

# DIVERGING DIAMOND INTERCHANGE/INTERSECTION (DDI) WASHINGTON ROAD (SR 19) AND I-70/79

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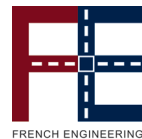
Josh Spano / Keith Johnson

Oct 20, 2022

# Topics

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- Purpose of the Study
- Project Overview
- Alternatives Considered
- Crash Analysis
- LOS Comparison
- Benefit-Cost Analysis
- Conclusion

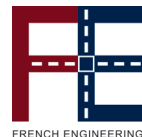


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## ● *Purpose of the Study*

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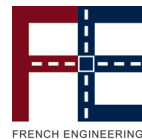


## Purpose of the Study

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The purpose of this study is to evaluate the effectiveness of those improvements and their impact on the reportable crashes within the study area

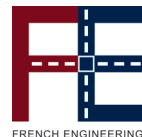
- “Before” time period 2011-2013 (3 years)
- “After Construction” time period 2017-2019 (3 years)
- Avoided Covid-19 time period
- Traffic Counts conducted November 2021



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# Roadway Facility Description

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- Raymond P. Shafer Highway (I-70/79) is classified as an Urban Interstate Highway and has an ADT of 33,800 in the westbound direction and 31,000 in the eastbound direction. This section went from a 4-lane to a 6-lane divided highway with a grass median.
- Murtland Avenue (South SR 19) is classified as a four-lane principal arterial highway and has an AM peak hour volume of 800 southbound and 700 northbound. It also has a PM peak hour volume of 700 southbound and 1100 northbound. Washington Road is “North” SR 19.









## Purpose and Need – Point of Access Study (2012)

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- **Inadequate Pavement** - The existing concrete pavement is failing with various repairs being required in recent years including bituminous patching and overlay. Along with the need to replace the existing pavement, additional pavement width will be required to maintain traffic during reconstruction
- **Deteriorating Level of Service (LOS)** - LOS for I-70/79 mainline with two (2) through lanes in each direction (existing condition) will continue to deteriorate and are anticipated to be LOS F in 2038
- **The cloverleaf interchange at Exit 19 (SR 19 Murtland Avenue) is substandard** - The interchange does not meet current design criteria for horizontal and vertical design elements, and does not and does not provide acceleration, deceleration and weave lengths meeting current design standards.
- **Crashes** - The high number of crashes along I-70/79 and within the interchange area indicates operational and safety problems with the existing condition
- **I-70/79 Bridges over SR 19 Needs** - Existing dual bridge structures carrying I-70/79 over S.R. 0019 in need of preservation type repairs

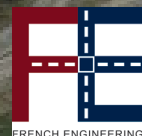


I-70 Future  
LOS Failing

Cloverleaf  
Interchange  
Substandard

Substandard  
Weave Areas  
/ Crash  
Clusters

I-70 Pavement  
Issues



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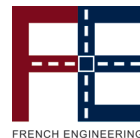


## Alternatives Considered – Point of Access Study (2012)

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All alternatives (except for the “No-Build” were developed to include three (3) lanes on I-70/79 in each direction, four (4) lanes on I-70/79 in each direction between the eastern S.R. 0019 ramps and the S.R. 0136 western ramps (weave/auxiliary lane)

- Existing Condition (No-Build)
- Alternative 1 – Improvements to the Existing Cloverleaf
- Alternative 2 – Standard Diamond Interchange and Modified Diamond Interchange
- Alternative 3 – Single Point Urban Interchange (SPUI)
- Preferred Interchange – Diverging Diamond Interchange (DDI)



## Disadvantages with Alternatives 1-3

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- Requiring a four (4) lane bridge in each direction on I-70/79 between the inner (Alternative 1 and 2)
- Requiring replacement of both bridges over S.R. 0019 (Alternative 1)
- Requiring dual left turning lanes from S.R. 0019 to the I-70/79 entrance ramps (Alternative 2 and 3)
- Requiring the replacement of the dual bridges over S.R. 0019 and requires the longest span bridges over S.R. 0019 for the SPUI ramps (Alternative 3)
- Highest construction cost estimate (Alternative 3)
- Various Design Exceptions required (Alternatives 1,2, and 3)



# Advantages of the DDI Alternative

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- Eliminates dual left turn lanes from S.R. 0019
- Eliminates traffic conflicts with the left turns at ramps
- Provides a two-phase traffic signal
- Reduces the number of conflict points from 26 to 14
- Requires a three (3) lane bridge in each direction on I-70/79 – does not require the replacement of the dual bridges



# Disadvantages of the DDI Alternative

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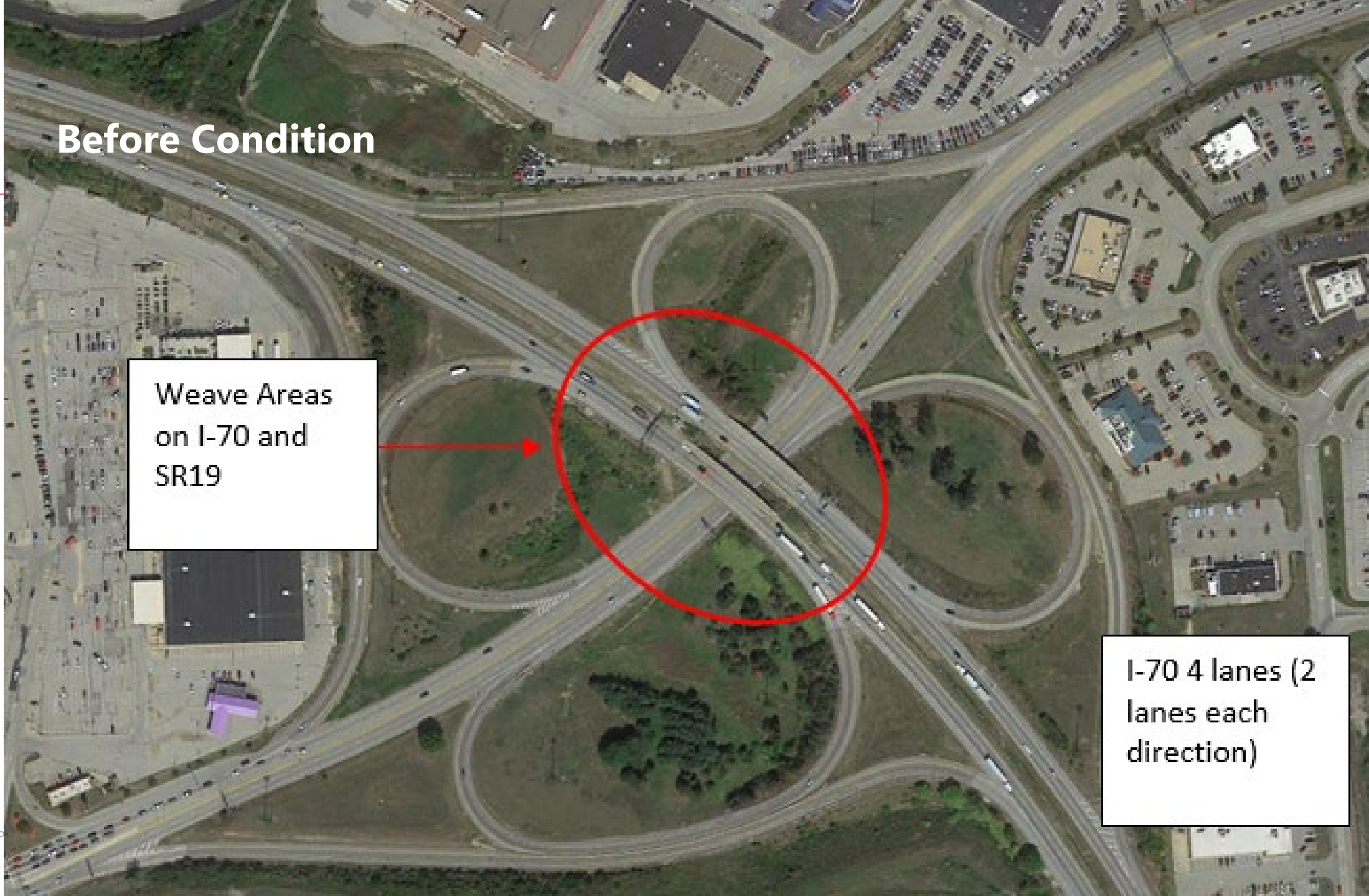
- Unfamiliar travel lane configuration for the travelling public along S.R.0019
- Speed reduction to 35 mph required
- Addition of two (2) new traffic signals on S.R. 0019 where no signals exist



# Before Condition

Weave Areas  
on I-70 and  
SR19

I-70 4 lanes (2  
lanes each  
direction)





An aerial photograph of a highway interchange. A multi-lane highway runs diagonally from the bottom left to the top right. It intersects with a road that runs horizontally across the middle. To the right, the highway curves and splits into two directions. The surrounding area includes parking lots, buildings, and some greenery. Three white callout boxes with black borders contain text. Red arrows point from the boxes to specific locations on the highway interchange. The top right box is labeled 'After Condition'. The bottom center box is labeled 'Addition of 2 Signalized Intersections with Sidewalks'. The bottom right box is labeled 'I-70 Widened to 6 lanes (3 lanes each direction)'.

## After Condition

Elimination of Weaves on both I-70 and SR 19

Addition of 2 Signalized Intersections with Sidewalks

I-70 Widened to 6 lanes (3 lanes each direction)

# Topics

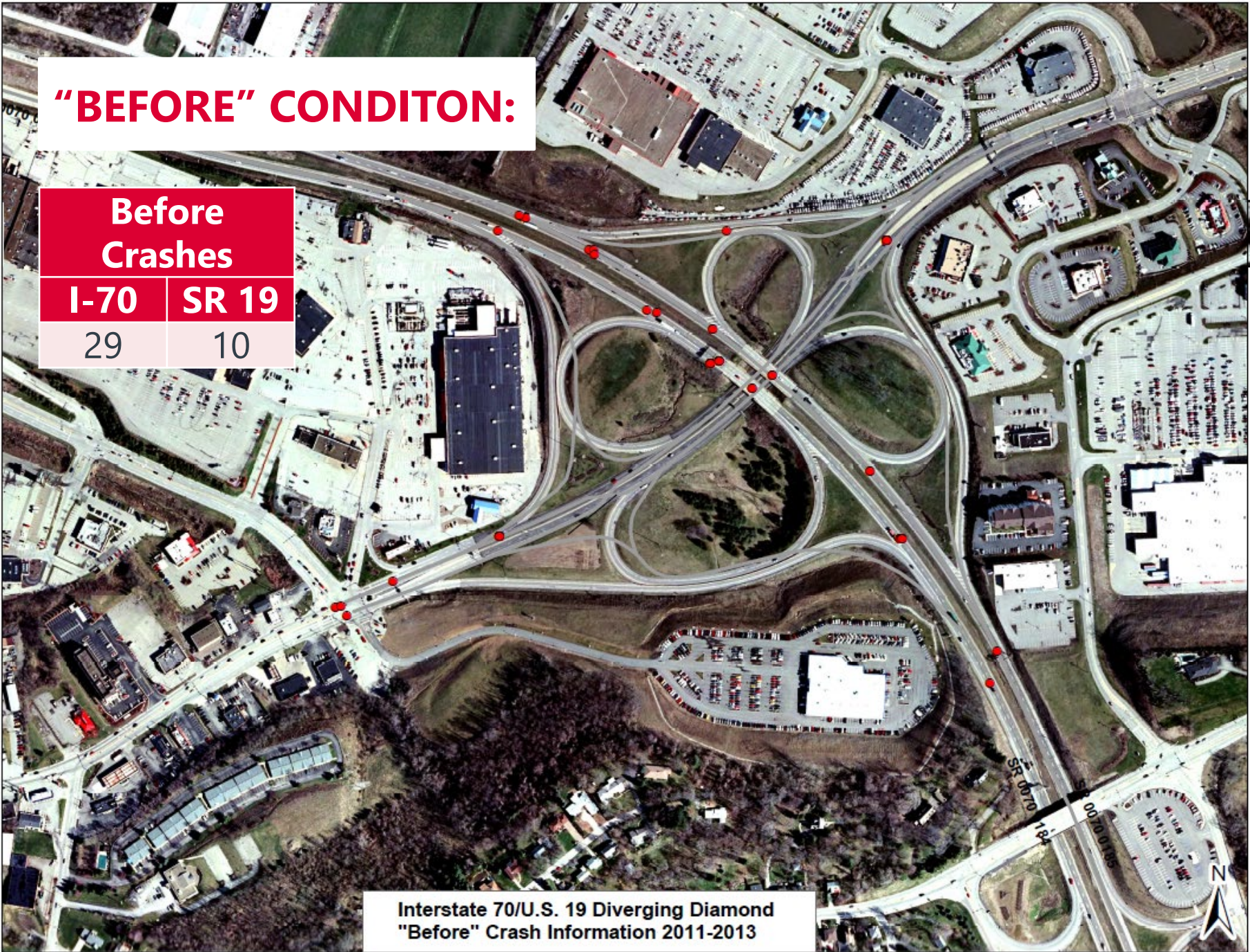
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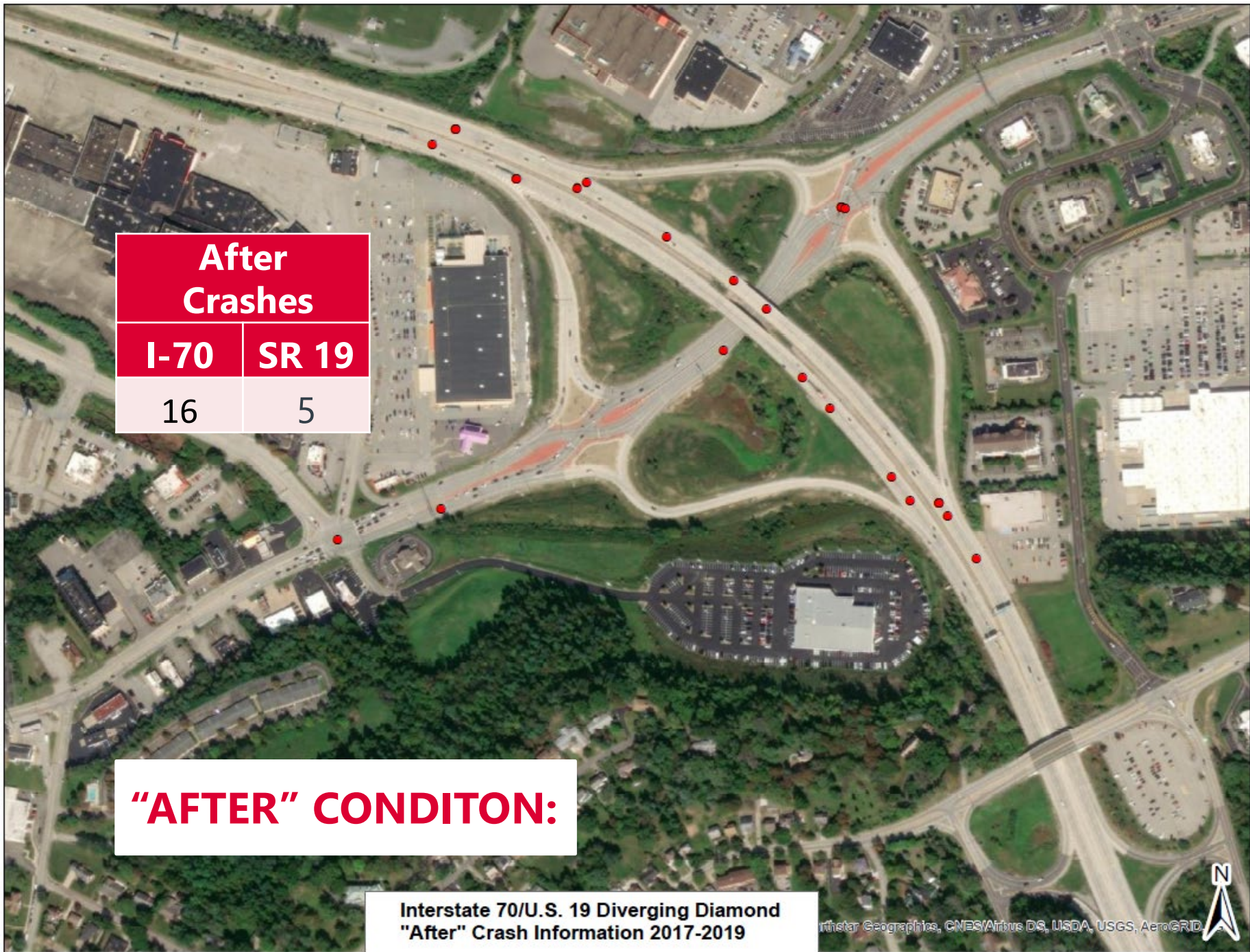
# "BEFORE" CONDITON:

Before Crashes	
I-70	SR 19
29	10



Interstate 70/U.S. 19 Diverging Diamond  
"Before" Crash Information 2011-2013



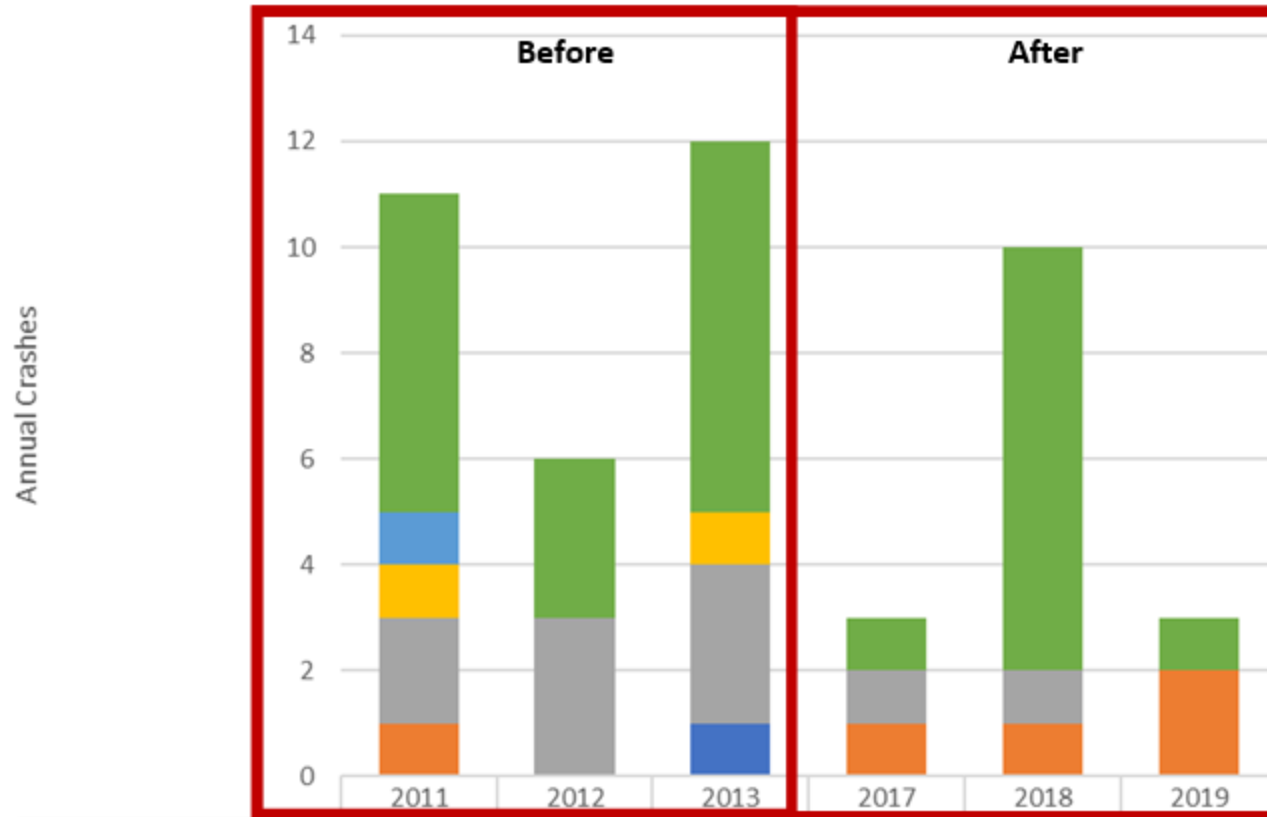


Artistar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID

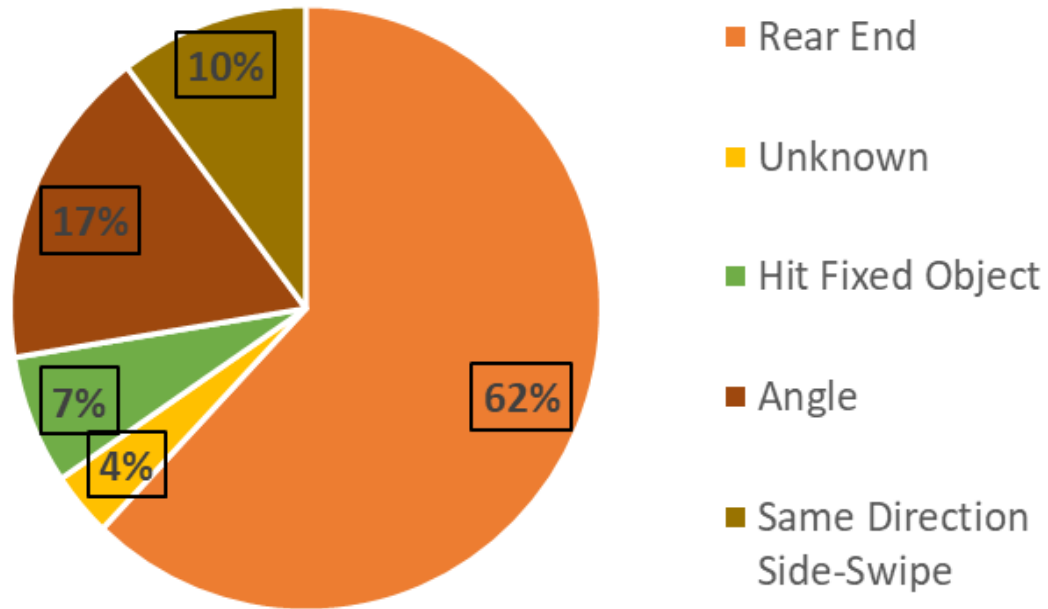


**GANNETT  
FLEMING**

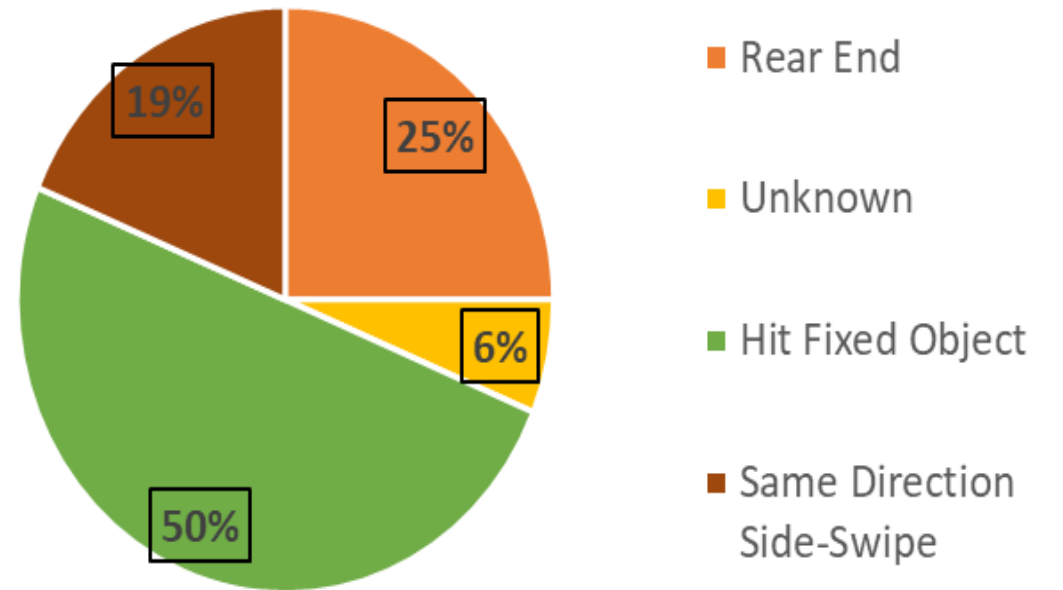
## I-70 Severity Level Trend



I-70 Crashes by Collision Type Before Improvements



I-70 Crashes by Collision Type After Improvements



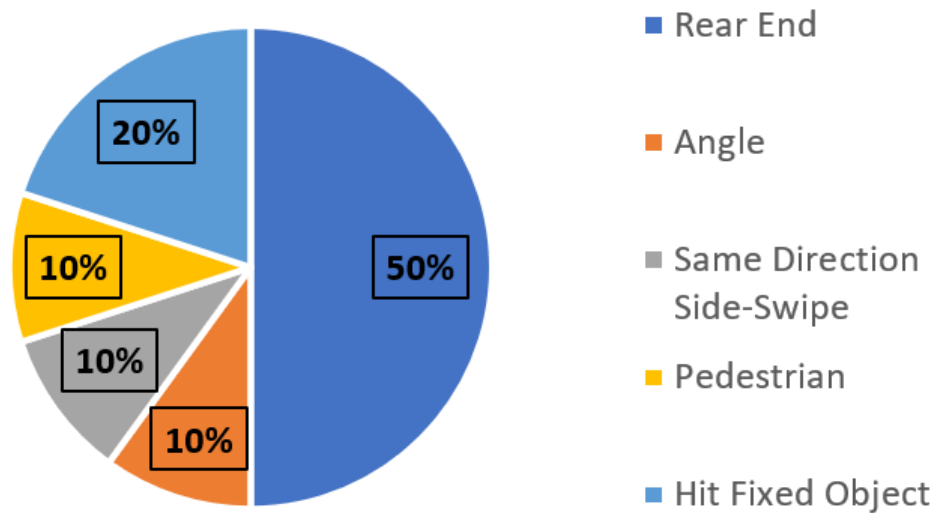
## SR 19 Severity Level Trend



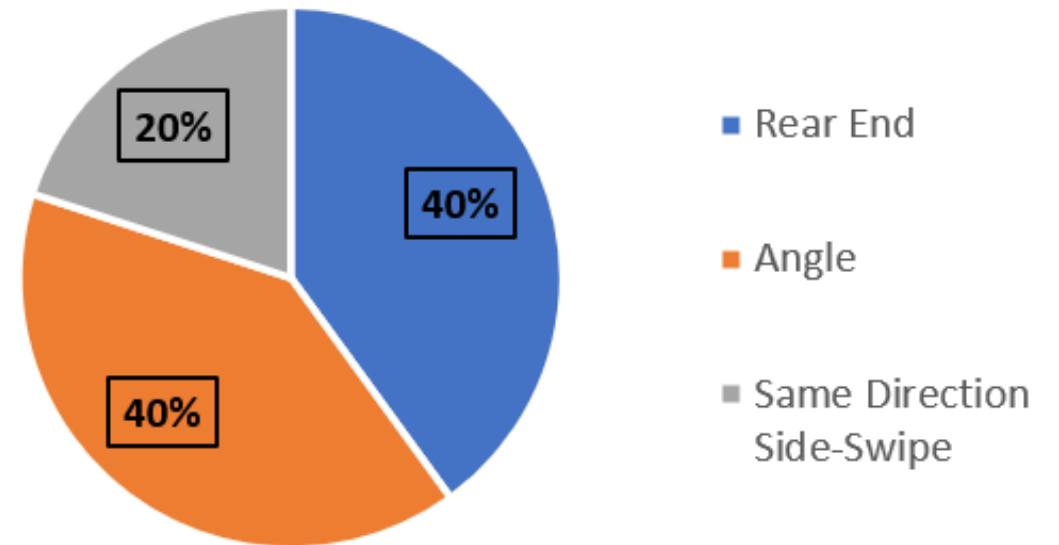
	2011	2012	2013	2017	2018	2019
■ Possible Injury	2	1	1	0	0	0
■ Property Damage Only	2	1	2	1	0	0
■ Unknown Severity	0	0	0	1	2	0
■ Suspected Minor	1	0	0	0	0	1



### SR 19 Crashes by Collision Type 2011-2013



### SR 19 Crashes by Collision Type 2017-2019





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# LOS Comparison – I-70

I-70/79 - Before					
Direction	Period	Description	Speed (mph)	Density (pc/mi/ln)	LOS
Eastbound	AM	Basic	58.5	23.8	C
	PM	Basic	58.5	27.9	D
	AM	Diverge	55.3	25.2	C
	PM	Diverge	55.6	29.3	D
	AM	Basic	58.5	21.0	C
	PM	Basic	58.5	25.6	C
	AM	Weave	58.6	24.8	C
	PM	Weave	54.6	33.4	D
	AM	Basic	58.5	18.5	C
	PM	Basic	58.5	24.9	C
	AM	Merge	60.8	18.9	C
	PM	Merge	59.1	27.6	C
Westbound	AM	Basic	58.5	23.3	C
	PM	Basic	58.5	22.9	C
	AM	Diverge	55.6	24.5	C
	PM	Diverge	55.6	24.1	C
	AM	Basic	58.5	21.0	C
	PM	Basic	58.5	20.6	C
	AM	Weave	58.5	24.9	C
	PM	Weave	59.4	24.3	C
	AM	Basic	58.5	19.0	C
	PM	Basic	58.5	21.5	C
	AM	Merge	60.6	19.8	C
	PM	Merge	59.7	24.9	C
	AM	Basic	58.5	20.7	C
	PM	Basic	58.5	25.7	C

I-70/79 - After						
Direction	Period	Description	Speed (mph)	Density (pc/mi/ln)	LOS	
Eastbound	AM	Basic	60.9	15.3	B	
	PM	Basic	60.9	17.8	B	
	AM	Diverge	58.8	15.8	B	
	PM	Diverge	59.6	18.2	B	
	AM	Basic	60.9	11.4	B	
	PM	Basic	60.9	14.0	B	
	AM	Merge	63.9	12.1	B	
	PM	Merge	62.9	17.4	B	
	Westbound	AM	Diverge	59.2	15.4	B
		PM	Diverge	59.9	14.7	B
AM		Basic	70.0	10.1	A	
PM		Basic	70.0	10.6	A	
AM		Merge	64.4	12.4	B	
PM		Merge	63.8	15.3	B	
AM		Basic	60.9	13.3	B	
PM		Basic	60.9	16.5	B	



# LOS Comparison – SR 19

SR 19 - Before					
Direction	Period	Description	Speed (mph)	Density (pc/mi/ln)	LOS
SB	AM	Basic	40	6.6	A
		Weave	38.4	17.1	B
		Basic	40	11	A
	PM	Basic	40	8.7	A
		Weave	37.6	21.9	C
		Basic	40	13.2	B
NB	AM	Basic	40	6.4	A
		Weave	38.0	19.4	B
		Basic	40	10.1	A
	PM	Basic	40	12.1	B
		Weave	36.9	20.9	C
		Basic	40	12.6	B

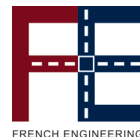
SR 19 - After - AM			
Time	Node	Delay (sec/veh)	LOS
AM	Northern Intersection	18.1	B
	Ramp	3.8	A
	Southern Intersection	23.6	C
	Ramp	0.5	A
	Ramp	0.1	A
	Ramp	17.8	B
PM	Northern Intersection	24.9	C
	Ramp	4.0	A
	Southern Intersection	25.2	C
	Ramp	0.3	A
	Ramp	1.0	A
	Ramp	5.3	A



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# Benefit-Cost Analysis Procedure

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- Establish construction cost for the project
- Annualize construction cost
- Determine Benefits of reduced crashes annually
  - (“before” annual crash costs – “after” annual crash costs)
- Calculate Benefit-Cost Ratio = Annual Benefit / Annual Cost



# Equivalent Annual Improvement Cost

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$$\text{Equivalent Annual Improvement Cost} = \frac{\text{Total Improvement Cost}}{(1 - (1/(1+R)^T))/R}$$

Where:

Total Improvement Cost = \$34,058,520

R = Discount Rate\*\* (0.005 or 0.05%)

T = Service Life of Improvements (50 years)

\*\*Based on 30-yr recommended value of real interest rates from Year 2022 Appendix C of OMB Circular No A-94, Office of Management and Budget, The White House.

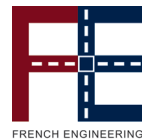
**The equivalent annual improvement cost is \$771,553**



# Pennsylvania Crash Facts and Statistics, 2020

## Pennsylvania Economic Loss Due to Reportable Traffic Crashes 2020

Max Severity	Number	Average Cost	Estimated Total Costs
Fatal Injury (crashes)	1,060	\$13,383,153	\$14,186,142,180
Suspected Serious Injury (crashes)	3,695	\$759,652	\$2,806,914,140
Suspected Minor Injury (crashes)	23,270	\$244,045	\$5,678,927,150
Possible Injury (crashes)	17,992	\$134,172	\$2,414,022,624
Property Damage Only (crashes)	58,458	\$12,446	\$727,568,268
<b>TOTAL</b>			<b>\$25,813,574,362</b>



# Crash Cost Savings

	I-70	SR 19
<b>Crash Costs Before:</b>	\$ 1,226,401	\$ 651,105
<b>Crash Costs After:</b>	\$ 627,124	\$ 410,890
<b>Cost Savings (Before – After):</b>	\$ 599,277	\$ 240,215
<b>Total Cost Savings:</b>	\$ 839,492	





## Benefit Cost Ratio (BCR)

- The BCR was calculated by comparing the equivalent annual improvement cost to the benefits (or disbenefits) of crash reduction and travel time costs from the previous sections. Below is a summary of these costs:
  - I-70/79 Annual Crash Reduction Cost Savings: \$599,277
  - SR 19 Annual Crash Reduction Cost Savings: \$240,201
  - **Total Annual Crash Reduction Savings: \$839,492**

Annual Benefits	Annual Cost of Improvements	Benefit- Cost Ratio (BCR)
\$839,492	\$771,553	1.09

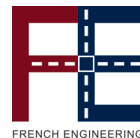
- The analysis shows that the benefits outweigh the costs under this analysis



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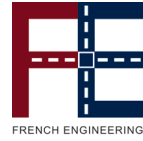


# Conclusions

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- The Benefit-Cost Ratio (BCR) value is **1.09**
- Crashes:
  - **55% reduction** in crashes on this section of I-70/79 since the DDI has been implemented
  - **50% reduction** in crashes on this section of SR 19 since the DDI has been implemented
- Crash Cost Savings:
  - The annual crash costs savings before and after crash costs was **\$599,277 on I-70/79**
  - The annual crash costs savings before and after crash costs was **\$240,215 on SR 19**
- The total annual crash cost savings on both I-70/79 and SR 19 is **\$839,492**
- There is a loss of travel time on SR 19 due to the introduction of 2 signalized intersections; however, the LOS remains at an acceptable level





**THANK YOU!**

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