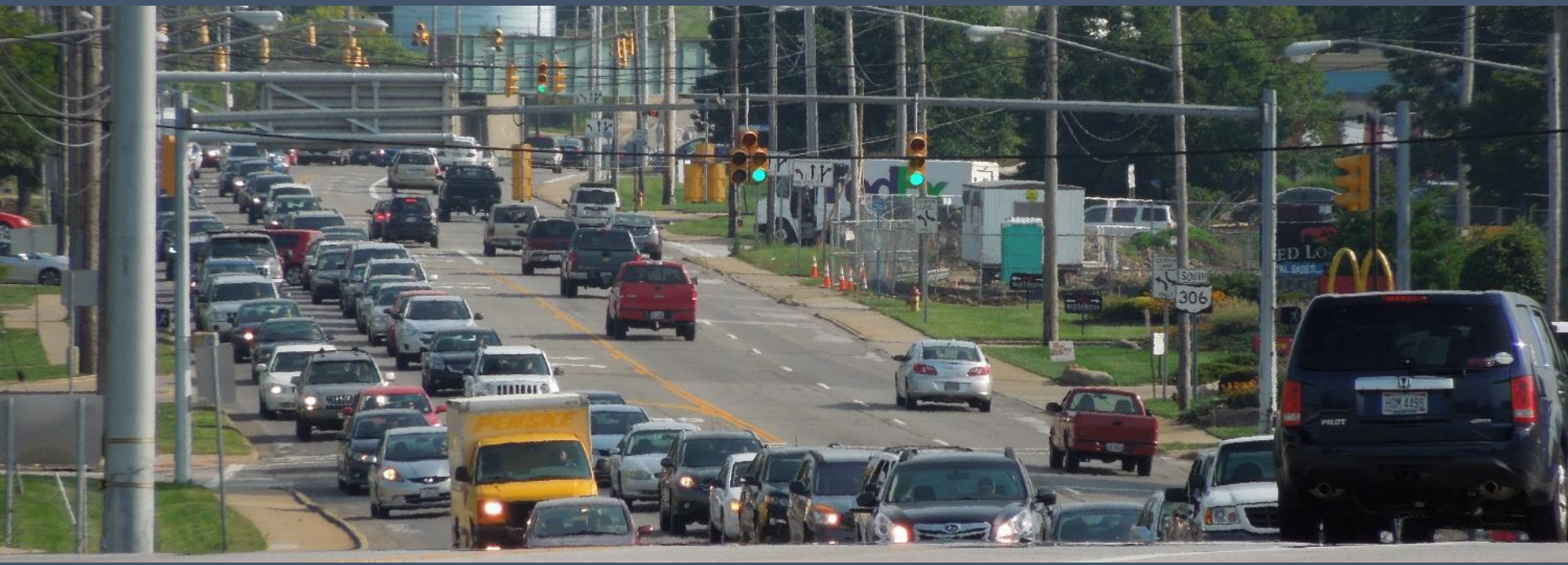
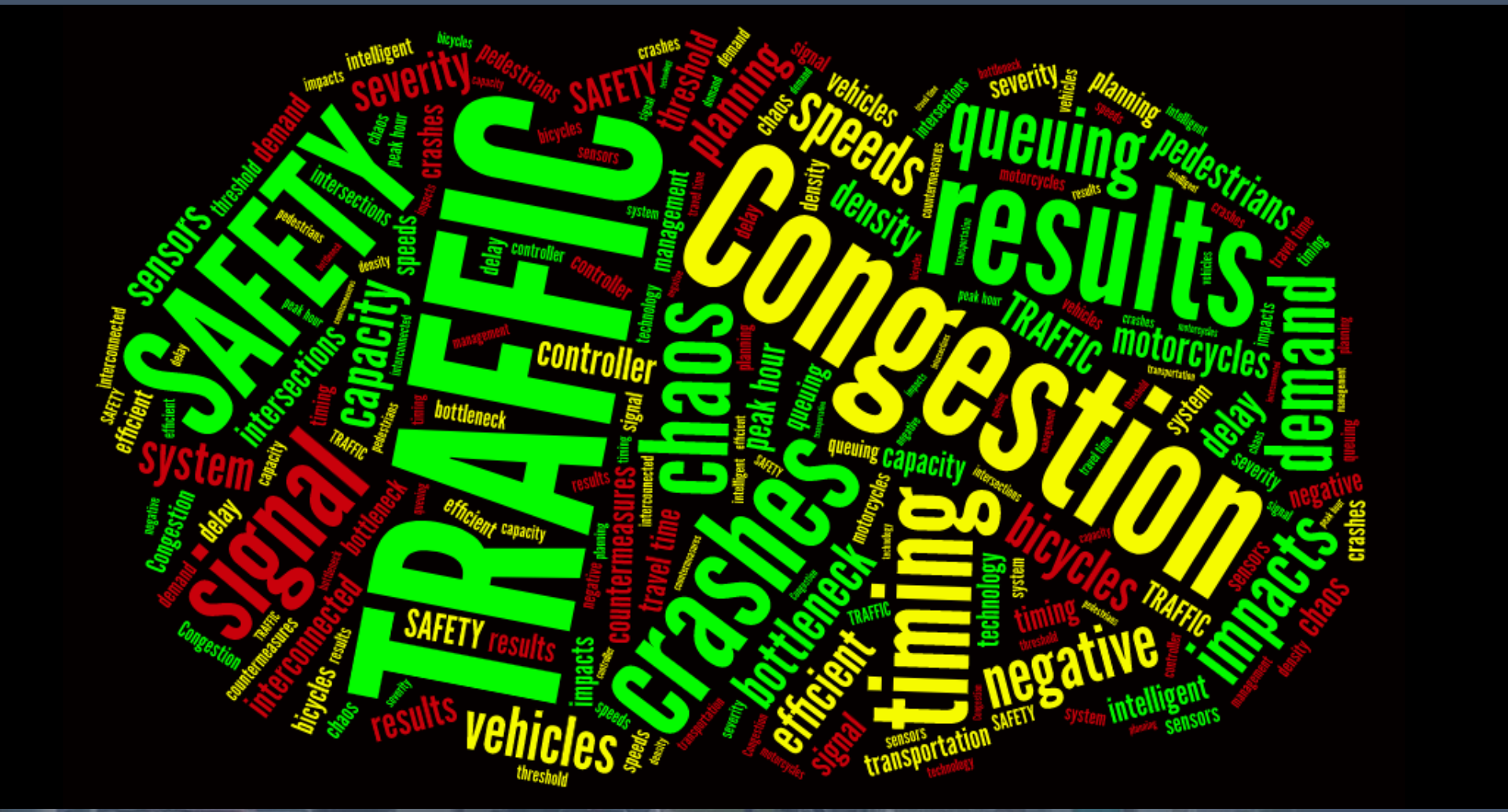
Strategic Signal Timing Changes = BIG Results



Signal Timing Updates



DGL CONSULTING ENGINEERS

Signal Timing Updates

Average Retiming Interval	Percent of Respondents
More Frequently than Every 3 Years	42
Around 5 Years	18
Around 10 Years	5
More than 10 Years	35

Source: Tarnoff and Ordonez (2004)

Benefits of Signal Retiming

The Institute of Transportation Engineers has determined that Signal Retiming reduces:

- Motorist delay
- Overall travel time
- Fuel Consumption
- Vehicle Emissions
- Number of Crashes

2013 Signal Timing Task Order

What are the expected outcomes from a signal timing project?

- Capacity Improvements ✓
- Travel Time Improvements ✓

2013 Signal Timing Task Order

Additional outcomes that may present from a signal timing project?

- Reduction in crash severity
- Change in crash type

Crash Modification Factors (CMFs)

Adjust Red/Yellow Phasing

- Left Turn
- Angle
- Sideswipe

CRASH MODIFICATION FACTORS IN PRACTICE

Signal Timing Adjustments / Coordination

- Severity
- Rear End

Average Crash Costs

OHIO DEPARTMENT OF TRANSPORTATION

Crash Cost Annual Adjustment

2001 Cost Table

Crash Severity		Human Capital Costs	Comprehensive Societal Costs	Cost Difference
Fatal	K	$1,245,600	$4,008,900	$2,763,300
Disabling Injury	A	$111,400	$216,000	$104,600
Evident Injury	B	$41,900	$79,000	$37,100
Possible Injury	C	$28,400	$44,900	$16,500
PDO	O	$6,400	$7,400	$1,000

Estimated Costs	2014	2016
Injury	$55,700	$57,000
PDO	$8,500	$8,700

Human Capital Costs

Crash Severity		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Fatal	K	$1,457,352	$1,519,632	$1,507,176	$1,532,088	$1,581,912	$1,619,280	$1,644,192	$1,656,648	$1,669,104	$1,694,016
Disabling Injury	A	$130,338	$135,908	$134,794	$137,022	$141,478	$144,820	$147,048	$148,162	$149,276	$151,504
Evident Injury	B	$49,023	$51,118	$50,699	$51,537	$53,213	$54,470	$55,308	$55,727	$56,146	$56,984
Possible Injury	C	$33,228	$34,648	$34,364	$34,932	$36,068	$36,920	$37,488	$37,772	$38,056	$38,624
PDO	O	$7,488	$7,808	$7,744	$7,872	$8,128	$8,320	$8,448	$8,512	$8,576	$8,704

Comprehensive Societal Costs

Crash Severity		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Fatal	K	$4,828,578	$5,001,390	$5,044,200	$5,124,378	$5,284,734	$5,377,368	$5,485,179	$5,635,800	$5,731,155	$5,811,333
Disabling Injury	A	$257,950	$267,704	$268,682	$273,002	$281,642	$287,076	$292,442	$298,786	$303,038	$307,358
Evident Injury	B	$94,285	$97,864	$98,187	$99,767	$102,927	$104,926	$106,877	$109,151	$110,683	$112,263
Possible Injury	C	$53,358	$55,438	$55,484	$56,382	$58,178	$59,360	$60,423	$61,532	$62,311	$63,209
PDO	O	$8,708	$9,068	$9,024	$9,172	$9,468	$9,680	$9,838	$9,952	$10,046	$10,194

Source: ODOT Office of Program Management (2017)

2013 Signal Timing Task Order

Corridors studied for pre-implementation vs post-implementation safety improvements

- COL-30, Lisbon, OH (3 signals)
- LOR-83, Avon, OH (8 signals)
- LAK-306, Mentor, OH (8 signals)

COL-30 Lisbon, OH

COL-30 Lisbon, OH

Corridor Issues:

- Heavy truck traffic (10% avg, 20% peak)
- US 30 (Lincoln Way) / Market St
  - Convergence of 1-US Route and 3-State Routes
  - Traffic using local streets to avoid congestion
  - Signal not upgraded with others COL-30-18.32
  - TBC never programmed to work with other signals
- Signal timing did not match COL-30-18.32 plans
- Inconsistencies in programming were found

COL-30 Lisbon, OH

DGL Recommendations:

- Signal Time Modifications
- Add GPS Time Clock at Market St or verify/correct time on a routine basis

Additional Recommendations:

- Remark crosswalks and stop bars
- Adjust signal head locations where needed
- Replace heads with LED’s where needed

COL-30 Lisbon, OH

Signal Timing Outcomes:

Capacity Improvements				
Intersection	Expected Reduction in Intersection Delay			
	AM Peak	Noon Peak	PM Peak	Night Off-Peak
US-30 & Beaver	-4.3%	-	-	-2.1%
US-30 & Market	-9.0%	-6.8%	-6.5%	-13.4%
US-30 & Jefferson	-6.0%	-6.3%	-6.1%	-
Market & Washington	-24.4%	-19.8%	-17.9%	-16.7%

COL-30 Lisbon, OH

Signal Timing Outcomes:

Travel Time Improvements			
Time Period	Direction	Reduction	
		Average Travel Time	Average Stopped Time
AM Peak	Eastbound	1”	3”
	Westbound	1”	2”
Day Off- Peak	Eastbound	-14”	-10”
	Westbound	14”	17”
Noon Peak	Eastbound	-3”	-
	Westbound	2”	-1”
PM Peak	Eastbound	-26”	-25”
	Westbound	-9”	-4”

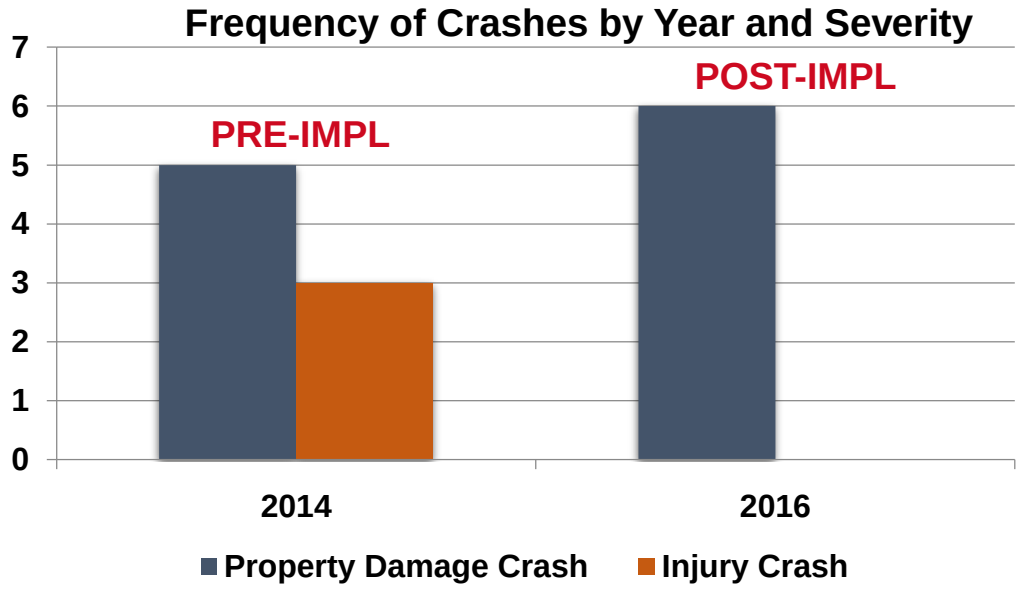
COL-30 Lisbon, OH

2014 Pre-Implementation

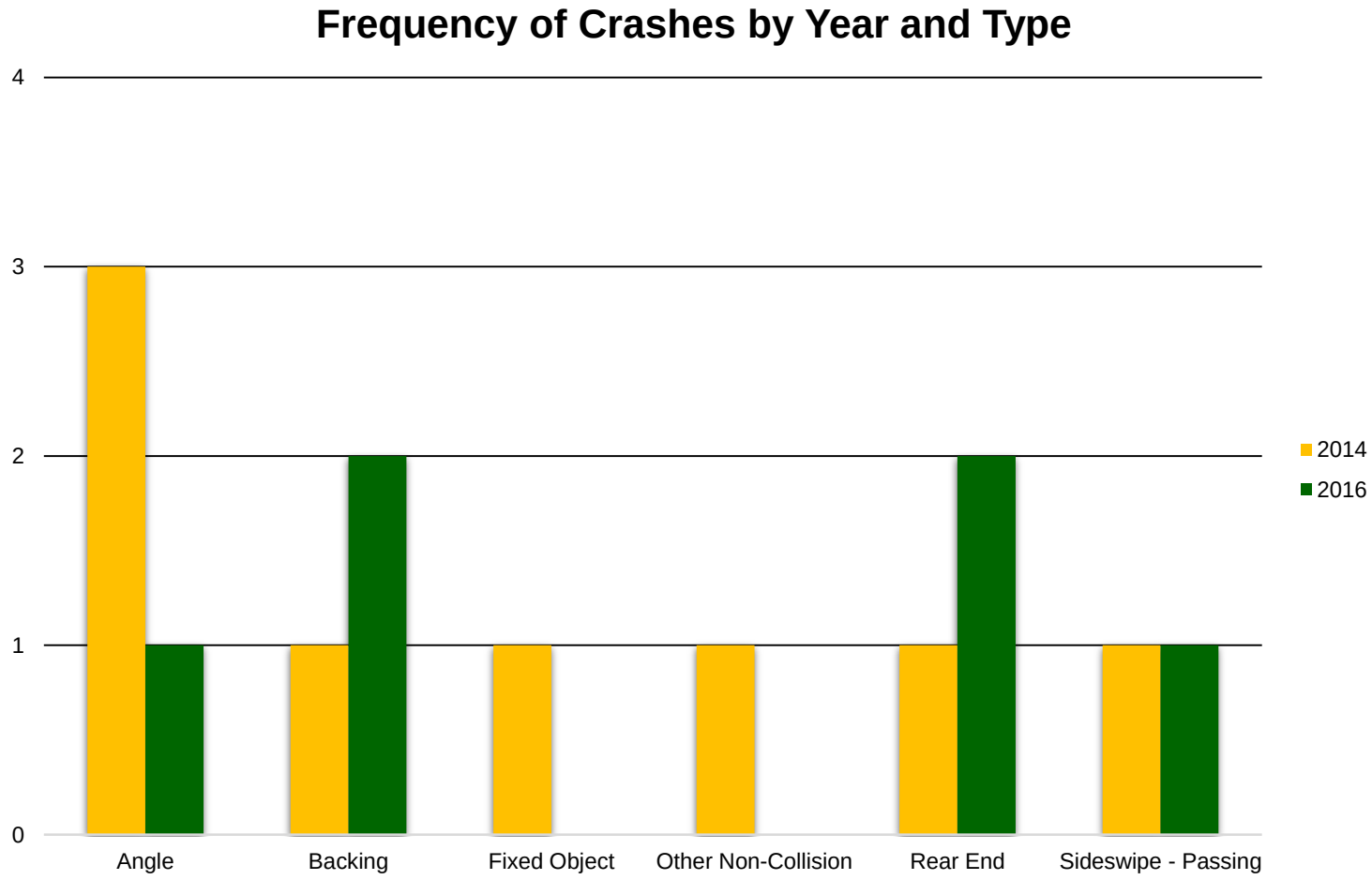
- 8 crashes
- 3 Injury, 5 PDO

2016 Post-Implementation

- 6 crashes
- 0 Injury, 6 PDO



COL-30 Lisbon, OH

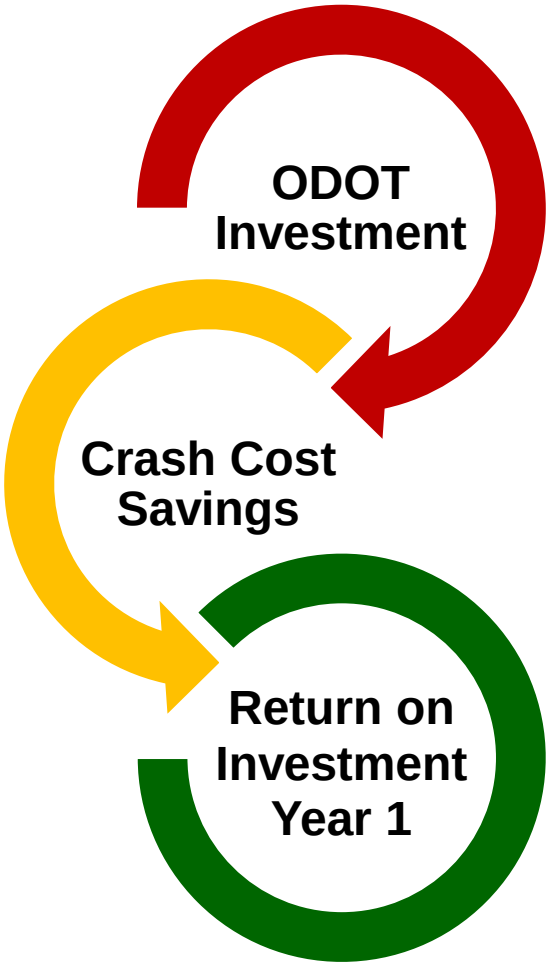


COL-30 Lisbon, OH

	2014			2016		
CRASH TYPE	# OF CRASHES	COST PER CRASH	TOTAL COST	# OF CRASHES	COST PER CRASH	TOTAL COST
INJURY	3	55,700	167,100	0	57,000	0
PDO	5	8,500	42,500	6	8,700	52,200
TOTALS	8		209,600	6		52,200

CRASH REDUCTION = 2
COST SAVINGS = $157,400

COL-30 Lisbon, OH



$19,262

$157,400

8:1

LOR-83, Avon, OH

LOR-83, Avon, OH

Corridor Issues:

- Highly commercial corridor
- Connectivity to major highway (I-90)
- ADT = 26,000 to 30,000 vpd
- Timing plans were present but not operational
- Did not accommodate directional changes throughout the day

LOR-83, Avon, OH

DGL Recommendations:

- Time of Day (TOD) Plans

Additional Recommendations:

- Add destination lane use pavement markings
- Consider adding a second left turn lane at I-90 ramp intersections
- Consider an alternate interchange design

LOR-83, Avon, OH

Signal Timing Outcomes:

SR-83 Arterial LOS Improvements (Synchro)			
Analysis Period	Expected Change in Travel Time		
	Northbound	Southbound	Overall
AM Peak	-9.5%	-5.8%	-7.9%
Day Off-Peak	4.0%	-18.6%	-8.6%
Mid-Day Peak	-9.5%	-14.7%	-12.1%
PM Peak	-6.5%	-12.5%	-9.6%
Weekend	-7.4%	-12.7%	-9.8%

LOR-83, Avon, OH

Signal Timing Outcomes:

SR-83 Travel Time Improvements (Actual)		
Time Period	Direction	Average Travel Time Reduction
AM Peak	Northbound	2”
	Southbound	-49”
Day Off- Peak	Northbound	-27”
	Southbound	-34”
Mid-Day Peak	Northbound	-52”
	Southbound	-64”
PM Peak	Northbound	-23”
	Southbound	82”

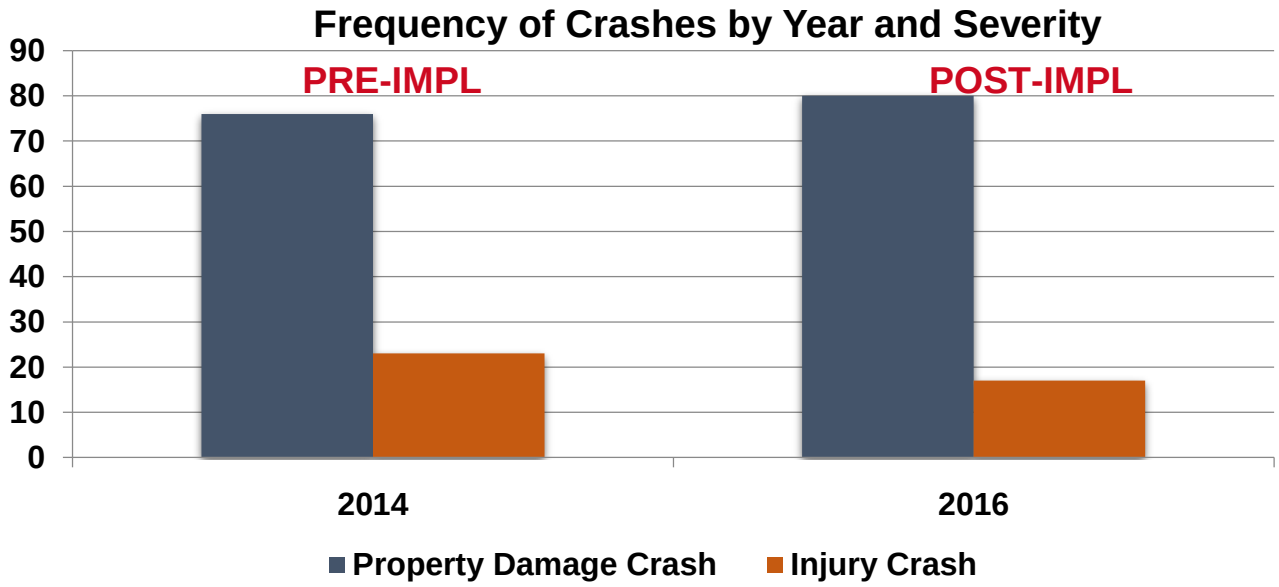
LOR-83, Avon, OH

2014 Pre-Implementation

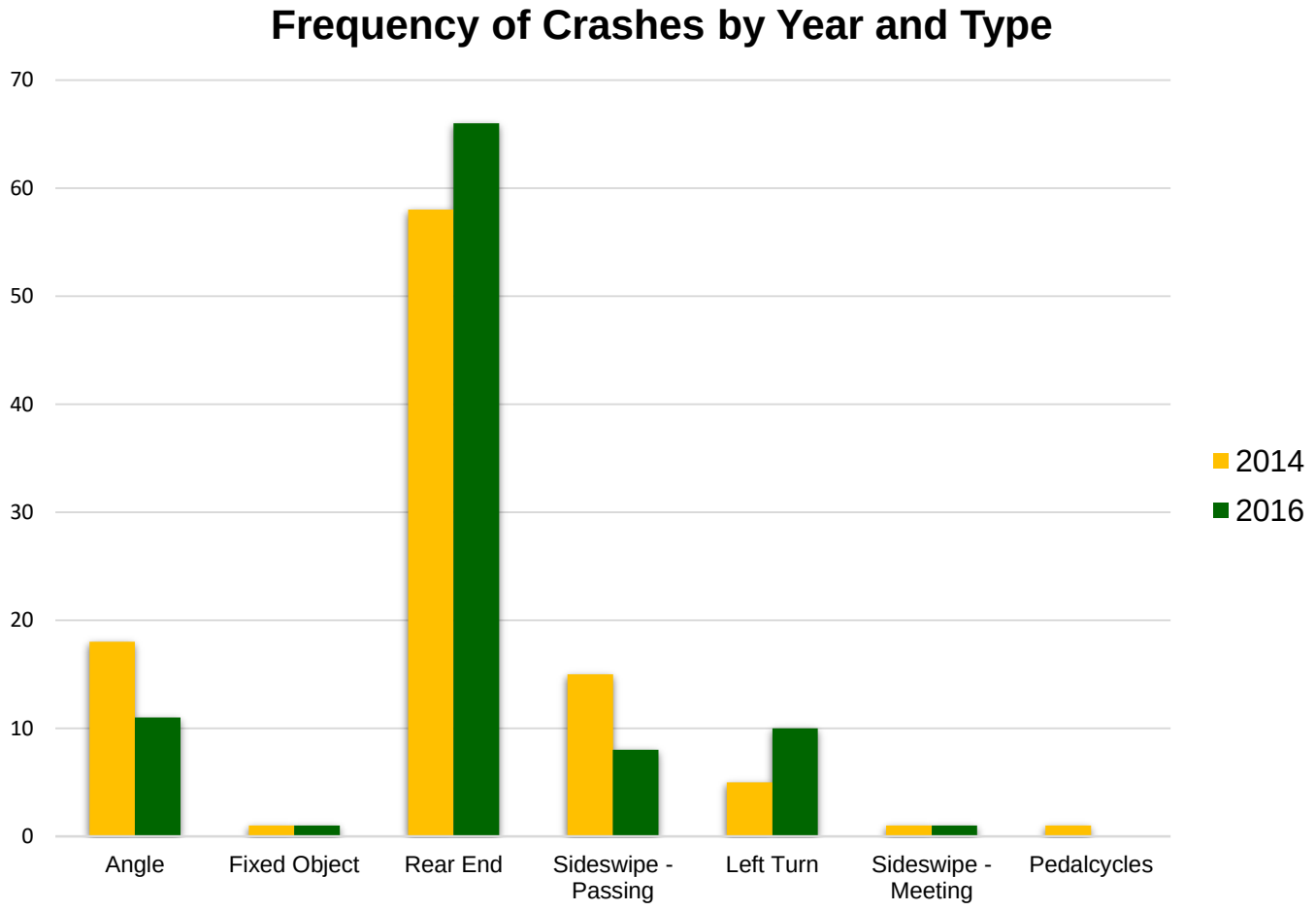
- 99 crashes
- 23 Injury, 76 PDO

2016 Post-Implementation

- 97 crashes
- 17 Injury, 80 PDO



LOR-83, Avon, OH

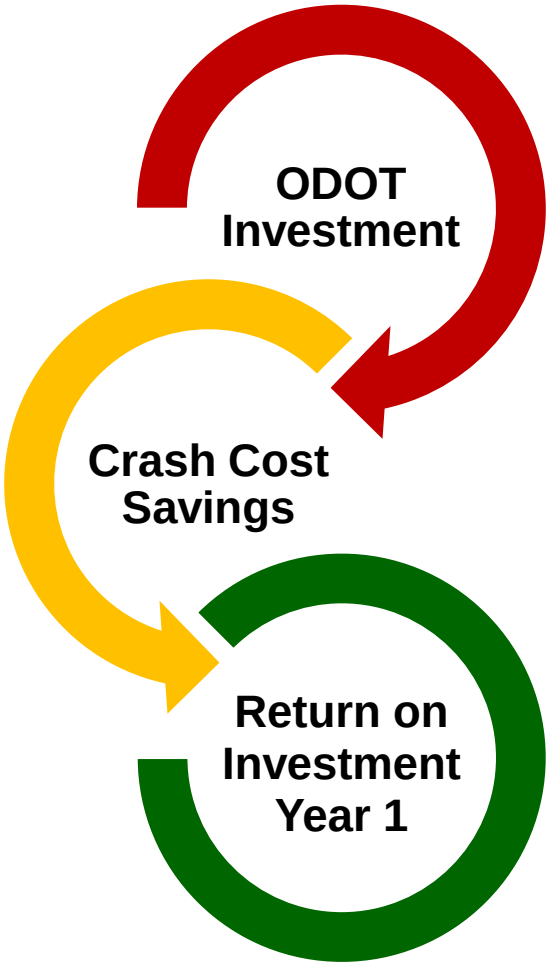


LOR-83, Avon, OH

	2014			2016		
CRASH TYPE	# OF CRASHES	COST PER CRASH	TOTAL COST	# OF CRASHES	COST PER CRASH	TOTAL COST
INJURY	23	55,700	1,281,100	17	57,000	969,000
PDO	76	8,500	646,100	80	8,700	696,000
TOTALS	99		1,927,100	97		1,665,000

CRASH REDUCTION = 2
COST SAVINGS = $262,100

LOR-83, Avon, OH

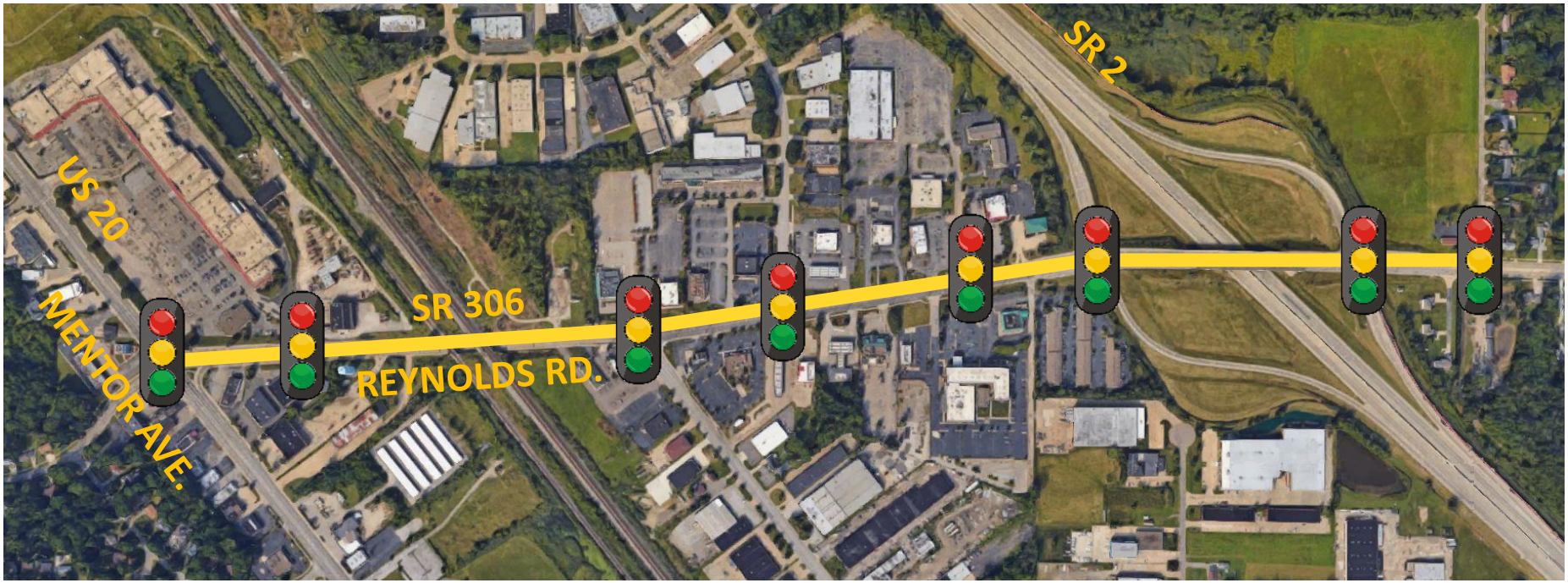


$27,152

$262,100

10:1

LAK-306, Mentor, OH



LAK-306, Mentor, OH

Corridor Issues:

- Highly commercial corridor
- Connectivity to major highway (SR 2)
- ADT = 35,000 vpd
- Significant queuing – especially northbound

LAK-306, Mentor, OH

DGL Recommendations:

- Phasing changes
- Timing changes
- Extend timing for protected lefts

Additional Recommendations:

- Look at timing changes at additional intersections
- Extend Phase Splits if queuing continues

LAK-306, Mentor, OH

Signal Timing Outcomes:

SR-306 Arterial LOS Improvements (Synchro)			
Analysis Period	Expected Change in Travel Time		
	Northbound	Southbound	Overall
AM Peak	-8.2%	4.1%	-1.6%
Day Off-Peak	-4.5%	-2.9%	-3.7%
Mid-Day Peak	-5.9%	-9.2%	-7.5%
PM Peak	-24.4%	-1.5%	-15.3%
Night Off-Peak	-2.1%	-1.3%	-1.7%
Weekend	0.9%	-9.3%	-4.2%

LAK-306, Mentor, OH

Signal Timing Outcomes:

SR-306 Travel Time Improvements (Actual)		
Time Period	Direction	Average Travel Time Reduction
AM Peak	Northbound	-30.8%
	Southbound	-37.9%
Day Off- Peak	Northbound	-27.5%
	Southbound	-15.3%
Mid-Day Peak	Northbound	-24.1%
	Southbound	-30.8%
PM Peak	Northbound	-37.4%
	Southbound	-12.9%
Weekend	Northbound	-18.2%
	Southbound	-20.6%

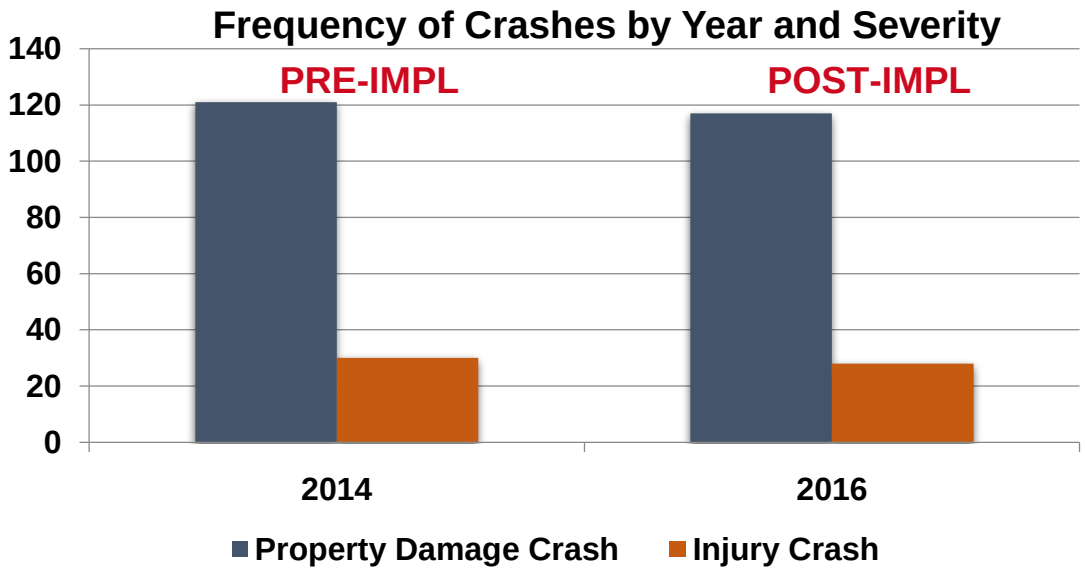
LAK-306, Mentor, OH

2014 Pre-Implementation

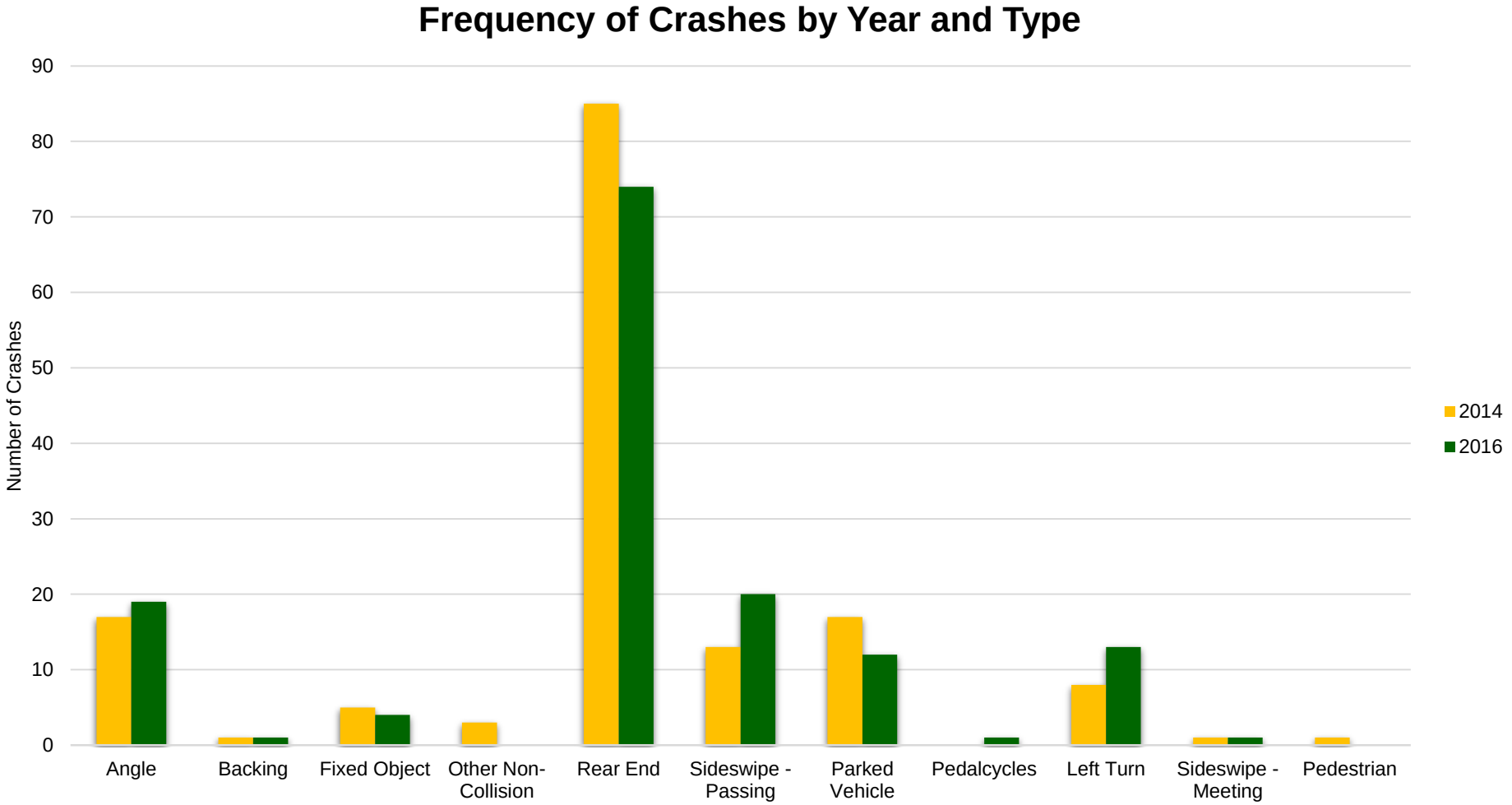
- 151 crashes
- 30 Injury, 121 PDO

2016 Post-Implementation

- 145 crashes
- 28 Injury, 117 PDO



LAK-306, Mentor, OH

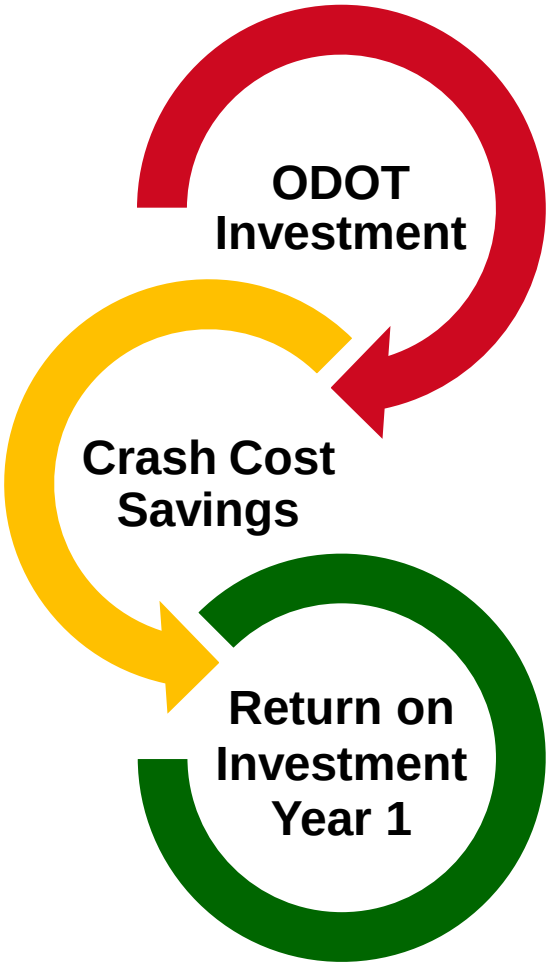


LAK-306, Mentor, OH

	2014			2016		
CRASH TYPE	# OF CRASHES	COST PER CRASH	TOTAL COST	# OF CRASHES	COST PER CRASH	TOTAL COST
INJURY	30	55,700	1,671,000	28	57,000	1,596,000
PDO	121	8,500	1,028,500	117	8,700	1,017,900
TOTALS	151		2,699,500	145		2,613,900

CRASH REDUCTION = 6
COST SAVINGS = $55,600

LAK-306, Mentor, OH



$43,873

$55,600

1.25:1

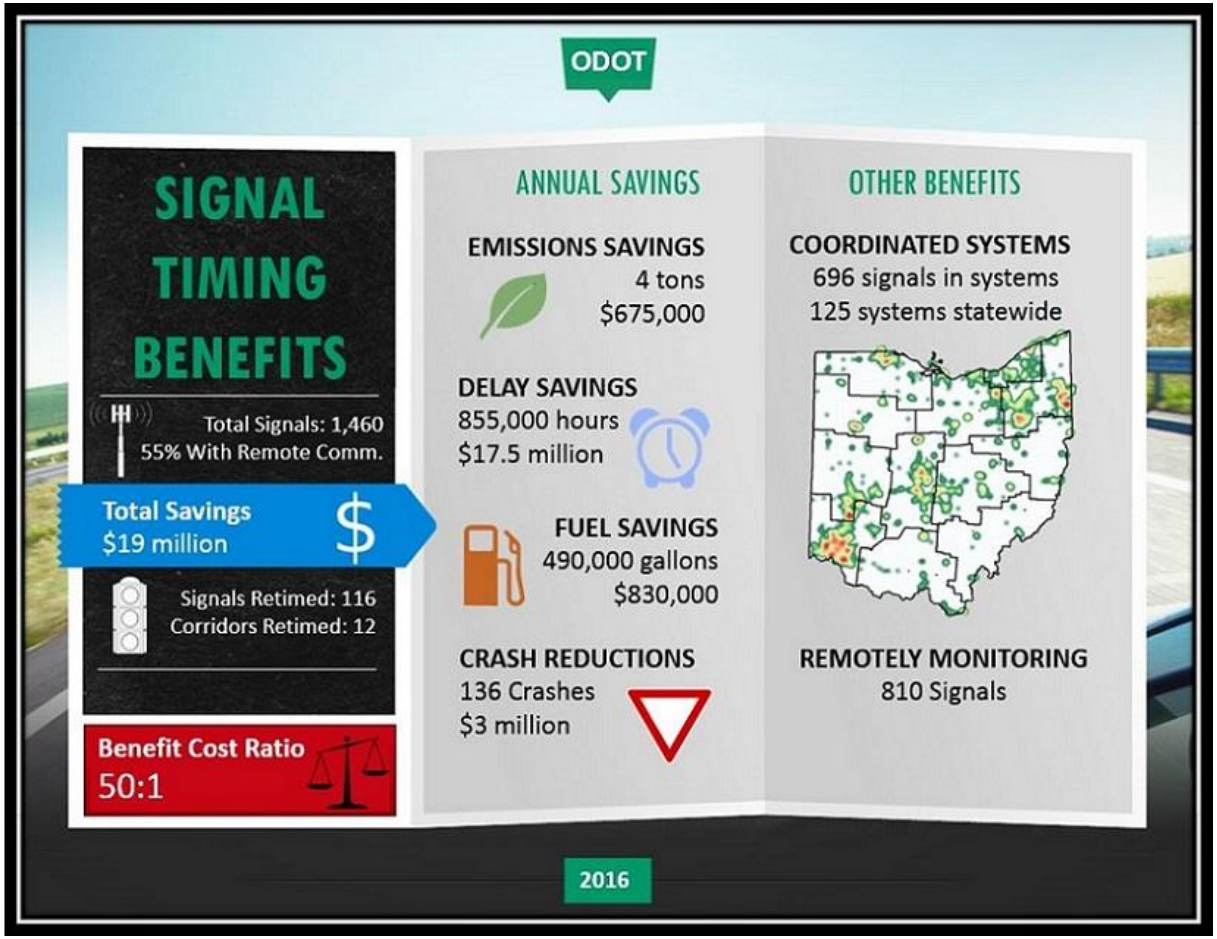
Results

Takeaway

Signal Timing Projects Benefits:

- Travel Speed Approaches Posted Speed
- Far Less Travel Time
- Far Fewer Stops

Takeaway



Source: ODOT Office of Traffic Operations (2016)

Conclusion


TRAFFIC
planning
technology
vehicles
System
efficient
signal
SAFETY
travel
controller
pedestrians
peak
intelligent
management
motorcycles
Timing
interconnected
transportation
threshold
bicycles
demand
sensors
intersections
capacity