,609	11,956,198,209	34.64978	43.53076	0.67777	310.71661	11956.19821	\$71,448	\$353,721	\$251,936	\$0	\$677,105	
13	2034	32,992,405	2,483,299	35,224,182	44,252,394	689,009	315,867,514	12,154,402,096	35.22418	44.25239	0.68901	315.86751	12154.40210	\$72,633	\$359,585	\$256,112	\$0	\$688,329	
14	2035	33,539,337	2,524,466	35,808,111	44,985,988	700,431	321,103,808	12,355,891,708	35.80811	44.98599	0.70043	321.10381	12355.89171	\$73,837	\$365,546	\$260,358	\$0	\$699,740	
15	2036	33,977,642	2,557,457	36,276,065	45,573,882	709,585	325,300,115	12,517,363,206	36.27606	45.57388	0.70958	325.30011	12517.36321	\$74,802	\$370,323	\$263,760	\$0	\$708,885	
16	2037	34,421,674	2,590,879	36,750,134	46,169,459	718,858	329,551,261	12,680,944,874	36.75013	46.16946	0.71886	329.55126	12680.94487	\$75,779	\$375,162	\$267,207	\$0	\$718,149	
17	2038	34,871,510	2,624,737	37,230,399	46,772,819	728,252	333,857,962	12,846,664,291	37.23040	46.77282	0.72825	333.85796	12846.66429	\$76,769	\$380,065	\$270,699	\$0	\$727,534	
18	2039	35,327,224	2,659,038	37,716,940	47,384,064	737,769	338,220,945	13,014,549,391	37.71694	47.38406	0.73777	338.22095	13014.54939	\$77,773	\$385,032	\$274,237	\$0	\$737,041	
19	2040	35,788,894	2,693,788	38,209,839	48,003,297	747,411	342,640,945	13,184,628,479	38.20984	48.00330	0.74741	342.64095	13184.62848	\$78,789	\$390,064	\$277,821	\$0	\$746,673	
20	2041	36,256,597	2,728,991	38,709,180	48,630,622	757,178	347,118,708	13,356,930,224	38.70918	48.63062	0.75718	347.11871	13356.93022	\$79,819	\$395,161	\$281,451	\$0	\$756,431	

\$1,605,225 \$7,947,044 \$5,660,243 \$0 \$15,212,512

Sources:

EPA420-F-08-024 October 2008 Average Annual Emissions and Fuel Consumption for Gasoline-Fueled Passenger Cars and Light Trucks

EPA420-F-08-027 October 2008 Average In-Use Emissions from Heavy-Duty Trucks

USDOT Benefit-Cost Analysis Guidance for TIGER and INFRA Applications, July 2017

NHTSA Corporate Average Fuel Economy for MY 2017-MY 2025 Passenger Cars and Light Trucks, August 2012

NO BUILD

		Grams per Year						Metric Tons/Year						Value of Emissions/Year				
														\$1,872	\$7,377	\$337,459	\$0	
														/short ton	/short ton	/short ton		
														1.1015				
														\$2,062	\$8,126	\$371,711		
														/metric ton	/metric ton	/metric ton		
Project Year	Annual Idling	Car Idling Hrs/Yr	Truck Idling Hrs/Yr	VOC	NO _x	PM ₁₀	CO	CO ₂	VOC	NO _x	PM ₁₀	CO	CO ₂	VOC	NO _x	PM ₁₀	CO	Total Non-CO ₂
Upfront 1	2018	138,756	10,444	408,366	840,348	12,491	10,150,552	-	0.40837	0.84035	0.01249	10.15055	0.00000	\$842	\$6,828	\$4,643	\$0	\$12,314
Upfront 2	2019	141,556	10,655	416,606	857,304	12,743	10,355,368	-	0.41661	0.85730	0.01274	10.35537	0.00000	\$859	\$6,966	\$4,737	\$0	\$12,562
Upfront 3	2020	144,418	10,870	425,029	874,638	13,001	10,564,739	-	0.42503	0.87464	0.01300	10.56474	0.00000	\$876	\$7,107	\$4,833	\$0	\$12,816
Upfront 4	2021	147,344	11,090	433,640	892,358	13,264	10,778,781	-	0.43364	0.89236	0.01326	10.77878	0.00000	\$894	\$7,251	\$4,930	\$0	\$13,076
1	2022	150,335	11,316	442,444	910,475	13,533	10,997,612	-	0.44244	0.91047	0.01353	10.99761	0.00000	\$912	\$7,398	\$5,031	\$0	\$13,341
2	2023	153,394	11,546	451,446	928,998	13,809	11,221,355	-	0.45145	0.92900	0.01381	11.22136	0.00000	\$931	\$7,549	\$5,133	\$0	\$13,613
3	2024	156,521	11,781	460,650	947,938	14,090	11,450,136	-	0.46065	0.94794	0.01409	11.45014	0.00000	\$950	\$7,703	\$5,238	\$0	\$13,890
4	2025	159,719	12,022	470,062	967,307	14,378	11,684,084	-	0.47006	0.96731	0.01438	11.68408	0.00000	\$969	\$7,860	\$5,345	\$0	\$14,174
5	2026	162,990	12,268	479,687	987,114	14,673	11,923,332	-	0.47969	0.98711	0.01467	11.92333	0.00000	\$989	\$8,021	\$5,454	\$0	\$14,464
6	2027	166,334	12,520	489,531	1,007,371	14,974	12,168,019	-	0.48953	1.00737	0.01497	12.16802	0.00000	\$1,009	\$8,186	\$5,566	\$0	\$14,761
7	2028	169,755	12,777	499,599	1,028,090	15,282	12,418,285	-	0.49960	1.02809	0.01528	12.41829	0.00000	\$1,030	\$8,354	\$5,680	\$0	\$15,065
8	2029	173,255	13,041	509,898	1,049,283	15,597	12,674,277	-	0.50990	1.04928	0.01560	12.67428	0.00000	\$1,051	\$8,526	\$5,797	\$0	\$15,375
9	2030	176,834	13,310	520,433	1,070,963	15,919	12,936,144	-	0.52043	1.07096	0.01592	12.93614	0.00000	\$1,073	\$8,702	\$5,917	\$0	\$15,693
10	2031	180,497	13,586	531,211	1,093,141	16,249	13,204,041	-	0.53121	1.09314	0.01625	13.20404	0.00000	\$1,095	\$8,883	\$6,040	\$0	\$16,018
11	2032	184,243	13,868	542,238	1,115,833	16,586	13,478,128	-	0.54224	1.11583	0.01659	13.47813	0.00000	\$1,118	\$9,067	\$6,165	\$0	\$16,350
12	2033	188,077	14,156	553,520	1,139,050	16,931	13,758,569	-	0.55352	1.13905	0.01693	13.75857	0.00000	\$1,141	\$9,256	\$6,293	\$0	\$16,690
13	2034	192,000	14,452	565,065	1,162,807	17,284	14,045,533	-	0.56506	1.16281	0.01728	14.04553	0.00000	\$1,165	\$9,449	\$6,425	\$0	\$17,039
14	2035	196,014	14,754	576,879	1,187,119	17,645	14,339,195	-	0.57688	1.18712	0.01765	14.33919	0.00000	\$1,190	\$9,646	\$6,559	\$0	\$17,395
15	2036	199,639	15,027	587,548	1,209,072	17,972	14,604,372	-	0.58755	1.20907	0.01797	14.60437	0.00000	\$1,212	\$9,825	\$6,680	\$0	\$17,716
16	2037	203,343	15,305	598,449	1,231,505	18,305	14,875,332	-	0.59845	1.23150	0.01831	14.87533	0.00000	\$1,234	\$10,007	\$6,804	\$0	\$18,045
17	2038	207,128	15,590	609,588	1,254,428	18,646	15,152,223	-	0.60959	1.25443	0.01865	15.15222	0.00000	\$1,257	\$10,193	\$6,931	\$0	\$18,381
18	2039	210,996	15,881	620,972	1,277,855	18,994	15,435,197	-	0.62097	1.27786	0.01899	15.43520	0.00000	\$1,280	\$10,384	\$7,060	\$0	\$18,724
19	2040	214,949	16,179	632,608	1,301,799	19,350	15,724,412	-	0.63261	1.30180	0.01935	15.72441	0.00000	\$1,304	\$10,578	\$7,193	\$0	\$19,075
20	2041	218,991	16,483	644,501	1,326,273	19,714	16,020,031	-	0.64450	1.32627	0.01971	16.02003	0.00000	\$1,329	\$10,777	\$7,328	\$0	\$19,434

\$25,713 \$208,516 \$141,781 \$0 \$376,010

Sources:
 EPA420-F-08-025 October 2008 Idling Vehicle Emissions for Passenger Cars, Light-Duty Trucks, and Heavy-Duty Trucks
 USDOT Benefit-Cost Analysis Guidance for TIGER and INFRA Applications, July 2017